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Propagation of capillary ripples at fluid/fluid interfaces

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PROPAGATION OF CAPILLARY RIPPLES AT FLUID/FLUID INTERFACES

by

Raymond Lee Bendure

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In Charge of Major Work

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Dean of Graduate College

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INTRODUCTION

Capillary ripples on liquids are distinguished from waves on the basis of their driving force and wave length. The more familiar waves have gravitational acceleration (gravitational head) as their principal restoring stress and have longer wave length. The pressure drop across curved interfaces due to surface tension provides the principal restoring stress for the shorter wave length ripples. One centimeter is usually taken as the rather arbitrary division between ripples and waves (29).

The effects of ripple propagation have been of interest for many years (9-12, 15-18, 51), but the subject has had a recent increase in popularity. This Laboratory has been active in extensions of the theory of capillary ripple propagation for the past ten years (3, 20-22, 37). Experimental verification of theory was attempted by J. Mann (40, 41) using apparatus which consists essentially of a wire lying in the interface which can be driven vertically by a loudspeaker connected to an audio oscillator. A second wire lying parallel to the first is connected to a phonograph crystal cartridge to provide a method of transducing the mechanical wave formed by the first wire into an electrical signal at the second wire. This second wire can be moved closer to the first wire. By observing the wave at various separations between the two wires, it is possible to determine the wave length and rate of damping. When these data are combined with other parameters, it is possible to compare the experimental nature of the wave with the theoretical calculations. The technique is most useful when the nature of the surface of the liquid is altered by additions of surface active chemicals.

While this experiment is quite simple conceptually, it is considerably more difficult in practice. Mann devised and constructed the somewhat involved instrumentation required for experimental measurement of wave properties (40). Moreover, he did extensive work demonstrating the validity of the techniques. These methods were applied to several surfactant systems at air/water surfaces (41). Although these results did not confirm the theory due to lack of necessary accuracy, they were sufficiently encouraging to continue the investigation.

S. Grossman made extensive measurements on carboxylic acids (19). He was followed by J. Lucassen on sabbatical leave from Unilever in Holland. Lucassen was concerned with air/water waves as modified by the presence of insoluble and sparingly soluble surfactants (22, 37). This study was the first to lend real support to the ripple propagation theory. Once again lack of suitable precision prohibited detailed confirmation of theoretical predictions.

The purpose of this work is to confirm the theoretical predictions with better experimental reliability. Moreover, it is desired to extend the experimental methods which have been so successful at air/water interfaces to the more complicated oil/water interfaces. Oils in surface chemistry refer to non polar liquids such as hydrocarbons. Interfacial data will be used to check the validity of ripple propagation theory for liquid/liquid systems.

Ripple propagation at air/water interfaces involves parameters which are believed to be important in foam stability theories (50). The surface may be considered to act like an elastic membrane. The magnitude of the strain in this membrane for a given stress is a function of an elastic modulus. If stress and strain are in phase in periodic motion the elastic modulus is real, but if there is a time delay, as would be expected if some relaxation process occurs in the film, the elastic modulus is a complex number with real and imaginary components (3, 20). In this experiment, the membrane is formed by surfactant molecules localized to the interface between the upper and lower fluids.

Similarly, propagation at oil/water interfaces should lead to information pertinent to emulsion stability studies.

Historical background and considerably more involved discussion of the work in this Laboratory are contained in the references from this Laboratory.

THEORY

The theory of capillary ripple propagation has received considerable attention in the past several years, much of it from this Laboratory (5, 13, 16, 17, 20-25, 27, 28, 33, 34, 43, 45, 46, 47-49, 52). As this material is published elsewhere, only the features that are of importance to this study will be discussed.

The theory of capillary waves is based on continuum hydrodynamics. The motion of a fluid is described by the Navier-Stokes equation, obtained by application of Newton's Laws of Motion to a fluid (31). Balances of normal and tangential stresses at the interface furnish boundary conditions which must be satisfied by physically significant solutions of the Navier-Stokes equation; surface properties enter the theory through these boundary conditions. The Navier Stokes equation is non-linear, but can be developed in power series in the ratio of ripple amplitude to wave length. If this ratio is sufficiently small only terms in first power of this ratio need be considered; the linearized Navier Stokes equation results, and the corresponding boundary value problem has been solved (35).

If experiments are to be compared with predictions obtained by solution of the linearized boundary value problem, the experiments must be so designed that the amplitude to wave length ratio is in fact small. Since wave amplitudes are of the order of a micron and wave lengths are of the order of a millimeter, this parameter is about .001. As the wave progresses from the sending probe, its amplitude will decrease but its wave length will not. Hence the amplitude to wave length ratio decreases as the distance from the generator is increased. Performing experiments at larger separations will lead to acceptably small ratios.

The ripple has the equation (20)

$$A = A_o e^{-\alpha x} e^{i(\omega t - kx)}$$

where A is the amplitude and A_o the amplitude at zero distance, x = 0. This is an oscillating wave with exponential damping. Alpha is the damping coefficient expressed in reciprocal centimeters while x is the distance from the source of the wave in cm. The wave is formed by causing a wire lying in the interface to oscillate while a second wire parallel to this one and separated by a distance x is used to detect the ripple. This second wire, the sensor, is attached to a phonograph cartridge which transduces mechanical motion into an electrical signal. A standing wave pattern is set up between these two wires (40).

Movement of the sensor relative to the first wire, the generator, permits determination of the wave length and damping coefficient. The wave length is obtained by observing the distance between two crests of the wave and the damping coefficient is determined by observing the decrease in wave amplitude with distance.

Ten variables are involved in the ripple propagation theory. These include the viscosities of the upper and lower phases, μ', μ (poises), the densities of the upper and lower phases, ρ, ρ' (g/cm^3), the frequency of the wave, υ (HZ), or, equivalently the cyclic frequency, ω ($\omega = 2\pi\upsilon$), the interfacial tension, γ (dynes/cm), the wave length, λ (cm), or equivalently the wave number, k ($k = 2\pi/\lambda$), the damping coefficient, α (cm^{-1}), the real component of the complex elastic modulus, E' (dynes/cm), and the imaginary component of the complex elastic modulus, E" (dynes/cm).

There are two dimensionless groups of these variables which prove convenient for theoretical discussion and for display of experimental results. Y1 is the Kelvin function defined as

$$Y1 = \frac{(\rho + \rho')\omega^2}{\gamma k^3}$$

and Y2 a dimensionless damping coefficient defined as

$$Y2 = \alpha/k$$

If energy dissipation in the ripple propagation is neglected, it can be shown that Y1 will equal unity and Y2 will be zero. When energy dissipation is considered, Y1 and Y2 become functions of the nature of the interface. The elasticity components, E' and E", determine this dependence.

Theory predicts that both Y1 and Y2 should show limiting behavior when the complex elastic modulus approaches zero and also when it approaches infinity. Between these two limiting forms the Y1 and Y2 curves exhibit behavior which depends on the relationship of E' and E" and on the values of the viscosities and densities of the bulk phases. One of the most surprising results of theoretical calculations for the air/water interface was the prediction of maxima in the Y1 and Y2 curves at intermediate elasticities (20).

It turns out that the region of intermediate elasticities where the maxima are expected is somewhat difficult to study experimentally. This is the result of the method in which experiments must be performed. Ideally only the elasticity, E = E' - iE", would be varied during the course of an experiment. The changes in ripple wave length and damping coefficient caused by these elasticity changes would lead to changes in values of Y1 and Y2. However, since the interface corresponds to a monolayer of surfactant molecules rather than an elastic membrane, its properties must be altered by changing the surface concentration of surfactant. Changing the concentration of surfactant will also change the surface tension. The rate of change of surface tension with surface concentration is a primary contributor to the elasticity, and this rate of change of surface tension can be quite rapid for many surfactants (37). Consequently, the elasticity changes extremely rapidly for very minor changes in surface concentration. The net result is that the Y1 and Y2 functions jump from their zero elasticity values to their infinite elasticity values almost completely skipping through the intermediate ranges where the maxima are predicted.

Early theoretical work for air/water systems resulted in two plots for Y1 and Y2 as a function of elasticity. These expected results are shown in the Appendix in Figure 1 and 2. Theory was extended to allow for non zero viscosity and density in the upper phase. Details of this extension are being published (22). The result of the calculation is that the ten principal variables can be related by one complex equation. This equation (42) takes the form

$$F = \sum_{j=1}^{5} C_j \ (k + i\alpha)^j = 0 \ .$$

The C_j are complex coefficients which involve all eight variables except k and α. Since a complex equation implies the existence of two real equations, two of the ten variables are dependent upon the remaining eight independent ones. Any two variables may be chosen as dependent, however, the equation may not be solved with equal ease for different choices.

For theoretical work, it is useful to choose k and α as the dependent variables. This choice allows comparison of theory with an experiment which will measure k and α. Generation of these theoretical plots requires statement of frequency, interfacial tension, E', E", and the viscosities and densities. The bulk phase viscosities and densities are easily assigned with adequate precision, but treatment of the remaining four independent variables for theoretical curve calculation is somewhat arbitrary. Frequency may be assumed to be constant. Assumption of an equation of state allows calculation of interfacial tension and E' as functions of surface coverage. E" must be varied arbitrarily. This kind of calculation corresponds most closely to a variable L, constant frequency experiment (40, 41).

Constant k experiments (3) are somewhat more difficult to model theoretically. This and other model building efforts are under active investigation in the field of capillary ripple propagation (36, 42, 46). Figures 3 and 4 show some theoretically expected constant frequency results for oil/water interfaces.

Several observations may be made relating the air/water and oil/water results. Both systems exhibit limiting cases for both elasticity extremes, however, the differences between low elasticity and high elasticity limits of Y1 and Y2 are much less for oil/water systems than for air/water systems. Both Y1 and Y2 exhibit pronounced maxima at intermediate elasticities for air/water systems, but these are almost absent at oil/water systems.

The existence of maxima in Y1 and Y2 plots has been of considerable interest in the capillary ripple field. It turns out that the height and even the existence of the maxima depend on the difference between upper and lower phase viscosity and density. It is also a function of the equation of state used in the calculation. Lucassen has been investigating this feature for air/water systems (36).

Theoretical plots for oil/water interfaces were prepared using a programmed calculation for the roots of the F equation which was prepared by Mann (41). Note in Figures 3 and 4 that the frequency shifts the curves vertically, but has little effect on curve shape. A slight Y1 maximum can be seen for heptane/water systems but not for nonane/water systems. Moreover, the Y2 curves differ appreciably for these two cases. As the upper phase density and viscosity approach the lower phase values the difference between the low and high elasticity limits decreases.

EXPERIMENTAL

Materials

The purity of chemical compounds is always of concern, but surface chemistry research is particularly subject to errors of contamination. The experimental techniques are designed to minimize the chances for accidental contamination and to provide for cleaning operations. Furthermore, particular attention must be paid to the type of contamination as discussed in standard works in surface chemistry (1, 11, 14, 23).

The serious impurities are those which interfere with the surface properties being studied. The bulk properties of density, viscosity, and solvency are not greatly affected by the small contamination which is possible. Substances altering the surface tension of an interface, however, must be scrupulously avoided. Surfactants are the prime source of this difficulty. One must be careful to avoid substances which can interact with surfactants which have deliberately been added. Thus multivalent ions can alter the monolayer behavior of oppositely charged surfactants (1). The natural organic substances present on skin are often very effective surfactants, thus contact with the experimental materials must be avoided.

Surface properties depend on the total amount of surface active material in the interface. Thus a small impurity in the surfactant which is intentionally added is considerably less important than a similar fraction in one of the bulk phases. Water is particularly subject to surfactant contamination; hydrocarbons are somewhat less critical because of their lower surface tension.

Reagent grade zinc chloride, sodium chloride, potassium bromide, and sodium sulfate were used as received from Baker.

Fisher reagent grade glycerol was used as received.

The water used in these experiments was distilled water available from the taps of the Chemistry Building which had been further purified. A block tin still located in the Physical Chemistry Laboratories (113 Chemistry) was charged with roughly 200 grams of potassium permanganate and 200 grams of sodium hydroxide (both Mallinckrodt reagent grade) along with sufficient tap distilled water to fill it. This steam heated still was operated for at least half an hour before collecting any distillate. Water was collected in two gallon polyethylene bottles which had been cleaned with alcoholic potassium hydroxide and cleaning solution (potassium dichromate dissolved in concentrated sulfuric acid). This permanganate water was used as feed to a two stage all quartz still (model BI-16 available from Amersil Quartz Division of Englehard Industries, Inc., Hillside, New Jersey). After at least 30 minutes of operation, the distillate was collected in cleaned polyethylene bottles and used within three days of preparation.

The hydrocarbons were distilled from a three liter standard taper glass still with a Vigreaux column and only the middle cut saved. The distillate was collected in cleaned glassware with ground glass stoppers. Again the substances were used as near to the distillation time as possible; the heptane used for the majority of the two phase experiments was distilled within an hour of its use. Petroleum ether feed was 30°-60° Baker and Adamson brand; hexane was Malinckrodt; Phillips heptane, octane, and nonane were used.

Most of the surfactants had been purified before use. The ethanol used by the author for recrystallizations was distilled on a 30 plate Oldershaw column. Glassware and fritted glass funnels used in the recrystallization were cleaned with both alcoholic KOH and cleaning solution before use. The crystals were repeatedly washed with portions of the solvent and then placed in cleaned ground glass stoppered bottles and placed in a dessicator to dry. This dessicator was evacuated with a water aspirator and calcium sulfate (Drierite) completed the drying. The accompanying table lists the surfactants, their molecular structure, a code name, and the purification procedure.

Table 1. Surfactants studied

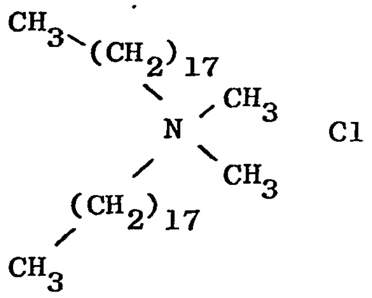
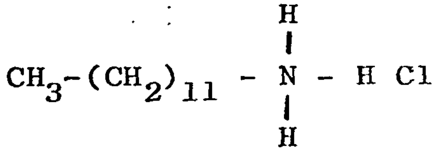
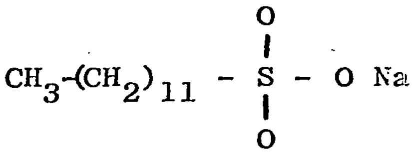
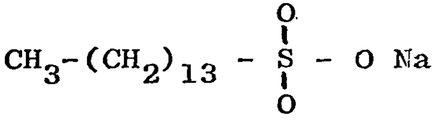
Compounds	Code	Structure	Purification
Distearyldimethyl ammonium chloride	DDAC		Recrystallized from ethanol (ETOH) by J. Lucassen
Hexadecanol	HXDOL	$CH_3-(CH_2)_{15}-OH$	As received from Calbiochem
Tetradecanol (used at air/water)	TDOL	$CH_3-(CH_2)_{13}-OH$	Recryst. from ETOH by J. Lucassen
Laurylammine hydrochloride	LAMHCL	 $CH_3-(CH_2)_{11}-\overset{H}{\underset{H}{N}}-H\,Cl$	Recryst. from ETOH by J. Lucassen
Sodium dodecyl sulfonate	NAC12SO3	 $CH_3-(CH_2)_{11}-\overset{O}{\underset{O}{S}}-O\,Na$	Recryst. from ETOH
Sodium tetradecyl sulfonate	NAC14SO3	 $CH_3-(CH_2)_{13}-\overset{O}{\underset{O}{S}}-O\,Na$	Recryst. from ETOH

Table 1. (Continued)

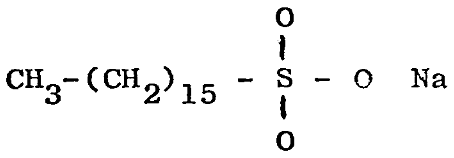
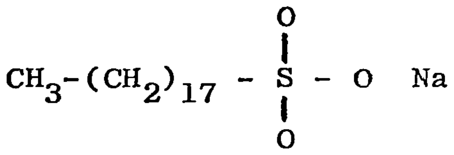
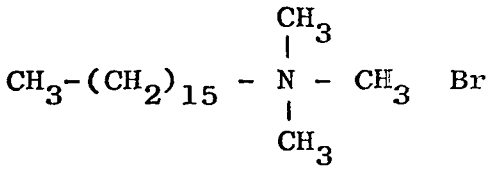
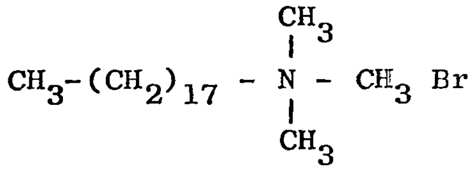
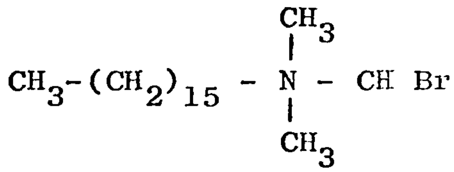
Compounds	Code	Structure	Purification
Sodium hexadecyl sulfonate	NAC16SO3	 $CH_3-(CH_2)_{15}-\overset{O}{\underset{O}{S}}-O\ Na$	Recryst. from ETOH
Sodium octadecyl sulfonate	NAC18SO3	 $CH_3-(CH_2)_{17}-\overset{O}{\underset{O}{S}}-O\ Na$	Recryst. from ETOH
Hexadecyltrimethyl ammonium bromide	CTAB	 $CH_3-(CH_2)_{15}-\overset{CH_3}{\underset{CH_3}{N}}-CH_3\ Br$	Recryst. from ETOH
Octadecyltrimethyl ammonium bromide	OTAB	 $CH_3-(CH_2)_{17}-\overset{CH_3}{\underset{CH_3}{N}}-CH_3\ Br$	Recryst. from ETOH
Eicosyltrimethyl ammonium bromide	ATAB	 $CH_3-(CH_2)_{15}-\overset{CH_3}{\underset{CH_3}{N}}-CH\ Br$	Recryst. from ETOH

Table 1. (Continued)

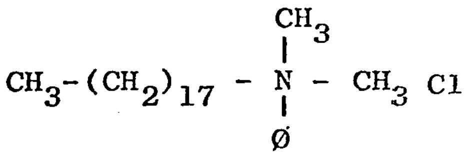
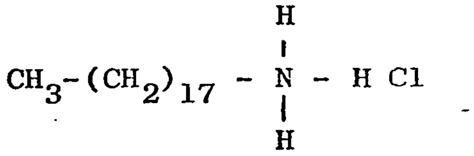
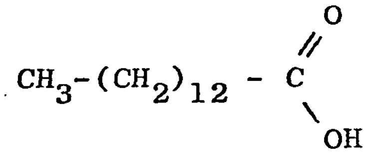
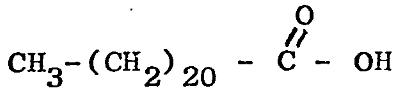
Compounds	Code	Structure	Purification
Dimethylstearylbenzyl ammonium chloride	DMSBAC	 $CH_3-(CH_2)_{17}-\overset{CH_3}{\underset{\O}{N}}-CH_3\ Cl$	Recryst. from ETOH
Octadecyltrimethyl ammonium chloride	C18NH3CL	 $CH_3-(CH_2)_{17}-\overset{H}{\underset{H}{N}}-H\ Cl$	Recryst. from ETOH
Tetradecanoic acid	C14OOH	 $CH_3-(CH_2)_{12}-\overset{O}{\overset{\|}{C}}-OH$	Recryst. from ETOH
Docosanoic acid	C22OOH	 $CH_3-(CH_2)_{20}-\overset{O}{\overset{\|}{C}}-OH$	Recryst. from ETOH
Hexanol	C6OH	$CH_3-(CH_2)_5-OH$	Distilled before use
Decanol	C10OH	$CH_3-(CH_2)_9-OH$	Distilled before use
Tetradecanol	C14OH	$CH_3-(CH_2)_{13}-OH$	Recryst. from ETOH
Eicosanol	C20OH	$CH_3-(CH_2)_{19}-OH$	Recryst. from ETOH

Table 1. (Continued)

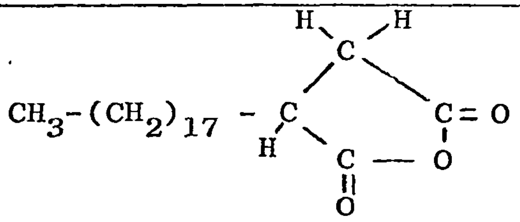
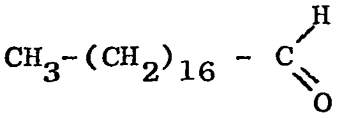
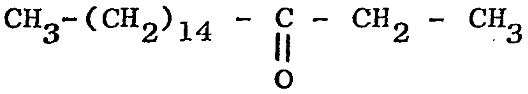
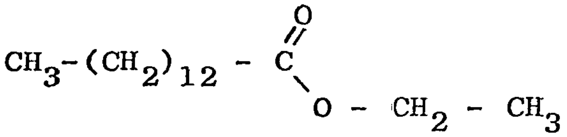
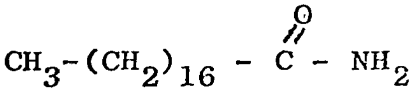
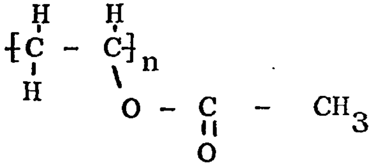
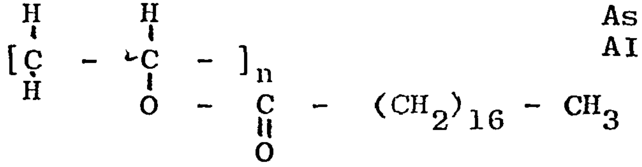
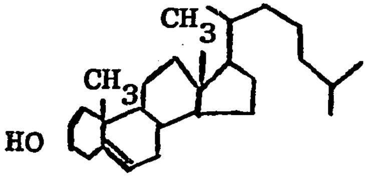
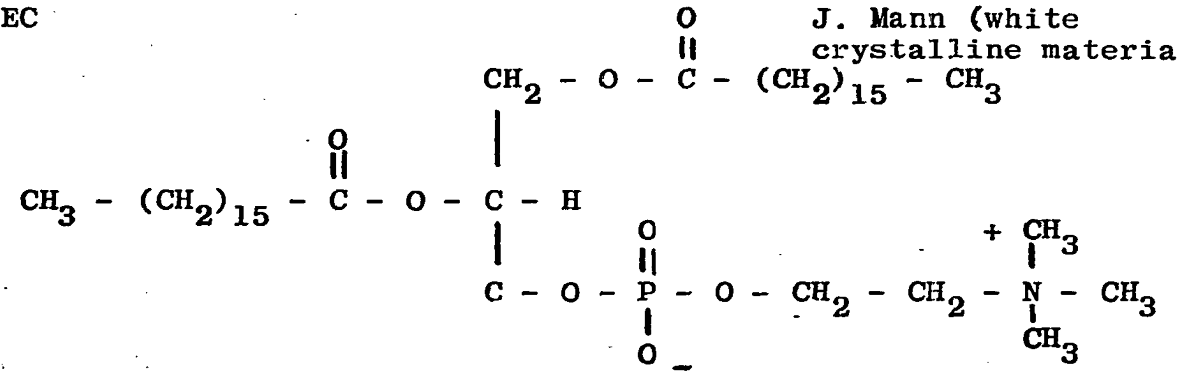
Compounds	Code	Structure	Purification
Octadecylsuccinic anyhydride	C18SCAHD		Recryst. from ETOH
Octadecyl aldehyde	C18ALD	 $CH_3-(CH_2)_{16}-C(H)=O$	Recryst. from ETOH
3-octadecanone	C18-3ONE	 $CH_3-(CH_2)_{14}-\underset{\underset{O}{\|}}{C}-CH_2-CH_3$	Recryst. from ETOH
Octadecyl acetate	C18OOET	 $CH_3-(CH_2)_{12}-\overset{\overset{O}{/\!/}}{C}-O-CH_2-CH_3$	Recryst. from ETOH
Octadecyl amide	C18AMD	 $CH_3-(CH_2)_{16}-\overset{\overset{O}{/\!/}}{C}-NH_2$	Recryst. from ETOH
Polyvinyl acetate	PVACE	 $\left[\underset{H}{\overset{H}{C}}-\underset{O-\underset{\underset{O}{\|}}{C}-CH_3}{\overset{H}{C}}\right]_n$	As received from City Chemical, N. Y.
Polyvinyl stearate	PVSTE	 $\left[\underset{H}{\overset{H}{C}}-\underset{O-\underset{\underset{O}{\|}}{C}-(CH_2)_{16}-CH_3}{\overset{H}{C}}-\right]_n$	As received from AIRCO

Table 1. (Continued)

Compounds	Code	Structure	Purification
Cholesterol (44)	CHOL		As received from J. Mann (white crystalline material)
Lecithin (26)	LEC	 $\begin{array}{l} CH_2-O-\overset{O}{\overset{\|}{C}}-(CH_2)_{15}-CH_3 \\ \quad\vert \\ CH_3-(CH_2)_{15}-\overset{O}{\overset{\|}{C}}-O-C-H \\ \quad\vert \\ C-O-\underset{O^-}{\underset{\vert}{\overset{O}{\overset{\|}{P}}}}-O-CH_2-CH_2-\underset{CH_3}{\underset{\vert}{\overset{+\,CH_3}{\overset{\vert}{N}}}}-CH_3 \end{array}$	As received from J. Mann (white crystalline material)

Surfactant Handling

Insoluble surfactants

Most of the compounds studied at the air/water interface were highly insoluble in water, thus they formed typical monolayers. Use of this fact was made both for ease of film handling and for surface tension determination. A Cenco film balance was used for the earlier water/air work, while the automatic recording film balance first constructed by J. Mann was resurrected for later work (38, 39).

A film balance consists of a shallow trough which has been made hydrophobic, a movable barrier which slides down the length of the trough, and a confining barrier or float. The float is attached to a torsion wire via a rigid tongue, while a pointer indicates the null position of this torsion wire. In practice a small amount of surfactant is placed on the surface of the balance in the large area between the compression barrier and the float, leaving the surface of water behind the float and the surface of water behind the barrier free of surfactant. The surface tension is lower on the surfactant side of the float than on the clean side, hence a pull is exerted towards the clean surface. This is traditionally called the "pressure" due to the surfactant.

$$\pi = \gamma_0 - \gamma$$

where π is the surface pressure, γ_0 the pure water surface tension, and γ the surfactant covered water surface tension.

all in dynes/cm (1, 11, 14, 23).

The surfactant was weighed and dissolved in a known volume of distilled spreading solvent. Freshly distilled 40-50° petroleum ether was the usual solvent, but occasionally a few drops of ethanol were required to induce solubility.

The trough was filled with 4X water and the surface was cleaned by sweeping with a barrier and sucking off the water and contamination with an aspirator and fine tipped tube. The surfactant was now spread on the surface between the probes by squirting small increments of spreading solution from a 250 microliter syringe equipped with an adapter which moved the plunger 1/50 of its range at a time. The tip of the syringe was held close to the surface and at a slight angle to it while a five microliter increment was squeezed out. The tip was moved to another part of the surface and the process repeated until the desired amount of solution was on the surface. The volatile solvent escaped leaving the surfactant molecules spread at the interface. It was necessary to spread surfactant at a concentration which corresponded to the low elasticity region at the maximum barrier separation and to the high elasticity region for the minimum barrier separation. Some experience was needed to realize this requirement, but adding enough surfactant to allow each molecule three times its close packed area was a good first guess.

After some time was allowed for solvent evaporation and monolayer equilibration, it was possible to proceed with the ripple experiment. After one set of ripple data was taken, the compression barrier was advanced so that the area available for the monolayer was reduced. Another set of data could be taken and the monolayer could be further compressed as desired. At each compression the surface pressure was measured so that the surface tension of the surfactant covered system could be calculated.

This particular method of procedure was convenient because surface tensions were easily obtained and the surfactant coverage required for any desired elasticity was quickly attained by moving the compression barrier. If the monolayer was reversible, it was even possible to lower the surface coverage if too large a compression increment was made

The compression barrier technique was so successful for air/water work that a similar method for oil/water systems was sought. The Cenco film balance could not be readily converted to an interfacial film balance.

Blight (4) has described a rather elaborate interfacial compression barrier requiring considerable machine shop fabrication. A simplified version of this device was prepared in the following way. A glass frame about 7 x 10 x 3 inches was constructed. A 2 1/2 x 7 inch rectangle of glass rod had glass tubes mounted parallel to the length of the frame fused on the sides; thus the rectangle could slide back and forth on the frame. A continuous strip of Teflon film (1 inch wide, 5 mil thick) was placed around the rectangle and one end of the frame. A wind-up crank on the movable rectangle served to keep the film tightly against the glass supports. This assembly was placed inside a plastic dish pan. Water came about half way up the Teflon and heptane covered the upper portion, while the surfactant was placed at the interface inside the square of ribbon along with the ripple apparatus. After taking a data point the area available to the surfactant was reduced by winding up some of the ribbon and hence pulling the rectangle closer to the end of the frame.

This prototype worked reasonably well, allowing free flow of upper and lower phases over and under the ribbon. It was difficult to maintain ribbon tension throughout the compression area, prevent surfactant loss on ribbon wind-up, and find a spreadable surfactant which was truly insoluble in both water and heptane.

Soluble surfactants

Air/water or oil/water systems in which the surfactant is soluble in the water phase could be easily handled. The surfactant was dissolved in water to make a concentrated solution. After each ripple data point, a volume of liquid was removed from the ripple tank. The desired volume of concentrated surfactant was diluted with pure lower phase fluid and the same volume of fluid that had been removed was now returned. The aliquot that had been removed could be saved for interfacial tension determination if an independent method was being used. Surfactant was added to a 25 ml volumetric flask from a buret and then diluted to volume from a separate supply of pure solvent. A 15 ml portion of this was then returned to the ripple tank after 15 ml of solution had been removed.

Thorough mixing of the solution in the trough was assured by use of a water-driven magnetic stirrer. The Teflon coated magnetic bar lay entirely within the lower phase, while the magnetic water-powered wheel was below the dish containing both phases. A G. Frederick Smith stirrer was used because it was only 3/4 inch thick and could be slipped under the ripple dish which had been elevated on rubber stoppers. The water pressure had to be increased to start agitation and then reduced to maintain a sufficiently slow rate of stirring; if this was not done, it was possible to throw solution out of the trough from violent action. Additional force was required to start the stirring motion due to static friction.

Surfactants which were not sufficiently soluble in the lower phase could be dissolved in spreading solvents and injected into the interface. Distilled ethanol was useful because it dissolved most of the long chain surfactants rather well. Ethanol spread at the oil/water interface dragging in the surfactant with it, but the alcohol was quite soluble in both phases and rapidly diffused out of the interface, leaving the surfactant at the interface (11). Surfactant solution was injected just above the interface since the density of the solvent was between that of the bulk phases so that gravity would favor location of the surfactant at the interface. Since the surfactant was not necessarily insoluble in the bulk phases, this technique did not permit determination of the molecular areas. In fact, most of the surfactants examined had appreciable oil phase solubility and several had slight aqueous phase solubility. Solubility of surfactant in either phase would lead to eventual diffusion out of the interface. It was possible to study surfactant with solubility sufficiently low that no appreciable depletion of the surface concentration occurred during the time required for data acquisition. After each ripple data set was taken, further injections of surfactant could be made.

Interfacial Tension

One of the most difficult phases of this project has been the determination of interfacial tensions with suitable accuracy. Several methods have been employed including film balances, Wilhelmy plates, and drop volumes (1,11,14,23).

Air/water systems with insoluble surfactants were readily studied with capillary ripple techniques since they were easy to handle and their surface tension was readily calculated from easily measured surface pressures and assumed pure system surface tensions. The previously described Cenco Hydrophil Film Balance was modified to improve the accuracy of surface pressure measurements.

The film balance was cleaned and coated with paraffin while the float and torsion head were removed. Coating was performed by heating the metal trough with heat lamps, pouring excess wax into it, and then spreading the paraffin by tilting the trough until all surfaces were covered. Excess wax was poured off and the heat sources removed.

The torsion head was repaired several times. The torsion wire supplied by Cenco was too large for adequate sensitivity, so a .008 inch diameter piano wire was substituted. The change in diameter made adequate clamping difficult. Clamping was achieved by means of two plates held together with two screws. A groove in the middle of the plates fit around the wire. The plates were flattened and filed down to reduce the size of the groove. New brass screws were obtained, as it appeared that the original aluminum ones were slipping.

A Shick razor blade was chipped by holding it in a vise and tapping carefully with a hammer until its dimensions were about 5 by 8 mm, as an oval hole in this blade was just the proper size to accomodate the two screws present in the float tongue clamp. The blade fragment was soldered to the wire with the wire perpendicular to the length of the oval. Good cleaning of the wire and the blade with acetone and an acid flux was essential for solid joints. The solder blob was filed to form a rectangular projection or key and the base of the clamp was filed to accomodate this key. The wire was now covered with epoxy resin and clamped firmly. This procedure prevented any slip of the wire in the torsion head clamp.

One mil Teflon film was used to fashion the float ribbons; these replaced the platinum foil provided by Cenco. The Teflon could be bonded to the mica float and the metal trough with hot paraffin if it was immobilized during cooling. The float was attached to the tongue by means of Nylon thread cemented with DuPont's Duco to the mica and the tongue. The float was coated by holding a hot paraffin covered spatula against the mica, allowing the wax to run on to the float.

The mechanical pointer did not permit returning the float to its null position with sufficient accuracy, so an optical lever was added. The float tongue has a side arm for holding calibration weights. A 1/4 inch diameter front surface mirror was cemented to a small cork and this cork was forced onto the arm. A light source was constructed by taking line voltage through a transformer with 6.3 volt secondary, a 1K potentiometer, and to a GE 851K light bulb in a socket. This bulb has a line filament instead of the usual spiral so that its image is a line. A 50 cm focal length 4 cm diameter lens was used to focus this light on the mirror while a second similar lens focused the reflected light spot on a black ruled white scale. Light source and scale were about three feet distant from the mirror on the film balance. The potentiometer permitted adjusting the light intensity. Some dispersion of the light took place, so that it was necessary to pick one color of the resulting spot of light as the reference.

The apparatus was calibrated by hanging weights from the horizontal arm, measuring the lengths of the two arms, the length of the float, and the amount of deflection of the torsion wire required to maintain the null position. The sensitivity was calculated from

$$S = w\ g\ l_c/\mathrm{deg}\ l_f\ L$$

where S is the sensitivity in dynes/cm, w is the weight, g is the acceleration of gravity pertinent to the units of w, l_c is the length of the calibration arm, deg is the number of degrees of deflection of the torsion wire, l_f the length of the float arm, and L the length of the float in cm. L is normally the actual length of the mica plus one half the sum of the spaces between the mica and trough wall. A sensitivity of .17 dynes/cm per degree was attained, but the standard deviation was at least .1 dynes/cm. The flexibility of the float ribbons was probably the limiting factor in both sensitivity and reproducibility.

Surface tensions were obtained by the following formula:

$$\gamma = \gamma_0 - S \times \text{deg}$$

where γ_0 is the assumed value for pure water.

J. Mann has described a film balance which is suitable for automatic recording of the surface pressure (39, 40). This was similar to the Langmuir trough, but was fabricated from a solid Teflon slab. The torsion head has a much stiffer torsion wire whose deflection is sensed by a LVDT position transducer. The Linear Variable Differential Transformer permits extremely accurate position determination of the transformer core with respect to the coils of the transformer. Moreover, the electrical signal is a linear function of the core position. This balance is not a null device, but the float displacement is so small that it may be neglected.

Mann's electrical circuit was replaced with considerable improvement in ease of operation, sensitivity, and noise. The primary of the LVDT was excited by a Hewlett Packard 200CD oscillator. Operation was normally at 2000 Hz with four volts across the load. The output from the series opposing secondaries was fed to a HP3400A RMS voltmeter. This instrument has a DC output of 0-1 volt which is proportional to the meter position which could be opposed by a DC offset supplied by a mercury cell voltage divider. This bucking voltage permitted offset of up to 99% of the voltmeter signal. The difference signal was smoothed by placing a 500 microfarad capacitor across the terminals of the Sargent SR strip chart recorder. This 125 mV recorder was normally used with a 25 or 50 mV range, but operation down to 5 to 10 mV was possible.

This circuit was quite satisfactory; the key point was that stability was quite essential since almost all of the signal was being bucked out and the difference signal was being amplified. The capacitor filter was quite essential as the RMS meter exhibited small "breathing" in which the needle oscillated slightly. This slight oscillation was quite a problem when the lower 99% of the signal was suppressed.

Sensitivity of the instrument was calculated as before with divisions of chart paper replacing degrees of torsion. A typical sensitivity which permitted performing the entire ripple experiment without changing scales was .02 dynes/cm per division. A sensitivity of .001 dynes/cm/division was easily attainable, but this limited the film pressure to a fraction of a dynes/cm; also the noise became somewhat objectionable at these sensitivities. All measurements were performed with the rather heavy torsion wire in use; if greater sensitivity were desired it would be possible to replace this with a finer one as long as only low pressure data were sought.

Continuous recording of film pressure made it possible to observe the time effect on surface tension. This in itself could easily provide an interesting subject for study.

This film balance was so useful at water/air surfaces that its modification at oil/water interfaces was attempted. A float was fashioned from Teflon which presented its broad side to the interface. Small holes were drilled vertically through the strip and the ends were split vertically with a razor blade. Twenty gauge platinum wire was soldered to the tongue attached to the torsion wire. The platinum wire passed through the holes in the Teflon slab and then was bent to hold the float in place. One mil Teflon film was slipped between the slit ends of the float while the slit was held open. When the spreading force was removed, the film was held reasonably securely. Teflon slabs were cut 1 inch x 2 inch x 1/4 inch and holes were drilled to correspond to the threads on the torsion head base. These slabs were partially slit and the free ends of the float ribbons slipped into the slit. The Teflon slabs were then fastened to the torsion head and served as the support for this head when on the trough.

A compression barrier was constructed from a piece of Teflon which had L cuts in the ends which permitted the top to glide along the trough rim and the bottom to pass by the trough side easily. Note that this barrier was vertical with respect to the surface of the water. Holes were drilled in the upper portion of the barrier to permit free motion of the oil phase through the barrier since it was essential to maintain hydrostatic equilibrium to avoid float movement from liquid flows. Five mil Teflon strips were cut and mounted in the compression barrier with the slit technique. These stiffer strips made contact with the trough wall and acted as brushes to contain the monolayer while still permitting barrier motion.

This modified barrier seemed to work quite well with a pure water/heptane interface. Sensitivity and stability were quite good as long as the float was kept immersed in the heptane. If the float became exposed a changing buoyant force resulted in a distinct drift in the recorder trace. Talc particles were placed in the interface and the effectiveness of the compression barrier brushes noted. The procedure seemed valid until some surfactant was added in addition to the talc. Although the brushes did not leak in the interface plane, the particles seemed to follow the edge of the brush strip as the barrier was moved. One of the techniques that proved quite useful at the water/air interface for preventing monolayer leakage was to pile up some talc particles near the leading edge of the barrier. Possibly a modification of this idea could prove practical with the interfacial leaks. Moreover, it was difficult to find surfactants which could be spread and still remain insoluble at the oil/water interface.

Other authors have had considerable difficulty with manipulation of interfacial films (1, 7, 8). The general conclusion is that it is possible to manipulate the films, but there do not seem to be any general methods for measuring the surface pressure at the same time. Most researchers resort to an independent surface tension determination.

One of the simplest surface tension measuring techniques determines the force required to balance an object of known perimeter in an interface. A Wilhelmy plate was fashioned from mica sheet, roughed with sand paper, and suspended from a Federal Pacific torsion balance in an air/water interface. If the surface tension acts parallel to the plate, the surface tension may be simply calculated from

$$\gamma = (w - w_o) \times g/p$$

where w is the weight to keep the plate from moving, w_o is the weight of the plate, g is the acceleration of gravity, and p is the perimeter of the plate in cm. Surface tensions were calculated by both the Wilhelmy plate method and the film balance for an insoluble monolayer. It was found that at very low surface pressures the two agreed, but at higher pressures the plate was increasingly inaccurate. This was attributed to the development of a non-zero contact angle when enough surfactant was present to lower the surface tension appreciably. Consequently the method was abandoned.

Apparatus was constructed for measuring the interfacial tension by drop volumes. This method was chosen because it could be applied to air/water or oil/water systems and it should be free of contact angle difficulties. The method consists of forming a drop of the denser solution at the base of a capillary tip which has been ground flat. The volume of liquid which just falls determines the interfacial tension from

$$\gamma = Vg(\rho - \rho') \; 2\pi r\Phi$$

where V is the volume of the drop in ml, ρ is the heavier fluid density, ρ' is the lighter fluid density, r is the radius of the tip, and Φ is an empirical correction factor which is a function of $r/V^{1/3}$ (24).

Fabrication of the dropping tip was rather critical (32). The following procedure proved to be reasonably successful. A 10 cm length of 8 mm capillary tubing was heated near its center and the thick wall blown to form a taper, then the glass was cut in the middle of the resulting bubble. A strip of paper 1 inch wide was wrapped around this capillary tube until the capillary and paper would just fit into a segment of 14 mm normal wall tubing. Woods metal was melted and eye droppered into the space between the two tube segments while a teasing needle was used to dislodge any entrapped air bubbles. After the metal had solidified a water-cooled silica carbide cutting wheel was used to cut through the entire assembly of tube, metal, and capillary. The fresh cut ends of two such tips were held against the flat side of the wheel from opposite directions until a suitable tip end resulted. The outer glass frequently split away during this operation, but the metal matrix usually remained intact. Hot water now served to melt the Woods metal and clean the glass capillary. The ground glass tip of an L adapter for Micro-Metric Syringe Microburets was cemented to the upper tapered portion of the tip with Duco, taking care that no cement was near the opening of the ground glass.

This tip assembly was held on a syringe of a few ml capacity by the ground glass fitting at the top of the adapter. The syringe was driven by a micrometer plunger mounted on a block which held the syringe and micrometer parallel. This block was fastened to a hex angle frame with standard chemical hardware. A flat plate had been previously leveled and this served as a reference for aligning the tip. The syringe assembly was moved until the dropping tip end was parallel with the reference plate. Attempted leveling with a cathetometer was no more successful than aligning by eye.

The drop volume technique requires that the drop just fall. Considerable time was required for equilibration of the drop but it proved possible to form the first 90-98% of the drop rather rapidly, and then allow 2-10 minutes for the final portion formation. The aqueous phase which contained the soluble surfactants under investigation was placed in the cleaned syringe while the heptane was contained in a glass thermostat consisting of a double walled glass cup with overall height 3 inches and diameter 2 inches connected to a water bath via the bath's circulating pump. Temperature control was .01 degree, with temperature maintained near 25°. After time for temperature equilibrium, two or three drop volumes were measured for each sample. More points were taken if .001 ml precision was not achieved.

The value of the tip radius was quite critical. Direct micrometer readings gave reasonable surface tensions, but it was decided to calculate the radius of the tip based on measurement of the volume for pure water/pure heptane and the assumed interfacial tension. For this purpose water was taken from the still while it was still hot and cooled in the apparatus to insure freshness. Note that the dependence of the function Φ on r requires a successive approximations solution.

Precision with this technique was quite acceptable until very high concentrations of surfactant were present.

These low interfacial tensions allowed only small drops with consequent poor relative precision. Proper measurement would require a set of tips of varying radii so that the best compromise tip radius could be used for each interfacial tension. For lower surfactant concentrations, it was important to allow sufficient time for equilibrium. The method of measurement increases the surface area, thus requiring more surfactant molecules to diffuse from the bulk system into the interface and for lower surfactant concentrations this diffusion time can be significant. The primary disadvantages of the method are that it is suitable only for truly water soluble systems which do not have any oil solubility and it requires 15-20 minutes per surface tension measurement. This method was used when aliquots were removed from the ripple tank for independent interfacial tension determination.

Many of these objections were overcome by use of an oleophilic Wilhelmy plate (7, 11). This was similar to the usual plate, but it was wet by the oil phase and not by the aqueous phase. Surface tension was pulling up rather than down, hence it was necessary to attach a weight to the plate which was sufficient to overcome the maximum surface tension. A torsion balance was used to provide the balancing vertical force. The contact angle problem was less severe because the surfactants tend to be water soluble. Davies and Rideal report that carbon forms the most satisfactory oil wetted surface (11).

Once again the plate fabrication proved to be critical. A thin sheet of mica was split from a thicker one by gentle prying of one sheet from another with spatulas and razor blades while keeping the opening wet with water. Possibly the water served to transmit the force more evenly. This thin sheet of mica was placed on a wet Petri dish bottom and roughened by gentle sanding with wet sandpaper. The wet dish prevented movement of the mica. The plate was removed by water flooding and the opposite side roughened similarly. The Physics Instrument Shop cut the mica into about 1.5 cm squares. A hole was punched on a center line near the bottom of the plate and near each upper corner. Punching without tearing the mica could be done by puncturing the mica on top of a pad of paper with a sharp small diameter sewing needle. Better holes resulted if the hole was punched through with a very fine dental pick and then enlarged with the sewing needle. Coating the mica with carbon utilized a sooty gas flame with almost no oxygen feed. A pair of forceps held the mica against a glass microscope slide while a pair of longer tongs could be used to hold the smaller forceps. The mica and slide were held at an angle over the top of the flame until an even coating of carbon was obtained. This procedure was repeated with the opposite side and a new glass slide. It was essential not to move the carboned mica against the glass or the coating would be scratched off. The heat stress on the slides resulted in numerous cracks, hence the one use only instruction. A weight was fashioned from fine platinum wire and fastened through the bottom hole. Nylon threads were passed through the upper holes and cemented to form a loop through each hole and the two larger loops were fastened together with another strand of thread which suspended the plate from the balance hook. The large loops around the plate kept the cement from being in contact with the upper phase.

The plate was kept in a bath of upper phase liquid when not in use. The oil wet plate was lowered through the oil/water interface until the weight was covered by the lower phase. It took some time and effort to displace the heptane from this weight so that the plate would glide easily up and down through the interface. The plate was held in the interface with about half of the plate showing above the apparent interfacial plane. Measurement of the force on the torsion balance required to keep the plate at this position determined interfacial tension through

$$\begin{aligned} \gamma = \frac{g}{p} (w_m + w_w - \mathrm{rdg} - (1 - \mathrm{frx})\ w_m \times \rho'/\rho_{plt} \\ - \mathrm{frx} \times w_m \times \rho/\rho_{plt} - w_w \times \rho/\rho_{wt}) \end{aligned}$$

where p is the plate perimeter in cm, w_m the weight of the mica in mg, w_w the weight of the platinum in mg, rdg the torsion balance reading in mg, frx the fraction of plate immersed, ρ' the upper phase density, ρ the lower phase density, ρ_{plt} the plate density, and ρ_{wt} the weight density.

Again absolute measurements were in reasonable agreement with theory, but it proved advantageous to use the observed reading for a pure system and its assumed interfacial tension to calculate the perimeter of the plate. As the surface tension was lowered, the plate tended to sink further into the interface. The torsion balance was mounted on a Lab Jack so that it could be raised during an experiment to keep the plate at the same immersion depth. Precision with this method appeared to be about .03 dynes/cm, but accuracy was difficult to check since the systems of interest were pure solvents to which various surfactants had been added. For water/heptane agreement was within 1 dyne/cm of literature values. Contact angles were a possible problem. Whenever erratic plate movements took place, the plate was removed and cleaned with the upper phase liquid. This technique seemed to be quite acceptable in the ranges of the usual experiments where surface pressures of up to 15 dynes/cm were observed. Plate performance at higher pressures where contact angle difficulties would appear more likely is unknown.

The advantages of the plate are considerable. The measurement requires about 20 seconds and it can be done at the same time as the ripple data are being collected.

It is suitable for oil soluble surfactants as well as water soluble and insoluble ones. Evolution of this particular technique was the necessary step for useful interfacial capillary ripple experiments. Disadvantages of the method could be overcome by use of deeper liquid layers, large perimenter plates, and an automatic null position detection system (such as a spring loaded LVDT). If the interface in which the plate was immersed was curved, the plate would be drawn towards the edge of the container. This problem was solved by employing a larger trough which enabled positioning the plate a few centimeters from the trough edges while still having enough surface area for unimpeded ripple propagation.

Instrumentation

The success of this Laboratory in measuring ripple parameters was a result of the novel instrumentation involved. The essential method was to set up mechanical waves with a wire lying in the interface which was driven by a loudspeaker. A second wire lying parallel to this one and a few centimeters away formed a boundary from which standing waves were set up. This second wire was connected to a phonograph cartridge which converted the mechanical motion to an electrical signal. The present techniques were fundamentally those first discussed by Mann (40).

Numerous seemingly minor modifications were made in the original instrumentation (3, 22). These alterations were essential for operation at two phase interfaces. Moreover, the modifications permitted measurement at air liquid interfaces with considerably more ease, precision, and accuracy.

A schematic of the original instrumentation is shown in Figure 5. Details are discussed in Propagation Characteristics of Capillary Ripples, II (40). The oscillator provided the AC signal for driving the generating probe, but a power amplifier was used to increase the power to the speaker. The frequency counter gave a .1 Hz accuracy, while the attenuator was used to control the power to the generating probe and hence its amplitude. The speaker had been highly modified. The cone was removed and replaced by an assembly which maintained the motion of the probe in the vertical direction, damped out motion in other directions, and provided the restoring force to position the speaker coil near the permanent magnet. The moving probe set up the capillary ripples which were sensed by the second probe. This probe was mounted on a micromanipulator which allowed positioning the cartridge in three mutually perpendicular directions. A variable resistance potentiometer was geared to the manipulator in the in-out direction. This resistance formed one leg of a Wheatstone bridge circuit which allowed distance measurement by balancing the bridge. Besides being more convenient, one more decimal place was obtained by this procedure. The output from the crystal cartridge was amplified by a wide-band battery powered preamplifier. The amplified signal was monitored with a voltmeter, filtered, and fed to the Y axis of an oscilloscope. The signal from the oscillator was filtered and fed to the X axis of the oscilloscope. Several numbers were recorded for each position of the sensor; frequency entered the calculations directly, input voltage was used to correct the sending probe amplitude for a slight frequency dependence, output signal was a measure of the capillary ripple amplitude, and the relationship of input and output signals as measured by the Lissajous figures on the oscilloscope provided a reference position on the waveform. Measurement of the resistance of the potentiometer on the micromanipulator provided a measurement of the position of the cartridge.

The instrumentation has gone through numerous alterations. The original apparatus was contained within an air thermostat. It was discovered that this box acted as an antenna for mechanical noise. Naturally, with a system capable of measuring mechanical waves only a fraction of a micron high, all sorts of mechanical vibrations appeared as noise signals. Four commercial vibration dampers were used to support the air thermostat. When these were removed the metal framework used to support the speaker rested on rubber pads which were on a 500 pound stone slab. The slab was supported by several layers of rubber sheeting. All mechanical connections between the metal framework, or cage, and rods supporting the speaker were insulated with rubber washers between the nut and bolt. Although the micromanipulator base was quite heavy, the best results were obtained when this base rested on rubber sheeting and lead bricks were placed on the manipulator base to provide even more weight. Best noise insulation was provided by a spongy rubber sheet combined with a firmer one. Rubber stoppers were used to elevate the ripple trough when necessary. The cage was covered with Lucite on the ends, back, and top. These provided a dust and air current shield. The front was open, but sheets of Saran Wrap were draped from the top down. This provided easy access to work inside the cage while giving an almost closed working space. Figure 6 shows the final arrangement.

Mann's apparatus has been modified in a number of respects to increase accuracy of parameter determination. Frequency was originally counted by beating the working oscillator against a standard oscillator and using the counter to observe the ratio. The standard oscillator was removed and frequency counted directly when it was discovered that the beat method had an accuracy of one part in 5000 at best, while direct counting was good to one part in 2000. Moreover, the standard oscillator was difficult to keep in top working condition. The original scope was replaced with a Hewlett-

Packard Model 130C. This permitted considerably more sensitivity and a variety of attenuation possibilities.

One of the key points of the technique was that the Lissajous figures provided a reference point on which further measurements could be based. Although the position of the sensor was known fairly well, the absolute distance between the probes was less well known in large part because probe diameters were not small compared to wave length. It was assumed that the electrical phase measurements corresponded to the mechanical phases of the wave. Thus if the sensor was moved from one position where the Lissajous pattern was a positive sloping straight line to the next position where a similar pattern was obtained, it was assumed that one wave length had been traversed. Thus the wave length resolution depended ultimately on the resolution of the phase pattern. It was possible to record the output signal as a function of distance and obtain the wave length from this plot in some cases. As Mann has shown (40), when the two probes were close together the output signal underwent periodic variations, and these variations corresponded to known fractions of a wave length. However, for larger separations the output signal decreased exponentially with distance. Thus a plot of signal against separation distance would not provide a measure of the wave length. Use of the phase patterns, however, permitted wave length measurement for all situations, provided the signals were sufficiently sinusoidal to form sharp Lissajous figures. Although any point on the wave could be taken for reference, the point which corresponded to a straight line Lissajous figure was the most suitable, since a straight line was easier to reproduce than any intermediate form of the ellipse.

Probe design for interfacial systems appeared to involve more art than science. Air/water system sensors could be paraffined to assure a non-wetting surface. Moreover, since coupling through air was small, a relatively large object could serve very well as a sensor. The sharp edge of a razor blade formed the sensor in early work. The presence of a liquid upper phase, however, ruled out both larger objects and paraffin coatings which were oil soluble. The original generating probe was a wire inverted T framework in which the bottom edge was ground to form a right angle with the front surface. Presumably the front corner formed the actual generating line.

First interfacial probes consisted of the same generator with a sensor consisting of a piece of wire. Numerous sizes of wire and orientations were investigated. L shaped sensors were much more effective than T shaped ones. A sensor similar to the generating probe, only smaller was rather ineffective. A U shaped sensor indicated that the output signal was a function of the orientation of the free arm of the U. These observations suggested that the mode of coupling of the mechanical wave was considerably more complex than simple vertical displacement. The piezoelectric effect was manifested as a tensor quantity in which an electrical signal would result from a stress in almost any direction on the crystal. Thus all motions of the sensor resulted in a contribution to the output signal; however, it was quite likely that some of these orientations were preferred over others. Torque, buoyant force, and displacement could all have been important in the production of a signal. It is important to note that although the signal and signal to noise ratio were functions of probe design, the capillary ripple parameters that were measured in these various modes were not dependent on design. Of course, reductions of signal to noise ratio and signal reduced accuracy of determination of the ripple parameters.

The generator probe was converted to interfacial use by fashioning an A frame in which the feet of the A held a thin wire. This wire touched the interface, while the bulk of the supporting frame was above the upper phase. The bulkier supporting legs might be expected to lead to wave form distortion; to avoid errors from this source the generating probe was made considerably longer than the sensor probe, so that only the central portion of the wave contacted the sensor.

The contact angle between the probe and the lower phase affected the magnitude of the signal drastically. If the lower phase wet the generator, its vertical motion would not be coupled very strongly to the interface. Similarly, the sensor had to be non-wettable if the wave motion was to couple with the sensor. Wetting properties of several substances were examined. These included Desicote, Silastic adhesive, mold release compounds, Teflon tape, and Teflon ribbon. The effectiveness of each modification was ascertained by performing a voltage distance experiment and examining both the wave forms and the signals obtained.

After considerable experimentation the following procedure was adopted. Sensing probes were made from a steel paper clip of 40 mil diameter. The clip was unfolded and part of the wire cut off to form an L about 3 x 4 cm in which the base of the L was left with a small foot. The generating probe was fashioned from 70 mil stainless steel rod. The supporting form consisted of three 3 inch pieces forming the upright and sides of the A and a 3 1/2 inch cross bar holding the sides at 45° angles to the upright all spot welded together. This resulted in the sides extending 1/2 inch vertically below the cross bar. Molybdenum wire with a 15 mil diameter was spot welded to one leg. The legs of the frame were compressed by squeezing them firmly towards each other. While pulling on the free end of the wire with pliers, the weld on the second foot was made. Proper construction required a fair amount of experience. Use of a wire puller aided keeping the tension on the wire high, but adjustment of the spot welder heat and pressure was more critical. The metal parts were cleaned with acetone and hydrochloric acid before welding. The frame was easier to weld if the ends of the rod are ground flat on one side; this also exposed fresh metal for better bonding. It was important that the frame be compressed reversibly; too much force would permanently deform the legs so that they did not exert any tension on the wire.

A hydrophobic surface was obtained on both probes by coating them with DuPont FEP 856-301 Teflon Resin. A mixture 10:7 by volume of resin and VM 7799 accelerator was agitated with a magnetic stirrer and carefully filtered through a Kim Wipe to remove froth. The probe parts could be dipped into the liquid or a small brush could be used to cover them. A little care was needed to get an even coat on the wire without any excess resin drops or air bubbles. Mounting the generating probe so that the wire was vertical coupled with careful drawing of the brush from top to bottom resulted in a good coat after several tries. The trick to good coating was to adjust the viscosity so that the coat flowed enough to even out while it remained high enough to stay on the wire. The small diameter of the wire was the feature which made its coating rather difficult. After a smooth coat was obtained, the solvent was driven off the probes by placing them in a moderate air stream for at least 1/2 hour. The Teflon coating was fused by baking the probes in a muffle furnace at 350° C for 20 to 30 minutes. After the parts had cooled they were ready for service if they passed a visual inspection for coat integrity.

Addition of a Lock-In Amplifier, a Princeton Model HR-8, improved data acquisition considerably. This amplifier has several modes of operation. The instrument is essentially a frequency tuned phase sensitive voltmeter in which phase control is established from a desired reference source. The AC input signal can be rectified and filter circuits used for averaging the resultant DC signal. Early work used the amplifier to supplant the oscilloscope as a phase sensing device. The maximum signal was adopted as the criterion which established the reference point on the wave. The adjustable phase feature enabled any point on the wave to be selected for reference. Results indicated that it did not make much difference what point was taken, so the point where the maximum signal from a wide band amplifier occurred was used. Wave lengths calculated from the maxima in the voltage were not as accurate as desired, since a slight mismatch in frequency tuning resulted in a response curve which was not smooth enough to locate the maximum voltage easily. That is, although there was always a unique maximum signal, searching for this maximum was difficult because of adjacent relative maxima. This would not normally be a problem in a constant frequency experiment, but the preferred mode of operation attempted to keep the wave length constant while altering the frequency. The zero crossing of the signal was tested as a reference point for wave length calculation. At zero signal it should be possible to increase the sensivity by several orders of magnitude, and hence determine the zero quite accurately.

Experiments with this method were performed at several phase settings. Voltage distance curves were plotted with the result that the shape of the voltage distance curve depended on the phase setting employed. The distance from one zero crossing to the next depended upon the phase, but the distance from one zero crossing to the third crossing gave reasonable wave length estimates. These rather surpriing results prompted a further examination of the expected response from the crystal cartridge. The time dependence of the mechanical wave was removed in the original method by use of a voltmeter for signal display. This AC instrument time averaged the input signal, however, the LIA made use of the time information in the signal. Thus the output changed polarities periodically. The phase sensitive nature of the detection system further complicated the interpretation by adding another factor in the response equation. Further analysis of the equations expected indicated that this phase problem could be resolved by working at probe separations at which the signal could be adequately represented as exponential. If the probe separation times the damping coefficient was larger than about 2.5, exponential behavior resulted and the phase problem with the LIA disappeared. Consequently all further work was carried out under these conditions.

One of the advantages of the LIA is that it was possible to suppress the output up to a factor of 10. This means that it was possible to buck out 90% of the signal and then amplify the remaining fraction by a factor of 10 for display. This corresponded to a factor of 10 better sensitivity, although the experiment is somewhat more difficult because numerous dials must be turned. Adjustment of all the dials for a given data point was difficult because an external oscillator and the internal reference oscillator had to be adjusted independently, and the detection system depended on the setting of both of these.

This problem was surmounted by yet another modification of technique. The final arrangement is shown schematically in Figure 6. It was possible to operate the Lock In Amplifier in a mode in which it acted like an oscillator, thus eliminating the external oscillator.

The Lock In Amplifier may be represented as a preamplifier followed by an intermediate amplifier, followed by a tuned amplifier, Figure 7. The first two are wide band devices which also incorporate the sensitivity control. The tuned amplifier narrows the frequency spectrum down to a desired fraction of the input frequency. The half width of the bandpass peak is normally operated at 1/10 of the nominal input frequency, but the Q may be adjusted until only 1/25 of the spectrum is passed. Although some stability was lost by this selectivity increase, most measurements were taken with Q = 25. The feedback network operating on the tuned amplifier constitutes the internal oscillator. The signal is fed through an attenuator to the output jack. This oscillator in conjunction with phase control and trigger circuits provides the reference at the phase sensitive mixer. The amplified input signal is beat against the reference signal of the mixer to provide sum and difference signals. The difference signal is now DC and can be filtered with any desired time constant, amplified at the DC amplifier, and displayed on the panel meter. The output is also available at the meter for external display.

The oscillations from the LIA were amplified by a Heathkit W-5M power amplifier and fed to the loudspeaker. An Astatic 81-002 cartridge was mounted on the original Brinkman 3050 Micromanipulator and its output fed to the Type A preamplifier on the LIA. The LIA was operated on Internal Mode, with Q = 25, Freq Trim = 0, Zero Suppress = 0, Time Constant = 3-10 sec, Meter/Monitor on either SIG for scope monitoring or OUT for signal averaging. The sensitivity was adjusted for various purposes. The oscilloscope was used for Lissajous pattern phase determination with the X signal taken across the speaker coil and the Y from the output of the signal tuned amplifier operated in the SIG mode. The OUT mode included the rectifying and averaging functions. The output was displayed on a Fairchild Model 7100 Integrating Digital Voltmeter. The LIA meter has a 10 volt full scale output; this was reduced by a voltage divider consisting of a 1K potentiometer and fed to the digital voltmeter on its .15 volt scale. Although five digits were displayed, the terminal digit appeared to have no significance.

A HP 450A amplifier produced an amplified pattern of the oscillator signal whose frequency could be monitored by a Computer Measurements Model 225C Universal Counter-Timer. The power amplified signal intensity was monitored with an HP 400H voltmeter. The Wheatstone bridge was powered from a mercury cell, while a Kintel Model 203 Microvolt-Ammeter was used for null detection.

The filter circuits originally in the instrument train are absent from the final version, as is the battery operated preamplifier. The preamplifier appeared to add a moderate amount of noise, and was replaced with the LIA preamplifier. The filter circuits were originally tuned to shunt noise of 20 to 60 cycle frequency to ground. This function was achieved reasonably well, but at the cost of almost unacceptable power loss in the output signal. Moreover, the filters led to some wave form phase distortion at low frequencies which was particularly critical for oil/water work since the high damping coefficients favored low frequency operation.

A slab of Teflon was fashioned into a rectangular trough with overall dimensions of 6 inch x 9 inch x 1 inch with 1/2 inch walls and a 1/4 inch bottom which sat inside a glass baking dish 8 inch x 12 inch. The inner trough could be filled with the lower phase solution by overflowing while the upper phase could be layered over the lower and the interface cleaned. When interfacial tensions were measured with the plate, a Federal Pacific LG torsion balance provided the restoring force.

Procedure

Capillary Ripple Propagation involves ten fundamental variables. Theory relates these ten variables with two equations so that independent measurement of any eight determines the remaining two. Four of the variables are reasonably simple to obtain with requisite accuracy. The density and viscosity of the upper and lower phases can be obtained from the literature provided the choice of phases is made with some care. The remaining quantities are the wave length, λ, or the wave number, k, the damping coefficient, α, the wave frequency υ, or cyclic wave frequency, ω, the interfacial tension, γ, the real component of the complex elastic modulus, E', and the imaginary component of the complex elastic modulus, E". Generally the last two quantities are calculated from values of the first eight.

Frequently the quantity actually measured must be manipulated with further variables and constants to attain the desired form. Several techniques for data acquisition have been used. These included Vary L, Min-Max Vary L, Vary Frequency, Constant k, and Multiple Constant k methods. They differed in which variables they altered and kept constant, ease of data acquisition, and interpretation.

A quantity known as the reference independent variable was associated with a ripple experiment, and furnished an abscissa for graphical presentation of data. The reference independent variable was usually a concentration of some sort. A point consisted of all the information required to compute the desired ripple parameters for each value of the reference independent variable.

The surface concentration was a convenient reference independent variable for insoluble monolayers at the air/water interface. If a trough was used for compression of the monolayer, the length available for the surfactant was recorded and the surface concentration calculated from

Γ = wtmup x voladd/(wtmol x volmup x width x length)

where Γ is the surface concentration in moles per square cm, wtmup is the weight of surfactant in g dissolved in VOLMUP liters of solution; voladd liters of solution are added to the trough width cm wide; length cm remain between the compression and float barriers; and the surfactant has a molecular weight of wtmol g. The surface tension was calculated from the amount of torsion produced in the float torsion wire as discussed in the surface tension measurements section.

Slightly soluble or soluble surfactants were normally run in a constant area experiment in which the available surface was kept constant but more molecules of surfactant were added to the system. If the surfactant was soluble in the lower phase so that lower phase mixing was part of the experimental procedure, the reference independent variable was the log of the bulk phase concentration. It was calculated from

log c = log (voladd x wtmup/(voltot x wtmol x volmup))

where c is the concentration in moles/l, the volume in liters of solution voladd added is being recorded, and voltot is the volume of the lower phase in liters. Less soluble surfactants had the surface concentration as a reference independent variable, but their solubility made interpretation of this number essentially meaningless. These systems usually resulted from spreading solvent injections near the interface. The surface concentration was calculated from

Γ = wtmup x voladd/(wtmol x volmup x area)

where the cumulative volume of solution added, voladd, was recorded and area is the number of square cm of surface available at the interface. When soluble surfactants were handled by removing and adding aliquots of the lower phase, the concentration was calculated from a running total in which the number of moles of surfactant present was counted to produce the next concentration value.

Cleaning operations for an air/water systems have been discussed. An oil/water experiment began with both the Teflon trough and glass dish immersed in cleaning solution consisting of potassium dichromate and sulfuric acid. The containers were rinsed several times with distilled water and then two more times with 4X water and the dish and trough were placed in the ripple cage. The generating probe was held in the speaker assembly with a set screw. The entire assembly was mounted so that vertical motion was quite simple, but so that leveling could be performed when needed. The trough was filled with 4X water until the water level was even with the trough edge and the generating probe lowered until it just depressed the surface of the water. If the probe did not meet the surface evenly, the support rods were adjusted until it did. The sensing probe was held in the crystal cartridge by another set screw. The micromanipulator was placed on a sheet of graph paper with its bottom edge along a line. The sensing probe was adjusted until the bottom of the L also lay along a parallel line. Rubber gloves were used for any operations where contact with wet end equipment was likely. The manipulator and attached sensor were positioned over the water so that the two probes were reasonably parallel and the sensor was lowered until it just depressed the surface of the water. The cartridge and sensor were adjusted until the sensor met the surface evenly and moved in until it just touched the generating probe at the surface of the water. Parallel alignment could be checked visually since the end of the case had a transparent cover. The entire manipulator assembly was adjusted until alignment was obtained. Lead bricks were placed on the manipulator base to improve noise properties and to prevent accidental movement of the aligned manipulator. The resistance from the Wheatstone bridge circuit when the probes just touched was recorded as RESGN in K ohms.

The water in the trough was next removed by suction from a water aspirator. During suction the tip was kept at the surface so that a mixture of air and water was removed simultaneously; this procedure aided in removing surface contamination. The lower trough was filled with a portion of lower phase solution which was usually 4X water, but sometimes contained small concentrations of various counterions. After some time was allowed for contamination to diffuse to the surface, a small diameter tip was used to suck off a portion of the water, with special care to take the water right at the surface.

The upper phase was poured into the outer dish until it covered the lower phase by 1-2 cm. After more time for equilibration, this interface could be cleaned by sweeping with Teflon bars with the probes raised, or by careful aspirating with the probes in place. It was important that attention be paid to the positioning of the two probes with respect to the level of the lower phase. Since the cleaning operations might have lowered the water level, it was sometimes necessary to lower the probes to compensate. Best results were obtained with the probes depressing the lower phase surface slightly.

If a plate method of interfacial tension determination was used, the oil cleaned plate was carefully immersed from the top and the balance height adjusted so that the plate remained in the interface. The relatively small depths of both phases compared to the plate dimensions made this particular operation somewhat difficult. Modification of the equipment to permit three or four centimeter depths would require deeper troughs and dishes as well as a longer arm on the sensing probe.

The clean system almost always provided one of the points desired, so a set of ripple data was taken for this value of the reference independent variable. In any of the constant area techniques a small addition of surfactant was made and time allowed for equilibrium. This time was considerable if the compound had a moderate solubility and diffused out of the interface. The real requirement was not that of final equilibrium, but a situation in which the measured properties did not change in the time required to measure them. Nevertheless, this time was one of the chief reasons why data taking was slow. Each surfactant addition constituted one value of the reference independent variable and was accompanied by recording of all the variables needed to calculate ripple parameters.

Vary L

This method (40) was the basic technique for which the instrumental method was designed. The frequency was kept constant throughout the experiment. For each reference independent variable value a complete plot of output signal as a function of probe separation was obtained. Although the interpretation of the results was easiest here, the data acquisition was quite time consuming and involved.

The initial probe separation was at least 10 wave lengths; the resistance corresponding to this distance was recorded as a value of RES in Kohms. The output signal as indicated by the digital voltmeter, DVM, was recorded, then the sensor was moved out slightly and the new resistance and signal recorded. The distance increment was 1/50 to 1/10 of a wave length. This procedure was continued until three or more wave lengths had been traversed. These 30 to 200 pairs of numbers could be converted to output signals as a function of distance and plotted; actually, the distance was an almost linear function of resistance, so that over separations of only a few wave lengths a plot of signal as a function of resistance was quite acceptable. The wave length was obtained by subtracting the distance corresponding to some point on the plot from the distance corresponding to a point one wave further out on the plot. Note that in this method the absolute probe separation was immaterial so long as several waves were between the probes. The logical point for wave length calculation was the one which could be most clearly resolved. Mann and Hansen (41) have shown that for RMS meter sensing of the output signal the signal was approximately an exponential curve which executed oscillations periodic in the wave length. The peak of one such oscillation was the best place to choose for a reference mark. Similarly, the damping coefficient could be obtained from this plot. If the curve was truly exponential, a semi-log plot would yield the damping coefficient immediately; if the curve was still oscillating the more complex formulas of Mann and Hansen were required.

It turned out that the envelope curves of the oscillating exponential are of major significance. If the maxima and minima of the voltage-distance curve were determined, the envelope curves could be determined with the lower number of points suggested above. The accuracy of the wave length determination could be increased by using the phase information contained in the Lissajous pattern. If one of the voltage distance points included the probe position where this pattern is a straight line during each wave length, then the reference point was determined more accurately than by the maximum of the voltage distance oscillations. All of this work coupled with the direct frequency measurement and an independent surface tension measurement constituted one damping coefficient, α, and one wave length, λ, for one value of the reference independent variable.

This entire procedure had to be repeated for each level of the reference independent variable desired, so that the amount of data taken for one complete plot was large. There was a further difficulty in that the output signal did not form curves which conformed exactly to those expected. Noise was always a problem, and the many adjustments required to perform the experiment were all subject to their own errors. It was particularly difficult to draw an unambiguous envelope curve through the maxima and minima; this led to an ambiguity in the damping coefficient such that its standard deviation was around 10% of the value of the damping coefficient itself. The standard deviation of the wave length was about 1% of its value.

Min-Max

J. Lucassen (37) favored a modification of this vary L procedure in which only a few points needed to be taken per wave length. The distance corresponding to a probe separation where the Lissajous figure was a straight line was recorded for each wave length. This was the in phase position. A straight line with opposite slope was encountered in the same wave length and was termed the out phase position. For each wave length the maximum signal and minimum signal which occurred nearest to the OP and IP positions were recorded along with their corresponding resistances. The distances at successive IP's provided estimates of the wave length, while the damping coefficients were calculated from an approximation to the envelope curve

$$\alpha = (\ell n\,(1/V_{max} + 1/V_{min})_{n+1} - \ell n(1/V_{max} + 1/V_{min})_n)/(x_{n+1} - x_n)$$

where V_{max} is the signal at the maximum, V_{min} is the signal at the minimum, x refers to the distance, and n and n + 1 indicate two adjacent IP positions. V_{min} was normally taken to be the average of minimum preceding the particular maximum and the minimum following it. The damping coefficients determined this way exhibited considerable scatter, hence 5 to 10 wave lengths would be covered to provide enough values for averaging. It turned out that for air/water systems the IP position corresponded closely to the maximum in output signal for that wave length.

This Min-Max modification of the Vary L procedure obviously required much less work per damping coefficient measured. It was possible to get a set of data for one value of the reference independent variable in about 15-30 minutes so that several levels could be examined. The principal loss was that the voltage distance curve was no longer available for reference. Once the more difficult full Vary L had confirmed the essential behavior of a system, the abbreviated Min-Max procedure could be effectively employed.

Vary Frequency

The 1% standard deviation for wave lengths appeared as a precision and an accuracy error in the above methods. A technique for avoiding some of this scatter made use of the very good precision available from the oscilloscope phase determination. This method was originally used by Mann and Hansen for accumulating a large block of data for the pure water/air interface (40). Once a suitable probe separation was obtained, the probes were kept fixed relative to each other. Thus this was a constant separation, or constant L, method. The frequency was varied until an IP condition resulted and was recorded. The frequency was then advanced until the next IP and so on. It was originally assumed that only an integral number of waves existed between the probes at an IP condition; hence if the number of waves between the probes was known for the first frequency, this number could be increased by one for each new IP frequency. The new wave length was simply obtained by dividing the probe separation L by the number of wave lengths. This procedure gave the wave lengths for a given set of frequencies. The probe could now be moved slightly to L' and the process repeated. This enabled determination of the wave length for the entire frequency spectrum with a reasonably simple experiment. The spectrum from 200 to 1200 Hz could be spanned in about 1/2 hour.

The major difficulty with this method was that the assumption of an integral number of waves existing between the probes at IP was not true in general. It was particularly not true with the recent instrumental modifications. Furthermore, it was not true that going from one IP frequency to the next increased the number of waves by one. This assumption, however, was only mildly violated in the higher frequency regions, particularly for air/water systems. These phase problems will be discussed in more detail, but it can be seen that the application of this technique requires careful examination of the conditions applying in the region where it is to be used. Nevertheless, the ease and rapidity of the method suggest that the technique be considered where it is applicable.

Constant k

The Constant k technique made use of the excellent resolution possible with oscilloscope phase detection while providing damping coefficients from a single output signal measurement (3). This method attempted to keep the wave length, or equivalently the wave number, constant, thus requiring that the frequency be free to vary.

The absolute separation of the probes was needed for calculation of the damping coefficient, but lack of precise knowledge of this value was not particularly critical. The separation was obtained by recording the resistance, RESGN when the generator and sensor were just touching and the resistance, RESFN, and when they were about 3-4 cm apart. This allowed calculation of the separation by conversion of the resistances into their corresponding positions and subtraction. The frequency was now adjusted until an in phase condition resulted on the pure system.

Measurement of the frequency, surface tension, input voltage to the speaker, and the output signal from the cartridge served to determine Y1 and Y2. The procedures required for calculation are slightly involved and will be discussed in a separate section. Essentially an exponential relationship between output signal and the damping coefficient was assumed, so that a single value of the output signal led to a value of the damping coefficient.

Next the concentration of surfactant was altered slightly, the changing surface chemistry resulting in a new wave length and damping coefficient. The new wave length caused a phase change so that the Lissajous pattern was no longer IP; next the frequency was adjusted until a new IP was obtained. It was essential to make changes gradually so that no confusion as to which IP was desired occurred; that is, one had to be careful not to lose a wave. In practice the frequency change desired was of the order of a few tenths of a Hz, but 2-3 Hz increments were possible. By adjusting the frequency so that the same number of waves was between the fixed probes, the wave number was kept constant. Of course the surface tension, frequency, and input and output signals were recorded, along with the value of the quantity which would allow calculation of the reference independent variable.

The relative nature of this experiment is apparent when it is realized that the ripple parameters are measured relative to the first point taken. Thus, if the wave length was figured from absolute probe separation, the accuracy would not be very great, but changes from this first value could be monitored quite well. The actual k that was being used might not be known with great accuracy but this quantity could be kept constant with considerably greater precision. Similarly, the calculation of the constant in the equation containing the damping coefficient required information not obtained from a Constant k experiment. However, once this constant was obtained, all subsequent signals led to damping coefficients with the accuracy of the output signal determination.

A reasonably good way to get all this information was to perform a Vary L experiment on the clean system to get the wave length and damping coefficient for the first point, and then continue with the Constant k experiment for all subsequent values. A second possibility was to calculate the values at the first point and then base all subsequent values on constants obtained from these calculations.

Y1 involves a third power of the wave number, k; thus a 1% error in k will lead to a 3% error in Y1. The total change expected in Y1 throughout the experiment from zero surface coverage until tightly compressed coverage was about 5%, and the detail of this function was a fraction of a per cent. Thus it is seen that a 1% error in k would prohibit acquiring any information about the Y1 function which would distinguish it from a constant. The Constant k technique kept this error from obliterating the experiment, since the constancy of k was probably .01 to .3% depending on the ease of phase resolution. The convenience of one point damping coefficient measurement allowed the entire range of surface coverages to be measured in a few hours of data acquisition.

Multiple Constant k

The advantages of the Constant k technique were combined with the advantage of the Vary Frequency technique in this new method. Essentially several Constant k experiments were performed simultaneously. This permitted an examination of the frequency dependence of the ripple parameters.

The probes were positioned as for a Constant k technique, but after recording the frequency, surface tension, input signal, and output signal, the frequency was advanced until a new IP condition resulted. This corresponded to increasing the number of waves by as many IP's as were passed during the frequency sweep. The same data were taken as at the first constant k frequency. The frequency could be advanced again as many times as were desired. In the present work, the frequency was advanced in two wave increments, and three to seven constant k positions were observed.

After conclusion of the last constant k position data collection, the frequency was reduced to the first value. The occurrence of the in phase condition at the same frequency as originally recorded could be used as an indication that the nature of the surface had not altered during the time required to measure the remaining constant k positions. Next a small change in surface concentration could be made. This would cause lack of phase registry so that the frequency would need to be altered slightly to attain IP. The data for this frequency were recorded just as in the Constant k method. Now the frequency was advanced to the value observed for the second constant k position for the first value of the reference independent variable. Since the surface state had been altered, this frequency would not correspond to IP, but had to be altered slightly for proper phase alignment. This procedure was repeated for the remainder of the constant k positions and then the frequency was returned to the value observed for the first constant k position. Again the stability of the data supported the unchanging nature of the surface state.

Thus a Constant k experiment was done at each of several frequencies. There are two magnitudes of frequency changes being discussed. Large frequency changes were associated with increasing the number of waves between the probes while the surface concentration was held constant. Small changes of frequency resulted from changing the surface concentration while holding the number of waves constant. It is essential that no confusion result from these two magnitudes of variation. The change of frequency required for unit increase in waves between probes was 10-40 Hz. The changes at a given constant k position resulting from surface concentration changes were less than 2 Hz at a time. The total change in frequency at a constant position might approach 20-30 Hz, but this change was brought about gradually so that confusion was avoided.

The advantages of this method included all of the advantages of the Constant k method which resulted from keeping difficultly measured variables constant. The amount of ripple information was directly proportional to the amount of data taken, so that performing a single Multiple Constant k experiment with five constant k positions yielded the same information as performing five separate Constant k experiments at the same initial frequencies. There was an additional advantage in the Multiple Constant k method when the time required for surface steady state was considerable. Frequently the slowest part of an experiment was the delay required for the surface properties to come to steady state. With the Multiple Constant k technique, this delay was paid only once, whereas for separate Constant k experiments the delay was paid each time. After some practice it was possible to record all the data for a single value of the reference independent variable in a five position Constant k experiment in about eight minutes. The time required for surface equilibration was generally 3-30 minutes or more. Full use of the Multiple Constant k technique required that the surface tension be measured at the same time as the remainder of the data were taken. The plate or surface balance were quite acceptable, but the drop volume method which required aliquot removal obliterated most of the advantages due to increased time consumption.

The validity of one point measurements required some assumptions about the behavior of the mechanical waves and the assumptions required for interpretation of their transduced electrical analog. In particular the phase behavior was not quite as simple as the above discussion of multiple k techniques implies. Moreover, the accurate characterization of one point damping coefficients required some calibration corrections, which will be discussed in detail in the calculation section. Regardless of the corrections which Constant k methods required, they were without doubt the best way to obtain capillary ripple parameters.

CALCULATIONS

The calculation of the damping coefficient, α, depends on the relationship of output signal and probe separation. Mann and Hansen (40) report that the output signal is represented by

$$V(L,\ t) = \frac{C \exp(-2\alpha L) \exp i\ (\omega t - \theta)}{\left\{1-2 \exp[-2\ (\beta+\alpha L)]\ \cos 2kL + \exp\ [-4(\beta+\alpha L)]\right\}^{1/2}} \tag{1}$$

where $\tan \theta = \coth(\beta + \alpha L) \tan KL$ and $V(L,\ t)$ is the output signal as a function of probe separation L and time t, C is a constant, ω is the cyclic frequency, and β allows for an amplitude change of the reflected wave.

Time dependence was removed experimentally by the voltmeter which responded to the RMS value of a sinusoidal wave. However, the lock in amplifier responded to the product of the input signal and the cosine of the angle between the input signal and the reference signal. It was this final product which was time averaged.

The reference signal may be represented as $VR(t) = B(\omega)\ e^{i(\omega t\ +\ \Phi)}$ where φ indicates all the phase dependency in the transduction of the mechanical wave to the observed electrical image.

Our time averaged LIA output now appears as

$$V(L) = \frac{VO \exp(-\alpha L) \cos(\Phi - \Theta)}{\{1 - 2e^{-2(\beta+\alpha L)} \cos 2kL + e^{-4(\beta+\alpha L)}\}^{1/2}} \qquad (2)$$

where VO replaces the product of C and $B(\omega)$. The Φ dependence is unknown precisely, as all the intimate details of the coupling and sensing mechanisms between mechanical values and the displayed Lissajous figure are unknown.

A RMS meter detection system permits removal of the $\cos(\Phi-\Theta)$ term. This was the situation for earlier workers as well as for the early work in the present study. For those cases two situations are possible.

If the denominator can be replaced by 1, $V(L) = Ce^{-\alpha L}$. For constant frequency C is a constant and so

$$\alpha = \frac{\ell n\, V(L_2) - \ell n\, V(L_1)}{L_2 - L_1} \qquad (3)$$

where the subscripts refer to the probe positions involved. Choosing the positions as successive in phase positions yields wave lengths concurrently. This is the simplest Vary L calculation procedure.

If the denominator oscillates rather than holding constant the maximum value of the signal $\bar{V}(L)$ occurs when $\cos 2kL = +1$ and the minimum value $\underline{V}(L)$ occurs when $\cos 2kL = -1$. It can be shown with $\beta = 0$ that

$$\alpha = \frac{1}{2(L_2-L_1)}\left[\ell n\left(\frac{\bar{V}(L_2) + \underline{V}(L_2)}{\bar{V}(L_2) - \underline{V}(L_2)}\right) - \ell n\left(\frac{\bar{V}(L_1) + \underline{V}(L_1)}{\bar{V}(L_1) - \underline{V}(L_1)}\right)\right] \qquad (4)$$

It is also true that (36)

$$\alpha = \frac{1}{(L_2 - L_1)} \left[\ell n \left(\frac{1}{\bar{V}(L_2)} + \frac{1}{\underline{V}(L_2)} \right) - \ell n \left(\frac{1}{\bar{V}(L_1)} + \frac{1}{\underline{V}(L_1)} \right) \right]$$

which is more accurate when $\bar{V}(L)$ and $\underline{V}(L)$ are close together. These two equations may be used to calculate α from Vary L or Max-Min experiments.

Obviously the oscillation of the denominator complicates damping coefficient calculation. Table 2 lists values of the denominator for the extremes which are possible for $\beta = 0$.

Table 2. Denominator extremes

αL	$1 - e^{2\alpha L}$	$1 + e^{2\alpha L}$
1.4	.938	1.062
2.0	.982	1.018
2.4	.992	1.008
2.8	.996	1.004
3.0	.9975	1.0025
3.6	.9992	1.0008

For $\alpha L = 2.4$ a maximum error of 2% results if the denominator in Equation 1 is replaced by unity. With larger αL this error is even less and amplitude decay may safely be taken as exponential. In this case $V(L) = VO\ e^{-\alpha L}$, and α may be obtained in a constant L experiment from a single output voltage measurement

$$\alpha = - \frac{1}{L} \ell n\ V(L)/VO \qquad (6)$$

One point damping coefficients thus depend on knowledge of the probe separation, L, and the quantity VO. VO may be considered the amplitude of the wave at the generating probe as seen by the receiving probe. This approach will allow for proportional error cancellation.

The earliest Constant k work took VO to be a constant independent of frequency. The probe separation actually measured, L_o, was combined with the observed $V_o(L_o)$ and independently determined initial damping coefficient, α_o, to obtain VO. Subsequent damping coefficients could be expressed relative to this first one independent of L_o.

$$\frac{\alpha}{\alpha_o} = \frac{\ell n \ V/VO}{\ell n \ V_o/VO} \tag{7}$$

Thus the initial value of α_o may not be known particularly well if it results from a Vary L experiment, but subsequent α's are known as well as V and VO are.

This fortunate situation will not obtain with a LIA detection system. Recall the cos $(\Phi-\Theta)$ term in Equation 2. Since a relative system is being proposed, let us use the adjustable phase control when the pure system first point is being determined. The phase Φ is now replaced with a phase Θ_o which is associated with the first damping coefficient α_o. It can be shown from the definition of Θ and considerable algebra that

$$\cos\,(\Theta_o-\Theta) \approx 1 - \frac{1}{2}\ \frac{\tan^2 kL\,(\coth \alpha_o L - \coth \alpha L)^2}{1 + \tan^2 kL \coth^2 \alpha_o L} \tag{8}$$

It turns out that this quantity does not differ greatly from 1 as long as α does not differ greatly from α_o and αL is not too small. The quantity depends on the value of kL, but the largest deviations from unity occur as kL approaches a multiple of $\pi/2$ radians. For αL near .5 the cosine term may vary 4%. For αL near 1 this is down to 1% and decreases rapidly. A 40% variation in α was assumed for these calculations. Thus it is obvious that the cosine term variation will be negligible in regions where the denominator variation in Equation 2 may be neglected.

It is essential to observe that this fortunate situation is only true if Φ can be equated to θ_o. A Constant k experiment provides the best method of approximating this condition. In a Vary L experiment it is quite possible that Φ would not behave this way. In fact the LIA has been used in a mode where Φ was arbitrarily adjusted to maximize V for the first point. Thereafter variations in V were attributed only to changes in an exponential α.

Part of the uncertainty in the proper calculation for α is removed when it is realized that VO is not a constant but is a function of frequency. This function is determined independently and used to calculate damping coefficients from

$$\alpha = -\frac{1}{L}\,\ell n\; V/VO(\omega)$$

where L is measured directly and VO(ω) is known from other experiments. This formula should be satisfactorily accurate if $\alpha L \geq 2.4$, and it was only used for interpretation of experiments satisfying this condition.

At separations sufficiently great to satisfy $\alpha L \geq 2.4$ the output signals were generally small. The noise was approximately independent of L, so on increasing L the signal to noise ratio continuously decreased. Thus the probe separation was a compromise between large separations where the behavior was very convenient and small separations where the signal to noise ratio permited good damping coefficient resolution.

A characteristic of oscillating mechanical systems which had been overlooked for some time was the nature of the resonance peak. The modifications of the loudspeaker which permitted vertical motion introduced elastic membranes into the system. The fluids touching the generating probes introduced more damping. These factors interacted with the forcing function causing oscillation in such a way that the vertical amplitude of the generating probe depended on the frequency, especially near the resonance frequency. The generator amplitude was reflected in the value of VO which became frequency dependent.

Since VO was an essential part of the damping coefficient calculation, it was important to determine VO as a function of frequency with considerable accuracy. The following experiment was performed towards this end. The absolute probe separation was measured for a given number of waves between the probes and a given frequency; a twenty wave separation was convenient. The system was adjusted so that these conditions were occurring at an in phase condition. Next the frequency was advanced slightly. This lack of phase registry was compensated for by decreasing the probe separation and the frequency, output signal, and resistance reading at this new in phase condition were recorded. Presumably the same number of waves was between the probes, but at any rate the same Lissajous figure was retained. This procedure was continued until the entire frequency spectrum had been covered. All of the observed resistances were converted into distances and these were used to calculate probe separations based on the original resistance when two probes were touching. Since this experiment took place on a pure system, theory could be used to calculate the expected damping coefficient for the particular experimental frequency. The observed output signal and probe separation were used with the theoretically calculated damping coefficient to establish the quantity VO for each frequency.

Since calculated damping coefficients were used, any calculations based upon this VO curve were based on the theoretical values. Since the curve was obtained by measuring values in the same way that unknown damping coefficients were determined, one should hope for cancellation of errors. Thus it was differences in behavior between the clean and surfactant covered surfaces that became important. If the output signal depended on contact angle, and if this contact angle changed between clean and covered systems differently on the generating and sensing probes, then the one point damping coefficient would be in error. Many sources of error could be imagined. For example in the aliquot removal techniques the level of the interface was lowered, contact between probes and lower phase was lost, and the probes became immersed entirely in the upper phase fluid. When the aliquot was returned the level raised and agitation with the stirring bar caused the interface to be disrupted. The fact that damping coefficients based on a one point output signal determination were even in moderate agreement was surprising. Naturally, the precision of multiple determinations of damping coefficients with this technique was lower than for less violent methods, but the numbers were still useful.

Many questions about the propriety of various damping coefficient calculational short cuts could be ignored when the experimental uncertainty in the best possible method, the Vary L technique, was recalled. Since in this simplest experiment the uncertainty was about 10% for various methods of drawing the envelope curves, alterations used in more approximate calculations which did not exceed this value could be accepted. That is not to say that the precision could not be made better than 10%, but only the accuracy of the first point upon which others were based was no better than that.

As can be seen by the representative VO curve, Figure 8, the resonance maximum was in the frequency region which was of interest. As a matter of fact, for oil/water systems the signal to noise problem was such that good measurements could only be taken when the generator amplitude was accentuated because of the resonance maximum. For air/water systems the immensely better signal/noise ratio permitted data accumulation at higher frequencies where the dependence of VO on frequency was much less. There was another resonance peak around 640 Hz. The curves with and without the presence of a liquid upper phase were similar, but the amplitude was somewhat reduced when an oil phase was present. Multiple determination of the VO curve resulted in similar plots, but they were not identical. These duplicates came closer to superimposing if the vertical scale was shifted. That is, the frequency dependence was pretty well known, but the amplitude varied somewhat.

The output signal was assumed to be directly proportional to the input signal. This was observed to be true as long as the input signal was not increased too far. It was probably true as long as the wave amplitude was not made so large that the physical assumptions required for linearization of the Navier-Stokes equation broke down. When the LIA was used for output signal determination in conjunction with the digital voltmeter, the DVM was set to read as a fraction of full scale of the LIA regardless of what scale of the LIA was being used. Thus it was necessary to record what sensitivity setting was associated with a given DVM output. The assumption of exponential damping thus resulted in the following equation to determine the damping coefficient

$$\mathrm{ALPHA} = \frac{1.0}{\mathrm{SEP}} \times \ln \frac{[\mathrm{VOONU} \times \mathrm{FACT} \times \mathrm{SKALO} \times \mathrm{EIN}}{(\mathrm{EOUT} \times \mathrm{EINO} \times \mathrm{SKAL})]} \qquad (10)$$

where ALPHA is the damping coefficient in cm^{-1}, SEP is the probe separation in cm, VOONU is the amplitude function previously called VO in volts, EOUT is the observed output signal in volts, EIN is the observed input signal in volts, and SKAL is the observed sensitivity setting in mV. EINO and SKALO refer to the input voltage and sensitivity setting for the first point. FACT is a scale factor which effectively shifts the VOONU curve vertically. It was calculated by assuming the theoretical value of the damping coefficient which was associated with the output data for the first clean system point. FACT was usually between .9 and 1.1. The value of FACT could be used to ascertain that the experiments were being performed similarly.

Oscillatory systems which have amplitude resonances undergo phase shifts at the same time. If no damping were present, an 180° phase shift would occur on passing the resonance frequency. The corners of this step function phase shift are increasingly rounded as the damping in the system increases.

In reality the Constant k experiments were more properly called constant Lissajous pattern experiments, or constant phase experiments. It became obvious that the phase should not be invariant with frequency. Since the experiments involved frequency changes, it was essential to know what was happening to the phase. The original assumption that an integral number of waves resided between the probes when an IP Lissajous pattern was observed was not true. Several reasons why this assumption may fail can be suggested. First, the electrical phase determination may not correspond to the mechanical system. The tuned amplifier and frequency dependent filters in the measuring circuit could easily lead to such lack of correspondence. Second, the wave pattern near the generator was probably not sinusoidal. Third, the probes were not infinite boundaries, but were in fact in motion.

The same calibration experiment which established VOONU could be used to determine the phase correction. If information was gathered for a pure system, theory could be used to calculate the expected wave length as well as the expected damping coefficient. The absolute probe separation was measured, although it was not known too well. The number of waves between the probes was simply obtained by dividing the observed probe separation by the calculated wave length. A number resulted which was not integral. Similar numbers resulted from each point of this constant phase calibration.

Even though the absolute probe separation was not known well, differences in sensor position were known with considerably more accuracy. Thus the number of waves presumably between the probes for the first position could be inaccurate by up to 1/2 wave; differences due to subsequent positions at higher frequencies were known to be nearer .01 wave. The apparent number of waves could now be plotted as a function of frequency. It was particularly true for air/water systems that these plots looked very much like plots of the phase as a function of frequency for damped oscillatory systems. Then the apparent number of waves could be corrected by reference to a plot of the deviation of the number of waves for the pure system from a constant.

This calibration technique kept the apparent number of waves constant while varying the frequency. Thus if 20 waves were between the probes at the first point, by the time that the frequency had been increased to its final value, only 19.5 waves might be between them.

This calibration could be performed in a second way which was similar to the Vary Frequency technique. The probes were placed about 4 cm apart and at an IP condition and the frequency and probe position noted. Now the frequency was advanced at constant probe position until a new IP resulted. This corresponded to increasing the number of waves by about one. This procedure was repeated until the end of the desired frequency range was reached; then the probes were moved slightly and the entire procedure repeated. The IP's occurred at different frequencies for this new position. This procedure was used to scan the frequency range as closely as desired and the same calculation of number of waves based on observed separations and calculated wave lengths was repeated. This time the number of waves was expected to increase by 1.0 for each new phase position. Thus if 20.0 waves were between the probes at first, the next position should have corresponded to 21.0 and so on. It was observed that this was approximately true, but not quite. Thus the second position might have resulted in a value of 20.98 waves instead. A correction plot could be made as a function of frequency by subtracting the original number of waves increased by the integral number of IP positions passed.

Such a plot for a heptane/water calibration is shown in Figure 9. Since the original absolute probe separation was somewhat uncertain, the starting value for the number of waves was essentially arbitrary. The accuracy of changes in separation was demonstrated by the degree to which the points from different positions superimposed on the curve.

The two methods of phase correction resulted in similar correction plots. The error made by assuming no correction at all, i.e., that phase was independent of frequency, rarely exceeded 5% from one side of the frequency range to the other. For low damping systems the assumption of simple 1/2 wave step decreases at resonance frequencies reduced error to 1-2%. For higher damping systems the step functions were not very realistic. Consequently the phase correction plots were used for adjusting the nominal values of k. It is interesting to note that with a little care in selection of frequency ranges for Constant k experiments, the total change in k could easily be kept under 1%. That is, even if no phase correction were made, the maximum error due to omission of this correction was 1%. Nevertheless, this 1% error was too large for Yl determination, so the correction was made.

The second method of phase correction was preferred, since it corresponded most closely to the way in which a Constant k experiment was performed. Also, the fractional error in probe separation was smaller for this method, since the probes were kept several cm apart. When the first type of correction was made and the probes moved closer together, the separation at higher frequencies could be less than a centimeter.

Computer Programs

A number of computer programs have been written to handle the calculations in converting raw data into the more useful variables of interest in capillary ripple propagation. Programs were written in Full Fortran IV language and implemented using the Fortran G compiler under OS control on an IBM 360/65 computer. Earlier work was done with a smaller system which did not permit all of the features of Full Fortran.

EXPT

A listing of the program with the name EXPT is found in Appendix B. An extensive series of comment cards details the data deck structure and there are a few further comments in the source listing, but the main logic will be discussed here. The purpose of this program is to convert the raw data from a variety of Constant k type experimental modes into useful ripple parameters, produce compact data summaries, and supervise the graphing of this data. The graphing is greatly simplified by the utilization of a plotter and controlling routines which are available at the ISU Computation Center.

A number of arrays are defined. All real variables are implicitly made double precision to avoid roundoff errors. A few variables are explicitly single precision to conform with subroutine requirements. Most of the array names should be obvious. X and Y are arrays which contain the 10 variables pertinent to ripple propagation. They are respectively damping coefficient, wave number, lower phase viscosity, upper phase viscosity, lower phase density, upper phase density, interfacial tension, cyclic frequency, real component of elasticity, and the imaginary component of elasticity. The next four arrays contain literal data for output listing labels. VARIND contains the number which will be converted to the reference independent variable. XVAL will hold the reference independent variables calculated from VARIND. BNOWV is an alternate array for holding the contents of ANOWV, both of which refer to the set of numbers representing how many waves are between the probes. RELFQ stands for the relative frequency which results from dividing subsequent frequencies by the first position frequency. HZOAMP, AAMP, and BAMP refer to polynomial equations fitting the VOONU curve as a function of frequency. The first gives values of the frequency which begin a section, the second gives the intercept, while the third holds the coefficients of the polynomial equation. The next three arrays perform a similar job for the phase correction curve.

The program begins by transferring some literal data to the title page of the output set and listing the system constants. Statements 23-27 cause reading of data which include parameters to control the further flow of the program. NOK is the number of constant k positions involved in the experiment. IINDVR and ISFTN detail the type of reference independent variable and type of surface tension measurement. The remaining variables specify how the data should be presented at output. The first call to Subroutines INDVAR snd SURFTN causes branching which depends on the kind of experiment being done. On this first call the additional constants needed for calculation of the reference independent variable and the interfacial tension are read in under Subroutine control. Subroutine DISTNC converts a resistance reading to a distance reading. The probe separation is computed and converted to double precision.

At Statement 35 the X array is loaded with the initial guesses for the damping coefficient, wave number, and surface tension. After some titles the input data for the first constant k position are read in. The two dimensional arrays have the following subscript pattern:

(I,J) where J refers to the constant k position number, and I refers to the reference independent variable number.

Using the observed base frequencies the POLZRO Subroutine is used to calculate the theoretical damping coefficient and wave number. The apparent number of waves is calculated from the observed probe separation. Since POLZRO uses an iteration solution, the initial guess for subsequent calculations is always set equal to the final result of the previous step.

The call to AMPLTD at Statement 53 calculates the VOONU value pertinent to the supplied frequency value. Using the calculated damping coefficient and observed signal, the factor VOOFAC is determined. Subsequent damping coefficients will use this factor to adjust the vertical scale of VOONU curve. Similarly the phase correction in terms of number of waves is obtained from the PHSCOR call at Statement 56. Note that on this first call to PHSCOR the corrections are stored in an array in PHSCOR; on subsequent calls to PHSCOR the correction obtained will be subtracted from this first correction. In other words, the first call establishes the reference to which further calls are compared. This is essential because of the arbitrary nature of the PHSCOR curve starting position. The first calculated wave number is taken as correct and the observed wave numbers are determined relative to it. These results are listed and this procedure looped until all the constant k positions are treated.

The second call to INDVAR at Statement 62 causes writing of the data which this subroutine is using to calculate the reference independent variable values. Again the output will depend on the type of experiment performed. Similar behavior occurs on the second call to SURFTN. Note that this subroutine has used the measured first value of a surface tension determination and the surface tension assumed for this point to calculate the constant involved in subsequent calls. This makes all values relative to the first one.

The remainder of the data is now read in and listed. Note that the input data are searched for a sentinel card which sets the number of independent variable values involved.

At Statement 82 the main calculation loop begins. INDVAR converts the observed data to a value of the reference independent variable. SURFTN calculates the interfacial tension. DMCOEF supervises a call to AMPLTD and then calculates the damping coefficient assuming an exponential relationship and using the sliding factor. PHSCOR calculates the phase correction, compares this to the first correction calculated, and uses this difference to calculate the number of waves and the wave number. ELASCX now calculates the real and imaginary components of the complex elastic modulus by inverting the theoretical calculation in POLZRO. Note that when POLZRO is used to calculate the damping coefficient and wave number, it is necessary to supply the values of the elasticities. These are normally both taken to be zero, hence the elasticity results obtained are relative to this initial assumption. Y1, Y2 and the relative frequency are now straightforwardly calculated.

Result outputs may be obtained in a variety of ways, including different types of printed output and punched cards. GRPHRT is called to supervise graphing options and the main program is repeated for as many data sets as desired.

Subroutine DISTNC is self explanatory. INDVAR branches to one of three sections depending on whether a constant area insoluble, variable area insoluble, or constant area soluble type experiment is done. The calculational methods have already been discussed and are obvious. The first call is used to input the various constants, the second call is used to list them, and subsequent calls perform the desired calculations. Note that the value assigned to a zero input is arbitrarily specified. This avoids dividng by zero or taking the log of zero which would terminate program execution.

AMPLTD represents the VOONU curve in segments by a polynomial in the coded frequency. Up to a tenth order polynomial may be used in each of ten segments. The data for this routine are entered so that changing calibrations can be accommodated without rewriting the source program.

PHSCOR is quite similar with the addition that the first call stores the correction in an array called RES. ANWV is the apparent number of waves while BNWV incorporates the correction to the number of waves. ANWV is calculated from the observed probe separation and the calculated wave length. This method of calculation means that the PHSCOR curve has an arbitrary additive constant.

SURFTN branches to sections pertinent to an oleophilic Wilhelmy plate calculation or to a film balance measurement. On the first call to either section the input parameters are read in. On the second call if a Wilhelmy plate calculation is desired, the immersed fraction of the plate is arbitrarily varied to obtain the interfacial tension closest to the assumed value and observed force. This calculation uses the input plate perimeter which is now regarded as determined from the assumed interfacial tension, calculated depth of immersion, and observed force. Regardless of which method is being used, the Subroutine lists the constants which are to be used for subsequent surface tension calculation. The formulas used have already been discussed.

DMCOEF is obvious except that all denominator terms are checked to avoid division by zero. An arbitrary value of ALPHA is assumed so that subsequent calculations do not attempt to take the log of zero. ELASCX calculates the components of the elasticity when all the quantities of the X array are known except EP and EPP, the real and imaginary elasticity components.

POLZRO, FNCALC, COEF and CCOEF are subroutines provided by J. Mann (42) which solve the complex equation relating the 10 capillary ripple parameters. Theory may be expressed in the equation

$$F = \sum_{j=1}^{5} C_j (k + i\alpha)^j = 0$$

where C_j are functions of all ten variables, k is the wave number, α is the damping coefficient, i is the square root of -1. Solution of the equation is possible because the coefficients are not very strong functions of the rapidly changing variables. Determination of the two elasticity variables given the other eight usually results in 1 to 4 loops where F is required to be less than $10^{-8} + i\ 10^{-8}$. Occasional convergence problems arise if the proper roots are too far from the initial guess. The program converges, but it produces the wrong roots. The required agreement between initial and final guesses depends on the remainder of the variables in the experiment, but no major difficulties result from this situation.

GRPHRT supervises labeling and calling the subroutines which produce graphs of the ripple parameters. The loops around each CALL GRAPH are used to cause superposition of all constant k positions on the same graph. Considerable transferring of literal data is required to make the routine versatile enough to handle any number of constant k positions from 1 to 10 without knowing how many until object time. Most of the graphs have the reference independent variable for their x axis, but it is also possible to obtain Y1 and Y2 plots with the surface pressure as ordinate.

NWV

The Appendix contains a listing and typical output results for the program NWV. This program handles calculation of the number of waves and the VOONU function for pure system calibration. The calculations are similar to parts of EXPT and should be easy to follow with that program's details in mind.

CALB

The amplitude curve and the phase correction curve which resulted from application of NWV could be fit with polynomials with the use of a program, CALB, programmed by G. Bierwagen. This program, which is listed in the Appendix, codes the input data and supervises calls to OPLSPA. OPLSPA is a subroutine provided by the system which calculates least squares polynomials by the orthogonal polynomial method. This program is extremely rapid in operation.

Although numerous other programs have been used, the ones discussed handled most of the experimental data work up. EXPT could be extended to handle drop volume surface tensions.

A rather extensive program, CRT, was written to perform theoretical calculations. At the time that it was written the Computation Center did not have Full Fortran available. This meant that all computations had to be done in purely real numbers. The complex theory was expressed in real and imaginary components by exceedingly tiresome algebra and programmed. Shortly after this task was completed the complex number capability of full Fortran became available so that the theory could be programmed directly. J. Mann was interested in theoretical interpretation and carried out this programming task. Mann also programmed a numerical differential error calculation to study error propagation. These and other programs will be published by Mann elsewhere (42). Some of the results of these programs will be presented as they pertain to the interpretation of experimental data.

Propagation of Error

Improvement in error level was a continuing challenge throughout this project. Determination of the quantities Y1 and Y2 was fairly difficult, but the propagation of error in the calculation of the derived components of the elasticities was astoundingly rapid.

It is important to distinguish accuracy from precision. Thus a Constant k experiment did nothing to improve the accuracy of the wave number, but its precision was as good as the phase resolution permitted. The accuracy of k was probably not better than 1%, but under favorable phase resolution conditions the precision could have been fifty times better than this. Although the phase error correction was small, if this correction was not made the error was near 1% again. This was particularly difficult, since it was a systematic error which might otherwise have been attributed to behavior of the surfactant.

The best possible error levels were those associated with the reading limit of the instruments involved. The following reading limits were pertinent to a Constant k experiment. The output signal could be read to four places, the force on the plate to .1 mg, the input signal to three places, and the frequency to .1 Hz.

More realistic error levels depended on the type of experiment performed. Thus if aliquots were removed the system was not as reproducible as if the interface level remained unchanged. Similarly, the output signal tended to fluctuate badly. The various filter systems in the LIA and DVM smoothed random noise very nicely, but slower trends were sometimes visible. It was possible that slight changes in the surface state were taking place to cause these, but the unknown sensing mechanism made detailed analysis difficult.

It was observed that the stability of the output signal was reasonably good for the pure system and for high coverages of surfactant, but tended to deteriorate at moderate surface coverages. Sometimes one could observe fluctuations in the output signal and the phase pattern which were correlated. These observations suggested that the nature of the surface was changing with time. This was particularly apparent with insoluble films at the air/water interface, perhaps due to islands of surfactant. It must be remembered that this experiment was at best a steady-state and not equilibrium one. Energy was constantly being fed into the system to maintain the wave motion and was being dissipated by frictional forces in the bulk phases and the interfacial film.

The accuracy of the damping coefficient was about 10-20%. This figure was a result of Vary L calculations in which the method of calculation was slightly ambiguous due to lack of data which follow the theoretical voltage distance curve precisely. The accuracy also depended on the error in measuring probe separation and the error in the amplitude, VOONU, curve. The absolute probe separation was known to about 1/2 a wave length. The amplitude of the VOONU curve was a strong function of frequency, hence the error in replicate determinations of this curve would depend on the frequency. A 50% error was possible in the steepest parts of the curve, but 10% was a more reasonable figure.

The precision of the damping coefficient was considerably better in a Constant k experiment. This was particularly true when the first value of alpha was calculated and used to vertically shift the amplitude curve. Here the probe separation was unchanged and its error could be taken to correspond to the error in phase resolution, about .01 wave or better. The error in the amplitude curve could be taken as a fraction of per cent. The input signal was known to about .2% while the various scales on the LIA appeared to be calibrated correctly to at least 1%. The output signal was unquestionably the limiting variable in precision. How good this was depended very much on the kind of experiment, the surface coverage, the type of compound, and numerous other unidentified quantities. Sometimes the signal seemed to be stable to three places or about .5%, while at other times a 10% or more variation occurred. Several of the relatively minor technique modifications introduced were for the purpose of improving stability of signal.

The accuracy of the frequency measurement was probably the same as its precision, .1 Hz. However, when an aliquot type experiment was done, the frequency for corresponding in phase positions on duplicate determinations could have been .5 Hz. This was not really a reflection of poorer frequency measurement, but an indication that the surface state was not readily repeated when the surface level was moved.

The accuracy of the interfacial tension measurements was more difficult to assess, as the right answer was unknown. Obviously, the surface balance measurements had better precision than the absolute method. Contact angles could produce quite serious systematic errors nearing a few dynes/cm for higher surface coverages, but it was felt that .1 to .5 dynes/cm was the probable error range.

Accuracy in the reference independent variable was not really important in this experiment, as this quantity really served only as a scale for plotting and reference. For truly insoluble surfactants, the surface concentrations were probably good to 10%. For the interfacial cases the solubility of the surfactant was again probably known to 10% assuming there was no oil phase solubility. For spread surfactants the apparent calculated surface concentration had little significance due to bulk phase solubility. Surfactant was adsorbed at the interface while it was being squirted into the ripple trough and its distribution was far from equilibrium. The numbers calculated could be incorrect by several orders of magnitude. It was precisely this reason that suggested that surface pressure might be a more useful reference independent variable. If all surfactants behaved identically, the results for various surfactants should superimpose.

The errors in the viscosities and densities of the upper and lower phases were essentially negligible. The precision error was negligible and the accuracy error depended upon how well the system under study conformed to the system for which these constants were determined. Viscosity was highly temperature dependent so the room was maintained at 25° with .1° control. The use of dilute salt solutions as the lower phase could have altered the density slightly. All these errors were neglected compared to the errors in the variables which changed during the course of an experiment.

The two principal display parameters combining the results of each experiment are Y1 and Y2. $Y1 = (\rho + \rho')\omega^2/\gamma k^3$ and $Y2 = \alpha/k$. It can be seen that a maximum differential error analysis leads to

$$\frac{dY1}{Y1} = \frac{2d\omega}{\omega} + \frac{d(\rho + \rho')}{(\rho + \rho')} + \frac{d\gamma}{\gamma} + \frac{3dk}{k}$$

$$\frac{dY2}{Y2} = \frac{d\alpha}{\alpha} + \frac{dk}{k}$$

Taking $d\omega = .1$ Hz, $d\rho = .001$ g/cm^3, $d\gamma = .1$ dynes/cm, $dk = .01$ cm^{-1}, and $d\alpha = .01$ cm^{-1}. The fractional error in Y1 is .4% and that in Y2 is .2%. Note that these are the lowest reasonable reading errors and represent the best possible accuracy. Error is mainly due to surface tension.

The more reasonable values of $d\omega = .1$, $d\gamma = .3$, $dk = .1$, and $d\alpha = .03$ lead to a 1.7% error in Y1 and 4% error in Y2. Here the wavenumber is becoming more critical. Note that this is only a .3% error in wave number.

A more pessimistic set of values would assign $d\omega = .5$, $d\gamma = .5$, $dk = .5$, and $d\alpha = .1$. These lead to relative errors of 4.5% in Y1 and 12% in Y2 in which errors in k and α are the most significant factors.

The reasons that these errors are so serious are obvious when the expected range of the Y1 and Y2 variables are considered. The change expected for Y1 from a pure system with zero elasticity to a completely covered one with infinite elasticity is only 5% for an air/water interface. The change expected for an oil/water interface is even less. The Y2 change for an air/water system is 100% but only 10% for an oil/water interface. Thus in all cases the Y1 curve is difficult to obtain with sufficient accuracy to be informative. This is not true for Y2 at the air/water interface but for the oil/water interface the Y2 range is almost of the same order of magnitude as the expected error in Y2.

Another criterion of precision and accuracy is the signal to noise ratio. Although this is not required for maximum differential error, it is a good indication of the accuracy of phase resolution and of output signal. In a Constant k experiment the question of how to determine the noise was important, if the output signal was measured with no input signal, the noise was negligible with the instrumental modifications discussed. If the LIA was not used, the zero input noise was sufficiently large that extensive modifications, previously discussed, were made to reduce it. The noise for air/water and oil/water systems was about the same, but the signal for air/water systems was 100 times greater than the signal for oil/water systems. A S/N ratio of 1000 or better held at the air/water interface; this dropped to 30 for the oil/water interface.

It was observed that a driven generator produced very appreciable signals from the sensor even when the sensor was not in the interface, so long as it remained in the oil phase. Moreover, these signals were sinusoidal and resulted in phase patterns. It was even possible to get some phase patterns when the sensor was completely external to the ripple trough. These surprising results were attributed to the existence of mechanical coupling of the generator and sensor through both the bulk phase and the rack supporting the experiment. This coupling was negligible for air/water work because the signals were so much larger at the interface. As the signals at the oil/water interface became smaller, higher and higher sensitivities were required to detect the wave. Another way of stating this is that the interfacial properties did not dominate the oil/water interface as strongly as they did the air/water system.

This mechanical coupling persisted up to quite high frequencies. It was the reason why oil/water experiments were best done around the speaker's resonance maximum. At the maximum the signal to noise ratio was highest, since the signal was a factor of 10 higher while no noise increase took place. Increasing the power to the generator increased the non interface coupling at the same time, hence no relative increase in surface effect was observed. As mentioned earlier, the random noise was no problem because of the signal averaging filters.

Some simple solutions to this problem were attempted. A second crystal cartridge was used to provide the noise signal for a differential input. If this noise sensor were properly positioned, the mechanical coupling component should be reduced. Unfortunately, the position of this noise sensor was critical. This idea might be pursued with a second micromanipulator by placing the noise sensor in the ripple trough at right angles to the wave propagation direction. An attenuator and phase shifting network would also be essential. Another possibility might be to work at the out of phase position rather than the in phase one. Mechanical coupling appeared to be smaller there.

An even more serious problem than the high levels of experimental error compared to the range of Y1 and Y2 was the propagation of error in calculations. It was desired to calculate the real component of the complex elastic modulus, E', and the imaginary component, E", when the remaining eight variables were known. The theoretical equation had been programmed for this as discussed under programming. It turned out that rather moderate uncertainties in the input variables led to quite large uncertainties in the elasticities.

J. Mann programmed an error analysis calculation to demonstrate this problem. The calculation was a maximum differential error type calculation, but was complicated by the great difficulty in differentiating the function F. Estimates of these required derivatives were obtained numerically.

Table 3 presents the error analysis for a few points of the octadecyl acetate data. Three surface pressures were chosen for examination, one at the beginning of the experiment, one at low pressures, and one at higher pressures. The associated values for the elasticities are zero, low, and intermediate. The absolute error assumed for each computation of the standard deviation is indicated in the table. All the values in this table are associated with essentially known viscosities and densities. The error assigned to these constants is one in the last place.

The first set shows the expected errors if all input variables are known to the reading accuracy. This indicates that perhaps one place elasticities are theoretically possible. The remainder of the table shows the results of more

Table 3. Standard deviations of elasticity components for octadecyl acetate experiment

	π	E'	E''
.1	0.0	0.0	0.0
.2	.9	-.7	.1
.3	4.9	4.9	1.3

$\Delta\mu' = \Delta\rho = .00001$

$\Delta\rho' = \Delta\rho = .0001$

No.	$S_{E'}$	$S_{E''}$	$\Delta\alpha$	ΔK	$\Delta\gamma$	$\Delta\upsilon$
1.1	.03	.02	.0001	.001	.0001	.01
1.2	.08	.06				
1.3	.03	.01				
2.1	.23	.14	.001	.01	.01	.1
2.2	.24	.47				
2.3	.28	.02				
3.1	.24	.19	.01	.01	.01	.1
3.2	.77	.67				
3.3	.28	.16				
4.1	.80	1.4	.1	.01	.01	.1
4.2	2.0	4.7				
4.3	.28	1.5				
5.1	.38	.26	.01	.01	.1	.1
5.2	1.2	.92				
5.3	.48	.16				
6.1	.85	1.4	.1	.01	.1	.1
6.2	2.2	4.8				
6.3	.48	1.5				
7.1	.63	.41	.01	.01	.2	.1
7.2	2.0	1.4				
7.3	.83	.16				
8.1	1.5	.94	.01	.01	.5	.1
8.2	4.7	3.2				
8.3	2.0	.17				
9.1	1.4	.80	.01	.1	.1	.1
9.2	4.3	2.7				
9.3	1.6	.16				

Table 3. (Continued)

No.	$S_{E'}$	$S_{E''}$	$\Delta\alpha$	ΔK	$\Delta\gamma$	$\Delta\upsilon$
10.1	2.7	1.5	.01	.2	.1	.1
10.2	8.4	5.2				
10.3	3.1	4.6	.18			
11.1	4.1	2.3	.01	.3	.1	.1
11.2	13.0	7.7				
11.3	4.6	.21				
12.1	.50	.33	.01	.01	.1	.2
12.2	1.6	1.1				
12.3	.62	.16				
13.1	.98	.60	.01	.01	.1	.5
13.2	3.2	2.1				
13.3	1.2	.16				

reasonable error estimates. Note that the low elasticities have extremely high standard deviations. It is evident why elasticity plots were quite erratic in this region; the standard deviation could easily be 10-50 times the value of the elasticity itself. This means that the elasticity is known to only one or two orders of magnitude. At higher surface coverages the ratio of standard deviation to the value of the elasticity is not quite as unreasonable. Again the behavior of elasticity plots reflects this. Note that a .01 error in k is a .03% error which is probably the error expected in phase resolution for a Constant k experiment at an oil/water interface. A .01 error in damping coefficient is only 1%. It is easily seen that accuracy and precision must be extremely good to enable prediction of elasticities with any degree of confidence.

Even use of relative techniques with their lower uncertainties was not good enough to obtain reasonable elasticities. It can easily be seen that with a pessimistic input like .1 on alpha and .5 on the wave number that there would be no point in calculating elasticities at all. Unfortunately, the nature of the elasticities provides the information necessary to build models of interfacial behavior. This could not be done with the present data, and it is unlikely that a factor of 10 improvement would do more than put the elasticities on the verge of usefulness.

RESULTS

Use of the Constant k technique with the modified film balance provided the first precise documentation of Y1 and Y2 maxima. Study of surfactants at air/water interfaces was easiest for insoluble monolayers. Figures 10-12 display Y1, Y2, and the surface tension for distearyldimethyl ammonium chloride, hexadecanol, and tetradecanol monolayers (3) as functions of surface concentration. Although Y2 maxima have been previously observed, their precise characterization had been difficult. These are believed to be the first Y1 maxima observed, although Lucassen published some wave length data which suggested the possibility of a maximum (37).

Several points of interest are exhibited in these figures. First the existence of maxima in accord with theory is demonstrated. Note that the Y1 maximum preceeds the Y2 maximum. Both maxima have occurred at rather low surface pressures, only a few dynes/cm. A further point of interest is summarized in the accompanying Table 4 which relates the theoretically predicted values for Y1 and Y2 with the observed ones.

The theoretical values result from assuming that the elasticity is purely real. Deviation from this assumption will result in a lowering of the maximum values. In all cases the agreement between theory and experiment for the

Table 4. Comparison of theory and experiment

		Low elastic		High elastic		At maxima	
Compounds	Rigidity	Y2	Y1	Y2	Y1	Y2	Y1
Theoretical		0.0074	1.021	0.0201	0.968	0.0400	1.062
Distearyldimethylammonium chloride	Low	0.0077	1.018	0.0216	0.966	0.0360	1.0324
Tetradecanol	Medium	0.0088	1.015	0.0214	0.970	0.0334	1.0274
Hexadecanol	High	0.0116	1.017	0.0218	0.965	0.0318	1.022

limiting values is reasonable to good. The experimental values for the maxima fall considerably short of prediction, especially for Y1. It is interesting to note that the agreement is best for the molecule which is intuitively the most flexible, and worst for the molecule which is more rigid. It is seen that the height of the Y1 maxima is most sensitive to these interpretations of molecular behavior.

A second series of water/air experiments was performed with compounds of biological interest. Cholestrol, lecithin, and mixed cholesterol-lecithin monolayers were formed on the recording film balance for ripple investigation. The Multiple Constant k technique was used for these experiments to see if any frequency dependence could be observed. The imaginary component of the complex elastic modulus, E", was expected to be manifested in a relaxation time for the interfacial film. Thus performing experiments at different frequencies should have yielded anomalous behavior in the region where the frequency was of the order of magnitude of the time involved for the relaxation process.

The corrections for amplitude of the generator and for phase error in Constant k experiments were made in these data and the EXPT computer program was used to handle the data. Figures 13-24 exhibit Y1 and Y2 plots along with calculated values of both components of the elastic modulus, E' and E". Once again maxima are displayed in both functions.

As indicated in the error propagation discussion, the significance attached to elasticity values is rather low. Nevertheless, distinct differences are readily seen between the two pure surfactants and the mixed monolayers. The mixed monolayer has been used for a model of the cell wall.

A great deal of data has been generated for oil/water systems. During preliminary studies the bulk phase parameters were altered. Some of the systems studied included aqueous lower phases coupled with hydrocarbon upper phases. The normal hydrocarbons, hexane, heptane, octane, and nonane all served as nonpolar oil phases. Aqueous phase density and viscosity were systematically varied by addition of glycerol and zinc chloride. At the time these experiments were performed the measurement techniques were not perfected so that the results are somewhat inconclusive. However, it does appear that the difference in density and viscosity between the two phases is the main source of changes in Y1 and Y2 behavior. Naturally the surfactant concentration will cause the change from zero elastic to infinite elastic behavior, but the bulk phases establish the zero elastic level and the infinite elastic level. Moreover, they interact to establish the degree to which elasticity changes will be reflected in Y1 and Y2 maxima.

The heptane/water interface has been selected for extensive study with various surfactants. Several classes of compounds have been examined using the Multiple Constant k method. The questions of interest are how the measured properties compare with theory, whether any frequency dependence can be detected, and what effect molecular structure of the surfactant has on the results. The length of the hydrocarbon tail was varied while keeping the polar head group the same, the head group was changed for constant length surfactants, and polymeric and mixed surfactants were examined.

Appendix C contains reductions of the output from the program converting raw data to ripple information. At the same time a series of graphs displaying this information are plotted. The full set of graphs for octadecyl acetate, Figures 25-32, are included to show the type of output.. The remainder of the graphs are not included due to the large number involved. However, all the information on these plots is available from the output listings.

The effect of changing chain length while keeping the same head group in ionic surfactants was ascertained by studies of the negatively charged sulfonates and the positively charged trimethyl ammonium bromides. Sodium sulfonates of chain length 12, 14, 16, and 18 were spread on .01 M sodium sulfate solution. Sulfonates rather than sulfates were used since it was hoped that purification would be easier. The hydrolysis of long chain sulfates has long been known as a serious source of contamination of surface chemistry studies (11). TAB's of length 16, 18, and 20 were spread on .01 M potassium bromide. Ionic surfactants were spread on dilute electrolytes with a common ion to repress hydrolysis and solubility. Dimethylstearylbenzyl ammonium chloride was used since it had a more complex structure than the TAB's. Octadecyltrimethyl ammonium chloride provided a comparison between the TAB's as well as the nonionic octadecyl compounds.

C14 and C22 straight chain carboxylic acids were studied along with straight chain alcohols of length 6, 10, 14, and 20. Note that these provided series in which the polar group was kept the same while the length of the tail was varied. The chain length varied over such a wide range that the shorter compounds were handled as water soluble while the longer ones were spread from an organic solvent.

Octadecylsuccinic anhydride, octadecyl aldehyde, 3-octadecanone, octadecyl acetate, and octadecyl amide demonstrated the effect of changing non-charged head groups on 18 carbon chains.

Polyvinyl acetate and polyvinyl stearate, sodium octadecyl sulfonate-octadecyl trimethyl ammonium bromide, and cholesterol-sodium hexadecyl sulfonate provided examples of polymeric and mixed surfactants.

Several general conclusions can be obtained by comparing the results for these various compounds. They are all in general agreement with theory. In some early preliminary work, the relative methods of calculation of EXPT were not used. Absolute values of Y1 and Y2 agreed with predictions within experimental error. Once this was established, theory was freely used to calculate the first point on Y1 and Y2 curves. This makes comparison between the various compounds simpler, since they all start at the same place.

The second question concerned a frequency dependence. A slight frequency dependence of Y1 and Y2 is expected theoretically. As can be seen from the Multiple Constant k figures, this slight expected difference serves very nicely to displace the various Constant k curves. However, all these curves remain parallel over the range of the reference independent variable, so that no anomalous frequency dependence can be detected over the range of frequencies studied. Note that the range of frequency available for examination is quite restricted. It is hoped that extension to higher frequencies may result in more extensive information on the relaxation process in interfacial films. It is interesting to note that Davies and Vose have seen a small frequency effect for air/water insoluble monolayers (12).

The third point concerned the effect of molecular structure on ripple parameters. In these experiments Y1 cannot be significantly distinguished from a constant. However, the value of the constant is not 1.0 as predicted by Kelvin equation level theory, but about .94 for these experiments. Similarly, Y2 does not show much difference between compounds. However, there are a few points of dissimilarity. The results of the error analysis suggest considerable doubt must be applied to a given curve, but if the results are accepted at face value a comparison may be useful.

Figure 33 shows the Y2 curves resulting from the first Constant k position for each of the compounds studied at the heptane/water interface. They are plotted in groups which correspond to their general functionality. Note that they all have the same starting point which corresponds to the zero elasticity value. No surfactant is present at this point. The starting frequency for these curves is about 160 Hz. The initial value of Y2 is .023, with the damping coefficient being about .7 cm^{-1} and the wave length being about 1.9 mm. Notice that all Y2 curves tend towards an infinite level of about .028.

It is the difference in change from the low level to the high level that distinguishes the various compounds. The surface pressure is chosen for the independent variable. Naturally the nature of the surfactant requires that different concentrations of surfactant are required to produce the same surface tension lowering. If all surfactants affected ripple propagation only through surface tension, all these curves should superimpose. The chain length of the compound appears to have no effect for the straight chain surfactants. All the ionics, including the mixed system, follow essentially the same curve. For these compounds the infinite level is reached after a few dynes/cm of surface pressure and the break between low and high levels is fairly sharp.

The simple straight chain acids and alcohols are all much alike. However, they do differ from the ionics in that they do not show the sharp break from low to high value. In fact, it appears even after 9 dynes/cm surface tension lowering that the infinite elasticity range has not been reached. With the more complicated polar groups of the octadecyl surfactants some differences in the surface pressure at which the break occurs can be seen. It is interesting that the anhydride and ketone which differ from the usual pattern are both surfactants in which the head group is quite bulky. However, the failure of the acetate to differ from the simple polar group pattern indicates that this explanation cannot be pushed very far.

The polymeric surfactants show the most individual character. The break from low value of Y2 to high value at very low film pressures for polyvinyl acetate is particularly interesting, as it suggests that the surfactant has strong interactions.

The final question to be answered is the behavior of the components of the elasticity. The error propagation discussion indicates that this answer must also be quite well hedged. Nevertheless it is observed that both the real and imaginary components exhibit an initial minimum followed by a leveling off at higher film pressures. Note that elasticities are forced to equal 0 at the first point. The leveling off in the elasticity components corresponds to the leveling off in the Y2 curves. Since the depth of the minimum is considerably less than the standard deviation of the elasticity, this may be a spurious result of the necessary numerical calculation. The level value of E' is around 5 dynes/cm while that of E" is 1 to 4 dynes/cm. The sign of the observed imaginary component of the elasticity is opposite that expected theoretically for the higher film pressures and at low pressures the sign may change from negative to positive.

DISCUSSION

Several conclusions can be drawn from the work presented. A principal result is that the theory of ripple propagation as presented by Hansen and Mann for air/water systems has been confirmed with considerable precision. The extended theory for oil/water systems has likewise been confirmed. The relaxation process predicted for interfacial films was not observed experimentally, but this is believed to be due to the extremely short range of experimentally available frequencies. Molecular structure is observed to exert a pronounced and reasonably well interpretable effect on ripple propagation at air/water systems. At oil/water systems the structure produced differences are much smaller.

The essential conclusion from oil/water experiments is that surfactant equations of state, while not identical, must be closely similar. Complex molecules are more likely to have interactions which simple equations do not predict. Many of the difficulties in oil/water work are a result of the small differences being examined. When the total change in a quantity to be measured is only 1 to 20%, it is not surprising that even rather good measurements do not answer critical questions.

The most important result of this work, however, is not in the numbers being produced, but in the discovery of techniques which permit their being produced at all. The development of the Multiple Constant k technique and methods suitable for oil/water interfaces were the most interesting and novel phases of the work. Devising the programs for data handling also represents significant and interesting advances.

A number of suggestions for future work might improve the accuracy and precision of the results. The resonance phenomena of the loudspeaker suggest a study of various speaker designs to obtain a larger output amplitude in the frequency independent regions. A flat frequency response of sufficient heightwould simplify the correction problems. Use of a second sensing probe to obtain a noise figure which can be subtracted from the signal might improve the signal to noise ratio considerably. Better mechanical isolation of the generator and sensor could be coupled with the second sensor to reduce the mechanical coupling problem. The depth of the lower phase trough should be increased; this will require longer sensing probes. Use of a larger Wilhelmy plate with possible LVDT null position detection should improve the interfacial tension measurement. A smoother elevating system for moving the torsion balance and plate is needed.

Perhaps the best solution is to abandon liquid/liquid interfacial work in favor of air/liquid interfaces. Insoluble monolayers are especially convenient to study, and the compounds exhibit relatively large differences.

This study has indicated that the procedure is sufficiently well worked out to constitute a standard procedure. This semiroutine procedure could be used like any other tool to study other areas. Monitoring surface reactions or correlating foam properties are two obvious possibilities. The precision possible at air/liquid systems is such that the calculated elasticities are almost on the verge of being useful. The suggested modifications might provide the factor of ten improvement which will yield this result. It may very well turn out that the fluctuations and lack of reproducibility observed will limit the accuracy of this technique even more than the measurement difficulties themselves.

SUMMARY

Capillary ripples provide a method of studying the surface properties of interfacial systems. The experimental techniques first employed in this Laboratory have been extended and modified. Use of a relative method has permitted the determination of the functions $Y1 = \rho\omega^2/\gamma k^3$ and $Y2 = \alpha/k$ where ρ is the density, ω is the cyclic frequency (2π x frequency in Hz), k is the wave number (2π/wave length, λ), γ is the surface tension, and α is the damping coefficient for liquid/air interfaces with greater precision than previously possible. The theory of ripple propagation predicts maxima in both Y1 and Y2 with increasing film elastic modulus and these are observed. The form of the maxima is used to interpret the elastic behavior of surfactant molecules.

The experimental methods have been altered to study surfactants at liquid/liquid intefaces in order to check the extended theory for such systems. Observed results are in excellent agreement with predictions. However, the combination of considerably more difficult measurements and smaller ranges for the variables limits the resolution severely.

Several classes of compounds have been studied to see if Y1 and Y2 for oil/water interfaces exhibit any dependence on surfactant structure. For these systems Y1 is independent of surface pressure ($\pi = \gamma_{pure} - \gamma$) within the experimental

error. The shape of Y2 vs. π plots is quite similar for all the surfactants investigated. At low pressures Y2 is constant; at higher pressures Y2 is again constant with a higher value. The class of surfactant has an effect on how the transition from low to high value occurs, and on what surface pressure corresponds to the high value. The lower constant value of Y2 corresponds to a small value of the elastic modulus, while the higher constant value corresponds to a very large value of this modulus. Surfactants consisting of a long hydrocarbon chain and an ionic head group behave similarly regardless of the type and charge of head group and the length of the chain. The high value of Y2 occurs at pressures of a few dynes/cm and the transition is fairly abrupt. Although the chain length for non ionic surfactants has little effect, the type of polar head group does result in different Y2 behavior. For small head groups such as acids and alcohols the high value of Y2 occurs at pressures around 10 dynes/cm with a gradual transition from low to high. With bulkier head groups the high value of Y2 occurs at lower pressures with more abrupt transitions. For polymeric surfactants the transition is quite sharp and occurs at pressures under one dyne/cm.

Computer programs have been written to handle data work-up and calculations. The real and imaginary components of the complex elastic modulus are calculated. Although the measured data have rather good precision, the propagation of error in the elasticity equation is so severe that the values obtained are quite uncertain. Nevertheless, both the real and imaginary components tend towards a minium at low surface pressures and approach a constant at higher pressures.

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APPENDIX A

The cited Figures follow:

Figures 1 - 4	Theoretical Y1 and Y2 plots
Figures 5 - 7	Instrumentation
Figures 8 - 10	Air/water results for simple surfactants
Figures 11 - 24	Air/water results for biological surfactants
Figures 25 - 32	Heptane/water results for octadecyl acetate
Figure 33	Y2 plots for heptane/water systems.

Figure 1. Theoretically calculated Yl values as a function of elasticity, u_2, for an air/water interface. The variables u_2 and Θ were used in early theoretical work as elements of the complex elastic modulus defined by $u_2 \exp(i\Theta) = k_e/\gamma - i\omega(k_v/\gamma)$ where k_e and k_v are viscoelastic parameters. Note that two limiting cases occur for low and high values of the elasticity and that for intermediate values a pronounced maximum exists. The nature of this maximum depends on Θ which reflects the inclusion of a complex elastic modulus rather than a purely real one.

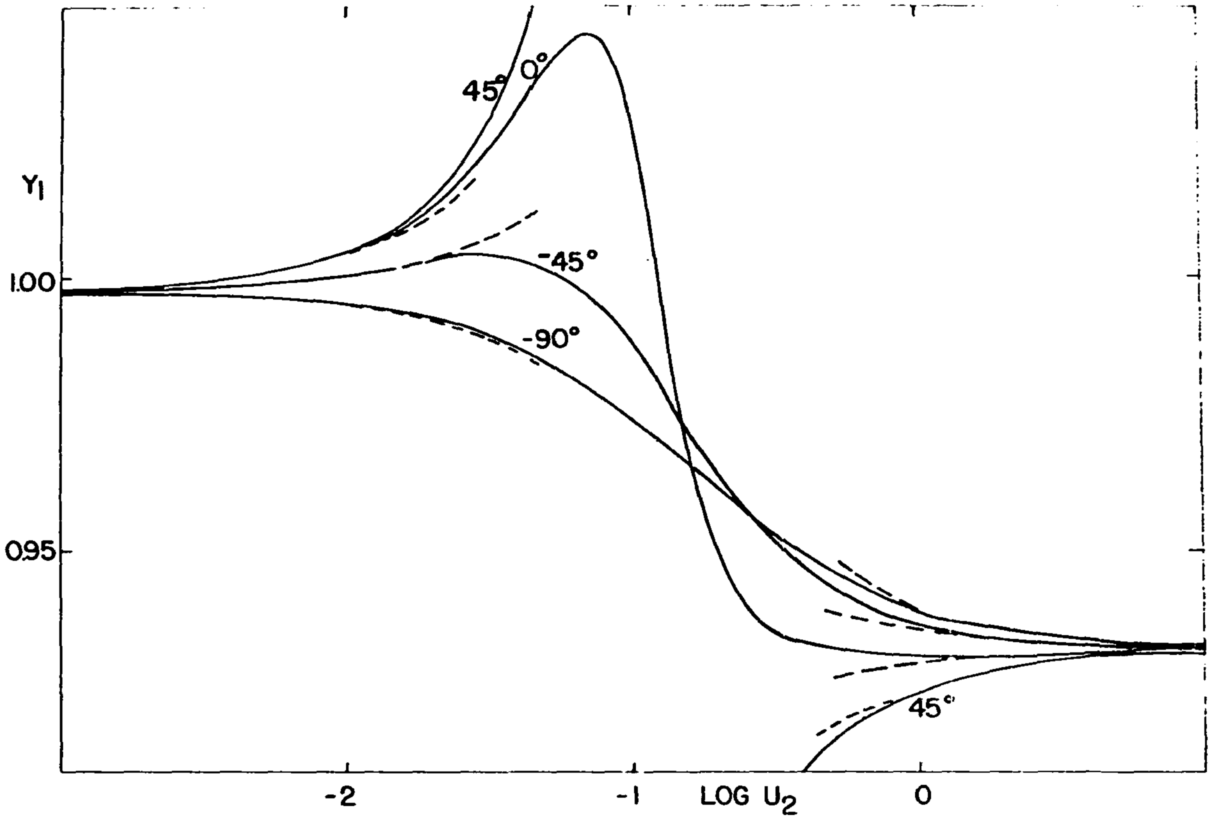

45°
0°
Y_1
1.00
0.95
-45°
-90°
45°
-2
-1
LOG U_2
0

Figure 2. Theoretically calculated Y2 values as a function of elasticity, u_2, for an air/water interface. Y2 also has limiting levels which are connected by a maximum for intermediate elasticities. Prediction of Y1 and Y2 maxima preceeded experimental verification of this phenomena.

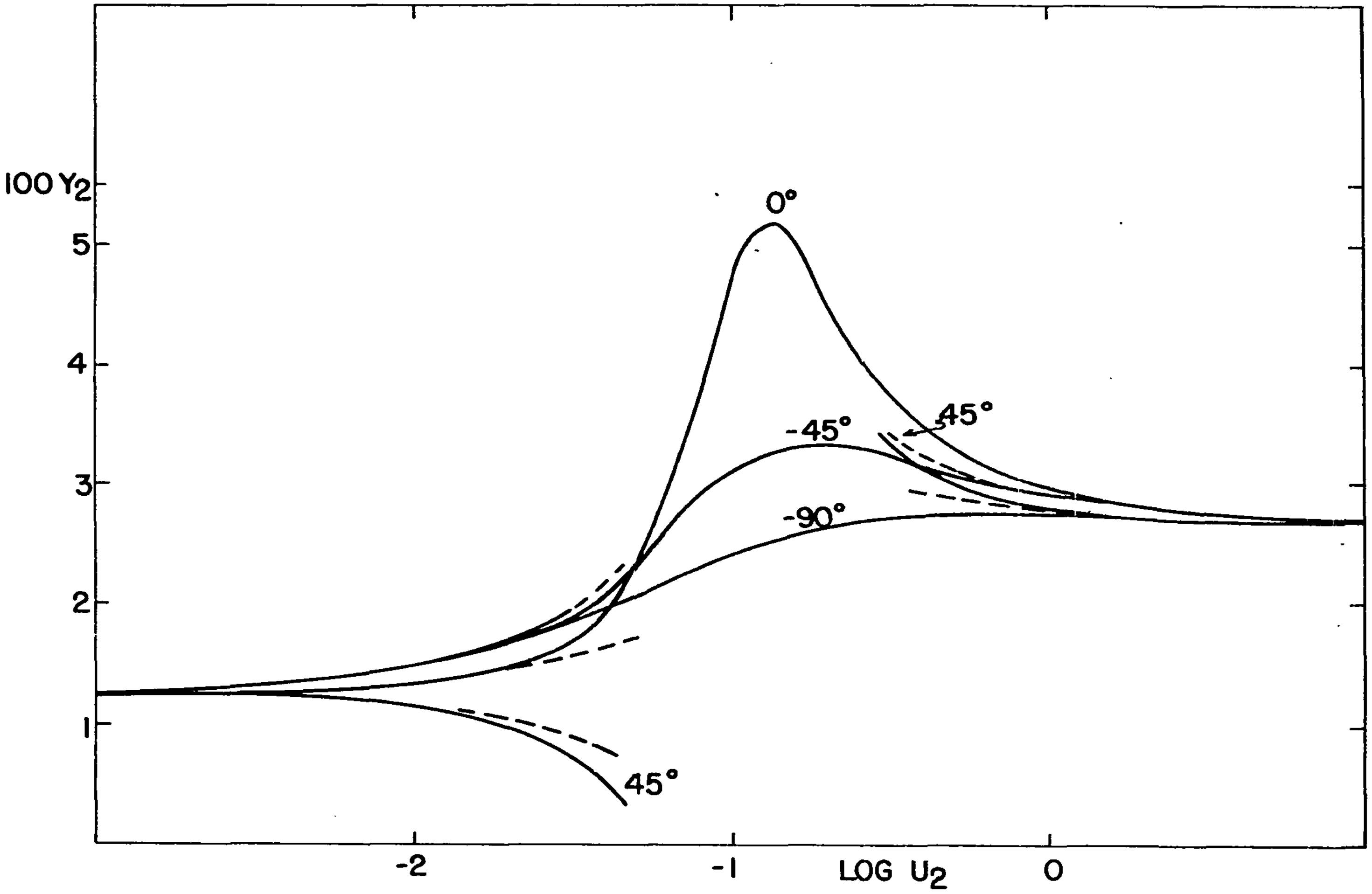

100 Y_2
5
4
3
2
1
0°
-45°
45°
-90°
45°
-2
-1
LOG U_2
0

Figure 3. Theoretically calculated Yl values as a function of the area per molecule for an oil/water interface. A gaseous equation of state is assumed to be valid for the heptane/water or nonane/water interface. This equation of state permits computation of the surface tension and real component of elasticity as a function of the area per molecule at the interface. The imaginary part of the elasticity is varied arbitrarily through the k_Y term by calculating E" as k_Y times the cyclic frequency. Although limiting values still result at low and high elasticities, the maximum is almost absent. For nonane/water there is no maximum. Also the change from low level to high level is considerably smaller than for air/water systems.

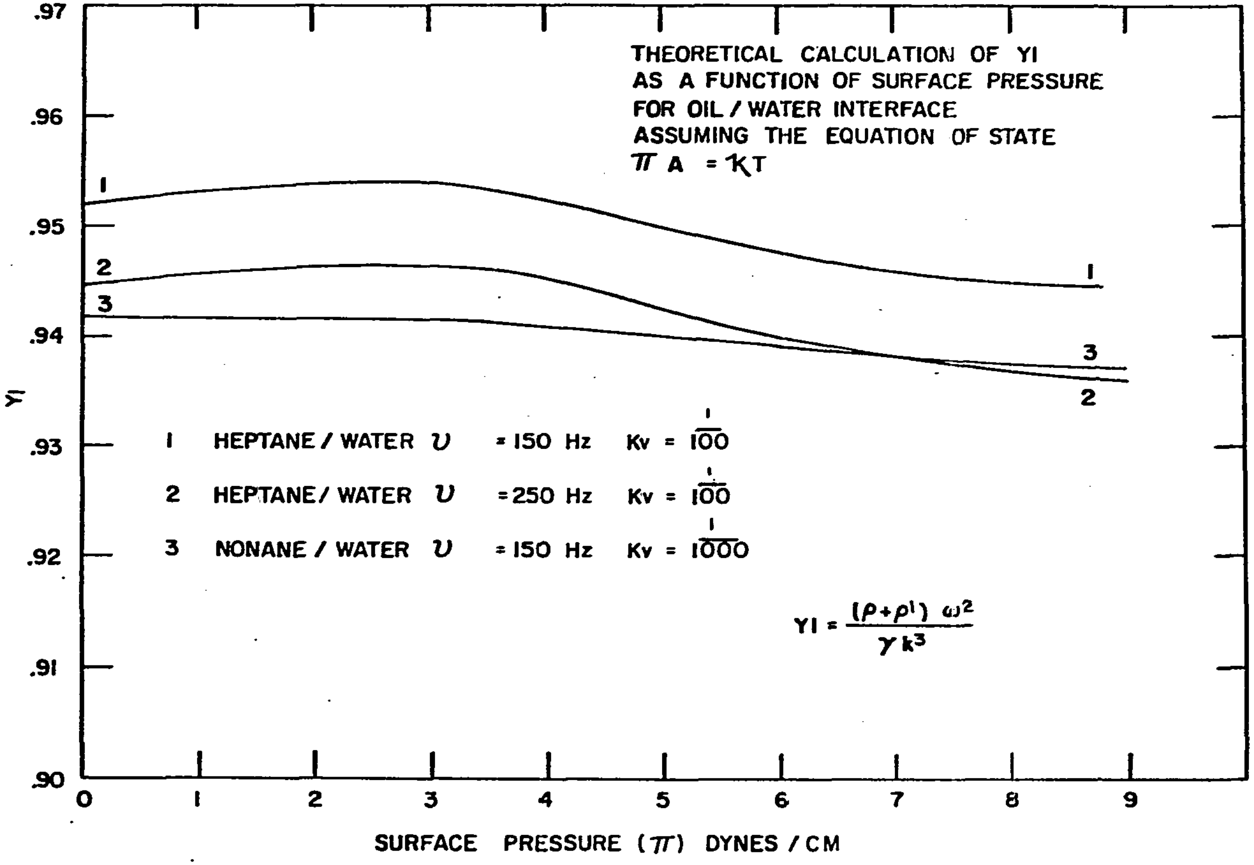

THEORETICAL CALCULATION OF YI
AS A FUNCTION OF SURFACE PRESSURE
FOR OIL / WATER INTERFACE
ASSUMING THE EQUATION OF STATE
$\pi A = kT$
1 HEPTANE / WATER ν = 150 Hz Kv = $\frac{1}{100}$
2 HEPTANE / WATER ν = 250 Hz Kv = $\frac{1}{100}$
3 NONANE / WATER ν = 150 Hz Kv = $\frac{1}{1000}$
$YI = \frac{(\rho+\rho^1)\,\omega^2}{\gamma k^3}$
YI
.97
.96
.95
.94
.93
.92
.91
.90
0
1
2
3
4
5
6
7
8
9
SURFACE PRESSURE (π) DYNES / CM
1
2
3
1
3
2

Figure 4. Theoretically calculated Y2 values as a function of area per molecule for an oil/water interface. Again the limiting behavior occurs but the maximum does not. Frequency changes shift the curve, but do not alter its shape. Figures 3 and 4 suggest that the bulk phase density and viscosity properties determine the existence and characteristics of maxima in Y1 and Y2 for intermediate elasticities. More complex behavior of the surfactant would also lead to changes in the properties of the maxima.

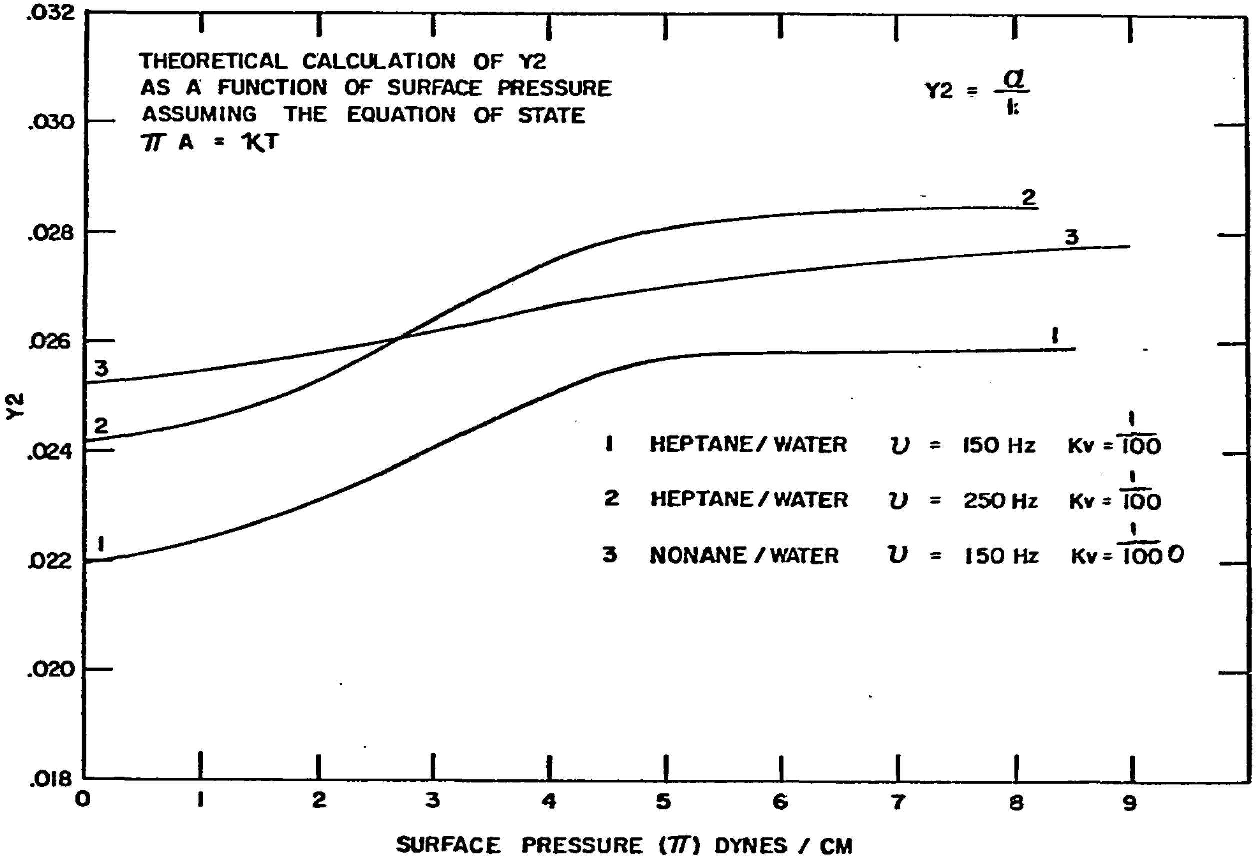

THEORETICAL CALCULATION OF Y2
AS A FUNCTION OF SURFACE PRESSURE
ASSUMING THE EQUATION OF STATE
$\pi A = kT$
$Y2 = \frac{a}{k}$
1 HEPTANE/WATER υ = 150 Hz $K_v = \frac{1}{100}$
2 HEPTANE/WATER υ = 250 Hz $K_v = \frac{1}{100}$
3 NONANE/WATER υ = 150 Hz $K_v = \frac{1}{1000}$
1
2
3
Y2
.032
.030
.028
.026
.024
.022
.020
.018
0
1
2
3
4
5
6
7
8
9
SURFACE PRESSURE (π) DYNES / CM

Figure 5. Block diagram of early experimental arrangement. An audio oscillator drives a speaker which produces the mechanical ripples. The phonograph cartridge transduces this mechanical motion to an electrical signal which can be displayed. By observing the signal as a function of cartidge position it is possible to infer the wave length and damping coefficient. The frequency of the wave may be counted directly. Filtering the signal is essential to remove objectionable noise frequencies.

BLOCK DIAGRAM OF EARLY INSTRUMENTATION

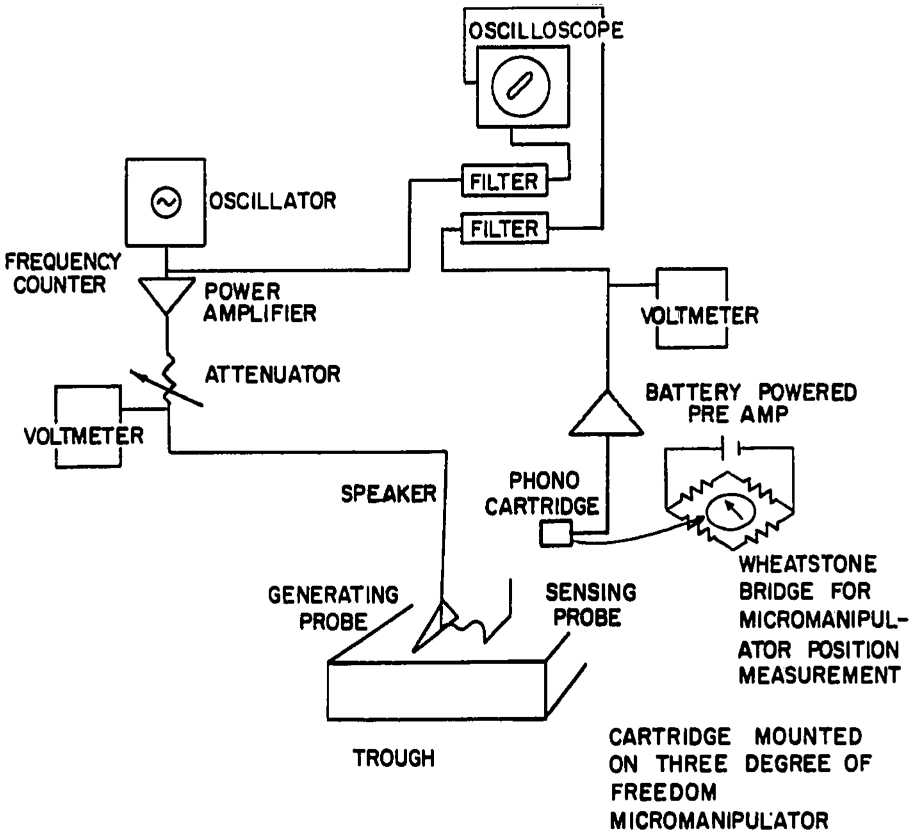


Figure 6. Block diagram of final instrument arrangement. The lock in amplifier performs many of the functions which required several devices in the earlier design. Note that the tuned filters have been removed to improve low frequency phase resolution. The oscillator and preamplifier have also been supplanted.

BLOCK DIAGRAM OF FINAL INSTRUMENTATION

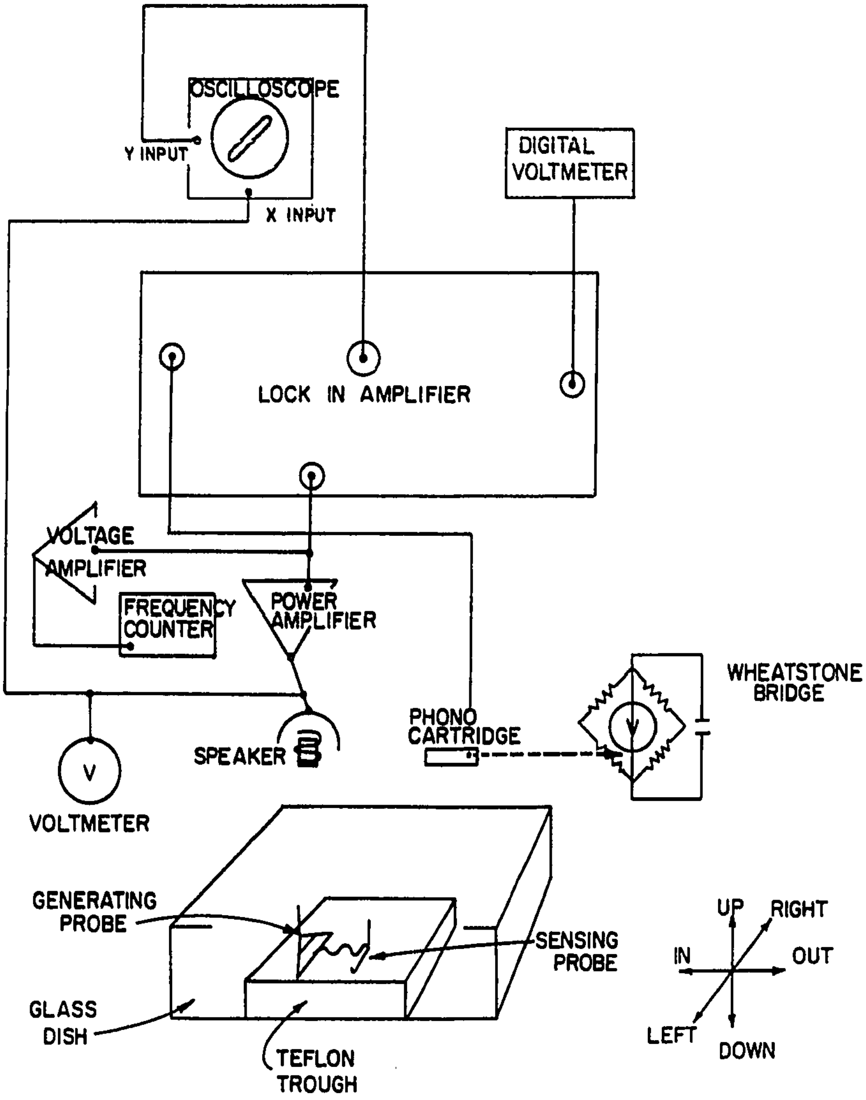


Figure 7. Block diagram of lock in amplifier detail. This instrument consists of two wideband amplifiers incorporating the sensitivity control followed by a tuned amplifier. A feedback network can be used to create oscillations in the tuned amplifier. When the input signal and reference signal are mixed, sum and difference signals result. The difference signal approaches DC and may be smoothed with resistance-capacitance filters and displayed. The input signal is also tapped for external oscilloscope display to form Lissajous patterns.

BLOCK DIAGRAM OF LOCK IN AMPLIFIER

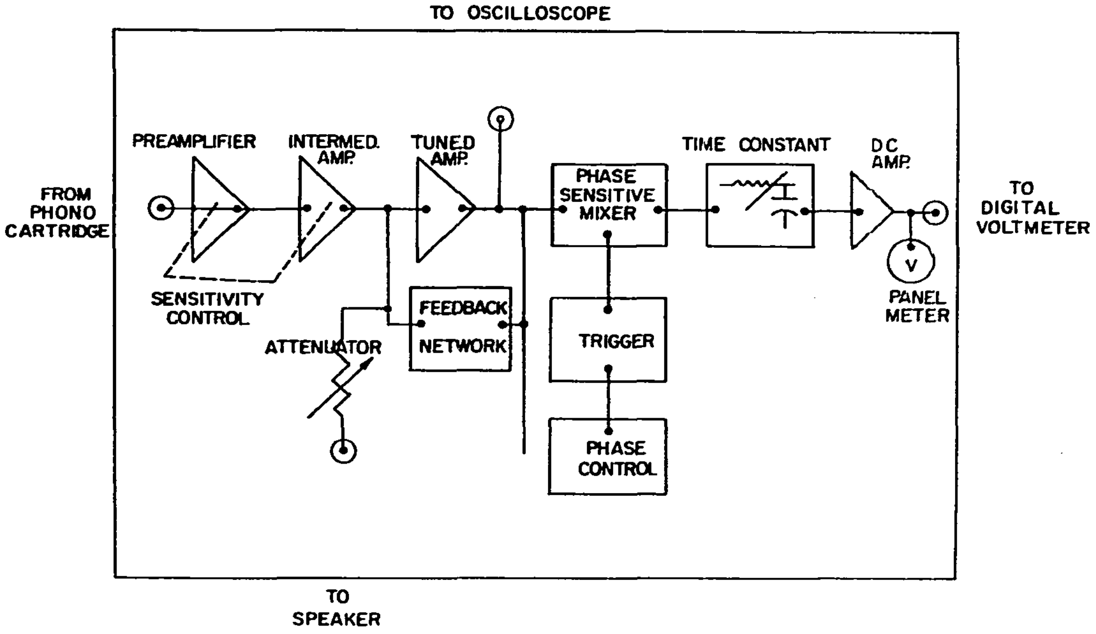


Figure 8. Generating probe amplitude as a function of ripple frequency. This calibration curve exhibits the calculated probe amplitude, VOONU, based on measurements of output voltage on clean heptane/water systems and theoretically calculated damping coefficients.

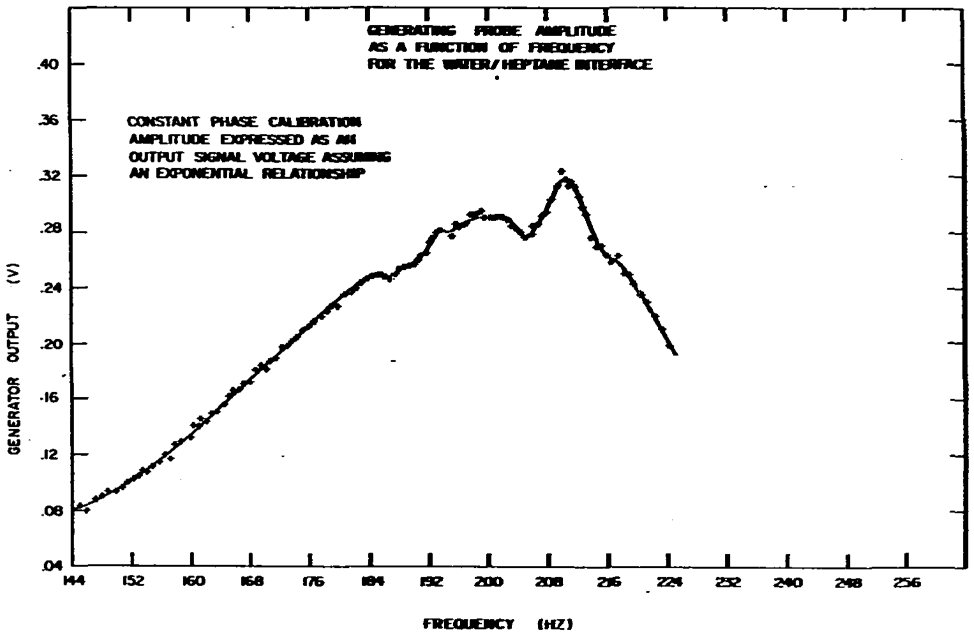

GENERATING PROBE AMPLITUDE
AS A FUNCTION OF FREQUENCY
FOR THE WATER/HEPTANE INTERFACE
CONSTANT PHASE CALIBRATION
AMPLITUDE EXPRESSED AS AN
OUTPUT SIGNAL VOLTAGE ASSUMING
AN EXPONENTIAL RELATIONSHIP
GENERATOR OUTPUT (V)
.04
.08
.12
.16
.20
.24
.28
.32
.36
.40
144
152
160
168
176
184
192
200
208
216
224
232
240
248
256
FREQUENCY (HZ)

Figure 9. Phase correction as a function of ripple frequency. The phase change of the generating probe is expressed as the number of waves to be subtracted from the nominal number of waves in a Constant k experiment. The data were obtained from several Vary Frequency, constant probe separation experiments at a heptane/water interface. Absolute probe separation ambiguity leads to an arbitrary additive constant.

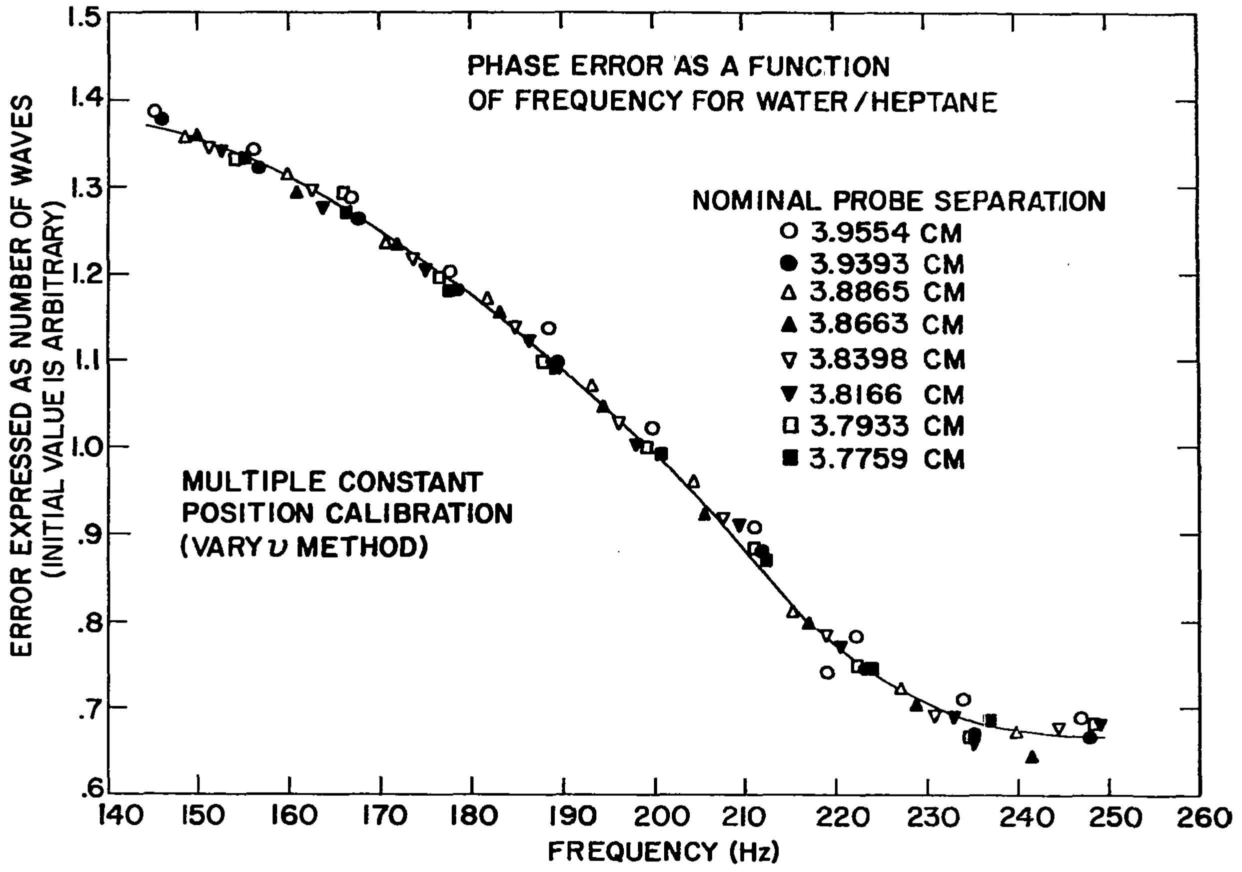

PHASE ERROR AS A FUNCTION
OF FREQUENCY FOR WATER/HEPTANE
NOMINAL PROBE SEPARATION
○ 3.9554 CM
● 3.9393 CM
△ 3.8865 CM
▲ 3.8663 CM
▽ 3.8398 CM
▼ 3.8166 CM
□ 3.7933 CM
■ 3.7759 CM
MULTIPLE CONSTANT
POSITION CALIBRATION
(VARY υ METHOD)
ERROR EXPRESSED AS NUMBER OF WAVES
(INITIAL VALUE IS ARBITRARY)
1.5
1.4
1.3
1.2
1.1
1.0
.9
.8
.7
.6
140
150
160
170
180
190
200
210
220
230
240
250
260
FREQUENCY (Hz)

Figure 10. Capillary ripple propagation characteristics on distearyldimethyl ammonium chloride monolayers. The dependence of surface tension, γ, Y1, and Y2 on surface concentration, Γ, is shown for an air/water system. The maxima in Y1 and Y2 for intermediate concentration are quite pronounced and are well documented.

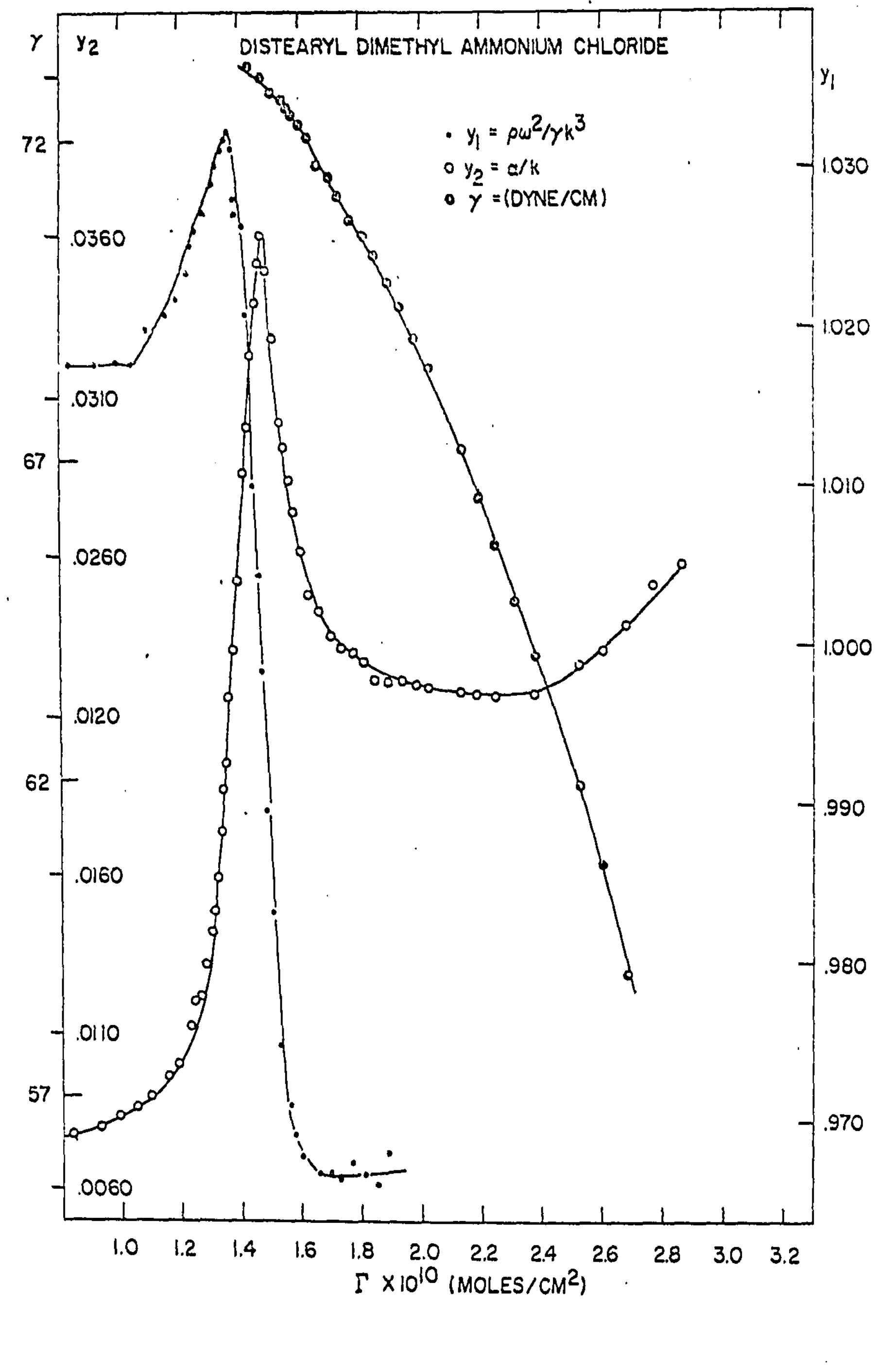

DISTEARYL DIMETHYL AMMONIUM CHLORIDE
• $y_1 = \rho\omega^2/\gamma k^3$
○ $y_2 = \alpha/k$
◉ γ =(DYNE/CM)
γ
y_2
y_1
72
67
62
57
.0360
.0310
.0260
.0120
.0160
.0110
.0060
1.030
1.020
1.010
1.000
.990
.980
.970
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
$\Gamma \times 10^{10}$ (MOLES/CM^2)

Figure 11. Capillary ripple propagation characteristics on tetradecanol monolayers. For this air/water system the Y1 and Y2 maxima are still present, but with reduced amplitude compared to Figure 10.

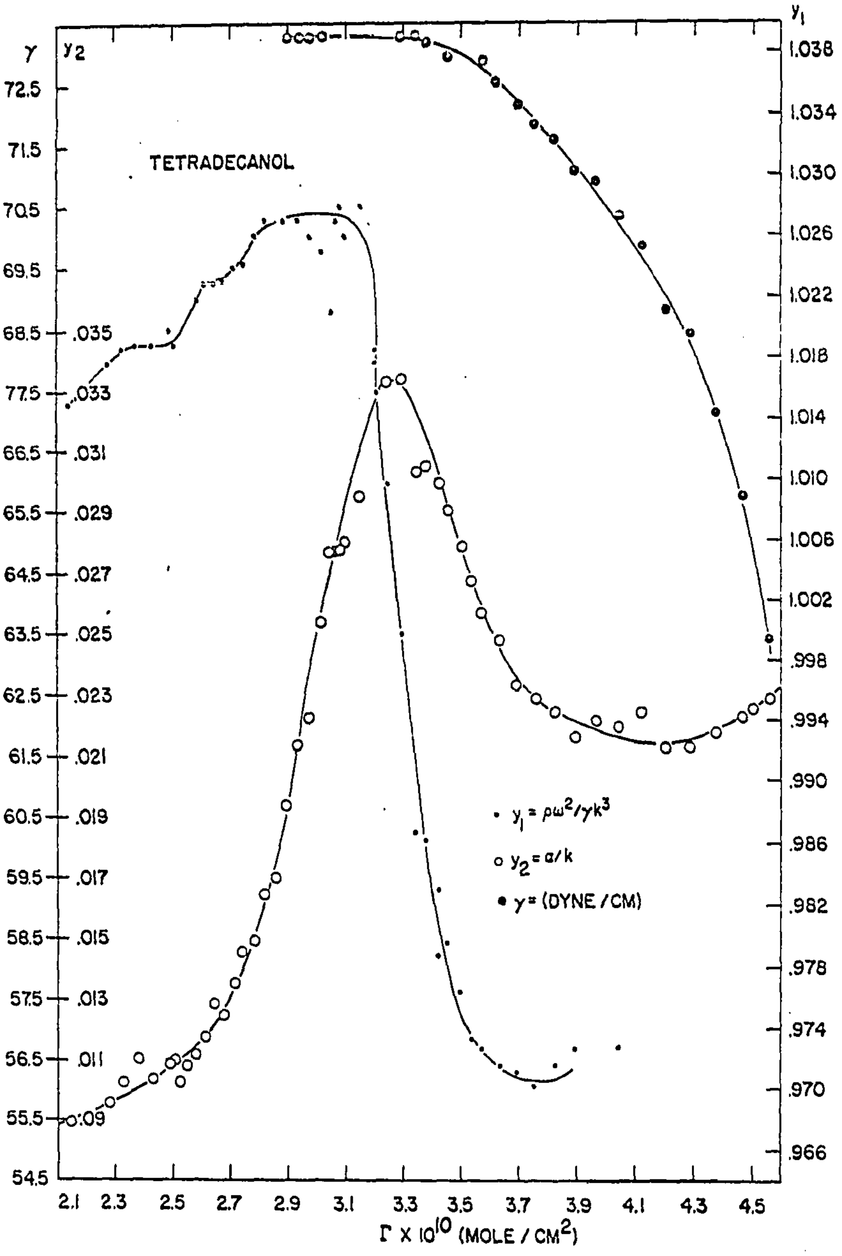

γ
y_2
y_1
TETRADECANOL
72.5
71.5
70.5
69.5
68.5 .035
77.5 .033
66.5 .031
65.5 .029
64.5 .027
63.5 .025
62.5 .023
61.5 .021
60.5 .019
59.5 .017
58.5 .015
57.5 .013
56.5 .011
55.5 .09
54.5
1.038
1.034
1.030
1.026
1.022
1.018
1.014
1.010
1.006
1.002
.998
.994
.990
.986
.982
.978
.974
.970
.966
2.1
2.3
2.5
2.7
2.9
3.1
3.3
3.5
3.7
3.9
4.1
4.3
4.5
Γ X 10^{10} (MOLE / CM^2)
• $y_1 = \rho\omega^2/\gamma k^3$
○ $y_2 = \alpha/k$
● γ = (DYNE / CM)

Figure 12. Capillary ripple propagation characteristics on hexadecanol monolayers. The maxima are reduced still further on this more rigid monolayer.

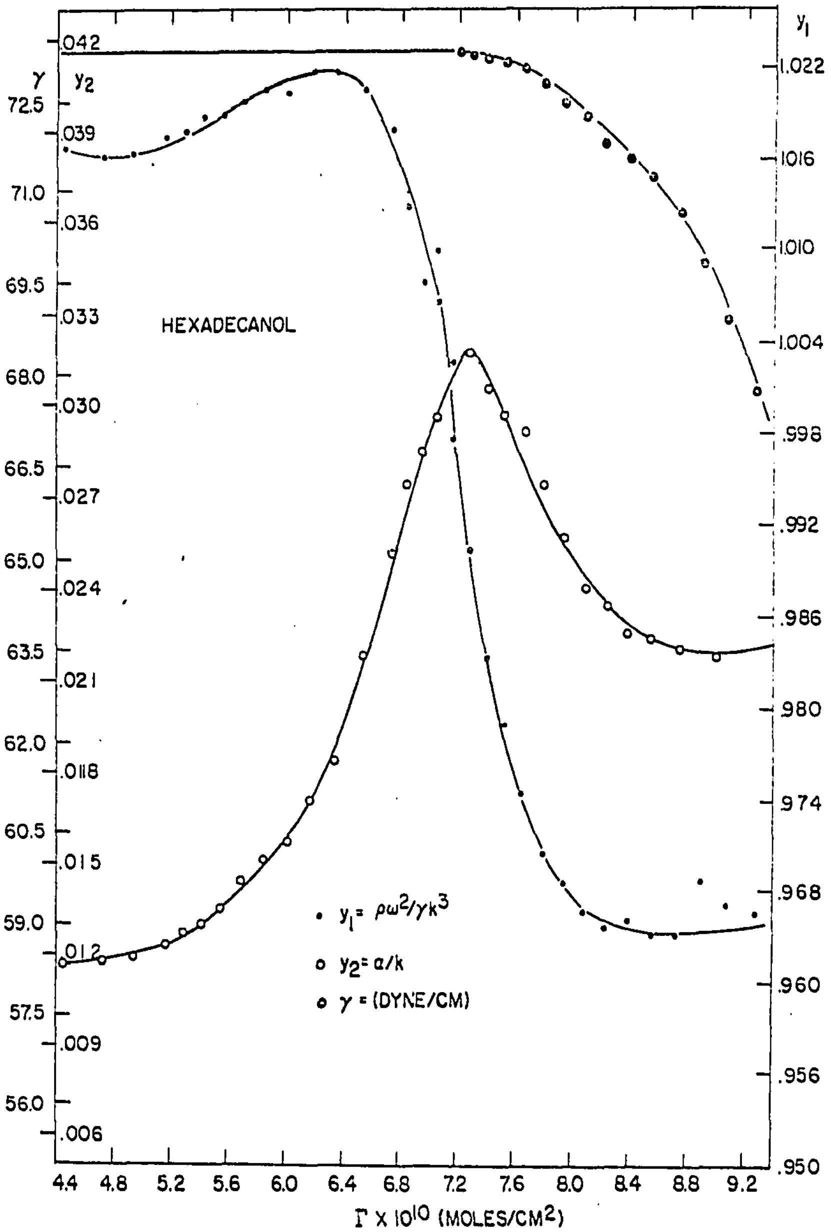

HEXADECANOL
γ
y_2
y_1
72.5
71.0
69.5
68.0
66.5
65.0
63.5
62.0
60.5
59.0
57.5
56.0
.042
.039
.036
.033
.030
.027
.024
.021
.0118
.015
.012
.009
.006
1.022
1.016
1.010
1.004
.998
.992
.986
.980
.974
.968
.960
.956
.950
4.4
4.8
5.2
5.6
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
Γ X 10^{10} (MOLES/CM^2)
• $y_1 = \rho\omega^2/\gamma k^3$
o $y_2 = \alpha/k$
o γ = (DYNE/CM)

Figure 13. Capillary ripple propagation characteristics on cholesterol monolayers. The dependence of Y1 on surface concentration is shown for a Multiple Constant k experiment at an air/water interface. Maxima occur for all frequencies.

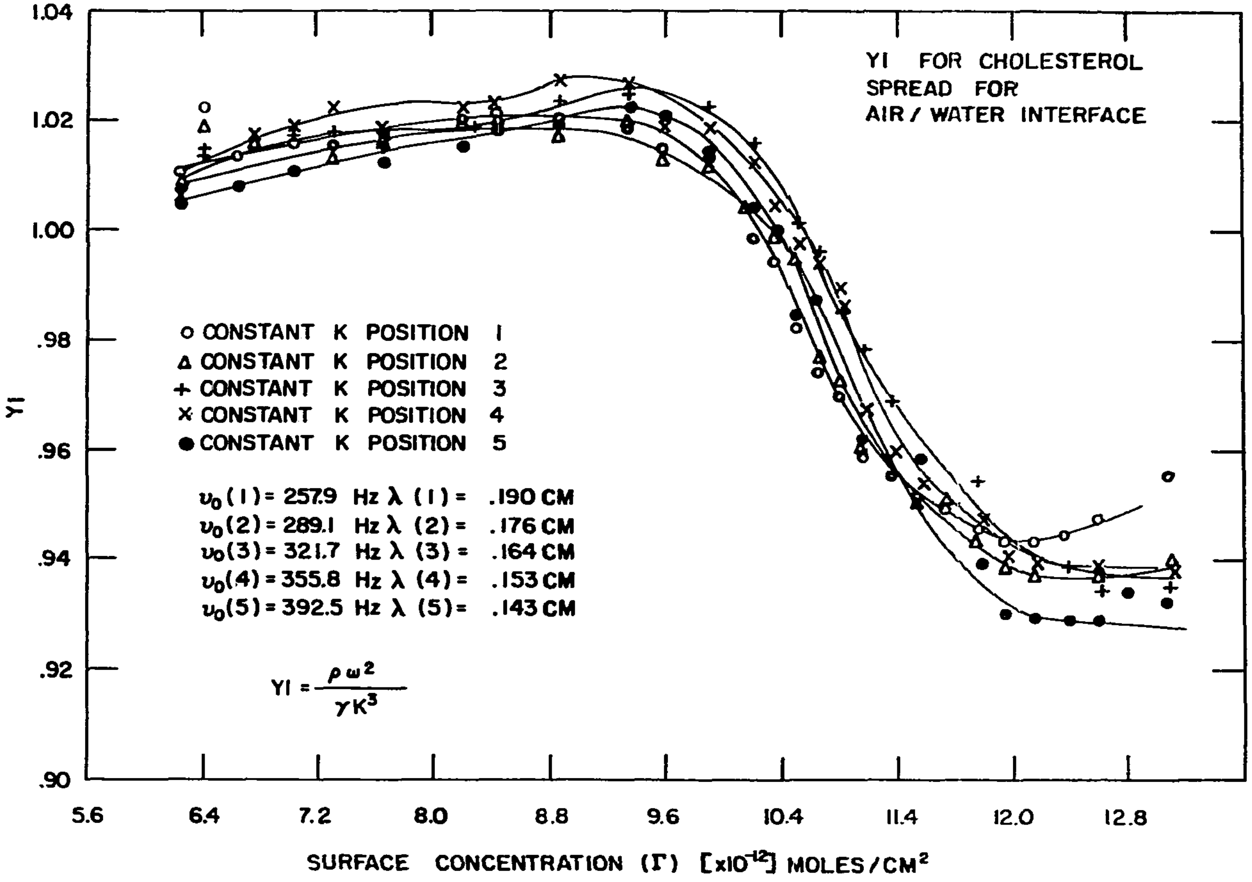

YI FOR CHOLESTEROL
SPREAD FOR
AIR / WATER INTERFACE
○ CONSTANT K POSITION 1
△ CONSTANT K POSITION 2
+ CONSTANT K POSITION 3
× CONSTANT K POSITION 4
● CONSTANT K POSITION 5
$\upsilon_0(1) = 257.9$ Hz $\lambda(1) = .190$ CM
$\upsilon_0(2) = 289.1$ Hz $\lambda(2) = .176$ CM
$\upsilon_0(3) = 321.7$ Hz $\lambda(3) = .164$ CM
$\upsilon_0(4) = 355.8$ Hz $\lambda(4) = .153$ CM
$\upsilon_0(5) = 392.5$ Hz $\lambda(5) = .143$ CM
$YI = \frac{\rho \omega^2}{\gamma K^3}$
YI
1.04
1.02
1.00
.98
.96
.94
.92
.90
5.6
6.4
7.2
8.0
8.8
9.6
10.4
11.4
12.0
12.8
SURFACE CONCENTRATION (Γ) [$\times 10^{-12}$] MOLES/CM^2

Figure 14. Capillary ripple propagation characteristics on cholesterol monolayers. The dependence of Y2 on surface concentration is shown for this air/water system. Note that pronounced maxima result at all frequencies.

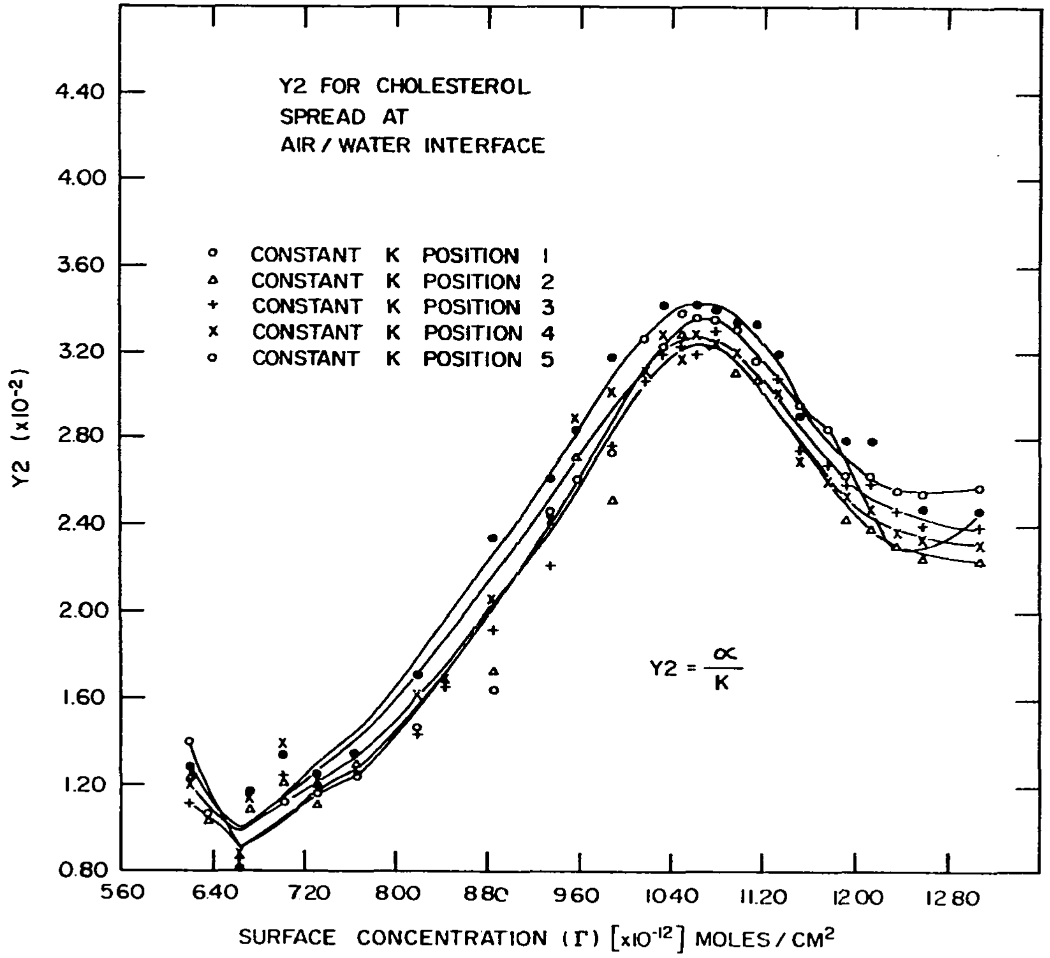

Y2 FOR CHOLESTEROL
SPREAD AT
AIR / WATER INTERFACE
○ CONSTANT K POSITION 1
△ CONSTANT K POSITION 2
+ CONSTANT K POSITION 3
x CONSTANT K POSITION 4
○ CONSTANT K POSITION 5
$Y2 = \frac{\alpha}{K}$
Y2 (x10^{-2})
4.40
4.00
3.60
3.20
2.80
2.40
2.00
1.60
1.20
0.80
560
640
720
800
880
960
1040
1120
1200
1280
SURFACE CONCENTRATION (Γ) [x10^{-12}] MOLES / CM^2

Figure 15. Capillary ripple propagation characteristics on cholesterol monolayers. The dependence of the real component of the complex elastic modulus, E', on surface concentration is shown for a Multiple Constant k experiment at an air/water interface. Although the scatter is more severe than for Y1 or Y2, the curves for various frequencies are similar.

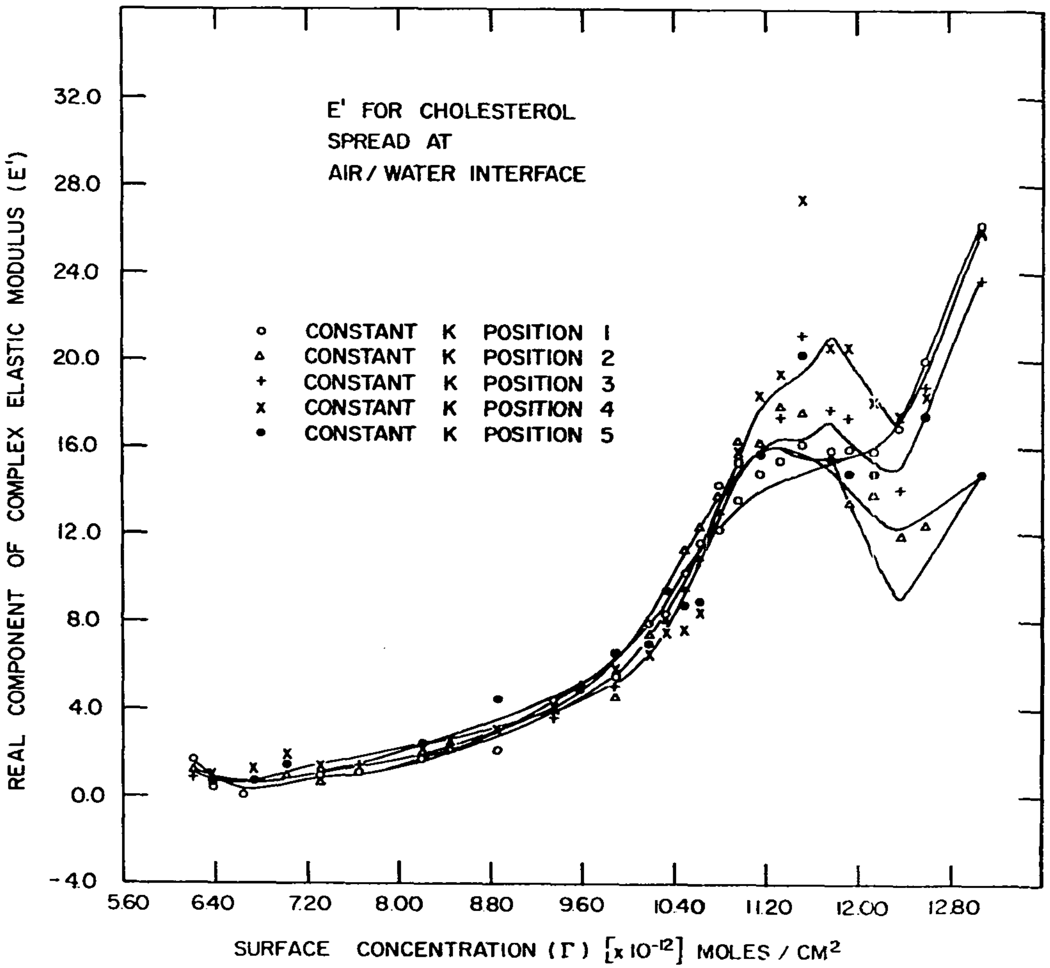

E' FOR CHOLESTEROL
SPREAD AT
AIR / WATER INTERFACE
○ CONSTANT K POSITION 1
△ CONSTANT K POSITION 2
+ CONSTANT K POSITION 3
x CONSTANT K POSITION 4
● CONSTANT K POSITION 5
REAL COMPONENT OF COMPLEX ELASTIC MODULUS (E')
32.0
28.0
24.0
20.0
16.0
12.0
8.0
4.0
0.0
-4.0
5.60
6.40
7.20
8.00
8.80
9.60
10.40
11.20
12.00
12.80
SURFACE CONCENTRATION (Γ) [x 10⁻¹²] MOLES / CM²

Figure 16. Capillary ripple propagation characteristics on cholesterol monolayers. The dependence of the imaginary component of the complex elastic modulus, E", on surface concentration is shown for a Multiple Constant k experiment at an air/water interface. Again the various frequency curves are similar.

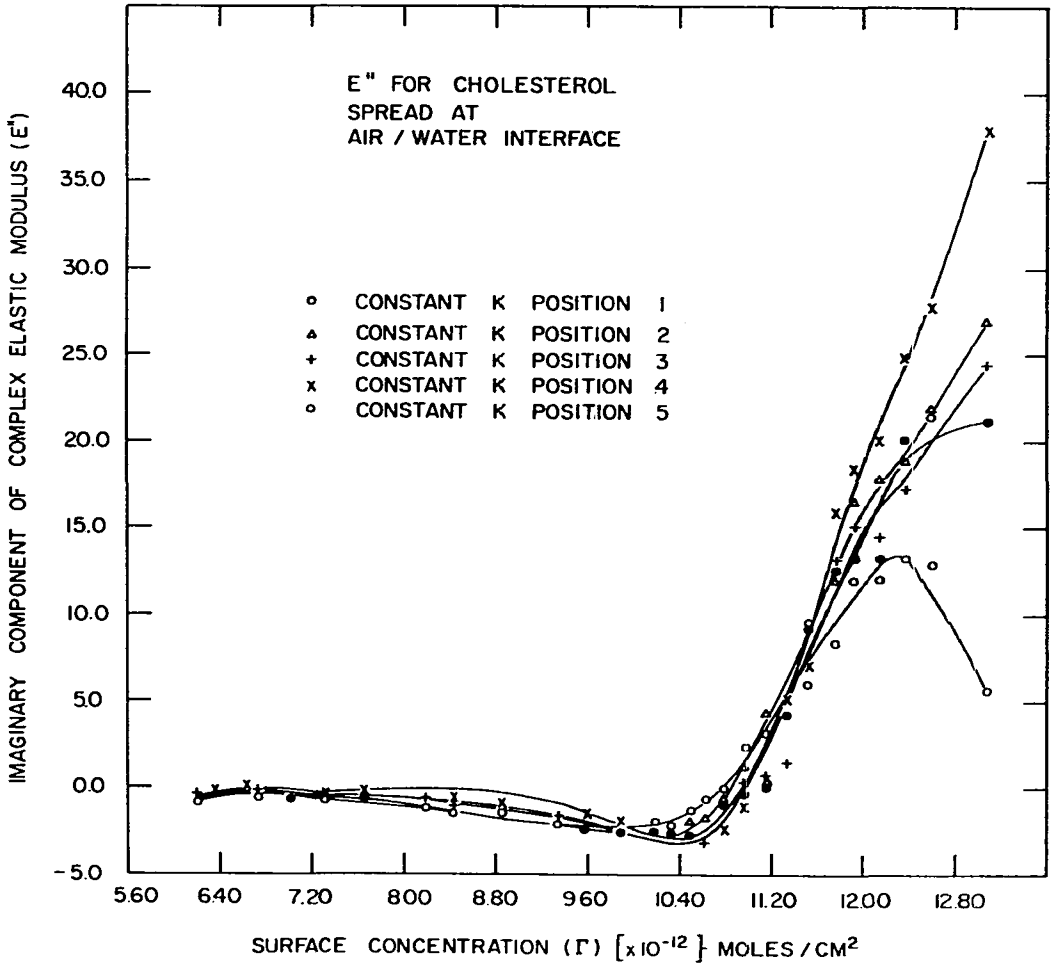

E" FOR CHOLESTEROL
SPREAD AT
AIR / WATER INTERFACE
○ CONSTANT K POSITION 1
△ CONSTANT K POSITION 2
+ CONSTANT K POSITION 3
x CONSTANT K POSITION 4
○ CONSTANT K POSITION 5
IMAGINARY COMPONENT OF COMPLEX ELASTIC MODULUS (E")
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
5.60
6.40
7.20
8.00
8.80
9.60
10.40
11.20
12.00
12.80
SURFACE CONCENTRATION (Γ) [x 10⁻¹²] MOLES / CM²

Figure 17. Capillary ripple propagation characteristics on lecithin monolayers. The dependence of Y1 on surface concentration is shown for a Multiple Constant k experiment at an air/water interface. Maxima occur for all frequencies.

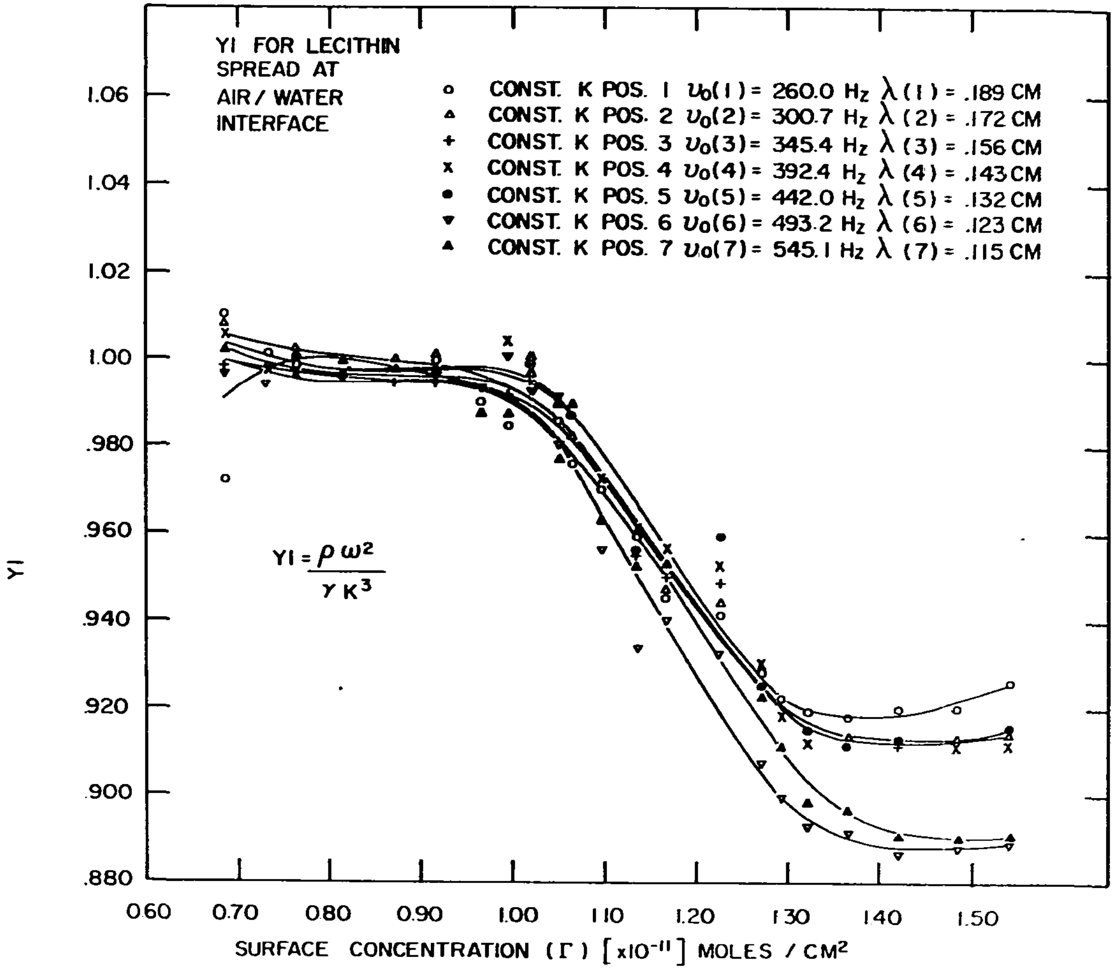

YI FOR LECITHIN SPREAD AT AIR / WATER INTERFACE
○ CONST. K POS. 1 υo(1) = 260.0 Hz λ(1) = .189 CM
△ CONST. K POS. 2 υo(2) = 300.7 Hz λ(2) = .172 CM
+ CONST. K POS. 3 υo(3) = 345.4 Hz λ(3) = .156 CM
x CONST. K POS. 4 υo(4) = 392.4 Hz λ(4) = .143 CM
● CONST. K POS. 5 υo(5) = 442.0 Hz λ(5) = .132 CM
▼ CONST. K POS. 6 υo(6) = 493.2 Hz λ(6) = .123 CM
▲ CONST. K POS. 7 υo(7) = 545.1 Hz λ(7) = .115 CM
YI = ρω²/γK³
YI
1.06
1.04
1.02
1.00
.980
.960
.940
.920
.900
.880
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
1.40
1.50
SURFACE CONCENTRATION (Γ) [x10⁻¹¹] MOLES / CM²

Figure 18. Capillary ripple propagation characteristics on lecithin monolayers. The dependence of Y2 on surface concentration is shown for this air/water system. Note that pronounced maxima result at all frequencies.

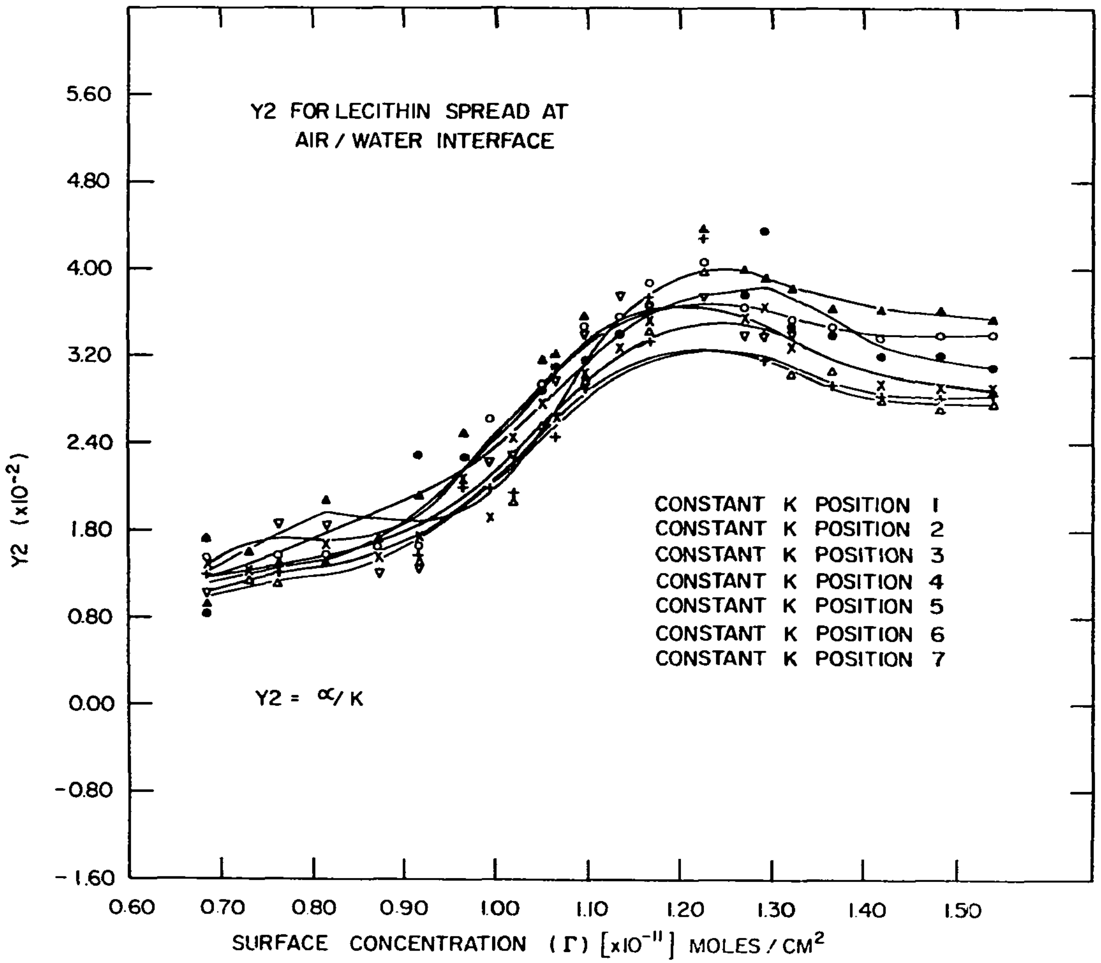

Y2 FOR LECITHIN SPREAD AT
AIR / WATER INTERFACE
Y2 = α/ K
CONSTANT K POSITION 1
CONSTANT K POSITION 2
CONSTANT K POSITION 3
CONSTANT K POSITION 4
CONSTANT K POSITION 5
CONSTANT K POSITION 6
CONSTANT K POSITION 7
Y2 ($\times 10^{-2}$)
5.60
4.80
4.00
3.20
2.40
1.80
0.80
0.00
-0.80
-1.60
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
1.40
1.50
SURFACE CONCENTRATION (Γ) [$\times 10^{-11}$] MOLES / CM^2

Figure 19. Capillary ripple propagation characteristics on lecithin monolayers. The dependence of the real component of the complex elastic modulus, E', on surface concentration is shown for a Multiple Constant [illegible] experiment at an air/water interface. Although the scatter is more severe than for Y1 or Y2, the curves for various frequencies are similar.

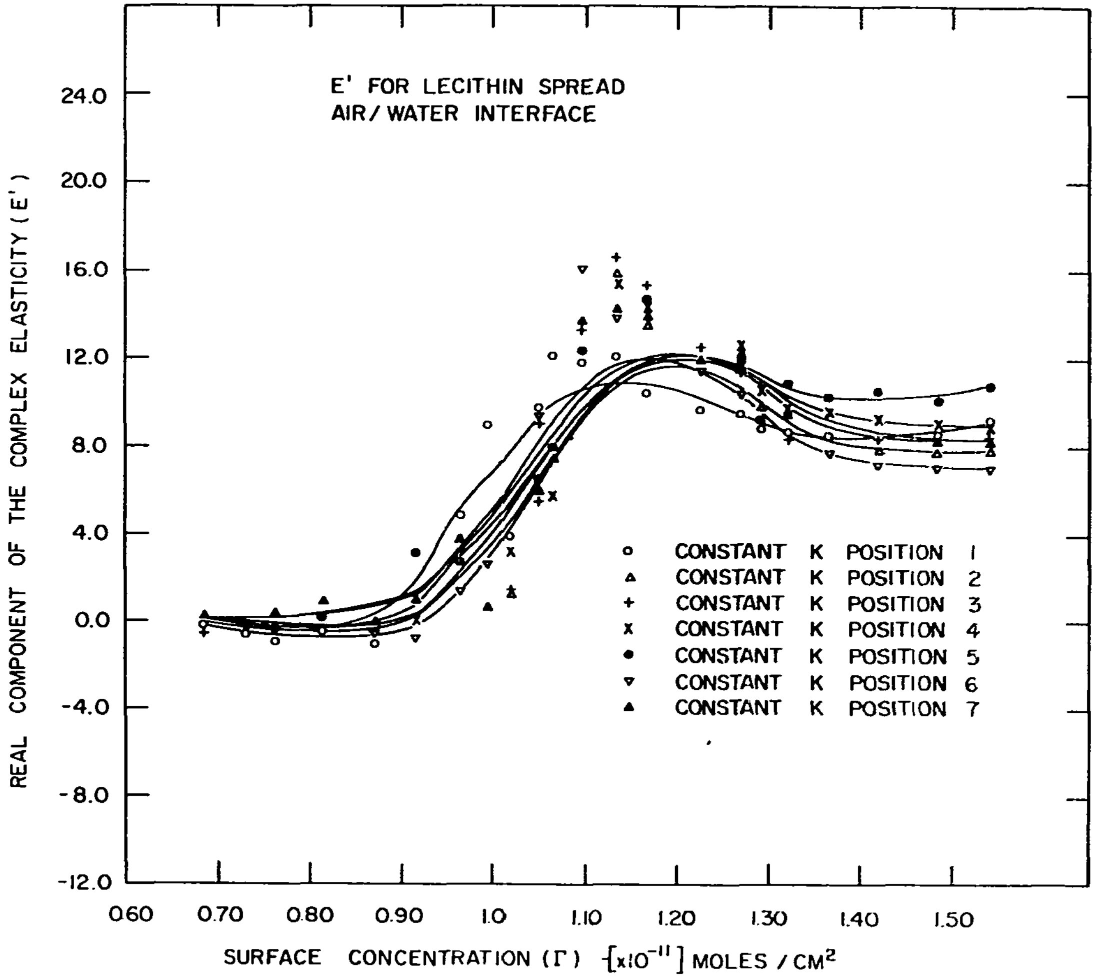

E' FOR LECITHIN SPREAD
AIR/WATER INTERFACE
REAL COMPONENT OF THE COMPLEX ELASTICITY (E')
24.0
20.0
16.0
12.0
8.0
4.0
0.0
-4.0
-8.0
-12.0
0.60
0.70
0.80
0.90
1.0
1.10
1.20
1.30
1.40
1.50
SURFACE CONCENTRATION (Γ) [x10⁻¹¹] MOLES / CM²
○ CONSTANT K POSITION 1
△ CONSTANT K POSITION 2
+ CONSTANT K POSITION 3
x CONSTANT K POSITION 4
● CONSTANT K POSITION 5
▽ CONSTANT K POSITION 6
▲ CONSTANT K POSITION 7

Figure 20. Capillary ripple propagation characteristics on lecithin monolayers. The dependence of the imaginary component of the complex elastic modulus, E", on surface concentration is shown for a Multiple Constant k experiment at an air/water interface. Again the various frequency curves are similar.

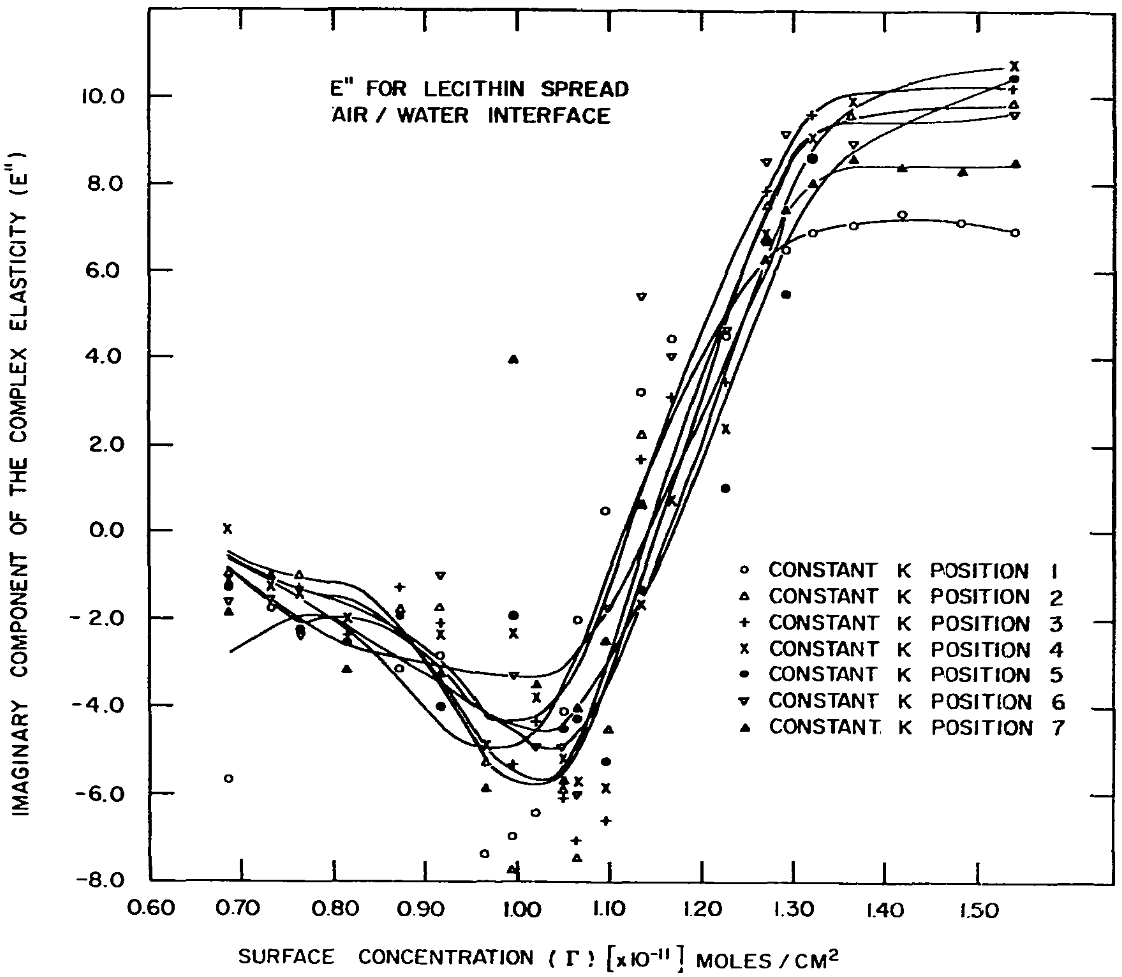

E" FOR LECITHIN SPREAD
AIR / WATER INTERFACE
IMAGINARY COMPONENT OF THE COMPLEX ELASTICITY (E")
10.0
8.0
6.0
4.0
2.0
0.0
- 2.0
-4.0
-6.0
-8.0
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
1.40
1.50
SURFACE CONCENTRATION (Γ) [x10⁻¹¹] MOLES / CM²
○ CONSTANT K POSITION 1
△ CONSTANT K POSITION 2
+ CONSTANT K POSITION 3
x CONSTANT K POSITION 4
● CONSTANT K POSITION 5
▽ CONSTANT K POSITION 6
▲ CONSTANT K POSITION 7

Figure 21. Capillary ripple propagation characteristics on 1:1 mixture of cholesterol and lecithin monolayers. The dependence of Y1 on surface concentration is shown for a Multiple Constant k experiment at an air/water interface. Maxima occur for all frequencies.

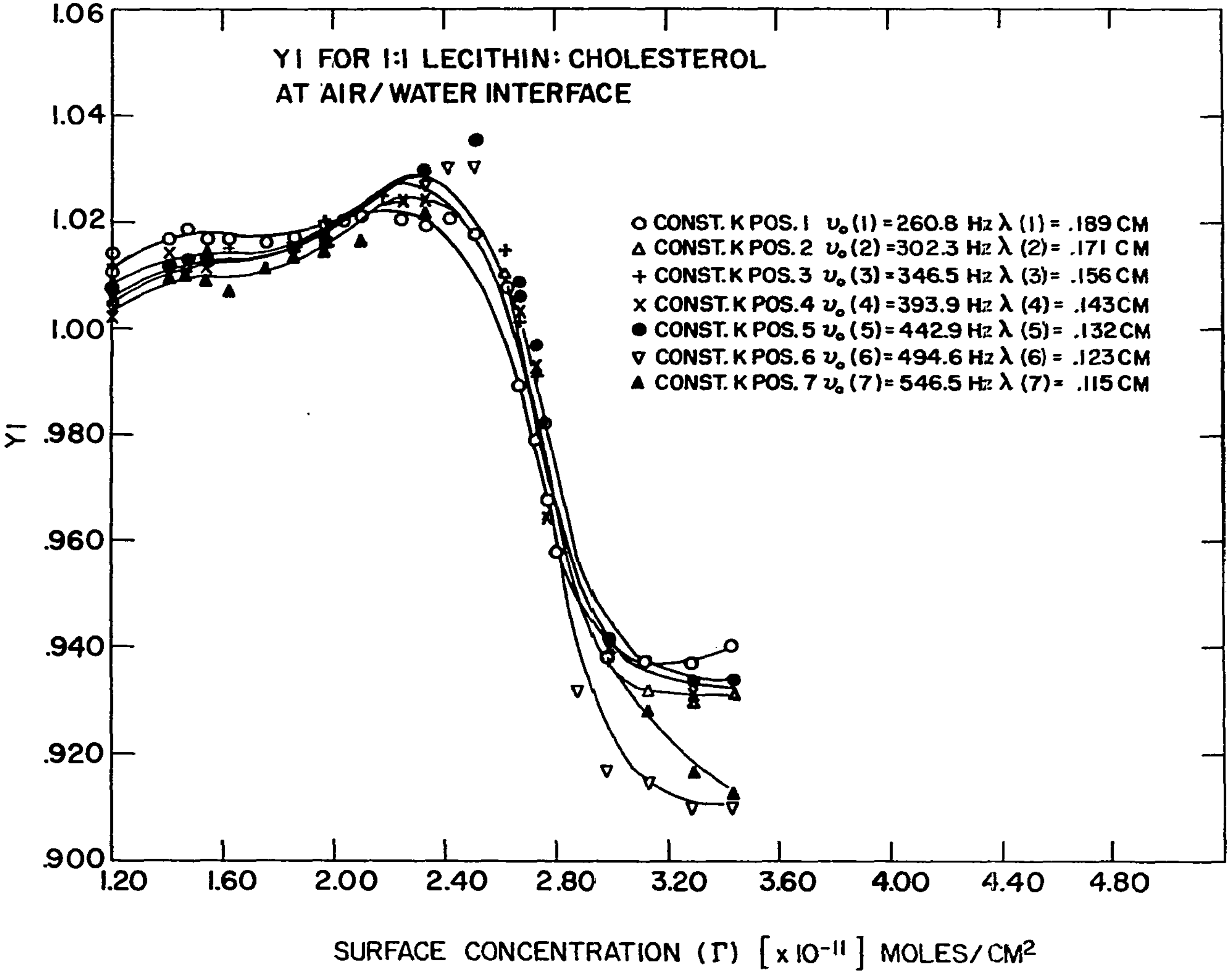

YI FOR 1:1 LECITHIN: CHOLESTEROL
AT AIR/WATER INTERFACE
○ CONST. K POS. 1 ν₀(1) = 260.8 Hz λ (1) = .189 CM
△ CONST. K POS. 2 ν₀(2) = 302.3 Hz λ (2) = .171 CM
+ CONST. K POS. 3 ν₀(3) = 346.5 Hz λ (3) = .156 CM
× CONST. K POS. 4 ν₀(4) = 393.9 Hz λ (4) = .143 CM
● CONST. K POS. 5 ν₀(5) = 442.9 Hz λ (5) = .132 CM
▽ CONST. K POS. 6 ν₀(6) = 494.6 Hz λ (6) = .123 CM
▲ CONST. K POS. 7 ν₀(7) = 546.5 Hz λ (7) = .115 CM
YI
1.06
1.04
1.02
1.00
.980
.960
.940
.920
.900
1.20
1.60
2.00
2.40
2.80
3.20
3.60
4.00
4.40
4.80
SURFACE CONCENTRATION (Γ) [x 10⁻¹¹] MOLES/CM²

Figure 22. Capillary ripple propagation characteristics on equimolar mixture of cholesterol and lecithin monolayers. The dependence of Y2 on surface concentration (using the average molecular weight) is shown for this air/water system. Note that pronounced maxima result at all frequencies, and that these maxima are sharper than for the pure components.

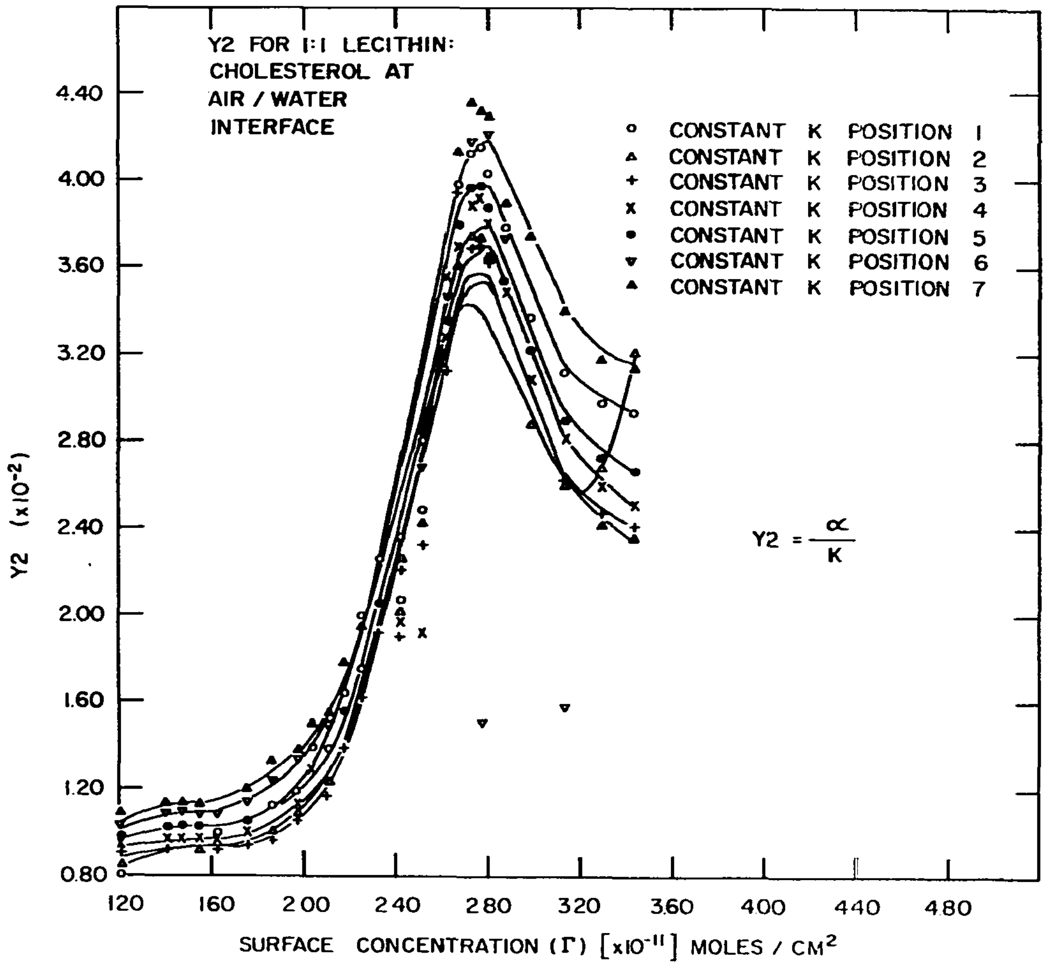

Y2 FOR 1:1 LECITHIN: CHOLESTEROL AT AIR / WATER INTERFACE
○ CONSTANT K POSITION 1
△ CONSTANT K POSITION 2
+ CONSTANT K POSITION 3
x CONSTANT K POSITION 4
● CONSTANT K POSITION 5
▽ CONSTANT K POSITION 6
▲ CONSTANT K POSITION 7
$Y2 = \frac{\alpha}{K}$
Y2 ($\times 10^{-2}$)
4.40
4.00
3.60
3.20
2.80
2.40
2.00
1.60
1.20
0.80
120
160
200
240
280
320
360
400
440
480
SURFACE CONCENTRATION (Γ) [$\times 10^{-11}$] MOLES / CM^2

Figure 23. Capillary ripple propagation characteristics on 1:1 mixture of cholesterol and lecithin monolayers. The dependence of the real component of the complex elastic modulus, E', on surface concentration is shown for a Multiple Constant k experiment at an air/water interface. Although the scatter is more severe than for Y1 or Y2, the curves for various frequencies are similar.

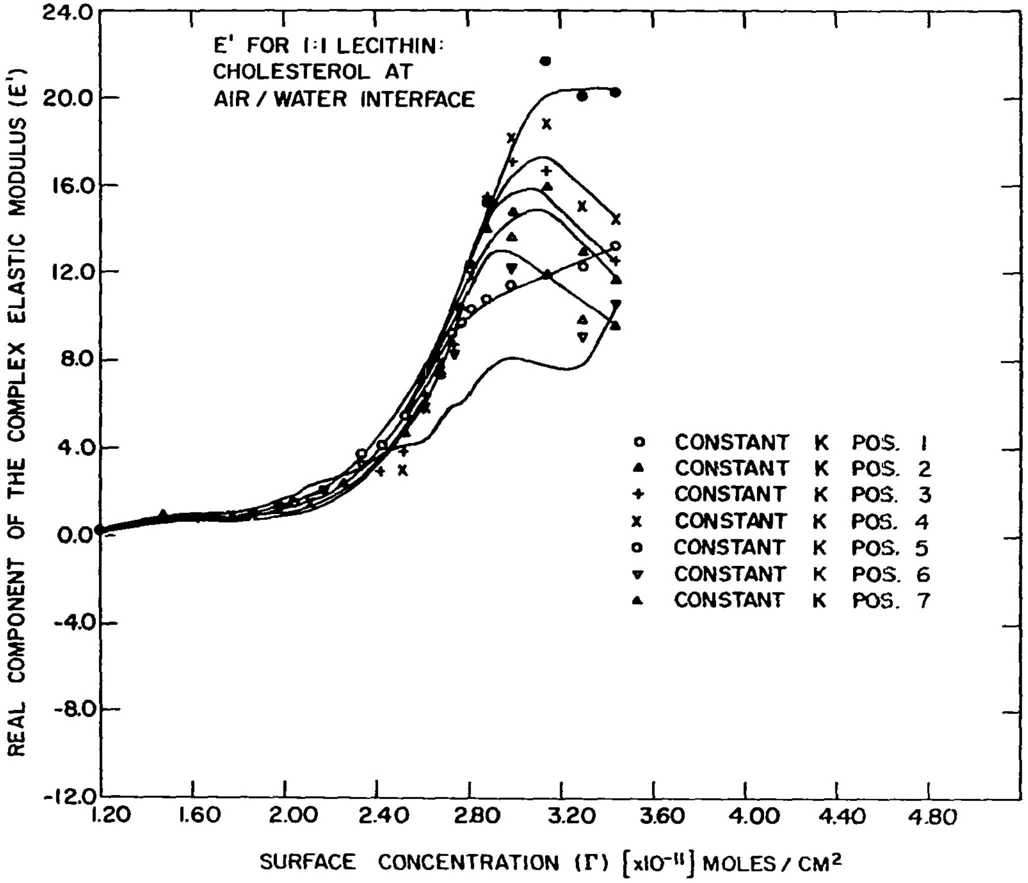

E' FOR 1:1 LECITHIN: CHOLESTEROL AT AIR / WATER INTERFACE
24.0
20.0
16.0
12.0
8.0
4.0
0.0
-4.0
-8.0
-12.0
REAL COMPONENT OF THE COMPLEX ELASTIC MODULUS (E')
1.20
1.60
2.00
2.40
2.80
3.20
3.60
4.00
4.40
4.80
SURFACE CONCENTRATION (Γ) [x10⁻¹¹] MOLES / CM²
○ CONSTANT K POS. 1
▲ CONSTANT K POS. 2
+ CONSTANT K POS. 3
x CONSTANT K POS. 4
○ CONSTANT K POS. 5
▼ CONSTANT K POS. 6
▲ CONSTANT K POS. 7

Figure 24. Capillary ripple propagation characteristics on 1:1 mixture of cholesterol and lecithin monolayers. The dependence of the imaginary component of the complex elastic modulus, E'', on surface concentration is shown for a Multiple Constant k experiment at an air/water interface. Again the various frequency curves are similar.

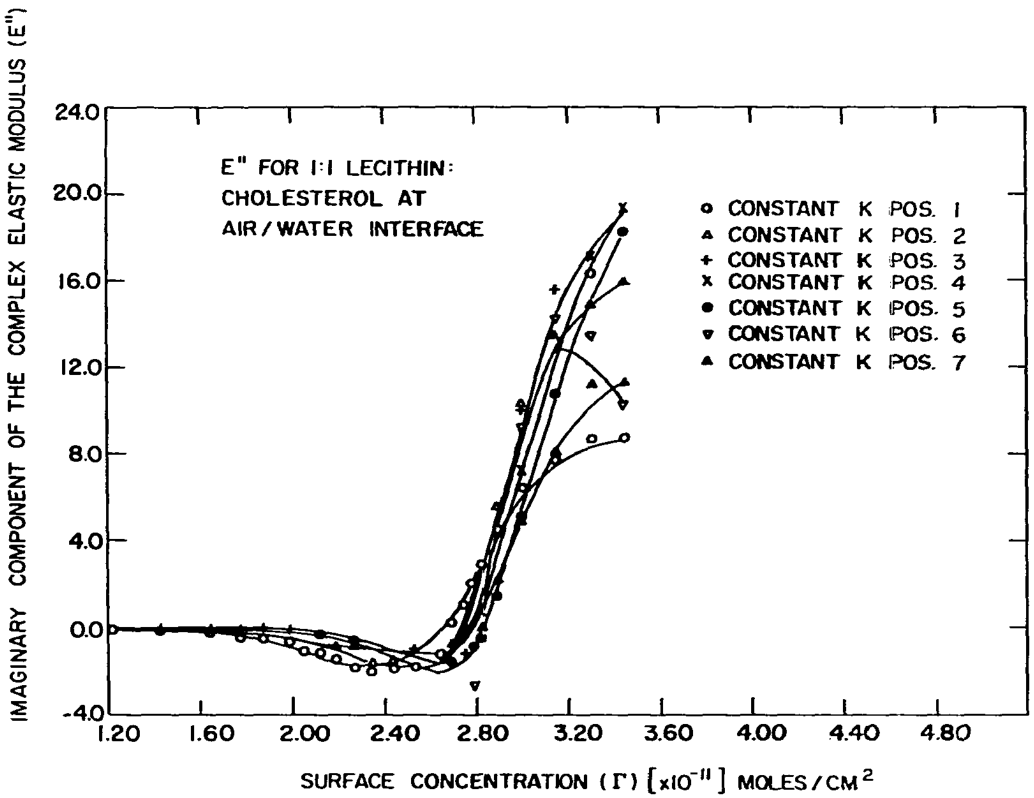
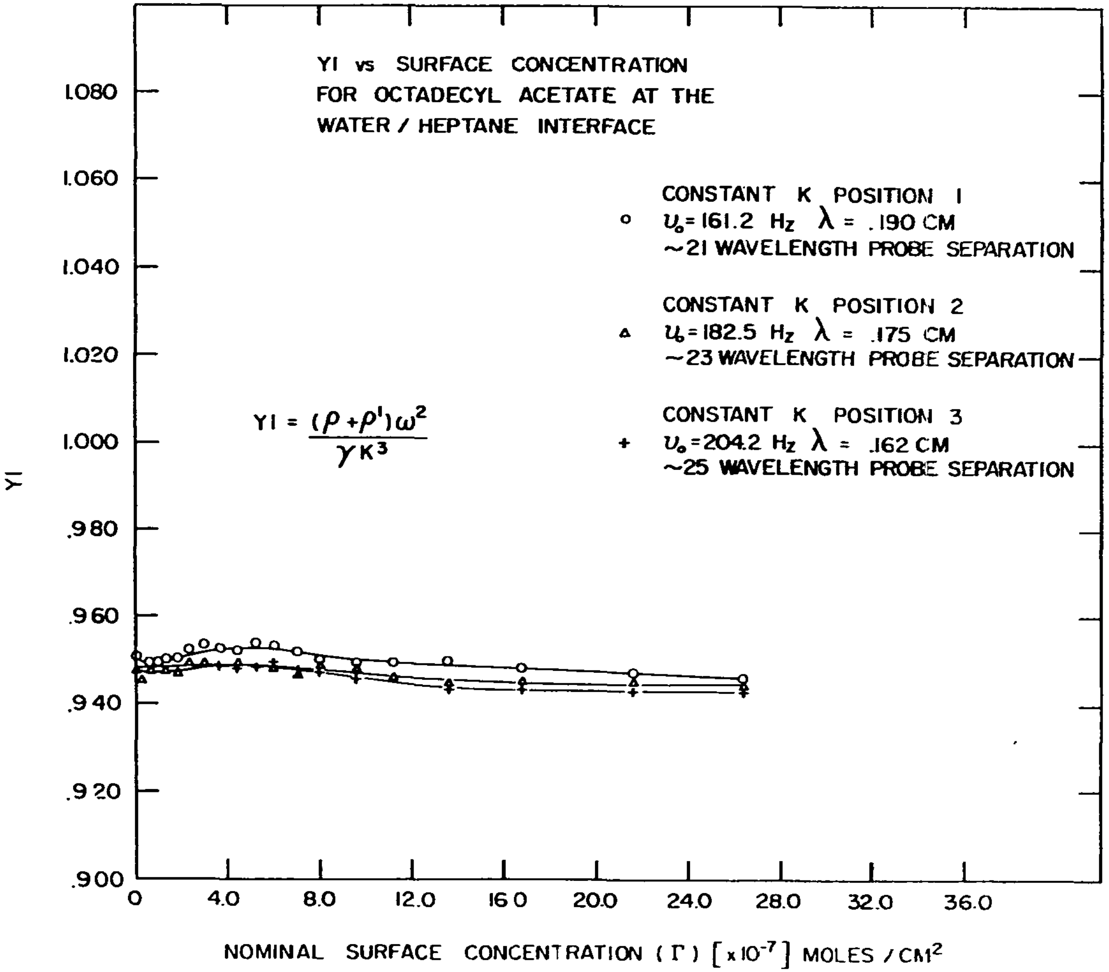

E" FOR 1:1 LECITHIN: CHOLESTEROL AT AIR/WATER INTERFACE
○ CONSTANT K POS. 1
△ CONSTANT K POS. 2
+ CONSTANT K POS. 3
× CONSTANT K POS. 4
● CONSTANT K POS. 5
▽ CONSTANT K POS. 6
▲ CONSTANT K POS. 7
IMAGINARY COMPONENT OF THE COMPLEX ELASTIC MODULUS (E")
24.0
20.0
16.0
12.0
8.0
4.0
0.0
-4.0
1.20
1.60
2.00
2.40
2.80
3.20
3.60
4.00
4.40
4.80
SURFACE CONCENTRATION (Γ) [x10⁻¹¹] MOLES/CM²

Figure 25. Typical capillary ripple propagation characteristics at heptane/water interfaces. The dependence of Y1 on surface concentration for octadecyl acetate in a Multiple Constant k experiment is shown.



YI vs SURFACE CONCENTRATION
FOR OCTADECYL ACETATE AT THE
WATER / HEPTANE INTERFACE
○ CONSTANT K POSITION 1
υ_0 = 161.2 Hz λ = .190 CM
~21 WAVELENGTH PROBE SEPARATION
△ CONSTANT K POSITION 2
υ_0 = 182.5 Hz λ = .175 CM
~23 WAVELENGTH PROBE SEPARATION
+ CONSTANT K POSITION 3
υ_0 = 204.2 Hz λ = .162 CM
~25 WAVELENGTH PROBE SEPARATION
$YI = \frac{(\rho + \rho')\omega^2}{\gamma K^3}$
YI
1.080
1.060
1.040
1.020
1.000
.980
.960
.940
.920
.900
0
4.0
8.0
12.0
16.0
20.0
24.0
28.0
32.0
36.0
NOMINAL SURFACE CONCENTRATION (Γ) [$\times 10^{-7}$] MOLES / CM^2

Figure 26. Typical capillary ripple propagation characteristics at heptane/water interfaces. The dependence of Y2 on surface concentration for octadecyl acetate in a Multiple Constant k experiment is shown.

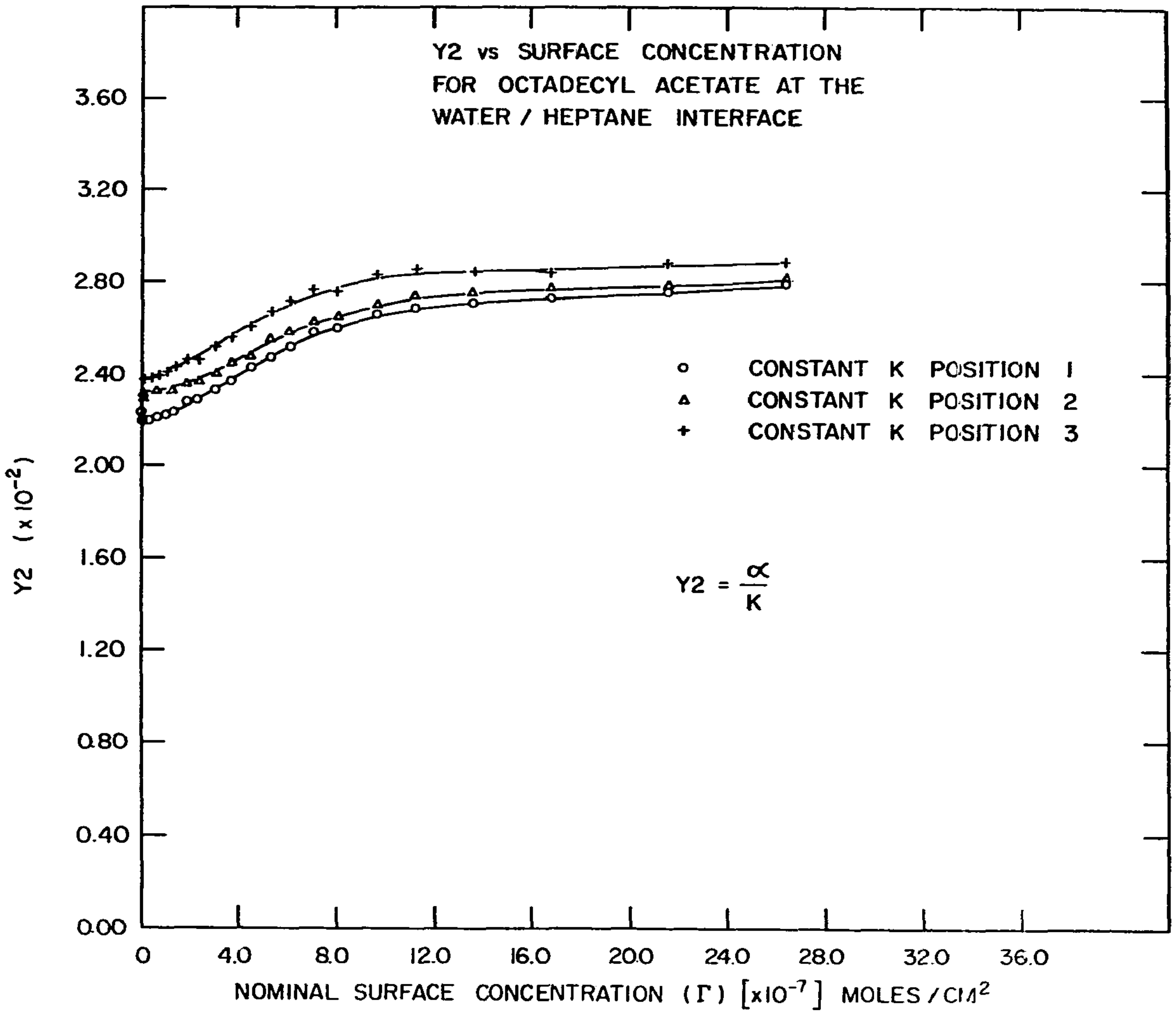

Y2 vs SURFACE CONCENTRATION
FOR OCTADECYL ACETATE AT THE
WATER / HEPTANE INTERFACE
o CONSTANT K POSITION 1
Δ CONSTANT K POSITION 2
+ CONSTANT K POSITION 3
$Y2 = \frac{\alpha}{K}$
Y2 ($\times 10^{-2}$)
3.60
3.20
2.80
2.40
2.00
1.60
1.20
0.80
0.40
0.00
0
4.0
8.0
12.0
16.0
20.0
24.0
28.0
32.0
36.0
NOMINAL SURFACE CONCENTRATION (Γ) [$\times 10^{-7}$] MOLES / CM^2

Figure 27. Typical capillary ripple propagation characteristics at heptane/water interfaces. The dependence of interfacial tension, γ, on surface concentration for ocatedcyl acetate in a Multiple Constant k experiment is shown.

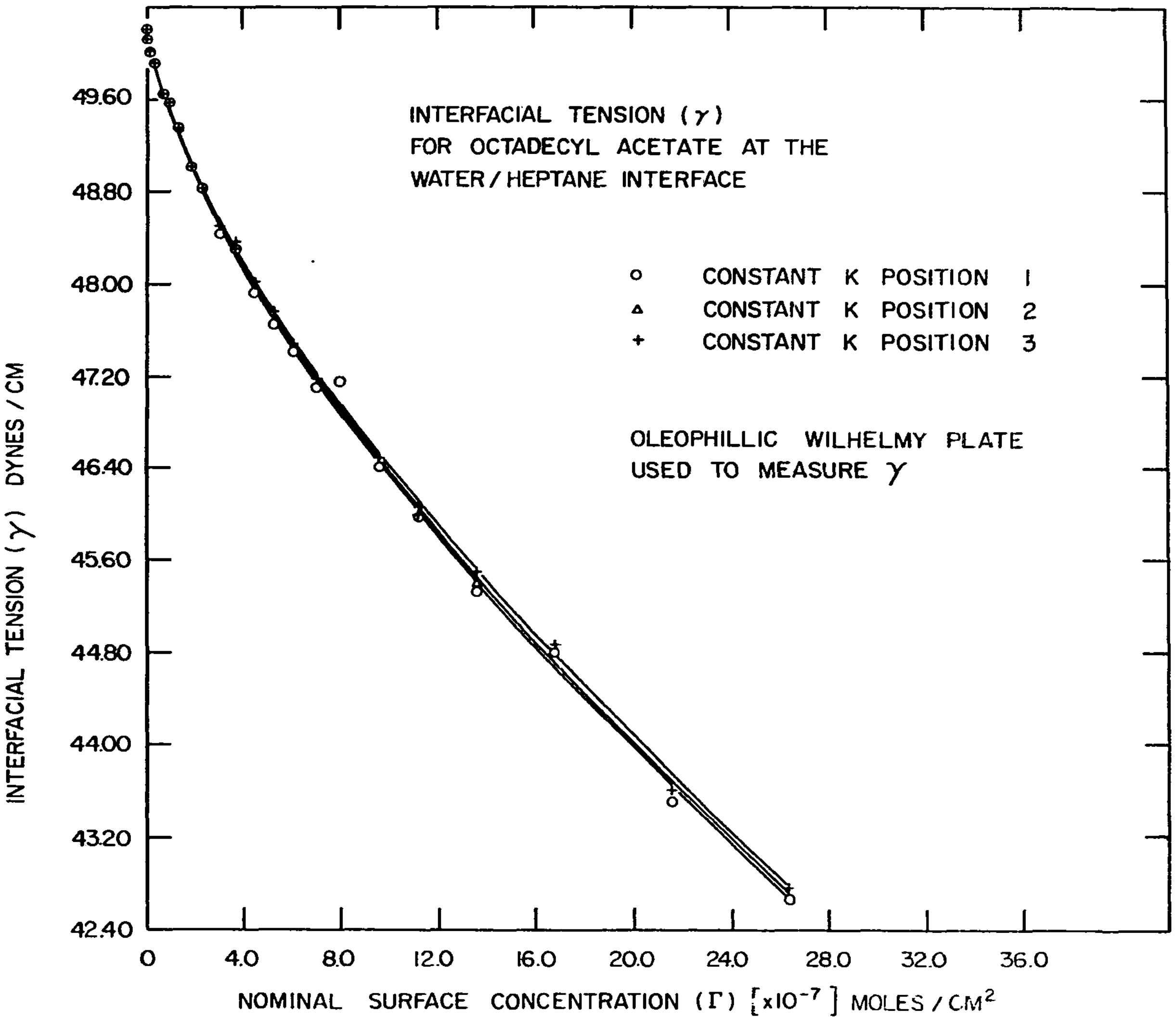

INTERFACIAL TENSION (γ)
FOR OCTADECYL ACETATE AT THE
WATER / HEPTANE INTERFACE
○ CONSTANT K POSITION 1
△ CONSTANT K POSITION 2
+ CONSTANT K POSITION 3
OLEOPHILLIC WILHELMY PLATE
USED TO MEASURE γ
INTERFACIAL TENSION (γ) DYNES / CM
49.60
48.80
48.00
47.20
46.40
45.60
44.80
44.00
43.20
42.40
0
4.0
8.0
12.0
16.0
20.0
24.0
28.0
32.0
36.0
NOMINAL SURFACE CONCENTRATION (Γ) [x10⁻⁷] MOLES / CM²

Figure 28. Typical capillary ripple propagation characteristics at heptane/water interfaces. The dependence of real component of the complex elastic modulus, E', on surface concentration for octadecyl acetate in a Multiple Constant k experiment is shown.

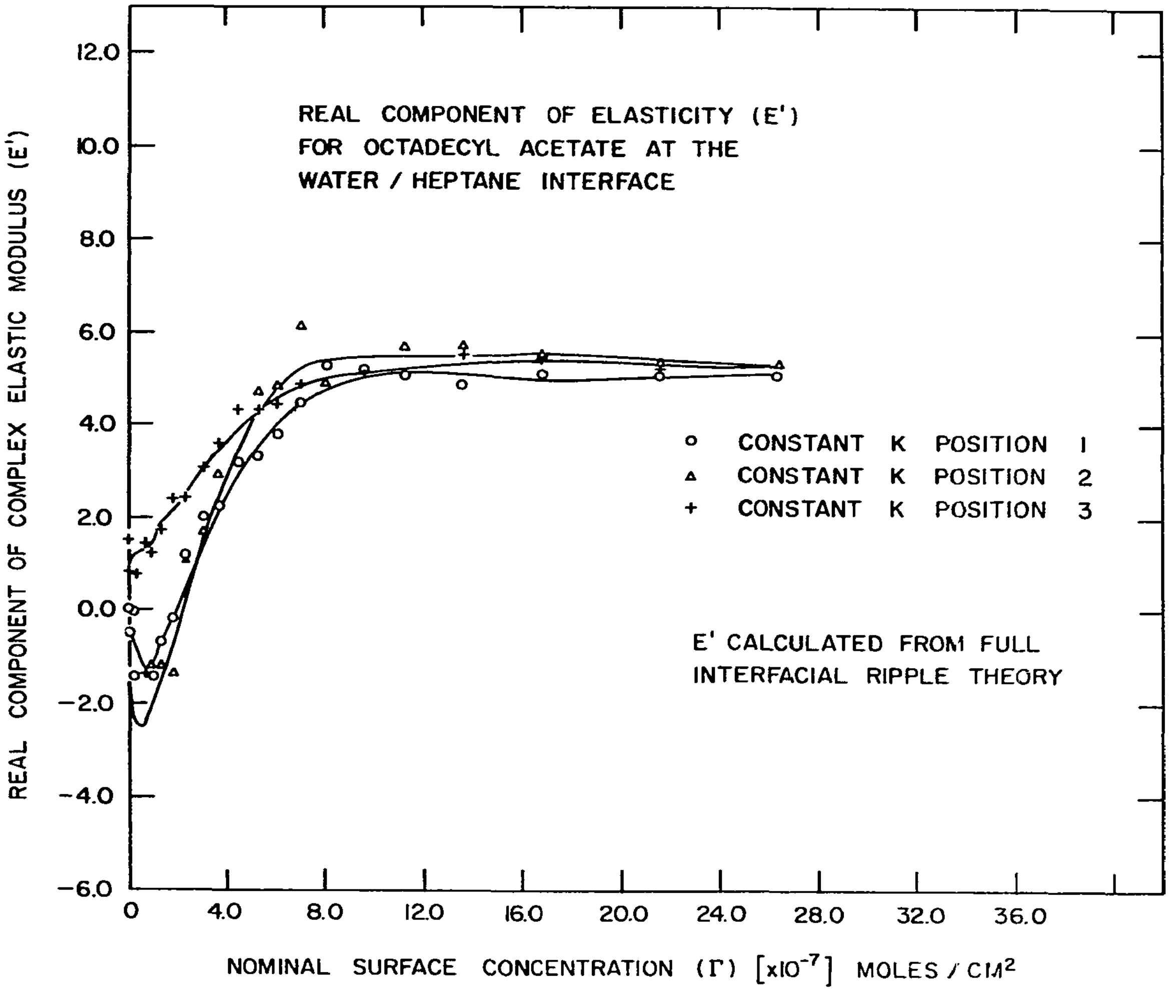

REAL COMPONENT OF ELASTICITY (E')
FOR OCTADECYL ACETATE AT THE
WATER / HEPTANE INTERFACE
○ CONSTANT K POSITION 1
△ CONSTANT K POSITION 2
+ CONSTANT K POSITION 3
E' CALCULATED FROM FULL
INTERFACIAL RIPPLE THEORY
REAL COMPONENT OF COMPLEX ELASTIC MODULUS (E')
12.0
10.0
8.0
6.0
4.0
2.0
0.0
−2.0
−4.0
−6.0
0
4.0
8.0
12.0
16.0
20.0
24.0
28.0
32.0
36.0
NOMINAL SURFACE CONCENTRATION (Γ) [x10⁻⁷] MOLES / CM²

Figure 29. Typical capillary ripple propagation characteristics at heptane/water interfaces. The dependence of imaginary component of the complex elastic modulus, E", on surface concentration for octadecyl acetate in a Multiple Constant k experiment is shown.

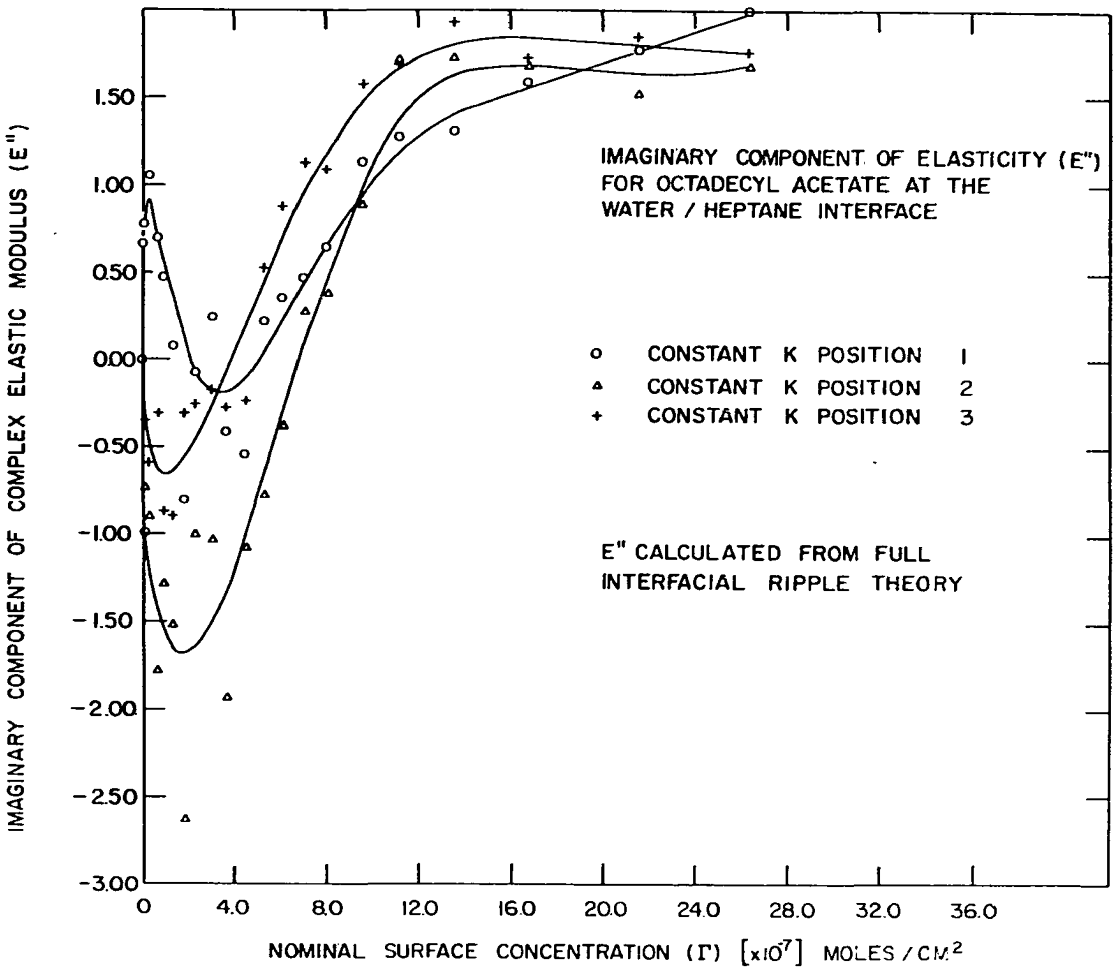

IMAGINARY COMPONENT OF ELASTICITY (E")
FOR OCTADECYL ACETATE AT THE
WATER / HEPTANE INTERFACE
o CONSTANT K POSITION 1
△ CONSTANT K POSITION 2
+ CONSTANT K POSITION 3
E" CALCULATED FROM FULL
INTERFACIAL RIPPLE THEORY
IMAGINARY COMPONENT OF COMPLEX ELASTIC MODULUS (E")
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
0
4.0
8.0
12.0
16.0
20.0
24.0
28.0
32.0
36.0
NOMINAL SURFACE CONCENTRATION (Γ) [x10⁻⁷] MOLES / CM²

Figure 30. Typical capillary ripple propagation characteristics at heptane/water interfaces. The dependence of reduced frequency, υ/υ_o, on surface concentration for octadecyl acetate in a Multiple Constant k experiment is shown.

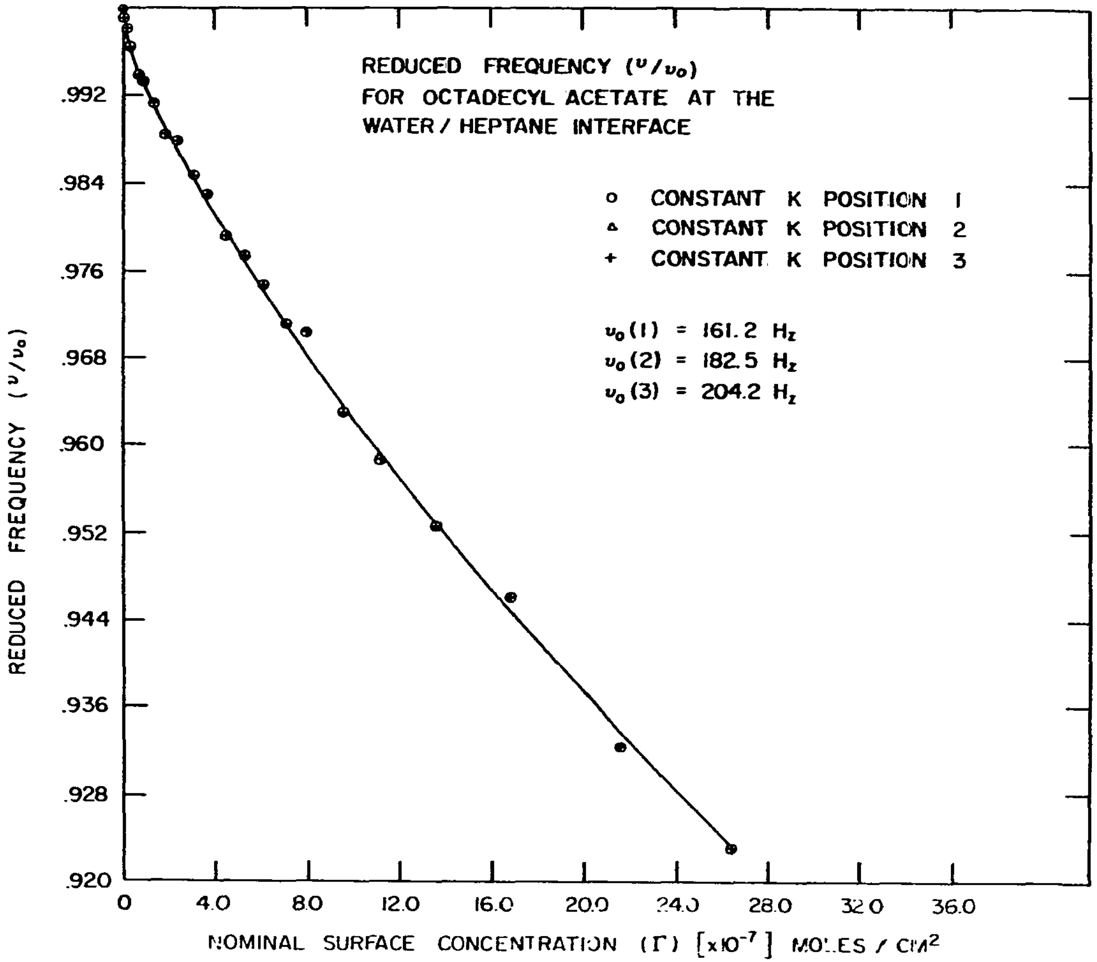

REDUCED FREQUENCY (ν/ν_o)
FOR OCTADECYL ACETATE AT THE
WATER / HEPTANE INTERFACE
○ CONSTANT K POSITION 1
△ CONSTANT K POSITION 2
+ CONSTANT K POSITION 3
$\nu_o(1)$ = 161.2 Hz
$\nu_o(2)$ = 182.5 Hz
$\nu_o(3)$ = 204.2 Hz
.992
.984
.976
.968
.960
.952
.944
.936
.928
.920
0
4.0
8.0
12.0
16.0
20.0
24.0
28.0
32.0
36.0
REDUCED FREQUENCY (ν/ν_o)
NOMINAL SURFACE CONCENTRATION (Γ) [$\times 10^{-7}$] MOLES / CM^2

Figure 31. Typical capillary ripple propagation characteristics at heptane/water interfaces. The dependence of Yl on surface pressure, π, for octadecyl acetate in a Multiple Constant k experiment is shown. Use of surface pressure makes comparison between various surfactants simpler.

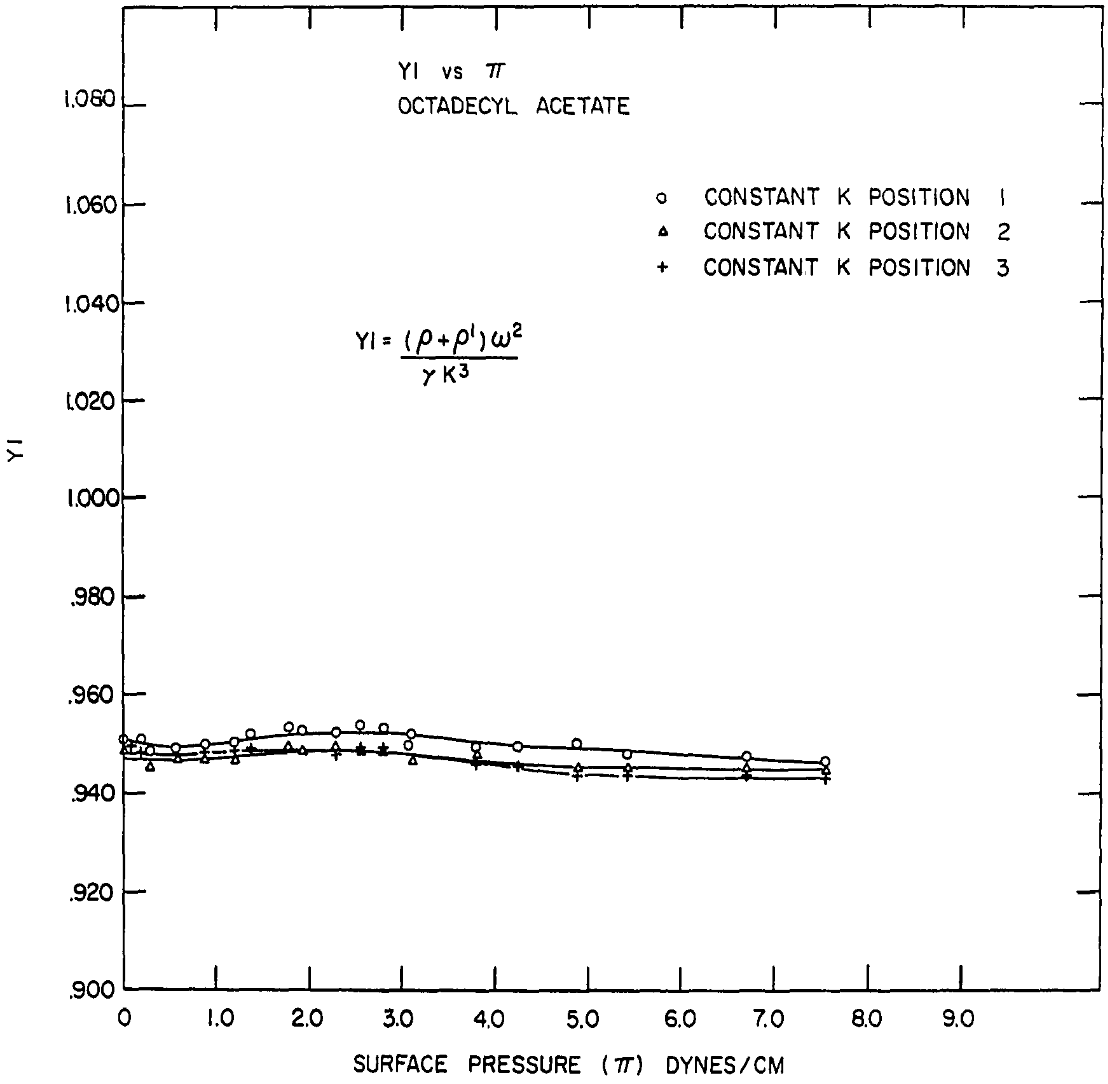

YI vs π
OCTADECYL ACETATE
○ CONSTANT K POSITION 1
△ CONSTANT K POSITION 2
+ CONSTANT K POSITION 3
$YI = \frac{(\rho+\rho')\omega^2}{\gamma K^3}$
YI
1.080
1.060
1.040
1.020
1.000
.980
.960
.940
.920
.900
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
SURFACE PRESSURE (π) DYNES/CM

Figure 32. Typical capillary ripple propagation characteristics at heptane/water interfaces. The dependence of Y2 on surface pressure, π, for octadecyl acetate in a Multiple Constant k experiment is shown. Use of surface pressure makes comparison between various surfactants simpler.

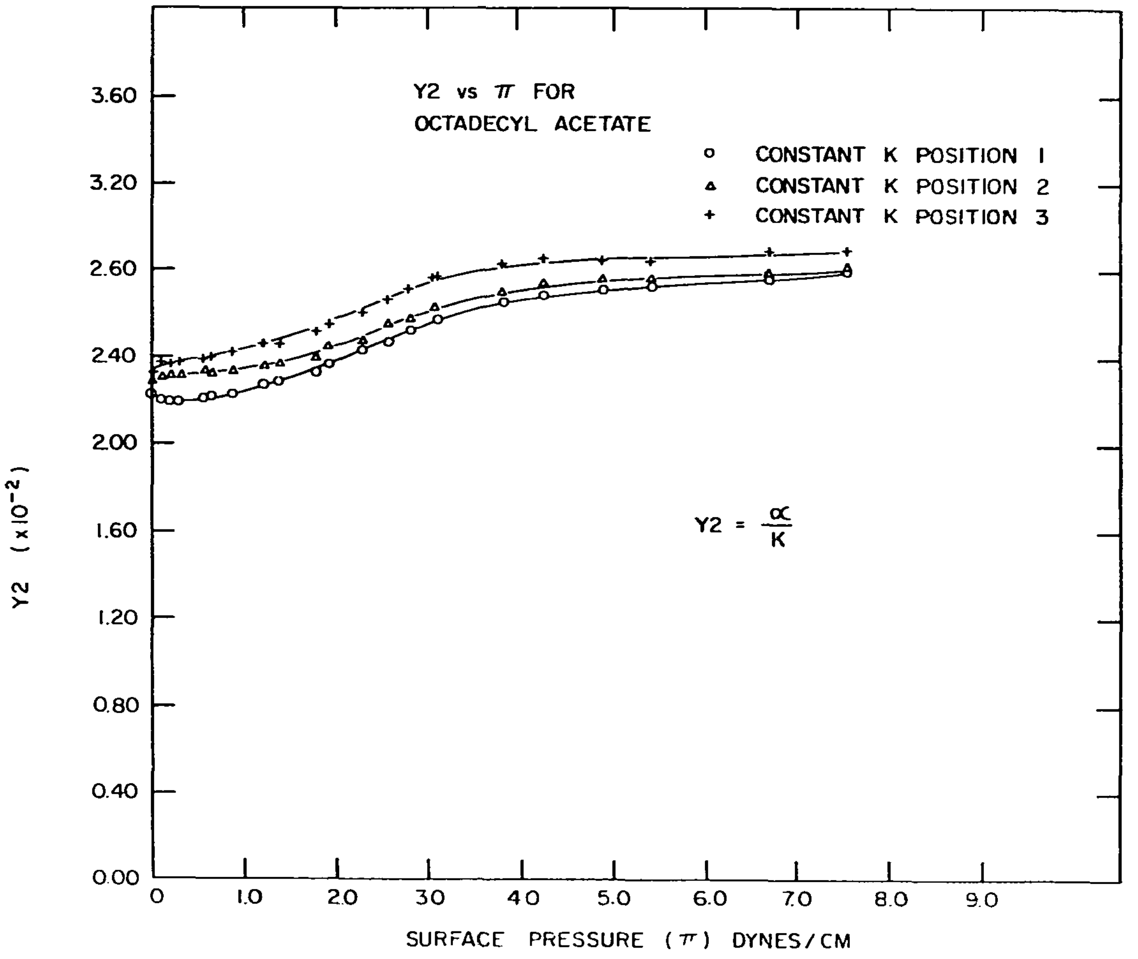
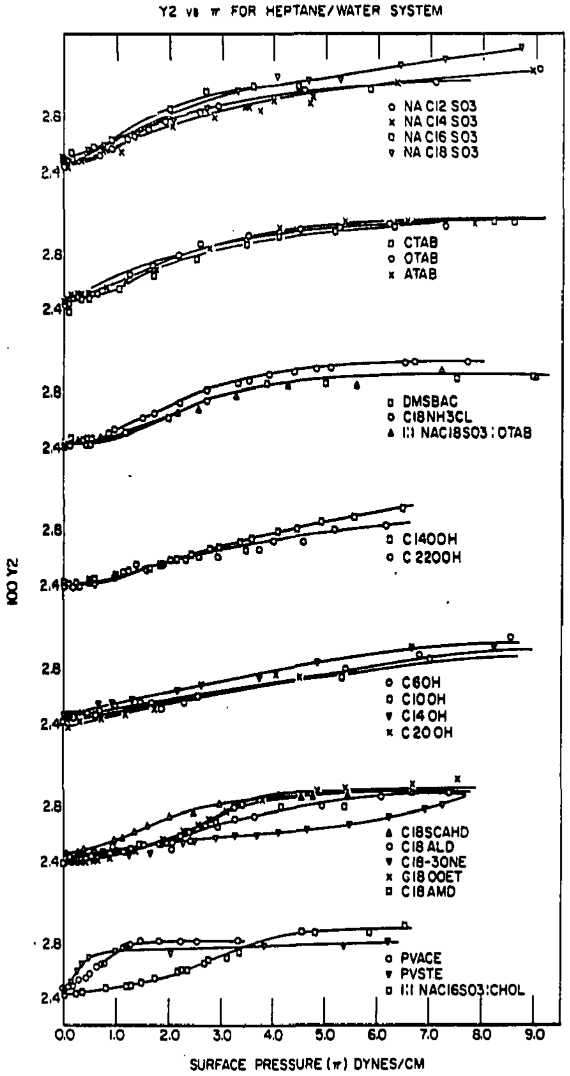

Y2 vs π FOR
OCTADECYL ACETATE
○ CONSTANT K POSITION 1
△ CONSTANT K POSITION 2
+ CONSTANT K POSITION 3
Y2 = α/K
Y2 (×10⁻²)
3.60
3.20
2.60
2.40
2.00
1.60
1.20
0.80
0.40
0.00
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
SURFACE PRESSURE (π) DYNES/CM

Figure 33. Comparison of Y2 as a function of surface pressure, π, for various surfactants. The first constant k position data for various surfactants at the heptane/water interface are superimposed in groups. Overall behavior is similar, but the effects of head group type can be seen. The uncharged simple surfactants do not change from low elastic limit to high elastic limit as abruptly as the ionic surfactants do. The low pressure transitions of the polymeric surfactants suggest stronger interfactions for these molecules than for monomeric surfactants.


Y2 vs π FOR HEPTANE/WATER SYSTEM
100 Y2
2.8
2.4
NA C12 SO3
NA C14 SO3
NA C16 SO3
NA C18 SO3
CTAB
OTAB
ATAB
DMSBAC
C18NH3CL
1:1 NAC18SO3 : OTAB
C1400H
C 2200H
C6OH
C10OH
C14 OH
C20 OH
C18SCAHD
C18 ALD
C18-3ONE
C18 OOET
C18AMD
PVACE
PVSTE
1:1 NAC16SO3:CHOL
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
SURFACE PRESSURE (π) DYNES/CM

APPENDIX B

The cited Computer Program listings follow:

EXPT	This is the main program and its subroutines used to convert experimental data into capillary ripple parameters.	Page 196
NWV	This program utilizes much of the logic of EXPT. Its purpose is to compute the calibration curves allowing for generating probe amplitude and phase dependence on frequency.	Page 206
CALB	Calibration data may be readily expressed as polynomial equations by utilizing this program. Least squares fits of the dependent variable on powers of the independent variable up to 10 are achieved by orthogonal polynomial calculations.	Page 211

```
C      ******************************************************************
C                              EXPT
C
C         PROGRAMMED BY R. L. BENCURE           FINAL VERSION  FEB 1968
C
C      THIS PROGRAM IS DESIGNED TO CONVERT DATA OBTAINED FROM A MULTIPLE
C      CONSTANT K EXPERIMENT INTO MORE USEFUL PARAMETERS.  THE EXTENDED
C      INTERFACIAL THEORY OF R. S. HANSEN AND J. A. MANN IS USED TO
C     CALCULATE THE REAL AND IMAGINARY COMPONENTS OF THE COMPLEX ELASTIC MODULUS.
C      SUBROUTINES POLZRO, FNCALC, COEF, AND CCOEF WERE SUPPLIED BY J. A. MANN.
C      FULL FORTRAN IV (G) IS UTILIZED.  THE GRAPHING OPTIONS UTILIZE
C      SIMPLOTTER.  THIS PROGRAM HAS BEEN RUN ON AN IBM 360/65 UNDER OS
C
C      ******************************************************************
C
C                                DECK MAKE UP
C
C         CARD 1     COL 1-80     TITLE
C
C         CARD 2     COL 1-40     NAME OF UPPER PHASE
C         CARD       COL41-80     NAME OF LOWER PHASE
C
C         CARD 3     COL 1-80     NAME OF SURFACTANT
C
C         CARD 4     COL 1-10     LOWER PHASE DENSITY (G/ML)
C         CARD       COL11-20     UPPER PHASE DENSITY (G/ML)
C         CARD       COL21-30     LOWER PHASE VISCOSITY (POISES)
C         CARD       COL31-40     UPPER PHASE VISCOSITY (POISES)
C         CARD       COL41-50     ELASTICITY (EP) ASSUMED FOR CALIBRATION
C         CARD       COL51-60     ELASTICITY (EPP) ASSUMED FOR CALIBRATION
C         CARD       COL61-70     ESTIMATED WAVENUMBER TO START CALIB. CALC.
C         CARD       COL71-80     ESTIMATED DAMPING COEF. TO START CALIB CALC.
C
C         CARD 5     COL 1-10     REFERENCE OUTPUT METER SCALE (MV)
C         CARD       COL11-20     INTERFACIAL TENSON  OF PURE SYSTEM (DYNE/CM)
C         CARD       COL21-30     REFERENCE INPUT VOLTAGE (VOLTS)
C
C         CARD 6     COL 1-10     RESISTANCE AT THE GENERATOR
C         CARD       COL11-20     RESISTANCE AT THE SENSOR
C
C         CARD 6A    COL 2-80     NAMELIST INPUT DATA FOR POLYNOMIAL EVALUATION
C              TO                 IN SUBROUTINES AMPLTD AND PHSCOR.  THE FREQUENCY
C              6X                 RANGES ARE IN HZO. THE INTERCEPT IS A AND THE
C                                 COEFFICIENTS ARE IN B.  NAMELIST NAM1 MAY BE IN THE
C                                 FOLLOWING FORM--
C                                  &NAM1 HZOAMP= (10 NUMBERS), AAMP=(10),
C                                  BAMP=(10,10),HZOPHS=(10),APHS=(10),BPHS=(10,10) &END
C
C         CARD 7     COL 5-       NUMBER OF CONSTANT K POSITIONS
C
C         CARD 8     COL  -       CONTROL CARD
C         CARD       COL 5-       INDEPENDENT VARIABLE TYPE


C         CARD       COL  -       1 = CONSTANT AREA EXPERIMENT, THE VOLUME
C         CARD       COL  -          OF SOLN ADDED IS READ IN (MICRO L)
C         CARD       COL  -       2 = LANGMUIR TROUGH EXPERIMENT, THE LENGTH
C         CARD       COL  -          FOR FILM IS READ IN. (CM)
C         CARD       COL  -       3 = SOLUBLE SURFACTANT EXPT. THE VOLUME SOLN
C         CARD       COL  -          ADDED IS READ IN (MICROLITERS)
C         CARD       COL10-       SURFACE TENSION TYPE
C         CARD       COL  -       1 = OLEOPHILLIC WILHELMY PLATE, BALANCE
C         CARD       COL  -         READING IS USED
C         CARD       COL  -       2 = LANGMUIR TROUGH - DIVISONS  OF DISPL.
C         CARD       COL  -          ARE READ IN
C         CARD       COL15-       PUNCHING INSTRUCTIONS
C         CARD       COL  -       1 PUNCH OUTPUT RESULTS IN SAME ORDER AS IN
C         CARD       COL  -       2 PUNCH OUTPUT RESULTS IN BATCHES WITH
C         CARD       COL  -           VALUES OF K THE SAME
C         CARD       COL  -       3 PUNCH BOTH WAYS
C         CARD       COL  -       4 PUNCH INPUT VALUES WITH K CONSTANT
C         CARD       COL  -       5 PUNCH INPUT AND 1
C         CARD       COL  -       6 PUNCH INPUT & 2
C         CARD       COL  -       7 PUNCH INPUT & 3
C         CARD       COL20-         ALTERNATIVE WRITING INSTRUCTIONS
C         CARD       COL  -       2 WRITE OUTPUT WITH VALUES OF K CONSTANT
C         CARD       COL  -         AS WELL AS IN TABLES OF INDEP. VAR. CONS.
C         CARD       COL25-       GRAPHING OPTIONS
C         CARD       COL  -       1 GRAPH Y1 AND Y2 AS FUNCTIONS OF INDEP. VAR.
C         CARD       COL  -       2 GRAPH Y1, Y2, SFTN.
C         CARD       COL  -       3 GRAPH Y1, Y2, SFTN, ELASRL, ELASMG
C         CARD       COL  -       4 GRAPH Y1, Y2, SFTN, ELASRL, ELASMG, PELEC
C         CARD       COL  -       5 GRAPH Y1 & Y2 AS FXNS OF INTER. TENS.
C
C         CARD       COL  -       FOR CONSTANT AREA EXPERIMENT WITH ADDITONS OF
C         CARD       COL  -           SURFACTANT
C         CARD 9     COL 1-10     WT. OF SURFACTANT IN MG
C         CARD       COL11-20     MOL. WT. IN G
C         CARD       COL21-30     VOLUME SURFACTANT DISSOLVED IN (L)
C         CARD       COL31-40     TOTAL AVAILABLE AREA (CM SQ.)
C         CARD       COL  -       FOR LANGMUIR TROUGH EXPER. WITH DECREASING
C         CARD       COL  -         AVAILABLE LENGTH (CM)
C         CARD       COL 1-10     WT. OF SURFACATANT IN MG.
C         CARD       COL11-20     MOL. WT. IN G
C         CARD       COL21-30     VOLUME SURFACTANT DISSOLVED IN (L)
C         CARD       COL31-40     VOL. SURF. ADDED IN MICROLITERS
C         CARD       COL41-50     WIDTH OF TROUGH IN CM
C         CARD       COL  -       FOR SOLUBLE SURFACTANT WITH ADDITIONS OF
C         CARD       COL  -             SURFACTANT
C         CARD       COL 1-10     WT. SURF. IN MG
C         CARD       COL11-20     MOLECULAR WT. IN G
C         CARD       COL21-30     VOLUME SURFACTANT IS DISSOLVED IN (L)
C         CARD       COL31-40     TOTAL BULK PHASE VOLUME (L)
C
C         CARD10     COL           SURFACE TENSION TYPE CONTROL CARD
C         CARD       COL  -       FOR OLEOPHILLIC WILHELMY PLATE
C         CARD       COL 1-10      ACCELERATION OF GRAVITY (MG)
```

```
               C      CARD      COL11-20    WT. OF MICA PLATE (MG)
               C      CARD      COL21-30    WT. OF IMMERSION WEIGHT (MG)
               C      CARD      COL31-40    DENSITY OF WEIGHT
               C      CARD      COL41-50    DENSITY OF PLATE
               C      CARD      COL51-60    PERIMETER OF PLATE (CM)
               C      CARD      COL61-70    FRACTION OF PLATE IMERSED
               C      CARD      COL71-80     ASSUMED INTERFACIAL TENSION
               C      CARD      COL  -      FOR LANGMUIR TROUGH
               C      CARD      COL 1-10    SENSITIVITY OF METHOD IN DYNES/CM PER
               C      CARD      COL  -        DIVISON, DIVISONS WILL BE READ IN
               C      CARD      COL11-20    PURE SYSTEM SURFACE TENSION
               C
               C                              DATA CARDS FROM 11 TO N-3
               C      CARD11    COL 1-10    INDEPENDENT VARIABLE
               C      CARD      COL11-20    FREQUENCY (HZ)
               C   TO N-3       COL21-30    INPUT VOLTAGE (VOLTS)
               C      CARD      COL31-40    OUTPUT VOLTAGE (VOLTS)
               C      CARD      COL41-50    OUTPUT METER SCALE (MV)
               C      CARD      COL51-60    SURFACE TENSION VARIABLE
               C      CARD N-2  COL11-20    BLANK (NOTE THAT DATA MUST BE BLOCKED IN
               C      CARD      COL  -          GROUPS EQUAL TO MAX. NO. OF K POSITIONS )
               C
               C      CARD N-1  COL 1-20    IF GRAPHS ARE DESIRED, A GRAPH LABEL MUST BE
               C      CARD      COL  -      SUPPLIED
               C
               C      CARD N    COL 1- 5    CONTINUATION CARD-POSITIVE NO. WILL CAUSE
               C      CARD      COL  -      RECYCLING TO FIRST READ STATEMENT
               C
 0001                 IMPLICIT REAL*8 (A-H, O-Z)
 0002                 REAL*4 RESGN, RESEN, PRBSP , DISTGN, DISTEN , CORR
 0003                 REAL*8 KAPPA, MU, MUP, XV, INTCPT
 0004                 COMPLEX*16 CI, B(10), CK, CKC, E, F
 0005                 DIMENSION X(10),Y(10), TITLE(10),ANMUP(5), ANMLR(5), ANMSRF(10),
                    1        WANO(50,10), WAVEL(10), VARINC(50,10), ANOWV(10),
                    2        VTIN(50,10), VTOUT(50,10), VFREQ(50,10), VARSF(50, 10),
                    3       SCALE (50,10), SFTN(50,10), XVAL(50,10), OMCO(50,10),
                    4       ELASRL(50,10), ELASMG(50,10), Y1(50,10), Y2(50,10),
                    5       VOONU(50,10),
                    6      VOOFAC(10), WVNMB(10), BNOWV(10), RFLFQ (50,10)
 0006                 COMMON CI,X,Y,B,LR,LW,   XVAL, Y1, Y2, SFTN, ELASRL, ELASMG,RFLFQ
 0007                 COMMON /COM1/ H2OAMP(10), AAMP(10), BAMP(10,10) / COM2 /
                    1      H2OPHS(10), APHS(10), BPHS(10,10)
 0008                 EQUIVALENCE (X(1),ALPHA),(X(2),KAPPA),(X(3),VISHEV),(X(4),VISLIT),
                    1          (X(5),RHOHEV),(X(6),RHOLIT),(X(7),GAMMA),(X(8),OMEGA),
                    2        (X(9),EP),(X(10),EPP)
 0009                 NAMELIST /NAM1/ H2OAMP, AAMP, BAMP, H2OPHS, APHS, BPHS
 0010                 LR = 1
 0011                 LW = 3
 0012                  M = 8
 0013                  N = 8
 0014                   CI = (0.0, 1.0)
               C
               C   IDENTIFICATION AND BULK SYSTEM PARAMETERS ARE LISTED

 0015             101 READ (1,1) TITLE, ANMLR, ANMUP, ANMSRF
 0016               1 FORMAT (10A8)
 0017                 WRITE (3,2) TITLE, ANMLR , ANMUP, ANMSRF
 0018               2 FORMAT('1',T31,'ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY ',
                    1       'RIPPLE EXPERIMENTS'//'0',10A8/'0','EXPERIMENTS PERFORMED',
                    2       ' AT THE ', 5A8,'/',5A8,'INTERFACE.'/'0','THE SYSTEM UNDER',
                    3       ' INVESTIGATION IS ',10A8/)
 0019                 READ (1,3) RHOHEV, RHOLIT, VISHEV, VISLIT, EP, EPP, WANOO,OMCOO,
                    1        SCALEO, SFTNO, EINO
 0020               3 FORMAT (8F10.0)
 0021                 WRITE (3,4)RHOHEV, RHOLIT, VISHEV, VISLIT,EP,EPP, WANOO,OMCOO,
                    1    SCALEO, SFTNO     ,  EINO
 0022               4 FORMAT ('0',T51,'SYSTEM PARAMETERS'//' ',T21,'LOWER PHASE DENSITY'
                    1       ,F8.4,' G/ML',T61,'UPPER PHASE DENSITY',F8.4,' G/ML'/' ',
                    2       T33,'VISCOSITY',F9.5,' POISES',T73,'VISCOSITY',F9.5,' PO',
                    3       'ISES'//'0',T41,'INITIAL VALUES ASSUMED IN CALCULATION'//
                    4        ' ',T21,'REAL ELASTICITY (EP)',F10.5, T61,'IMAGINARY ELA',
                    5       'STICITY (EPP)',F10.5,/' ',T21,'WAVENUMBER',F10.5,' RECIP',
                    6       'ROCAL  CM', T61,'DAMPING COEFFICIENT', F10.5,' CM'/' ',
                    7       T21,'REFERENCE METER SCALE',     F 8.2,' MV.',T61,'INTER',
                    8       'FACIAL TENSION',F8.4,' DYNES/CM'/' ',T21,
                    9     'REFERENCE INPUT VTG.', F7.3, ' VT.')
 0023                 READ(LR ,3) RESGN, RESEN
 0024                 READ (LR, NAM1)
 0025                 READ (LR, 6) NOK
 0026               6 FORMAT (I5)
 0027                 READ (LR, 10) IINDVR, ISFTN, IPCH, IWRT, IGPH
 0028              10 FORMAT (I6(4X,I1))
               C
               C   THE FIRST CALL TO INDVAR AND SURFTN CAUSES READING OF PARAMETERS
               C   THAT ARE PERTINENT TO THE TYPE OF EXPERIMENT AND INTERFACIAL
               C   TENSION MEASUREMENT
               C
 0029                 CALL INDVAR (IINDVR, VLO, RESO, 1)
 0030                 CALL SURFTN (ISFTN, ROGO, GAMMAO, 1)
 0031                 CALL DISTNC (RESGN, DISTGN, CORR, INTERV)
 0032                 CALL DISTNC (RESEN, DISTEN, CORR, INTERV)
 0033                 PRBSP  = ABS (DISTEN - DISTGN)
 0034                 PRBSPO = PRBSP
               C
               C   THE X ARRAY IS LOADED WITH THE INITIAL GUESSES
               C
 0035                 X(1)  = OMCOO
 0036                 X(2)  = WANOO
 0037                 X(7)  = SFTNO
 0038                 CKO = DCMPLX (WANOO, OMCOO)
 0039                 WRITE (LW, 5) PRBSPO, RESGN, RESEN, DISTGN, DISTEN
 0040               5 FORMAT ('0',T51,'PROBE POSITION DATA'/
                    1        '0','THE CALCULATED PROBE SEPARATION IS',F8.5,' CM. BASED
                    2ON ', 'RESGN=',F8.5,' RESEN=',F8.5,' DISTGN=',F8.5,      ' DISTEN=
                    3',    F8.5/'0',T41,'CALCULATION OF ZERO ELASTICITY PARAMETERS'/
                    4   '0','POS. NO.',2X,'FREQUENCY',5X,'DMP. COFF.',6X,'WAVE NO.',6X,
```

```
     5   'WAVELENGTH',6X,'NO. WAVES', 3X,'PHS.COR.WANO',2X,'GN. PR. ' ,
     6       'SCL.FCTR.')
      DO 12 J=1,NOK
   12 READ (LR,11) VARIND(1,J), VFREQ(1,J), VTIN(1,J), VTOUT(1,J),
     1          SCALE(1,J), VARSF(1,J)
   11 FORMAT (6F10.0)
      DO 685 J=1, NOK
      X(8) = 6.28318 DO * VFREQ (1,J)
C
C   POLZRO IS USED TO CALCULATE THE ZERO ELASTICITY DAMPING COEFFICIENT
C   AND WAVENUMBER BASED ON THE FREQUENCY OF THE FIRST POINT
C   AT EACH CONSTANT K POSITION.  DATA FOR THIS POINT ARE THOSE
C   FOR THE PURE SYSTEM
C
      CALL POLZRO (CKO, CK, ISTOP, M, N, F)
      WVNMB(J) = CK
      DMCO(1,J) = -CI * CK
       X(1) = DMCO(1,J)
       X(2) = WVNMB(J)
      BNUMV(J) = PRBSPD * WVNMB(J) / 6.28318DO
      CKO = CK
C
C   THE CALCULATED DAMPING IS USED TO CALCULATE A FACTOR
C   BY WHICH ALL THE AMPLTD RESULTS ARE MULTIPLIED.  THIS ALLOWS
C   VERTICAL SLIDING OF THE AMPLTD CURVE BUT NO FREQUENCY SHIFTS.
C
      CALL AMPLTD (VFREQ(1,J), VOONU(1,J), DUM)
      VOOFAC(J) =VTOUT(1,J)*SCALE(1,J)/SCALEO*EINO/VTIN(1,J)*
     1   DEXP(DMCO(1,J) * PRBSPD) / VOONU(1,J)
      WAVEL(J) = 6.28318DO/WVNMB(J)
C
C   THE FIRST PHSCOR CALL ESTABLISHES THE REFERENCE VALUE.  THE
C   CORRECTION TO THE NUMBER OF WAVES IS BASED ON THE DIFFERENCE
C   BETWEEN SUBSEQUENT CALL RESULTS AND THE REFERENCE VALUE.  THIS IS
C   ESSENTIAL SINCE THE ABSOLUTE VALUE OF THE VERTICAL PHSCOR SCALE
C   IS ARBITRARY.  SINCE THE ABSOLUTE PROBE SEPARATION HAS A FAIR
C   UNCERTAINTY, THE ACTUAL NUMBER OF WAVES IS UNCERTAIN TO ABOUT HALF
C   A WAVE.  DIFFERENCES ARE MUCH BETTER KNOWN.  NOTE THAT THE CALCULATED
C   PURE SYSTEM WAVENUMBERS ARE COMBINED WITH THE MEASURED PROBE
C   SEPARATION TO DETERMINE THE NUMBER OF WAVES.
C
      CALL PHSCOR (VFREQ(1,J),PRBSPD, BNOWV(J), WANO(1,J), 1, J)
      ANOWV(J) = WANO(1,J) * PRBSPD/ 6.28318DO
  672 FORMAT (I6, F15.2, 6F15.8)
  685 WRITE (LW, 672) J, VFREQ(1,J), DMCO(1,J), WVNMB(J), WAVEL(J),
     1    ANOWV(J), WANO(1,J), VOOFAC(J)
      WRITE (LW, 401)
  401 FORMAT (  '0',T51,'INDEPENDENT VARIABLE DATA')
C
C   THE SECOND CALL TO INDVAR AND SURFTN IS USED TO LIST THE
C   PARAMETERS FOR THIS ROUTINE.  NOTE THAT THE SURFACE TENSION ROUTINE
C   CALCULATES A PARAMETER BASED ON THE OBSERVED FIRST VALUE AND THE
C   ASSUMED VALUE.

C
      CALL INDVAR (IINDVR, VARIND(1,1), XVAL(1,1), 2)
      WRITE (LW, 402)
  402 FORMAT (/ '0',T51,'INTERFACIAL TENSION DATA')
      CALL SURFTN (ISFTN, VARSF(1,1),SFTN(1,1), 2)
C
C   THE BULK OF THE DATA ARE READ IN AND LISTED.
C
      WRITE (LW,32)
   32 FORMAT ('1',T51,'INPUT DATA'/'0','ID .K ',5X,'INDEP. VAR.',5X,
     1       'FREQUENCY',5X,'INPUT VOLT.',4X,'OUTPUT VOLT.', 4X,
     2       'METER SCALE', 4X, 'SFTN. VAR.'//)
      DO 13 I = 2, 50
      DO 13 J = 1, NOK
      READ (LR,11) VARIND(I,J), VFREQ(I,J), VTIN(I,J), VTOUT(I,J),
     1     SCALE(I,J), VARSF(I,J)
       IF(J.EQ.1.AND.VTIN(I,J).LE.0.0) GO TO 500
       GO TO 13
  500 NOIND = I    - 1
      GO TO 501
   13 CONTINUE
  501 DO 14 I= 1, NOIND
      DO 14 J = 1, NOK
   14 WRITE (LW, 15) I, J, VARIND(I,J),VFREQ(I,J),VTIN(I,J),VTOUT(I,J),
     1  SCALE(I,J), VARSF(I,J)
   15 FORMAT (' ',I3,'.',I2,F13.5, 5F15.5)
      WRITE (LW, 16)
   16 FORMAT ('1',T51,'TABLE OF RESULTS'/'0',' ID .K ',1X,'INDEP. VAR.',
     1     2X,'DMP. COEF.',2X,'WAVE NO.',4X,'REL. FQ. ',2X,'INTERF. TENS.'
     2       , 1X, 'GEN. AMPL.',4X,'Y1',13X,'Y2',4X,'REAL ELS.',
     3   2X, 'IMAG. ELAS.'//)
C
C   THIS IS THE MAIN LOOP FOR CALCULATION OF PARAMETERS.  THE RESULTS
C   MAY BE LISTED IN VARIOUS FORMS DEPENDING ON OPTIONS SPECIFIED.
C   DISPLAY PARAMETERS ARE CALCULATED HERE
C   INDVAR CONVERTS THE PARTICULAR EXPERIMENTAL NUMBER TO A CONCENTRATION
C           OF THE DESIRED TYPE
C   SURFTN CONVERTS THE PARTICULAR EXPERIMENTAL NUMBER TO AN
C           INTERFACIAL TENSION
C   DMCCEF COMBINES A CALL TO AMPLTD WITH OBSERVED SIGNALS AND CALCULATED
C           PARAMETERS TO A DAMPING COEFFICIENT.
C   AMPLTD RELATES THE GENERATING PROBE DISPLACEMENT TO THE FREQUENCY
C   PHSCOR MAKES A SLIGHT CORRECTION TO THE NUMBER OF WAVES AS A FUNTION
C           OF FREQUENCY
C   ELASCX CALCULATES THE ELASTICITIES USING EXPERIMENTAL DAMPING
C           COEFFICIENTS, PHASE CORRECTED WAVENUMBERS, AND POLZRO AND
C           ASSOCIATED ROUTINES.
C
      DO 17 I = 1, NOIND
      DO 17 J = 1, NOK
      IF (VTIN(I,J) .LE. 0.0) GO TO 111
      CALL INDVAR (IINDVR, VARIND(I,J),XVAL(I,J),3)
      CALL SURFTN (ISFTN,VARSF(I,J), SFTN(I,J), 3)
```

```
     5    'WAVELENGTH',6X,'NO. WAVES', 3X,'PHS.COR.WANO',2X,'GN. PR. ' ,
     6       'SCL.FCTR.')
      DO 12 J=1,NOK
   12 READ (LR,11) VARIND(1,J), VFREQ(1,J), VTIN(1,J), VTOUT(1,J),
     1          SCALE(1,J), VARSF(1,J)
   11 FORMAT (6F10.0)
      DC 685 J=1, NOK
      X(8) = 6.28318 DO * VFREQ (1,J)
C
C    POLZRC IS USEC TO CALCULATE THE ZERO ELASTICITY DAMPING COEFFICIENT
C    AND WAVENUMBER BASED ON THE FREQUENCY OF THE FIRST POINT
C    AT EACH CONSTANT X POSITION.  DATA FOR THIS POINT ARE THOSE
C    FOR THE PURE SYSTEM
C
      CALL POLZRO (CKO, CK, ISTOP, M, N, F)
      WVNMB(J) = CK
      DMCO(1,J) = -CI * CK
       X(1) = DMCO(1,J)
       X(2) = WVNMB(J)
      BNOWV(J) = PRBSPO * WVNMB(J) / 6.2831800
      CKC = CK
C
C    THE CALCULATED DAMPING IS USED TO CALCULATE A FACTCR
C    BY WHICH ALL THE AMPLTD RESULTS ARE MULTIPLIED.  THIS ALLOWS
C    VERTICAL SLIDING OF THE AMPLTC CURVE BUT NO FREQUENCY SHIFTS.
C
      CALL AMPLTD (VFREQ(1,J), VOONU(1,J), DUM)
      VOOFAC(J) =VTCUT(1,J)*SCALE(1,J)/SCALEO*EINO/VTIN(1,J)*
     1   DEXP(DMCO(1,J) * PRBSPO) / VOONU(1,J)
      WAVFL(J) = 6.28318DO/WVNMB(J)
C
C    THE FIRST PHSCOR CALL ESTABLISHES THE REFERENCE VALUE.  THE
C    CORRECTION TO THE NUMBER OF WAVES IS BASED ON THE DIFFERENCE
C    BETWEEN SUBSEQUENT CALL RESULTS AND THE REFERENCE VALUE.  THIS IS
C    ESSENTIAL SINCE THE ABSOLUTE VALUE OF THE VERTICAL PHSCOR SCALE
C    IS ARBITRARY.  SINCE THE ABSOLUTE PROBE SEPARATION HAS A FAIR
C    UNCERTAINTY, THE ACTUAL NUMBER OF WAVES IS UNCERTAIN TO ABOUT HALF
C    A WAVE.  DIFFERENCES ARE MUCH BETTER KNOWN.  NOTE THAT THE CALCULATED
C    PURE SYSTEM WAVENUMBERS ARE COMBINED WITH THE MEASURED PROBE
C    SEPARATION TO DETERMINE THE NUMBER OF WAVES.
C
      CALL PHSCOR (VFREC(1,J),PRBSPO, BNOWV(J), WANO(1,J), 1, J)
      ANOWV(J) = WANO(1,J) * PRBSPO/ 6.2831800
  672 FORMAT (I6, F15.2, 6F15.8)
  685 WRITE (LW, 672) J, VFREQ(1,J), DMCO(1,J), WVNMB(J), WAVFL(J),
     1   ANOWV(J), WANO(1,J), VOOFAC(J)
      WRITE (LW, 401)
  401 FORMAT (  '0',T51,'INDEPENDENT VARIAPLE CATA')
C
C    THE SECOND CALL TC INDVAR AND SURFTN IS USED TO LIST THE
C    PARAMETERS FOR THIS ROUTINE.  NOTE THAT THE SURFACE TENSION ROUTINE
C    CALCULATES A PARAMETER BASED ON THE OBSERVED FIRST VALUE AND THE
C    ASSUMED VALUE.
C
      CALL INDVAR (IINDVR, VARIND(1,1), XVAL(1,1), 2)
      WRITE (LW, 402)
  402 FORMAT (/ '0',T51,'INTERFACIAL TENSION DATA')
      CALL SURFTN (ISFTN, VARSF(1,1),SFTN(1,1), 2)
C
C    THE BULK CF THE DATA ARE REAC IN AND LISTEC.
C
      WRITE (LW,32)
   32 FORMAT ('1',T51,'INPUT DATA'/'0','ID .K ',5X,'INDEP. VAR.',5X,
     1       'FREQUENCY',5X,'INPUT VOLT.',4X,'OUTPUT VOLT.', 4X,
     2       'METER SCALE', 4X, 'SFTN. VAR.'//)
      DO 13 I = 2, 50
      DO 13 J = 1, NOK
      READ (LR,11) VARINC(I,J), VFREQ(I,J), VTIN(I,J), VTOUT(I,J),
     1     SCALE(I,J), VARSF(I,J)
       IF(J.EQ.1.AND.VTIN(I,J).LE.0.0) GO TO 5C0
       GO TC 13
  500 NOIND = I    - 1
      GO TO 501
   13 CONTINUE
  501 DO 14 I= 1, NOIND
      CO 14 J = 1, NOK
   14 WRITE (LW, 15) I, J, VARINC(I,J),VFREQ(I,J),VTIN(I,J),VTOUT(I,J),
     1  SCALE(I,J), VARSF(I,J)
   15 FORMAT (' ',I3,'.',I2,F13.5, 5F15.5)
      WRITE (LW, 16)
   16 FORMAT ('1',T51,'TABLE OF RESULTS'/'0',' ID .K ',1X,'INDEP. VAR.',
     1     2X,'DMP. COEF.',2X,'WAVE NO.',4X,'REL. FQ. ',2X,'INTERF. TENS.'
     2      , 1X, 'GEN. AMPL.',4X,'Y1',13X,'Y2',6X,'REAL ELS.',
     3   2X, 'IMAG. ELAS.'//)
C
C    THIS IS THE MAIN LCOP FCR CALCULATION OF PARAMETERS.  THE RESULTS
C    MAY BE LISTED IN VARIOUS FORMS DEPENDING ON OPTIONS SPECIFIED.
C    DISPLAY PARAMETERS ARE CALCULATED HERE
C    INDVAR CONVERTS THE PARTICULAR EXPERIMENTAL NUMBER TO A CONCENTRATION
C           OF THE DESIRED TYPE
C    SURFTN CCNVERTS THE PARTICULAR EXPERIMENTAL NUMBER TO AN
C           INTERFACIAL TENSION
C    DMCCEF COMBINES A CALL TO AMPLTD WITH OBSERVED SIGNALS AND CALCULATED
C           PARAMETERS TO A DAMPING CCEFFICIENT.
C    AMPLTD RELATES THE GENERATING PROBE DISPLACEMENT TC THE FREQUENCY
C    PHSCOR MAKES A SLIGHT CORRECTICN TO THE NUMBER OF WAVES AS A FUNTION
C           OF FREQUENCY
C    ELASCX CALCULATES THE ELASTICITIES USING EXPERIMENTAL DAMPING
C           COEFFICIENTS, PHASE CORRECTED WAVENUMBERS, AND POLZRO AND
C           ASSOCIATED ROUTINES.
C
      DO 17 I = 1, NCINC
      DO 17 J = 1, NCK
      IF (VTIN(I,J) .LE. 0.0) GO TO 111
      CALL INDVAR (IINDVR, VARINC(I,J),XVAL(I,J),3)
      CALL SURFTN (ISFTN,VARSF(I,J), SFTN(I,J), 3)
```

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      CALL DMCOEF (VTIN(I,J),VTOUT(I,J),VFREQ(I,J),SCALE(I,J),
     1   SCALEO     ,DMCO(I,J),PRBSPO,EINO,VOONU(I,J), VOOFAC(J))
      CALL PHSCOR (VFREQ(I,J), PRBSPO, BNOWV(J),WANO(I,J), 0, J)
      CALL ELASCX (DMCO(I,J), WANO(I,J), SFTN(I,J), VFREQ(I,J),
     1         ELASRL(I,J),ELASMG(I,J))
      Y1(I,J) = (RHOHEV + RHOLIT)*39.4783500 * VFREQ(I,J)**2/
     1   (SFTN(I,J) * WANO (I,J) **3)
      Y2(I,J) = DMCC(I,J) / WANO(I,J)
      RELFQ (I,J) = VFREQ(I,J)/VFREQ(1,J)
      WRITE(LW,18)I, J, XVAL(I,J),DMCO(I,J),WANO(I,J), RELFO(I,J),
     1   SFTN(I,J), VOONU(I,J),
     2       Y1(I,J),Y2(I,J),ELASRL(I,J),ELASMG(I,J)
   18 FORMAT (' ',I3,'.',I2, F10.5, 9F12.5)
      IF(IPCH.EQ.1.OR.IPCH.EQ.3.OR.IPCH.EQ.5.OR.IPCH.EQ.7)GO TO 19
      GO TO 17
   19 WRITE(2,20)XVAL(I,J),DMCC(I,J),SFTN(I,J),VOONU(I,J),
     1        Y1(I,J),Y2(I,J),ELASRL(I,J),ELASMG(I,J)
   20 FORMAT (8F10.5)
      GO TO 17
  111 WRITE (LW, 112) I,J
  112 FORMAT (' ',I3,'.',I2)
   17 CONTINUE
      IF (IWRT.EQ.2) GO TO 41
      IF (IPCH.GT.2.AND.IPCH.LE.7) GO TO 41
      GO TO 222
   41 DO 22 J = 1, NOK
      WRITE (LW, 127) J, WANO(1,J), WAVEL(J), VFREQ(1,J)
  127 FORMAT ('1', T41,'TABLE OF RESULTS FOR', I3,'  POSITION'/
     1    '0',T11,'CALCULATED WAVENUMBER=', F9.5, '  RECIP. CM.  WAVE',
     2      'LENGTH=', F7.5, '  CM.  INITIAL FREQUENCY =', F8.2, '  HZ.'
     3                                  / '0','ID .K ',1X,'INDEP. VAR.',
     4    2X,'DMP. COEF.',2X,'WAVE NO.',4X,'REL. FQ.',2X,'INTERF. TENS.'
     5     , 1X, 'GEN. AMPL.',4X,'Y1',10X,'Y2',6X,'REAL ELS.',
     6   2X, 'IMAG. ELAS.'//)
      DO 22 I = 1, NCIND
      IF (VTIN(I,J) .LE. 0.0) GO TO 113
      WRITE (LW, 18) I, J, XVAL(I,J),DMCO(I,J), WANO(I,J), RELFQ(I,J),
     2     SFTN(I,J), VOONU(I,J),
     1        Y1(I,J),Y2(I,J),ELASRL(I,J),ELASMG(I,J)
      IF (IPCH.GT.4.AND.IPCH.LE.7) GO TO 25
      GO TO 22
   25 WRITE (2,26) VARIND(I,J),VTIN(I,J),VTOUT(I,J),SCALE(I,J),
     1        VARSF(I,J)
   26 FORMAT ( 6F10.5)
      GO TO 22
  113 WRITE (LW, 112) I, J
   22 CONTINUE
  222 CONTINUE
C
C   THE SUBRCUTINE DATA ARE LISTED, GRAPHS ARE CALLED FOR, AND
C   RECYCLING PARAMETER IS EXAMINED.
C
      WRITE (LW, 387)
  387 FORMAT ('1', T11, 'THE DATA USED FOR EVALUATING THE POLYNOMIALS',
     1        ' IN SUBROUTINES AMPLTD AND PHSCCR FOLLOW--'//)
      WRITE (LW, NAM1)
  117 CALL GRPHRT (IGPH, NCIND, NOK)
  118 READ (LR, 101) NEXT
  101 FORMAT (I5)
      IF (NEXT) 102, 102, 100
  102 STOP
      END
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             SUBROUTINE DISTNC (RESIS, DIST, CORREC, INTERV)                  DIS 23
C                SUBROUTINE DIST WILL COMPUTE THE MICROMANIPULATOR DISTANCE IN DIS  1
C                CM WHEN GIVEN THE RESISTANCE READINGS IN KOHMS.  A LINEAR     DIS  2
C                EQUATION IS SUPPLEMENTED BY VARIOUS CORRECTIONS DEPENDING ON  DIS  3
C                THE VALUE OF THE RESISTANCE.                                  DIS  4
C                VARIABLES.                                                    DIS  5
C                  RESIS  - OBSERVED RESISTANCE (KOHM)                         DIS  6
C                  DIST   - CALCULATED DISTANCE (CM)                           DIS  7
C                  CORREC - CORRECTION TERM TO LINEAR FIT                      DIS  8
C                  INTERV - INTERVAL IN WHICH CORRECTION IS FOUND (RES. UNITS) DIS  9
C                             10 -  .125  LT  .40                              DIS 10
C                             11 -  .40   LT 1.60                              DIS 11
C                             12    1.60  LT 2.75                              DIS 12
C                             13    2.75  LT 3.60                              DIS 13
C                             14    3.60  LT 4.20                              DIS 14
C                             15    4.20  LT 5.00                              DIS 15
C                             16    5.00  LT 5.25                              DIS 16
C                             17    5.25  LT 6.50                              DIS 17
C                             18    6.50  LT 6.95                              DIS 18
C                             19    6.95  LT 7.65                              DIS 19
C                             20    7.65  LT 8.05                              DIS 20
C                             21    8.05  LT 9.00                              DIS 21
C                                                                              DIS 22
C                4 ARGUMENTS                                                   DIS 24
C                                                                              DIS 25
C                THE REGRESSION EQ. WAS BASED ON CALIBRATION OF THE ORIGINAL   DIS 26
C                MICROMANIPULATOR BY J. LUCASSEN.  THE CORRECTIONS ARE BASED ONDIS 27
C                VARIOUS FITTINGS OF THE DEVIATIONS FROM THE LINEAR REGRESSION DIS 28
C                OF THE ORIGINAL CALIB. DATA.                                  DIS 29
C                A RANGE CHECK IS MADE AND THEN THE APPROPRIATE BRANCHING DONE DIS 30
             R = RESIS                                                        DIS 301
             CORR = CORREC                                                    DIS 302
             IF (R - .125)1,2,2                                               DIS 31
           1 WRITE (3,3)                                                      DIS 32
           3 FORMAT ('1DIST TERM WITH RESISTANCE LESS THAN .125')             DIS 33
             RETURN                                                           DIS 34
           2 IF (R- 9.00)5,4,4                                                DIS 35
           4 WRITE (3,36)                                                     DIS 36
          36 FORMAT ('1DIST TERM WITH RESISTANCE GREATER THAN OR EQUAL TO 9.0')DIS 37
             RETURN                                                           DIS 38
           5 IF ( R - .40)6,7,7                                               DIS 39
           6 CORR    =  -1.0E-03  +  3.636E-03 * (RESIS - .125)               DIS 40
             INTERV  =  10                                                    DIS 41
             GO TO 100                                                        DIS 42
           7 IF ( R - 1.60000) 8,9,9                                          DIS 43
           8 CORR    =  + 2.300E-03 * SIN ((RESIS - .40000) * 3.14159 /1.2000) DIS 44
             INTERV  =  11                                                    DIS 45
             GO TO 100                                                        DIS 46
           9 IF ( R - 2.75)  10,11,11                                         DIS 47
          10 CORR    =   -7.400E-03 * SIN ((RESIS -1.6000)*3.14159/1.15000)   DIS 48
             INTERV  =  12                                                    DIS 49
             GO TO 100                                                        DIS 50
          11 IF (R - 3.6000) 12,13,13                                         DIS 51
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0025          12 CORR     = +4.200E-03 * SIN((RESIS - 2.75000)*3.14159/.85000)        DIS 52
0026             INTERV  =  13                                                       DIS 53
0027             GO TO 100                                                           DIS 54
0028          13 IF (R - 4.2000) 14,15,15                                            DIS 55
0029          14 CORR    =     - .200E-03                                            DIS 56
0030             INTERV  =  14                                                       DIS 57
0031             GO TO 100                                                           DIS 58
0032          15 IF (R - 5.00000) 16,17,17                                           DIS 59
0033          16 CORR    =   -3.200E-03*SIN((RESIS - 4.20000)*3.14159/.80000)        DIS 60
0034             INTERV  =  15                                                       DIS 61
0035             GO TO 100                                                           DIS 62
0036          17 IF (R - 5.25000) 18,19,19                                           DIS 63
0037          19 CORR    = +28.000E-03*(RESIS - 5.00000)                             DIS 64
0038             INTERV =   16                                                       DIS 65
0039             GO TO 100                                                           DIS 66
0040          17 IF (R - 6.50000) 20,21,21                                           DIS 67
0041          20 CORR    =  +7.000E-03  -  2.800E-03 * (RESIS - 5.25000)             DIS 68
0042             INTERV =   17                                                       DIS 69
0043             GO TO 100                                                           DIS 70
0044          21 IF (R - 6.95000) 22,23,23                                           DIS 71
0045          22 CORR    =    3.500E-03  -    .777E-03 * (RESIS - 6.50000)           DIS 72
0046             INTERV =   18                                                       DIS 73
0047             GO TO 100                                                           DIS 74
0048          23 IF (R - 7.65000) 24,25,25                                           DIS 75
0049          24 CORR    =     - 5.400E-03 * SIN ((RESIS - 6.95000)*3.14159 / .70000)DIS 76
0050             INTERV =   19                                                       DIS 77
0051             GO TO 100                                                           DIS 78
0052          25 IF (R - 8.05000) 26,27,27                                           DIS 79
0053          26 CURR  =  0.0                                                        DIS 80
0054             INTERV =  20                                                        DIS 81
0055             GO TO 100                                                           DIS 82
0056          27 IF (R - 9.0000)28,4,4                                               DIS 83
0057          28 CORR  =  - 3.578E-03 * (RESIS - 8.0500)                             DIS 84
0058             INTERV =  21                                                        DIS 85
0059         100 DIST   =  - .74578 * RESIS  + 6.23722  +  CORR                      DIS 86
0060             CURREC = CORR                                                       DIS 861
0061             RETURN                                                              DIS 87
0062             END                                                                 DIS 89

0001             SUBROUTINE  INDVAR (IINDVR,  VALUE,  RESULT, KTIND)
           C
           C   THE NATURE OF THE EXPERIMENT FORMS ONE BRANCHING DECISION.  USE OF
           C   THE SUBROUTINE FOR READING, WRITING, OR CALCULATING FORMS A SECOND.
           C
0002             IMPLICIT REAL*8 (A-H,O-Z)
0003             LR = 1
0004             LW = 3
0005             GO TO (11,21 ,31 ), IINDVR
0006          11 IF ( KTIND.NE.1) GO TO 12
0007             READ (LR, 13) WTMUP,WTMOL,VOLMUP, AREA
0008          13 FORMAT (5F10.0)
0009             RETURN
0010          12 IF (KTIND.NE.2) GO TO 14
0011             WRITE (LW,15)WTMUP,WTMOL,VOLMUP,AREA
0012          15 FORMAT ('0','THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION',
              1        ' IN MOLES/CM SQ. X 10**10'/' ','INPUT PARAMETERS ARE',
              2         ' WT. OF SURFACTANT =',F10.5,'  MG.  MOLECULAR WT.=',F10.5,
              3         ' MAKE-UP VOLUME=',F6.4' L.'/' ','THE AREA IS KEPT CONST.',
              4         ' AT',F10.5,' SQ. CM')
0013          14 RESULT  =1.001  * WTMUP * VALUE / (WTMOL * VOLMUP * AREA)
0014             RETURN
0015          21 IF ( KTIND.NE.1) GO TO 22
0016             READ (LR,13)WTMUP,WTMOL, VOLMUP, VOLADD,  WIDTH
0017             RETURN
0018          22 IF (KTIND.NE.2) GO TO 24
0019             WRITE (LW, 25)WTMUP,WTMOL,VOLMUP,VOLADD, WIDTH
0020          25  FORMAT ('0','THE INDEPENDENT VARIABLE IS SURFACE CONCENTRATION',
              1           ' IN MOLES/SQ.CM.X 10**10'/' ', 'INPUT PARAMETERS ARE',
              2           ' WT. OF SURFACTANT=',F10.5 ,' MG.  MOLECULAR WT.=',F10.5,
              3           ' MAKE-UP VOL.=',F6.4,' L.'/' ','VOLUME SURFACTANT ADDED',
              4           ' =',F10.3,' MICROLITERS.  TROUGH WIDTH IS', F8.3,' CM.',
              5           '  THE LENGTH AVAILABLE IS ALTERED')
0021             RESULT = 0.0
0022             RETURN
0023          24 IF (VALUE.LE.0.0) GO TO 26
0024             RESULT = 1.001 *WTMUP*VOLADD/(WTMOL*WIDTH*VALUE)
0025              RETURN
0026          26 RESULT = 0.0
0027             RETURN
0028          31 IF (KTIND .NE. 1) GO TO 32
0029             READ (LR, 13) WTMUP, WTMOL, VOLMUP, VOLTOT
0030             RETURN
0031          32 IF (KTIND. NE. 2 ) GO TO 34
0032             WRITE (LW, 35) WTMUP, WTMOL, VOLMUP, VOLTOT
0033          35 FORMAT ('0','THE INDEPENDENT VARIABLE IS THE LOGARITHIM OF THE ',
              1        'BULK PHASE SURFACTANT CONCENTRATION (MOLES/L).'/' ',
              2         'INPUT PARAMETERS ARE- WT. OF SURFACTANT =',F10.5,' MG.'
              3         '   MOLECULAR WT. =,'F10.5,' G.'/' ','MAKE-UP VOL. =',F10.5,
              4     ' L. TOTAL SOLUTION VOLUME =',F10.5,' L'/' ',
              5     'SURFACTANT SOLUTION IS ADDED TO BULK PHASE AND MIXED. ',
              6   'THE VOLUME ADDED IN MICROLITERS IS READ IN.')
0034             RESULT = 0.0

0035             RETURN
0036          34 IF (VALUE .LE. 0.0) GO TO 36
0037             RESULT = DLOG10(VALUE * WTMUP * 1.0D-09 / (VOLTOT * WTMOL *
              1          VOLMUP))
0038             RETURN
0039          36 RESULT = -10.000
0040             RETURN
0041             END
```

```
      SUBROUTINE AMPLTD (HZ, GENAMP, X)
C
C   POLYNOMIAL EXPRESSIONS OF THE CURVE ARE USED.  IT IS POSSIBLE TO FIT
C   THIS CURVE IN SEVERAL SECTIONS.
C
      REAL * 8 HZ, GENAMP, X,   XV, HZOAMP(10), AAMP(10), BAMP(10,10)
      COMMON /COM1/ HZOAMP, AAMP, BAMP
      IF (HZ .LE. HZOAMP(2))  I = 1
      IF ( HZ .GT. HZOAMP(2) .AND. HZ .LE. HZOAMP(3 )) I = 2
      IF ( HZ .GT. HZOAMP(3) .AND. HZ .LE. HZOAMP(4 )) I = 3
      IF ( HZ .GT. HZOAMP(4) .AND. HZ .LE. HZOAMP(5 )) I = 4
      IF ( HZ .GT. HZOAMP(5) .AND. HZ .LE. HZOAMP(6 )) I = 5
      IF ( HZ .GT. HZOAMP(6) .AND. HZ .LE. HZOAMP(7 )) I = 6
      IF ( HZ .GT. HZOAMP(7) .AND. HZ .LE. HZOAMP(8 )) I = 7
      IF ( HZ .GT. HZOAMP(8) .AND. HZ .LE. HZOAMP(9 )) I = 8
      IF ( HZ .GT. HZOAMP(8) .AND. HZ .LE. HZOAMP(9 )) I = 8
      IF ( HZ .GT. HZOAMP(9) .AND. HZ .LE. HZOAMP(10)) I = 9
      IF ( HZ .GT. HZOAMP(10)) I = 10
      XV = .01D0 * ( HZ - HZOAMP(I))
      GENAMP = AAMP(I)
      DO 5 J = 1,10
    5 GENAMP = GENAMP + BAMP(J, I) * XV ** J
      RETURN
      END

      SUBROUTINE PHSCOR (HZ, PRBSPD, ANWV, WVNC, IMD, JNO)
C
C   POLYNOMIAL EXPRESSIONS OF THE CURVE ARE USED.  IT IS POSSIBLE TO FIT
C   THIS CURVE IN SEVERAL SECTIONS.
C
      REAL*8 HZ, PRBSPD, ANWV, WVNC, CORR, BNWV, APHS(10), BPHS(10,10),
     1     HZOPHS(10), RES(10), XV
      COMMON /COM2/ HZOPHS, APHS, BPHS
      IF (HZ .LE. HZOPHS(2))  I = 1
      IF (HZ .GT. HZOPHS (2) .AND. HZ .LE. HZOPHS(3 )) I = 2
      IF (HZ .GT. HZOPHS (3) .AND. HZ .LE. HZOPHS(4 )) I = 3
      IF (HZ .GT. HZOPHS (4) .AND. HZ .LE. HZOPHS(5 )) I = 4
      IF (HZ .GT. HZOPHS (5) .AND. HZ .LE. HZOPHS(6 )) I = 5
      IF (HZ .GT. HZOPHS (6) .AND. HZ .LE. HZOPHS(7 )) I = 6
      IF (HZ .GT. HZOPHS (7) .AND. HZ .LE. HZOPHS(8 )) I = 7
      IF (HZ .GT. HZOPHS (8) .AND. HZ .LE. HZOPHS(9 )) I = 8
      IF (HZ .GT. HZOPHS (9) .AND. HZ .LE. HZOPHS(10)) I = 9
      IF (HZ .GT. HZOPHS(10)) I = 10
      XV = .01D0 * (HZ - HZOPHS(I))
      CORR = APHS (I)
      DO 5 J = 1, 10
    5 CORR = CORR + BPHS(J,I) * XV ** J
      IF (IMD - 1) 11, 12, 11
   12 RES (JNO)  = CORR
   11 BNWV = ANWV + CORR - RES (JNO)
      WVNC = 6.28318D0 * BNWV / PRBSPD
      RETURN
      END

      SUBROUTINE SURFTN (ISFTN, RDG, GAMMA, KTSF)
C
C   TYPE OF EXPERIMENT AND READ, WRITE, CALCULATE FUNCTION ARE BRANCHING
C   DECISIONS.  NOTE THAT THE FIRST VALUE CAN BE USED TO CALCULATE THE
C   PARAMETER USED FOR SUBSEQUENT CALCULATIONAL PASSES.
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMPLEX*16  CI,B(10), CK, CKD,F, F
       EQUIVALENCE (X(5), RHOHEV), (X(6), RHOLIT)
      COMMON CI,X(10), Y(10), B,LR, LW
      GO TO   (11,21      ),ISFTN
   11 IF (KTSF.NE.1)GO TO 15
      READ (LR,12)GRAV,WMICA,WPT,RHOPT,RHOPLT,PERIM,FRX,SFTNO
   12 FORMAT (8F10.0)
      RETURN
   15 IF (KTSF.NE.2) GO TO 16
   18 G1 = GRAV/PERIM *(WMICA + WPT - RDG - (1. - FRX)*WMICA*RHOLIT /
     1                  RHOPLT  -FRX*WMICA*RHOHEV/ RHOPLT     -
     2                  WPT * RHOHEV / RHOPT )
       IF (SFTNO-G1.GT.0.0 .AND.DABS(SFTNO-G1) .GT..1.AND.FRX.LE.
     1     .7) GO TO 17
       IF(SFTNO-G1.LT.0.0.AND.DABS(SFTNO-G1).GT..1.AND.FRX.GE.
     1     .3) GO TO 19
       PERIM =GRAV/SFTNO*(WMICA+WPT-RDG-(1.-FRX)*WMICA*RHOLIT/RHOPLT-FRX*
     1         WMICA*RHOHEV/RHOPLT-WPT*RHOHEV/RHOPT)
       GO TO 20
   17 FRX = FRX +.1
       GO TO 18
   19 FRX = FRX-.1
       GO TO 18
   20 WRITE (LW, 13)GRAV,WMICA,WPT,RHOPT,RHOPLT,PERIM,FRX,SFTNO
   13 FORMAT ('0','INTERFACIAL TENSIONS WILL BE CALCULATED USING AN',
     1         ' OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:'/' '
     2         'ACCEL. OF GRAVITY=',F10.3,' WEIGHT OF PLATE=',F10.2,
     3         'MG.  WEIGHT OF WEIGHT=',F10.2,' MG.  DENSITY OF WT=',
     4         F8.5/' ','DENSITY OF PLATE=',F8.5,' CALCULATED PERIMETER',
     5         'OF PLATE=',F8.5,' CM.  CALCULATED FRACTION IN LOWER PHA',
     6         'SE=',F5.3,/' ','WHERE THE CALCULATIONS ASSUME AN INITIA',
     7'L  INTERFACIAL TENSION OF',F10.5,' DYNES/CM.')
   16 GAMMA = GRAV / PERIM*(WMICA + WPT - RDG - (1. -FRX) *WMICA*
     1                         RHOLIT / RHOPLT - FRX * WMICA * RHOHEV /
     2                         RHOPLT - WPT * RHOHEV / RHOPT)
      RETURN
   21 IF (KTSF.NE.1) GO TO 25
      READ (LR, 22) SENS, SFTNO
   22 FORMAT(2F10.0)
      RETURN
   25 IF (KTSF.NE.2) GO TO 26
      WRITE (LW,23) SENS, SFTNO
   23 FORMAT('0','SURFACE TENSIONS WILL BE CALCULATED USING A LANGMUIR',
     1       ' TROUGH WITH A SENSITIVITY OF ',F10.5,' DYNE/CM/DIVISION'/
     2       ' ','AND INITIAL SURFACE TENSION OF',F10.5,' DYNE/CM')
   26 GAMMA = SFTNO - SENS* RDG
```

```
      SUBROUTINE DMCOFF (EIN, EOUT, ANU, SKAL, SKALC, ALPHA, SEP, FINO,
     1      VOONU, FACT)
C
C   AN EXPONENTIAL RELATION OF OUTPUT SIGNAL TO DAMPING COEFFICIENT IS
C   ASSUMED.  THE VARIABLE FACTOR CORRECTS FOR UNCERTAINTIES IN THE
C   ACTUAL PROBE SEPARATION.  OUTPUT IS ASSUMED PROPORTIONAL TO INPUT.
C
      IMPLICIT REAL*8 (A-H,O-Z)
   21 CALL AMPLTD (ANU, VOONU, CALB)
       IF (EOUT .LE.0.0) GO TO 10
       IF (EIN .LE.0.0) GO TO 10
       IF (VOONU.LE. 0.0) GO TO 10
       IF (EINO.LE. 0.0) GO TO 10
   22 ALPHA = 1.0D0 / SEP * DLOG (VOONU * FACT * SKALO * FIN/
     1        (EOUT * EINO * SKAL))
   23 RETURN
   10 ALPHA = 10.0
    2  RETURN
      END

      SUBROUTINE ELASCX (DMCC, WVNUM, GAMMA, HZ, ELASRL, ELASMG)
C
C   FULL INTERFACIAL THEORY (INCLUDING GRAVITY) IS USED TO GET THE ELASTICITIES.
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMPLEX*16 E, CI, B(10), C(5), D(2), G, CK
      COMMON CI, X(10), Y(10), P, LR, LW
      X(1) = DMCO
      X(2) = WVNUM
      X(7) = GAMMA
      X(8) = 6.28318 * HZ
    1 CK = DCMPLX (X(2),X(1))
      CALL CCOEF (CK, C, D)
      G = (1. + 980.*(X(5)-X(6))/(X(7)*CK**2))
      E = (-D(2)*X(7)*G - C(5))/(C(1)*X(7)*G + D(1))
      ELASRL = E
      ELASMG = -CI*E
    2 RETURN
      END

      SUBROUTINE POLZRO(CKO, CK, ISTOP, M, N,F)
C
C   POLZRO AND ASSOCIATED SUBROUTINES MAY BE CONSIDERED BLACK BOXES
C   WHICH SOLVE THE FUNCTION 0 = F = SUM C(I) * K ** I FROM 1 TO 5
C   WHERE K = WAVENUMBER + CI * DAMPING COEFFICIENT AND THE C(I) ARE
C   COMPLEX FUNCTIONS OF ALL THE TEN PRINCIPAL VARIABLES (I.E., THE
C   X ARRAY).  A PATTERNED DIRECT SEARCH ITERATION METHOD IS USED.
C   THE INITIAL GUESS MUST BE SUCH THAT CONVERGENCE TO THE PROPER ROOT
C   OCCURS.  THE REQUIRED CLOSENESS OF THE GUESSED AND ACTUAL VALUES
C   DEPENDS STRONGLY ON FREQUENCY AS WELL AS THE REMAINDER OF THE
C   VARIABLES.
C
      IMPLICIT REAL*8(A-H,O-Z)
      REAL*8 KAPPA, KAPPO
      COMPLEX*16 CK, CKO, F, FP, B(10),CI, FPP  ,DCK
      DIMENSION X(10), Y(10)
      COMMON CI, X, Y, B, LR, LW
C THIS PROGRAM REQUIRES B(1) THROUGH B(6) AS COMPLEX AND INTEGERS M, N
C STORED IN COMMON.  M AND N SET 10**(-I) FOR RELATIVE PRECISION OF ALPH
C A AND KAPPA CALCULATED IN THIS SUBROUTINE.
      CUTALP = 1./10.**M
      CUTKAP = 1./10.**N
      ISTOP = 0
    1 ISTOP = ISTOP + 1
      CALL FACALC(CKO,F,FP,FPP)
      IF (CDABS (FP) .LT. 1.D-20) GO TO 50
      DCK=(-F/FP)*(1.+(F*FPP)/(2.*FP**2))
      CK=CKO+DCK
      KAPPA = (CK+DCONJG(CK))/2.
      ALPHA = -CI*(CK-DCONJG(CK))/2.
      KAPPO = (CKO+DCONJG(CKO))/2.
      ALPHO = -CI*(CKO-DCONJG(CKO))/2.
      IF(DABS((ALPHA-ALPHO)/ALPHA).LT.CUTALP .AND. DABS((KAPPA-KAPPO)
     1 /KAPPA) .LT.  CUTKAP ) GO TO 500
      IF(ISTOP .LT. 100) GO TO 53
      WRITE (LW,103) ALPHA, KAPPA, ALPHO, KAPPO
  103 FORMAT('0'//' ISTOP .EQ.100 WITH ALPHA = ',F16.7, 5X,'KAPPA = ',
     1 E16.7,//' ALPHO = ',G16.7,' KAPPO = ',G16.7)
      STOP
   53 CKO = CK
      GO TO 1
   50 WRITE(LW, 101)FP, F, ISTOP
  101 FORMAT('0',///' FIRST DERIVATIVE OF POLYNOMIAL IS TOO CLOSE TO
     1 ZERO,FP = ',2G16.7, //'THE POLYNOMIAL = ', 2G16.7,//' THE'
     2'ITERATION NUMBER IS ',G3)
      STOP
  500 RETURN
      END
```

```
      SUBROUTINE FNCALC(CK,F,FP,FPP)
      IMPLICIT REAL*8(A-H,O-Z)
      COMPLEX*16 CI,B,CK,C(5),D(2),F,FP,FPP,CP5,CPP5,DP1,DPP1,DP2,
     1DPP2,CP1,CPP1,E,G
      COMMON CI, X(10),Y(10),B(10),LR,LW
      CALL CCOEF(CK,C,D)
      G=1.
      ABCK=CDABS(CK)
      IF(ABCK.LT.1D-2.OR.ABCK.GT.1D3)GO TO1
      G=(1.+980.*(X(5)-X(6))/(X(7)*CK **2))
    1 E=DCMPLX(X(9),X(10))
      F=C(1)*X(7)*G*E+D(1)*E+D(2)*X(7)*G+C(5)
      CP5 = 3.*B(5)*CK**2+2.*B(6)*CK+B(7)
      CPP5= 6.*B(5)*CK +2.*B(6)
      DP1=4.*B(2)*CK**3+3.*B(3)*CK**2+2.*B(4)*CK
      DPP1= 12.*B(2)*CK**2+6.*B(3)*CK+2.*B(4)
      DP2= 4.*B(2)*CK**3+3.*B(3)*CK**2
      DPP2=12.*B(2)*CK**2+6.*B(3)*CK
      CP1= 5.*B(1)*CK**4
      CPP1= 20.*B(1)*CK**3
      FP= CP1*X(7)*G*E+DP1*E+DP2*X(7)*G+CP5
      FPP= CPP1*X(7)*G*E+DPP1*E+DPP2*X(7)*G+CPP5
      RETURN
      END

      SUBROUTINE COEF(CK)
      IMPLICIT REAL*8(A-H,O-Z)
      COMPLEX*16 CK,B,CMUCMP,CMUCM, CI
      COMMON CI, X(10),Y(10),B(10),LR,LW
      CMUCM =CDSQRT((X(3)*CK)**2 - CI*X(5)*X(8)*X(3))
      CMUCMP =CDSQRT((X(4)*CK)**2 - CI*X(6)*X(8)*X(4))
      B(1)= -1./X(8)**2
      B(2)= CI*(X(3)+X(4))/X(8)
      B(3)= CI*(CMUCMP+CMUCM)/X(8)
      B(4)= X(5)+X(6)
      B(5)= 4.*X(3)*X(4)
      B(6)= 4.*(X(3)*CMUCM+X(4)*CMUCMP)
      B(7)= 4.*CMUCM*CMUCMP-CI*(X(3)+X(4))*(X(5)+X(6))*X(8)
      B(8)= -CI*(CMUCM+CMUCMP)*X(8)*(X(5)+X(6))
      RETURN
      END

      SUBROUTINE CCOEF(CK,C,D)
      IMPLICIT REAL*8(A-H,O-Z)
      COMPLEX*16 CI,B,D(2),C(5),CK
      COMMON CI, X(10),Y(10),B(10),LR,LW
    5 CALL COEF(CK)
      DO 1 J=1,4
    1 C(J)=B(J)*CK**(6-J)
      C(5)= ((B(5)*CK+B(6))*CK+B(7))*CK+B(8)
      D(1)= C(2)+C(3)+C(4)
      D(2)= C(2)+C(5)
   10 RETURN
      END

      SUBROUTINE GRPHPT (IGPH, NCIND, NOK)
C
C     THIS SUBROUTINE PROVIDES FOR SUPERPOSITON OF UP TO TEN CONSTANT K
C     EXPERIMENTS FOR EACH TYPE OF DEPENDENT VARIABLE.
C
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*4 XL(5), YL1(5), YL2(5),YL3(5),YL4(5),YL5(5), DL(5), D(50),
     1      GL(5), XSIZE(10), YL6(5)
      REAL*4 XL2(5)
      COMPLEX*16 CI, B(10), CK, CKC, F, F
      COMMON CI, X(10),Y(10),R, LR, LW, XVAL(50,10),Y1(50,10),Y2(50,10),
     1    SFTN(50,10),FLASHL(50,10), FLASMG(50,10), RELFG(50,10)
      DIMENSION PI(50)
      DATA XL/'SURF','  CO','NC (','MOL/','CM2)'/
      DATA XL2/'SURF', 'ACE ', 'PRES', 'SURE', '(PI)'/
      DATA YL1/'    ','   Y','1   ','    ','    '/, YL2/'    ','   Y','2
     1','    ','    '/, YL3/'INTE','RF. ','TENS','ION ','    '/,
     2YL4 /'REAL',' ELA','STIC','ITY ','    '/,YL5/'IMAG','INAR','Y EL',
     3 'ASTI','CITY'/,YL6/'REDU','CED ','FREQ','UENC','Y   '/
      DATA  D/'CONS','T. K',' POS','. NO','. 1 ',
     1        'CONS','T. K',' POS','. NO','. 2 ',
     2        'CONS','T. K',' POS','. NO','. 3 ',
     3        'CONS','T. K',' POS','. NO','. 4 ',
     4        'CONS','T. K',' POS','. NO','. 5 ',
     5        'CONS','T. K',' POS','. NO','. 6 ',
     6        'CONS','T. K',' POS','. NO','. 7 ',
     7        'CONS','T. K',' POS','. NO','. 8 ',
     8        'CONS','T. K',' POS','. NO','. 9 ',
     9        'CONS','T. K',' POS','. NO','. 10'/
      DATA XSIZE/10.0, 9*0.0/
      DO 51 I=1,50
   51 PI(I) = SFTN(1,1) - SFTN (I,1)
   11 READ (LR, 12) GL
   12 FORMAT (5A4)
      DO 15 I = 1, NOK
      DO1000J=1,5
       JJ = 5 * (I - 1) + J
 1000 DL(J) = D(JJ)
   15 CALL GRAFH (-NOINC,XVAL(1,I),Y1(1,I)    ,I,112, XSIZE(I), 10.0,
     1     0, 0, .02, .90, XL, YL1, GL, DL)
      DO 16 I = 1, NOK
      DO1001J=1,5
       JJ = 5 * (I - 1) + J
 1001 DL(J) = D(JJ)
   16 CALL GRAFH (-NCIND,XVAL(1,I),Y2(1,I)    ,I,112, XSIZE(I),10.0,
     1  0, 0, .CC4, 0.0, XL, YL2, GL, DL)
      IF (IGPH.GE.2) GO TO 17
      RETURN
   17 DO 19 I = 1, NOK
      DO1002J=1,5
       JJ = 5 * (I - 1) + J
 1002 DL(J) = D(JJ)
   18 CALL GRAFH (-NOINC,XVAL(1,I),SFTN(1,I)  ,I,112, XSIZE(I),10.0,
```

```
      1    0, 0, 0, 0, XL, YL3, GL, DL)
           IF (IGPH.GE.3) GO TO 19
           RETURN
        19 DO 20 I = 1, NOK
           DO1C03J=1,5
            JJ = 5 * (I - 1) + J
      1C03 DL(J) = D(JJ)
        20 CALL GRAPH (-NOIND,XVAL(1,1),ELASRL(1,I),1,112, XSIZE(I),10.0,
      1    0, 0, 0, 0, XL, YL4, GL, DL)
           DO 21 I = 1, NCK
           DO1004J=1,5
            JJ = 5 * (I - 1) + J
      1004 DL(J) = D(JJ)
        21 CALL GRAPH (-NOIND,XVAL(1,1),ELASMG(1,I),I,112, XSIZE(I),10.0,
      1    0, 0, 0, 0, XL, YL5, GL, DL)
           IF (IGPH.GE.4) GO TO 22
           RETURN
        22 DC 23 I=1, NOK
           DO 1005 J = 1, 5
            JJ = 5 * (I - 1) + J
      1C05 DL(J) = E(JJ)
        23 CALL GRAPH (-NOIND,XVAL(1,1),RELFQ(1,1) ,I,112, XSIZE(I),10.0,
      1    0, 0, 0, 0, XL, YL6, GL, DL)
           IF (IGPH.GE.5) GC TC 91
           RETURN
        91 DO 92  I =1, NOK
           DO 93  J = 1,5
           JJ = 5* (I-1) + J
        93 DL(J) = D(JJ)
        92 CALL GRAPH (-NCIND, PI(1), YL(1,I), I, 112, XSIZE(I), 10.0,
      1  1.0, 0.0, .02, .90, XL2, YL1, GL, DL)
           DO 95 I=1, NOK
           DO 96  J=1,5
           JJ = 5* (I-1) + J
        96 DL(J) = D(JJ)
        95 CALL GRAPH (-NCIND, PI(1), Y2(1,I), I, 112, XSIZE(I), 10.0,
      1   1.0, 0.0, .004, 0.0, XL2, YL2, GL, DL)
           RETURN
           END

           IMPLICIT REAL*8 (A-H, O-Z)
           REAL*4 DISTGN, RESGN,DISTEN(200), RESEN(200) , S
           REAL*8 NOWV(200)
           COMPLEX*16 CI,P(10),CK,CKO,E,F
           DIMENSION  FREQ(200), EIN(200), EOUT(200), SCALE(200), OMCO(200),
      1                WVLN(200),                VOONU(200), PPRSP(200)
           COMMON  CI,K(10), Y(10), M, LR, LK
           NAMELIST/NAM1/X,EINO,SCALEO,RESGN
           LR =  1
           LK =  3
           M  =  8
           N  =  8
           CI =  (0.0, 1.0)
        25 READ(1, NAM1)
           CALL DISTNC (RESGN, DISTGN,S,L)
           CKO = DCMPLX ( X(2), X(1))
           DO 1)  I = 1, 200
           READ (1, 2) FREQ(I),RESEN(I),EIN(I),EOUT(I),SCALE(I)
           NPTS = I
           IF (FREQ(I) .LE. 0.0) GO TO 3
        1) CONTINUE
         2 FORMAT ( 5F10.0)
         3 NPTS = NPTS - 1
           WRITE (3,4)
         4 FORMAT ('1',T21,'CALCULATION OF PHASE ERROR AND GENERATING PROBE',
      1          ' OUTPUT'/'0', T51,'CONSTANTS AND INITIAL VALUES')
           WRITE (3, NAM1)
           WRITE (3,5)
         5 FORMAT ('0',T51,'INPUT DATA'/'0',' NO. ',3X,'FREQUENCY',8X,
      1          'RESISTANCE',5X,'INPUT VTG.',4X,'OUTPUT VTG.',4X,
      2          'D.V. SCALE'//)
           WRITE (3,6) (I,FREQ(I),RESEN(I),EIN(I), EOUT(I),SCALE(I),I=1,NPTS)
         6 FORMAT (' ',I3, 5F15.7)
           WRITE (3,7)
         7 FORMAT ('1',T51,'OUTPUT RESULTS'/'0',' NO. ',3X,'FREQUENCY',
      1       7X,'DISTANCE',7X,'PRB. SEP.',6X,'DM. COFF.',7X,'WAVE LG.',
      2        8X,'NO. WAVES',8X,'GEN. AMPL.'//)
           DO 20  I =1, NPTS
           CALL DISTNC (RESEN(I), DISTEN(I),S,L)
           PRBSP(I) =   ABS ( DISTEN(I) - DISTGN)
           X(1) = 6.2831800 * FREQ(I)
           CALL  POLZRO ( CKO, CK, ISTOP, M, N, F )
           CKO = CK
           WANO =  CK
           WVLN(I) = 6.2831800 / WANO
           OMCC(I) =  -CI * CK
           X(1) = OMCO(I)
           X(2) = WANO
           NOWV(I) = PRBSP(I) / WVLN(I)
           VOONU(I) = EINO / EIN(I) * SCALE(I)/SCALEO * DEXP ( OMCC(I)*
      1               PRBSP(I)) * EOUT(I)
           WRITE(3,9)I,FREQ(I),DISTEN(I),PRBSP(I),OMCO(I),WVLN(I),NOWV(I),
      1             VOONU(I)

         9 FORMAT (' ', I3, 7F15.7)
        20 WRITE (2,8) FREQ(I), NOWV(I), VOONU(I)
         8 FORMAT (3F10.5)
           CALL GRAPH (-NPTS,FREQ,NOWV,3,1,15.0,10.C,C,C,C,0,
      1'FREQUENCY (HZ)         ', 'NO. WAVES BETWEEN PB',
      2'PHASE ANGLE CALIBRAT' , 'MICROMANIP. CHANGED ' )
           CALL GRAPH (-NPTS,FREQ,VOONU,3,1,15.C,1C.C,0,0,0,0,
      1'FREQUENCY (HZ)         ' , 'GENERATOR OUTPUT(MV)',
      2'GEN. PROBE CALIBRAT ' , 'MICROMANIP. CHANGED ' )
           READ (1,21)NEXT
        21 FORMAT (I5)
           IF (NEXT.GT.  0 ) GO TO 25
           STOP
           END
```

```
                         CALCULATION OF PHASE ERROR AND GENERATING PROBE OUTPUT
                                                    -
                                                        CONSTANTS AND INITIAL VALUES
&NAM1
X= 0.7659999999999998     ,  30.799999999999994    , 0.8959999999999992D-02,
  0.3859999999999999D-02, 0.5569999999999999        -
  0.6779999999999999      ,  50.199999999999998     ,  899.11999999999997        ,
  0.0                     , 0.0                     ,FINO=
  0.0999999999999990      ,SCALEO= 0.9999999999999990     ,RESGN= 0.47029996
  &END

                                                         INPUT DATA

   NO.     FREQUENCY       RESISTANCE        INPUT VTG.    OUTPUT VTG.     O.V. SCALE

    1     143.1000000       5.0709000       0.6410000      0.0704000      1.0000000
    2     144.5000000       5.0408993       0.6400000      0.0729000      1.0000000
    3     145.6000000       5.0143998       0.6400000      0.0736000      1.0000000
    4     147.4000000       4.9740000       0.6400000      0.0778000      1.0000000
    5     148.8000000       4.9401999       0.6400000      0.0802000      1.0000000
    6     150.9000000       4.8966999       0.6390000      0.0850000      1.0000000
    7     153.4000000       4.8411999       0.6390000      0.0927000      1.0000000
    8     155.0000000       4.8076992       0.6390000      0.0972000      1.0000000
    9     156.3000000       4.7781992       0.6390000      0.1005000      1.0000000
   10     157.8000000       4.7519999       0.6390000      0.1046000      1.0000000
   11     159.0000000       4.7249994       0.6390000      0.1083000      1.0000000
   12     160.4000000       4.6975994       0.6400000      0.1131000      1.0000000
   13     161.7000000       4.6723995       0.6400000      0.1180000      1.0000000
   14     163.3000000       4.6414995       0.6400000      0.1229000      1.0000000
   15     165.6000000       4.5983992       0.6400000      0.1285000      1.0000000
   16     167.8000000       4.5546995       0.6400000      0.1362000      1.0000000
   17     169.3000000       4.5306997       0.3210000      0.0712000      1.0000000
   18     171.8000000       4.4866991       0.3210000      0.0734000      1.0000000
   19     174.3000000       4.4199991       0.3210000      0.0774000      1.0000000
   20     177.0000000       4.3970995       0.3210000      0.0803000      1.0000000
   21     178.9000000       4.3679991       0.3200000      0.0832000      1.0000000
   22     180.2000000       4.3432999       0.3200000      0.0842000      1.0000000
   23     181.5000000       4.3234997       0.3200000      0.0854000      1.0000000
   24     182.0000000       4.3130995       0.3200000      0.0856000      1.0000000
   25     182.6000000       4.3062992       0.3200000      0.0864000      1.0000000
   26     183.2000000       4.2983999       0.3200000      0.0878000      1.0000000
   27     184.0000000       4.2849998       0.3200000      0.0894000      1.0000000
   28     184.6000000       4.2751999       0.3200000      0.0891000      1.0000000
   29     185.1000000       4.2657995       0.3200000      0.0892000      1.0000000
   30     185.5000000       4.2629995       0.3200000      0.0906000      1.0000000
   31     185.8000000       4.2567997       0.3200000      0.0910000      1.0000000
   32     186.1000000       4.2510996       0.3200000      0.0915000      1.0000000
   33     186.7000000       4.2410994       0.3200000      0.0908000      1.0000000
   34     187.3000000       4.2333994       0.3200000      0.0919000      1.0000000
   35     187.9000000       4.2243996       0.3200000      0.0929000      1.0000000
   36     188.6000000       4.2115993       0.3200000      0.0938000      1.0000000
   37     189.1000000       4.2053995       0.3200000      0.0933000      1.0000000
   38     189.8000000       4.1945992       0.3200000      0.0949000      1.0000000
   39     190.4000000       4.1849995       0.3200000      0.0958000      1.0000000
   40     191.1000000       4.1732998       0.3200000      0.0960000      1.0000000
   41     191.8000000       4.1629992       0.3200000      0.0966000      1.0000000
   42     192.6000000       4.1489992       0.3200000      0.0994000      1.0000000
   43     193.3000000       4.1440992       0.3200000      0.1001000      1.0000000
   44     193.7000000       4.1350994       0.3200000      0.1004000      1.0000000
   45     194.4000000       4.1231995       0.3200000      0.1006000      1.0000000
   46     194.8000000       4.1186991       0.3200000      0.1010000      1.0000000
   47     195.4000000       4.1099997       0.3200000      0.1008000      1.0000000
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 48    196.3000000     4.0965996     0.3200000     0.1028000     1.0000000
 49    197.0000000     4.0875998     0.3200000     0.1022000     1.0000000
 50    197.8000000     4.0784998     0.3200000     0.1037000     1.0000000
 51    198.4000000     4.0674000     0.3200000     0.1030000     1.0000000
 52    199.2000000     4.0563993     0.3200000     0.1038000     1.0000000
 53    199.9000000     4.0407991     0.3200000     0.1055000     1.0000000
 54    200.7000000     4.0345993     0.3200000     0.1072000     1.0000000
 55    201.5000000     4.0199995     0.3200000     0.1120000     1.0000000
 56    202.4000000     4.0095997     0.3200000     0.1157000     1.0000000
 57    203.5000000     3.9912996     0.3200000     0.1262000     1.0000000
 58    204.1000000     3.9826994     0.3200000     0.1298000     1.0000000
 59    205.0000000     3.9691992     0.3200000     0.1337000     1.0000000
 60    205.9000000     3.9573994     0.3200000     0.1365000     1.0000000
 61    206.8000000     3.9427996     0.3200000     0.1377000     1.0000000
 62    207.5000000     3.9305998     0.3200000     0.1361000     1.0000000
 63    208.2000000     3.9195991     0.3200000     0.1270000     1.0000000
 64    209.2000000     3.9066992     0.3200000     0.1266000     1.0000000
 65    210.0000000     3.8948994     0.3200000     0.1210000     1.0000000
 66    211.1000000     3.8814999     0.3200000     0.1156000     1.0000000
 67    212.0000000     3.8680992     0.3200000     0.1137000     1.0000000
 68    213.1000000     3.8532991     0.3200000     0.1153000     1.0000000
 69    214.8000000     3.8416996     0.3200000     0.1129000     1.0000000
 70    216.3000000     3.8123999     0.3200000     0.1113000     1.0000000
 71    217.2000000     3.8001995     0.3200000     0.1086000     1.0000000
 72    218.2000000     3.7830000     0.3200000     0.1048000     1.0000000
 73    219.6000000     3.7651997     0.3200000     0.0986000     1.0000000
 74    220.9000000     3.7505999     0.3200000     0.0923000     1.0000000
 75    221.9000000     3.7366991     0.3200000     0.0867000     1.0000000
 76    223.1000000     3.7223997     0.3200000     0.0826000     1.0000000
 77    224.3000000     3.7059994     0.3200000     0.0773000     1.0000000
 78    225.3000000     3.6952000     0.3200000     0.0729000     1.0000000
 79    226.4000000     3.6827993     0.3200000     0.0690000     1.0000000
 80    228.0000000     3.6657000     0.3200000     0.0628000     1.0000000
 81    229.6000000     3.6466999     0.6320000     0.1103000     1.0000000
 82    230.4000000     3.6376991     0.6320000     0.1039000     1.0000000
 83    231.5000000     3.6268997     0.6330000     0.0968000     1.0000000
 84    232.4000000     3.6151991     0.6330000     0.0938000     1.0000000
 85    233.5000000     3.6023996     0.6330000     0.0869000     1.0000000
 86    235.2000000     3.5872993     0.6330000     0.0791000     1.0000000
 87    236.5000000     3.5749998     0.6350000     0.0751000     1.0000000
 88    237.5000000     3.5613995     0.6380000     0.0690000     1.0000000
 89    239.8000000     3.5417995     0.6340000     0.0632000     1.0000000
 90    241.2000000     3.5279999     0.6340000     0.1158000     0.5000000
 91    242.9000000     3.5159998     0.6330000     0.1118000     0.5000000
 92    245.0000000     3.4975996     0.6330000     0.1030000     0.5000000
 93    247.7000000     3.4613995     0.6330000     0.0925000     0.5000000
 94    250.6000000     3.4453993     0.6330000     0.0827000     0.5000000
 95    253.5000000     3.4219999     0.6330000     0.0761000     0.5000000
 96    255.3000000     3.4016991     0.6340000     0.0704000     0.5000000
 97    257.9000000     3.3860999     0.6340000     0.0670000     0.5000000
 98    259.9000000     3.3701992     0.6360000     0.0620000     0.5000000
 99    262.7000000     3.3477993     0.6370000     0.0578000     0.5000000
100    265.5000000     3.3274994     0.6370000     0.1321000     0.2000000
101    268.3000000     3.3025999     0.6360000     0.1215000     0.2000000
102    271.5000000     3.2793999     0.6370000     0.1108000     0.2000000
103    274.9000000     3.2577000     0.6370000     0.1022000     0.2000000
104    277.8000000     3.2335997     0.6370000     0.0938000     0.2000000
105    282.9000000     3.2023993     0.6370000     0.0861000     0.2000000
106    286.1000000     3.1797991     0.6370000     0.0812000     0.2000000
107    290.7000000     3.1447992     0.6390000     0.0706000     0.2000000
108    296.2000000     3.1103992     0.6380000     0.0664000     0.2000000

109    300.5000000     3.0835991     0.6370000     0.1216000     0.1000000
110    306.0000000     3.0542994     0.6380000     0.1190000     0.1000000
111    311.5000000     3.0206995     0.6380000     0.1108000     0.1000000
112    317.8000000     2.9835997     0.6380000     0.1030000     0.1000000
113    327.2000000     2.9295998     0.6390000     0.0930000     0.1000000
114    335.4000000     2.8882999     0.6390000     0.0884000     0.1000000
115    343.2000000     2.8416996     0.6390000     0.0784000     0.1000000
116    354.3000000     2.7895996     0.6390000     0.0741000     0.1000000
117    370.2000000     2.7207994     0.6400000     0.0726000     0.1000000
118    380.9000000     2.6640997     0.6400000     0.0622000     0.1000000
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                                              OUTPUT RESULTS

 NO.    FREQUENCY      DISTANCE       PRR. SEP.      DM. COEF.      WAVE LG.       NO. WAVES      GEN. AMPL.

  1    143.1000000    2.4371452      3.4478731      0.6630434      0.2061435      16.7255949     0.1080316
  2    144.5000000    2.4587994      3.4262190      0.5680174      0.2047978      16.7297619     0.1125751
  3    145.6000000    2.4777822      3.4072361      0.6729918      0.2037558      16.7221580     0.1139078
  4    147.4000000    2.5074883      3.3775301      0.5801402      0.2020797      16.7139319     0.1209099
  5    148.8000000    2.5324125      3.3526058      0.6856919      0.2007979      16.6964151     0.1249459
  6    150.9000000    2.5645094      3.3205090      0.6540041      0.1989142      16.6931704     0.1332641
  7    153.4000000    2.6055164      3.2795019      0.7038935      0.1967292      16.6702148     0.1459146
  8    155.3000000    2.6303101      3.2547083      0.7101935      0.1953603      16.6600292     0.1534706
  9    156.3000000    2.6521740      3.2328444      0.7153139      0.1942662      16.6413149     0.1598609
 10    157.8000000    2.6716185      3.2133999      0.7212149      0.1930228      16.6477971     0.1661617
 11    159.0000000    2.6916876      3.1933308      0.7259301      0.1920418      16.6283111     0.1721304
 12    160.4000000    2.7120867      3.1729317      0.7214252      0.1909132      16.6197619     0.1795602
 13    161.7000000    2.7308765      3.1541414      0.7365219      0.1898799      16.6112464     0.1881054
 14    163.3000000    2.7539597      3.1310596      0.7427872      0.1886271      16.5992057     0.1965239
 15    165.6000000    2.7862320      3.0987864      0.7517790      0.1868618      16.5833054     0.2062708
 16    167.8000000    2.8190470      3.0659714      0.7603640      0.1852113      16.5539091     0.2190010
 17    169.3000000    2.8371096      3.0479088      0.7642096      0.1841066      16.5551269     0.2291012
 18    171.8000000    2.8702946      3.0147238      0.7759342      0.1823015      16.5370204     0.2371044
 19    174.3000000    2.9207592      2.9642591      0.7856406      0.1805399      16.4188610     0.2475365
 20    177.0000000    2.9381256      2.9468927      0.7961024      0.1786843      16.4921770     0.2612523
 21    178.9000000    2.9602203      2.9247980      0.8034515      0.1774067      16.4864049     0.2726066
 22    180.2000000    2.9789925      2.9060259      0.8084737      0.1765455      16.4604996     0.2757486
 23    181.5000000    2.9940538      2.8909645      0.8134910      0.1756948      16.4544729     0.2803304
 24    182.0000000    3.0019693      2.8830490      0.8154194      0.1753702      16.4397849     0.2807300
 25    182.6000000    3.0071449      2.8778734      0.8177326      0.1749828      16.4466979     0.2840558
 26    183.2000000    3.0131598      2.8718586      0.8200448      0.1745975      16.4484547     0.2891551
 27    184.0000000    3.0233641      2.8616543      0.8231261      0.1740870      16.4380703     0.2945565
 28    184.6000000    3.0308294      2.8541889      0.8254359      0.1737066      16.4310937     0.2936999
 29    185.1000000    3.0379906      2.8470278      0.8273599      0.1733911      16.4196856     0.2939021
 30    185.5000000    3.0401249      2.8448935      0.8288986      0.1731398      16.4311931     0.2992054
 31    185.8000000    3.0448586      2.8401599      0.8300524      0.1729515      16.4217332     0.3004251
 32    186.1000000    3.0491924      2.8358259      0.8312059      0.1727665      16.4144015     0.3019747
 33    186.7000000    3.0568142      2.8282042      0.8335121      0.1723912      16.4057319     0.2907207
 34    187.3000000    3.0626831      2.8223352      0.8358174      0.1720200      16.4070216     0.3038418
 35    187.9000000    3.0695436      2.8154745      0.8381216      0.1716507      16.4023499     0.3073794
 36    188.5000000    3.0793018      2.8057165      0.8408087      0.1712223      16.3863925     0.3101585
 37    189.1000000    3.0840273      2.8009911      0.8427272      0.1709190      16.3879215     0.3089380
 38    189.8000000    3.0919933      2.7930250      0.8454119      0.1704942      16.3819347     0.3144878
 39    190.4000000    3.0991907      2.7858276      0.8477121      0.1701330      16.3744099     0.3175679
 40    191.1000000    3.1079636      2.7770548      0.8503943      0.1697141      16.3631398     0.3182364
 41    191.8000000    3.1156864      2.7693319      0.8530752      0.1692976      16.3577703     0.3204981
 42    192.5000000    3.1261835      2.7588348      0.8561376      0.1688248      16.3414027     0.3296210
 43    193.3000000    3.1298571      2.7551613      0.8598157      0.1684138      16.3594703     0.3332506
 44    193.7000000    3.1366053      2.7484131      0.8603454      0.1681801      16.3420823     0.3378190
 45    194.4000000    3.1455278      2.7394905      0.8630215      0.1677730      16.3285546     0.3342675
 46    194.8000000    3.1489019      2.7361164      0.8645501      0.1675415      16.3309908     0.3361238
 47    195.4000000    3.1554241      2.7295942      0.8668422      0.1671957      16.3257488     0.3356655
 48    196.3000000    3.1654720      2.7195463      0.8702786      0.1666903      16.3149471     0.3425431
 49    197.1000000    3.1722193      2.7127991      0.8729498      0.1662821      16.3144356     0.3410122
 50    197.8000000    3.1790429      2.7059755      0.8760011      0.1658300      16.3177672     0.3468141
 51    198.4000000    3.1873646      2.6976538      0.8782985      0.1654929      16.3007192     0.3440977
 52    199.2000000    3.1956129      2.6894054      0.8813365      0.1650461      16.2948709     0.3470912
 53    199.9000000    3.2073097      2.6777086      0.8840029      0.1646576      16.2622794     0.3516597
 54    200.7000000    3.2119579      2.6730604      0.8870483      0.1642164      16.2776665     0.3587691
 55    201.5000000    3.2229052      2.6621132      0.8900920      0.1637782      16.2543837     0.3742311
 56    202.4000000    3.2307024      2.6543159      0.8935142      0.1632886      16.2553675     0.3874236
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57	203.5000000	3.2444229	2.6405954	0.8576941	0.1626951	16.2303284	0.4220670
58	204.3000000	3.2508717	2.6341467	0.9007321	0.1622669	16.2334202	0.4350480
59	205.0000000	3.2609940	2.6240244	0.9033899	0.1618945	16.2082393	0.4471904
60	205.9000000	3.2698412	2.6151772	0.9068033	0.1614188	16.2011967	0.4559774
61	206.8000000	3.2807875	2.6042309	0.9102156	0.1609466	16.1807176	0.4405117
62	207.5000000	3.2896347	2.5953836	0.9128483	0.1605816	16.1673926	0.4546233
63	208.2000000	3.2994330	2.5860853	0.9155197	0.1602188	16.1409615	0.4235401
64	209.2000000	3.3076547	2.5771637	0.9193351	0.1597039	16.1371310	0.4224773
65	210.0000000	3.3167029	2.5683155	0.9223321	0.1592050	16.1230103	0.4040761
66	211.1000000	3.3264494	2.5585690	0.9264914	0.1587370	16.1182778	0.3944777
67	212.0000000	3.3367568	2.5482216	0.9298923	0.1582841	16.0799402	0.3700055
68	213.1000000	3.3479037	2.5371246	0.9340463	0.1577358	16.0967470	0.3451600
69	214.8000000	3.3554903	2.5284281	0.9434605	0.1568952	16.1153958	0.3304001
70	215.3000000	3.3785591	2.5064592	0.9461143	0.1561636	16.0597194	0.3775485
71	217.2000000	3.3877768	2.4973116	0.9495042	0.1557287	16.0362929	0.3474481
72	218.2000000	3.4056023	2.4844160	0.9532684	0.1552490	16.0027790	0.3457450
73	219.5000000	3.4135450	2.4710693	0.9585344	0.1545836	15.9453259	0.3201530
74	220.8000000	3.4244954	2.4601231	0.9630446	0.1540185	15.9728682	0.3083707
75	221.9000000	3.4353180	2.4497064	0.9671760	0.1535057	15.9583671	0.2904272
76	223.1000000	3.4466392	2.4389791	0.9716759	0.1529507	15.9441802	0.2741036
77	224.3000000	3.4581359	2.4266325	0.9761896	0.1524097	15.9230666	0.2591157
78	225.3000000	3.4664326	2.4185858	0.9799296	0.1519461	15.9173977	0.2427101
79	226.4000000	3.4757309	2.4092975	0.9849489	0.1514495	15.9091519	0.2409497
80	228.0000000	3.4885511	2.3964672	0.9910373	0.1507351	15.8984117	0.2104812
81	229.6000000	3.5027971	2.3822212	0.9960200	0.1500291	15.8742336	0.1977940
82	230.4000000	3.5095463	2.3754721	0.9990093	0.1496791	15.8704343	0.1764171
83	231.5000000	3.5176430	2.3673754	1.0031172	0.1492011	15.8670092	0.1643470
84	232.9000000	3.5264158	2.3586025	1.0064764	0.1489129	15.8494539	0.1591333
85	233.5000000	3.5356370	2.3493805	1.0105796	0.1483417	15.8276233	0.1474007
86	235.2000000	3.5477314	2.3372665	1.0169159	0.1476219	15.8330343	0.1345005
87	236.3000000	3.5571442	2.3278742	1.0217571	0.1470755	15.8277475	0.1247036
88	237.6000000	3.5674516	2.3174667	1.0254537	0.1466180	15.8061597	0.1165402
89	238.8000000	3.5815462	2.3024721	1.0340304	0.1457134	15.8013774	0.1077072
90	241.2000000	3.5731196	2.2919178	1.0392305	0.1451445	15.7905463	0.0998854
91	242.5000000	3.6022768	2.2927415	1.0455374	0.1444621	15.8016480	0.0956588
92	244.0000000	3.6163616	2.2686768	1.0533246	0.1436295	15.7953622	0.0887500
93	247.7000000	3.6474432	2.2471352	1.0633710	0.1425764	15.7603154	0.0770474
94	250.3000000	3.6561598	2.2289189	1.0749417	0.1414665	15.7550906	0.0711844
95	253.5000000	3.6747499	2.2109776	1.0847459	0.1403770	15.7501926	0.0661514
96	255.3000000	3.6865117	2.1955147	1.0932239	0.1395292	15.7351593	0.0612178
97	257.1000000	3.7011780	2.1836433	1.1009555	0.1387654	15.7362123	0.0594644
98	259.1000000	3.7134547	2.1715536	1.1083113	0.1380476	15.7304669	0.0549036
99	262.7000000	3.7304744	2.1545401	1.1185967	0.1370581	15.7199957	0.0505167
100	265.5000000	3.7456771	2.1351411	1.1288675	0.1360840	15.7193369	0.0446014
101	268.3000000	3.7634776	2.1213478	1.1391235	0.1351210	15.6984055	0.0428143
102	271.6000000	3.7822924	2.1027355	1.1511934	0.1340766	15.6983464	0.0391470
103	276.9000000	3.7946571	2.0863514	1.1632435	0.1329444	15.6934161	0.0343317
104	277.8000000	3.8114336	2.0591849	1.1739179	0.1320112	15.6667425	0.0343767
105	282.9000000	3.8240036	2.0447145	1.1923763	0.1306099	15.6702604	0.0320050
106	284.1000000	3.8571693	2.0277491	1.2035986	0.1294280	15.6670055	0.0292011
107	290.7000000	3.8834856	2.0015326	1.2206754	0.1280497	15.6309967	0.0254737
108	296.2000000	3.9091864	1.9758320	1.2405691	0.1264498	15.6255467	0.0241461
109	300.5000000	3.9271621	1.9559563	1.2560882	0.1252315	15.6179288	0.0222709
110	306.0000000	3.9505563	1.9340620	1.2758953	0.1237162	15.6339504	0.0210007
111	311.5000000	3.9758959	1.9091228	1.2956557	0.1222459	15.6170738	0.0120051
112	317.8000000	4.0033493	1.8816490	1.3182326	0.1206141	15.6005773	0.0152065
113	326.2000000	4.0432520	1.8417464	1.3514907	0.1182774	15.5715781	0.0176400
114	335.5000000	4.0736447	1.8113337	1.3805561	0.1163789	15.5707937	0.0159774
115	343.2000000	4.1073574	1.7779510	1.4046713	0.1145680	15.5135947	0.0149961
116	354.3000000	4.1466866	1.7383318	1.4479127	0.1121271	15.5032216	0.0143687
117	370.2000000	4.1766244	1.6883898	1.5038427	0.1089722	15.5070219	0.0143707

```
C      PROGRAM FOR FITTING CURVE OF AMPLITUDE(FEQUENCY) DEPENDENCE OF
C      WAVE GENERATING PROBE OF INTERFACIAL RIPPLE APPARATUS
C      DESCRIPTION OF NECESSARY DATA CARDS FOLLOWS:
C        CARD 1: NPARTS = NO. OF SECTIONS OF CURVE (COL.1-2)
C        CARD 2: NPTS: NO. OF POINTS IN SECTION J (J=1,NPTS) (COL.1-2)
C                INTS: IF PTS. NOT WEIGHTED,LEAVE COL.3-4 BLANK
C                      IF PTS. WEIGHTED,PUT POSITIVE INTEGER IN COL.3-4
C        CARDS 3 TO(NPTS+2) :DATA :FREQUENCY COL.1-10,AMPLITUDE COL.51-60
C                            IF PTS. WEIGHTED ,WT. OF PT. IN COL.71-80
C
C        REPEAT CARDS 2 TO NPTS+2  FOR EACH SECTION OF CURVE (NPARTS)
C
C
       REAL*8 X(100), Y(100), W(100), Q(11), RES(100), ERROR(100), REST,
      1   STDEV(10), DSQRT, SUM, FMIN, Z, A(100)
C
       READ(1,60) NPARTS
    60 FORMAT(I2)
C
       DO 10 I=1,NPARTS
       WRITE(3,1)I
     1 FORMAT('1',20X,'CURVE SECTION NO. = ',I2)
C
C
       READ(1,2)NPTS,INTS
     2 FORMAT(2I2)
       IF(INTS)15,15,16
    16 READ(1,3)(A(J),Y(J),W(J),J=1,NPTS)
     3 FORMAT(F10.0,10X,F10.0,10X,F10.0)
       GO TO 18
    15 DO 100 J=1,NPTS
   100 W(J)=1.0D0
       READ(1,4)(A(J),Y(J),J=1,NPTS)
     4 FORMAT (F10.0, F10.0)
    18 CONTINUE
       DO 500 J=1,NPTS
   500 X(J) = .01D0 * (A(J) - A(1))
C
C
       TUMYLO = 0.0
       WRITE(2,9) I
     9 FORMAT('POLYNOMIAL COEFFICIENTS OF SECTION ',I2)
C
       DO 25  NDEG=1,10
       CALL DPLSPA(NDEG,NPTS,X,Y,W,Q,TUMYLO)
       TUMYLO=1.0
       WRITE(3,5)NDEG
     5 FORMAT(///' ',15X,'COEFFICIENTS OF ',I2,' TH DEGREE FIT IN ASCENDI
      1NG POWERS OF THE FREQUENCY')
       NDEG1=NDEG+1
       DO 200 K=1,NDEG1
       NN=K-1
       WRITE(3,7)Q(K),NN

     7 FORMAT(' ',20X,D20.10,4X,'FREQUENCY**',I2)
   200 CONTINUE
C
       WRITE(2,8)NDEG
     8 FORMAT('COEFFICIENTS OF ',I2,' TH DEGREE FIT')
C
       WRITE(2,6)(Q(K),K=1,NDEG1)
     6 FORMAT(4D20.10)
C
C
C
C      EVALUATE POLYNOMIAL AND COMPARE TO INPUT DATA
C
       SUM = 0.0
       WRITE(3,12)
    12 FORMAT (///' ',3X,'FREQUENCY',5X,'CODED FREC.',4X,'EXP. AMPL.',
      1   5X,'CALC. AMPL.', 7X, 'ERROR')
C
       DO 11 J=1,NPTS
       RES(J)= Q(1)
       DO 1001 L=2,NDEG1
       RES(J)= RES(J) +Q(L)*X(J)**(L-1)
  1001 CONTINUE
       ERROR(J)=Y(J)-RES(J)
       WRITE (3,13) A(J), X(J), Y(J), RES(J), ERROR(J)
    13 FORMAT (' ', 5F15.5)
       SUM=SUM + ERROR(J)**2
    11 CONTINUE
C
       STDEV(NDEG) =DSQRT(SUM/(NPTS-NDEG-1))
C
       WRITE(3,14) STDEV(NDEG)
    14 FORMAT(///' ','STANDARD DEVIATION= ',F11.8)
    25 CONTINUE
C
C      FIND FIT WHICH GIVES SMALLEST STANDARD DEVIATION
C
       FMIN = STDEV(5)
       M = 5
       DO 30  L=6,10
       IF(STDEV(L) .LT. FMIN) GO TO 40
       GO TO 30
    40 FMIN =STDEV(L)
       M = L
    30 CONTINUE
C
       WRITE(3,50)M,STDEV(M)
    50 FORMAT(//' ','BEST FIT IS OF ORDER ',I2,' AND ITS STANDARD DEVIATI
      1ON = ',F11.8)
C
    10 CONTINUE
       STOP
       END
```

```
      SUBROUTINE OPLSPA (NDEG,NPTS,X,Y,W,Q,TUWYLO)                      OPLSPA01
      DOUBLE PRECISION X(1),Y(1),W(1)                                   OPLSPA02
      DOUBLE PRECISION Q(1), PN(21), PN1(20), SUM(4), B, C, PNX, TMP    OPLSPA03
      IF (TUWYLO)   2,1,2                                               OPLSPA04
    1 N=0                                                               OPLSPA05
      C =0.                                                             OPLSPA06
      PN(1)=1.0                                                         OPLSPA07
      GO TO 6                                                           OPLSPA08
    2 C =-SUM(3)/SUM(4)                                                 OPLSPA09
    3 B=-SUM(1)/SUM(3)                                                  OPLSPA10
      SUM(4)=SUM(3)                                                     OPLSPA11
      N=N+1                                                             OPLSPA12
      PN1(N)=0.                                                         OPLSPA13
      PN(N+1)=0.                                                        OPLSPA14
      DO 4   J=1,N                                                      OPLSPA15
      TMP=PN(J)                                                         OPLSPA16
      PN(J)=B*PN(J)+C*PN1(J)                                            OPLSPA17
    4 PN1(J)=TMP                                                        OPLSPA18
      DO 5   J=1,N                                                      OPLSPA19
    5 PN(J+1)=PN(J+1)+PN1(J)                                            OPLSPA20
    6 DO 7   K=1,3                                                      OPLSPA21
    7 SUM(K)=0.0                                                        OPLSPA22
      DO 11  I=1,NPTS                                                   OPLSPA23
      PNX=1.0                                                           OPLSPA24
      J=N                                                               OPLSPA25
    8 IF (J)  10,10,9                                                   OPLSPA26
    9 PNX=PN(J)+PNX*X(I)                                                OPLSPA27
      J=J-1                                                             OPLSPA28
      GO  TO  8                                                         OPLSPA29
   10 SUM(1)=SUM(1)+W(I)*X(I)*PNX*PNX                                   OPLSPA30
      SUM(2)=SUM(2)+W(I)*Y(I)*PNX                                       OPLSPA31
   11 SUM(3)=SUM(3)+W(I)*PNX*PNX                                        OPLSPA32
      C(N+1)=SUM(2)/SUM(3)                                              OPLSPA33
      IF  (N)   3,3,12                                                  OPLSPA34
   12 DO  13  J=1,N                                                     OPLSPA35
   13 C(J)=C(J)+C(N+1)*PN(J)                                            OPLSPA36
      IF (N-NDEG)   2,14,14                                             OPLSPA37
   14 RETURN                                                            OPLSPA38
      END
```

```
COEFFICIENTS OF 10 TH DEGREE FIT IN ASCENDING POWERS OF THE FREQUENCY
          0.1369290775D 01     FREQUENCY** 0
         -0.5167444891D-01     FREQUENCY** 1
         -0.5018828822D 01     FREQUENCY** 2
          0.4381281661D 02     FREQUENCY** 3
         -0.2577845244D 03     FREQUENCY** 4
          0.8839603579D 03     FREQUENCY** 5
         -0.1810329051D 04     FREQUENCY** 6
          0.2235193352D 04     FREQUENCY** 7
         -0.1624977992D 04     FREQUENCY** 8
          0.6396721261D 03     FREQUENCY** 9
         -0.1051725714D 03     FREQUENCY**10


FREQUENCY     CODED FREQ.    EXP. AMPL.     CALC. AMPL.      ERROR
  144.00000     0.0            1.37000        1.36929        0.00071
  146.00000     0.02000        1.36600        1.36656       -0.00056
  148.00000     0.04000        1.36000        1.36142       -0.00142

  150.00000     0.06000        1.35500        1.35485        0.00015
  152.00000     0.08000        1.34800        1.34738        0.00062
  154.00000     0.10000        1.34000        1.33921        0.00079
  156.00000     0.12000        1.33100        1.33040        0.00060
  158.00000     0.14000        1.32200        1.32092        0.00108
  160.00000     0.16000        1.31100        1.31072        0.00028
  162.00000     0.18000        1.29800        1.29976       -0.00176
  164.00000     0.20000        1.28700        1.28802       -0.00102
  166.00000     0.22000        1.27500        1.27554       -0.00054
  168.00000     0.24000        1.26200        1.26236       -0.00036
  170.00000     0.26000        1.24800        1.24857       -0.00057
  172.00000     0.28000        1.23400        1.23424       -0.00024
  174.00000     0.30000        1.22000        1.21947        0.00053
  176.00000     0.32000        1.20500        1.20433        0.00067
  178.00000     0.34000        1.19000        1.18888        0.00112
  180.00000     0.36000        1.17500        1.17315        0.00185
  182.00000     0.38000        1.15800        1.15715        0.00085
  184.00000     0.40000        1.14200        1.14084        0.00116
  186.00000     0.42000        1.12400        1.12420       -0.00020
  188.00000     0.44000        1.10600        1.10714       -0.00114
  190.00000     0.46000        1.08800        1.08959       -0.00159
  192.00000     0.48000        1.06900        1.07147       -0.00247
  194.00000     0.50000        1.05100        1.05272       -0.00172
  196.00000     0.52000        1.03200        1.03327       -0.00127
  198.00000     0.54000        1.01200        1.01309       -0.00109
  200.00000     0.56000        0.99300        0.99219        0.00081
  207.00000     0.58000        0.97300        0.97062        0.00238
  204.00000     0.60000        0.95100        0.94845        0.00255
  206.00000     0.62000        0.92800        0.92582        0.00218
  208.00000     0.64000        0.90600        0.90289        0.00311
  210.00000     0.66000        0.88100        0.87990        0.00110
  212.00000     0.68000        0.85600        0.85707       -0.00107
  214.00000     0.70000        0.83200        0.83469       -0.00269
  216.00000     0.72000        0.81000        0.81304       -0.00304
  218.00000     0.74000        0.78900        0.79240       -0.00340
  220.00000     0.76000        0.77200        0.77307       -0.00107
  227.00000     0.78000        0.75500        0.75527       -0.00027
  224.00000     0.80000        0.74000        0.73923        0.00077
  226.00000     0.82000        0.72700        0.72509        0.00191
  228.00000     0.84000        0.71600        0.71296        0.00304
  230.00000     0.86000        0.70500        0.70284        0.00216
  232.00000     0.88000        0.69600        0.69467        0.00133
  234.00000     0.90000        0.68800        0.68831       -0.00031
  236.00000     0.92000        0.68200        0.68353       -0.00153
  238.00000     0.94000        0.67700        0.68003       -0.00303
  240.00000     0.96000        0.67400        0.67744       -0.00344
  242.00000     0.98000        0.67100        0.67534       -0.00434
  244.00000     1.00000        0.68800        0.67330        0.01470
  246.00000     1.02000        0.66600        0.67085       -0.00485
  248.00000     1.04000        0.66500        0.66754       -0.00254
  250.00000     1.06000        0.66400        0.66296        0.00104


STANDARD DEVIATION=   0.00305667
```

APPENDIX C

Data and result listings for various surfactants in Multiple Constant k experiments at the heptane/water interface follow:

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                    ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA SOLUBLE IONIC SURFACTANTS - LIA (NO FILTERS) FEB 1968  RLB

EXPERIMENTS PERFORMED AT THE .01 M SODIUM SULFATE (FRESH 4X H2O)     /FRESHLY DISTILLED N HEPTANE              INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS NAC12SO3 - SODIUM DODECYL SULFONATE (1X FROM DIST. ABS. ETHANOL) ETOH  2/7/68

                                        SYSTEM PARAMETERS

                 LOWER PHASE DENSITY  0.9980 G/ML         UPPER PHASE DENSITY  C.6780 G/ML
                         VISCOSITY  0.00896 POISES                  VISCOSITY  0.00386 POISES

                                   INITIAL VALUES ASSUMED IN CALCULATION

                 REAL ELASTICITY (EP)   C.0               IMAGINARY ELASTICITY (EPP)   0.0
                 WAVENUMBER  31.00000 RECIPROCAL  CM      DAMPING COEFFICIENT   0.70000 CM
                 REFERENCE METER SCALE    1.00 MV.        INTERFACIAL TENSION 50.2000 DYNES/CM
                 REFERENCE INPUT VTG.  0.100 VT.

                                        PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.42825 CM. BASED ON RFSGN= 0.25480 RESFN= 4.82520 DISTGN= 6.04565 DISTFN= 2.61735

                                  CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY     DMP. COEF.     WAVE NC.      WAVELENGTH      NO. WAVES   PHS.COR.WANO  GN. PB. SCL.FCTR.
    1         157.50     0.72004601    32.51607068    0.19323307    17.74174763    32.51607068     0.95402901
    2         181.70     0.81427531    35.79519787    0.17553137    19.53093820    35.79519787     0.97571018
    3         206.70     0.90585163    39.03368910    0.16096813    21.29795657    39.03368910     0.91763383
    4         231.50     1.00313448    42.12021230    0.14917256    22.98205661    42.12021230     1.12707560

                                        INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE IS THE LOGARITHIM OF THE BULK PHASE SURFACTANT CONCENTRATION (MOLES/L).
INPUT PARAMETERS ARE- WT. OF SURFACTANT =  81.40000 MG.  MOLECULAR WT. =, 276.00000 G.
MAKE-UP VOL. =   0.02500 L. TOTAL SOLUTION VOLUME =   0.49500 L
SURFACTANT SOLUTION IS ADDED TO BULK PHASE AND MIXED, THE VOLUME ADDED IN MICROLITERS IS READ IN.


                                        INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=      34.30MG.  WEIGHT OF WEIGHT=     171.4C MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETERCF PLATE= 2.88413 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
```

```
                                             INPUT DATA

ID .K      INCEP. VAR.      FREQUENCY      INPUT VOLT.    OUTPUT VOLT.     METER SCALE     SETN. VAR.

 1. 1      0.0              157.50000      0.46200        0.09200          0.50000         38.40000
 1. 2      0.0              181.70000      0.46300        0.13240          0.50000         38.40000
 1. 3      0.0              206.70000      0.46600        0.10750          0.50000         38.40000
 1. 4      0.0              231.50000      0.46800        0.13130          0.20000         38.40000
 2. 1      0.00500          157.40000      0.46200        0.09480          0.50000         38.60000
 2. 2      0.00500          181.40000      0.46300        0.13430          0.50000         38.60000
 2. 3      0.00500          206.40000      0.46700        0.10580          0.50000         38.60000
 2. 4      0.00500          231.40000      0.46800        0.13100          0.20000         38.60000
 3. 1      0.02000          157.10000      0.46200        0.09270          0.50000         39.00000
 3. 2      0.02000          181.20000      0.46300        0.13180          0.50000         39.00000
 3. 3      0.02000          206.00000      0.46500        0.09980          0.50000         39.00000
 3. 4      0.02000          230.90000      0.46600        0.12410          0.20000         39.00000
 4. 1      0.04000          156.80000      0.46200        0.08630          0.50000         39.50000
 4. 2      0.04000          180.90000      0.46300        0.12740          0.50000         39.50000
 4. 3      0.04000          205.50000      0.46300        0.09620          0.50000         39.50000
 4. 4      0.04000          230.30000      0.46600        0.12450          0.20000         39.50000
 5. 1      0.07000          156.60000      0.46100        0.08680          0.50000         40.00000
 5. 2      0.07000          180.60000      0.46200        0.12280          0.50000         40.00000
 5. 3      0.07000          205.00000      0.46300        0.09300          0.50000         40.00000
 5. 4      0.07000          229.90000      0.46400        0.12190          0.20000         40.00000
 6. 1      0.12000          156.30000      0.46200        0.08100          0.50000         40.40000
 6. 2      0.12000          180.20000      0.46300        0.11170          0.50000         40.40000
 6. 3      0.12000          204.90000      0.46300        0.08830          0.50000         40.40000
 6. 4      0.12000          224.60000      0.46600        0.11800          0.20000         40.40000
 7. 1      0.22000          156.00000      0.46300        0.07700          0.50000         40.70000
 7. 2      0.22000          180.10000      0.46700        0.11310          0.50000         40.70000
 7. 3      0.22000          204.50000      0.46800        0.08940          0.50000         40.70000
 7. 4      0.22000          229.30000      0.46900        0.11220          0.20000         40.70000
 8. 1      0.42000          155.80000      0.46300        0.07450          0.50000         41.20000
 8. 2      0.42000          179.70000      0.46700        0.10630          0.50000         41.20000
 8. 3      0.42000          204.20000      0.46800        0.08480          0.50000         41.20000
 8. 4      0.42000          228.90000      0.46900        0.11220          0.20000         41.20000
 9. 1      0.82000          155.50000      0.46600        0.07130          0.50000         41.80000
 9. 2      0.82000          179.50000      0.46800        0.10150          0.50000         41.80000
 9. 3      0.82000          203.70000      0.46800        0.08340          0.50000         41.80000
 9. 4      0.82000          228.40000      0.46900        0.11060          0.20000         41.80000
10. 1      1.32000          155.40000      0.46700        0.06900          0.50000         42.00000
10. 2      1.32000          179.30000      0.46900        0.09800          0.50000         42.00000
10. 3      1.32000          203.60000      0.46900        0.08130          0.50000         42.00000
10. 4      1.32000          228.30000      0.47000        0.10810          0.20000         42.00000
11. 1      2.82000          155.20000      0.46800        0.06670          0.50000         42.40000
11. 2      2.82000          177.00000      0.47000        0.09370          0.50000         42.40000
11. 3      2.82000          203.40000      0.47000        0.08010          0.50000         42.40000
11. 4      2.82000          228.10000      0.47000        0.10490          0.20000         42.40000
12. 1      5.82000          154.90000      0.46900        0.06280          0.50000         43.20000
12. 2      5.82000          178.60000      0.47000        0.08650          0.50000         43.20000
12. 3      5.82000          202.50000      0.47000        0.07640          0.50000         43.20000
12. 4      5.82000          227.30000      0.47000        0.10420          0.20000         43.20000
13. 1      12.82000         154.20000      0.46900        0.05700          0.50000         44.10000
13. 2      12.82000         178.30000      0.47000        0.08090          0.50000         44.10000
13. 3      12.82000         202.20000      0.47000        0.07250          0.50000         44.10000
13. 4      12.82000         226.60000      0.47000        0.10080          0.20000         44.10000
14. 1      27.82000         153.10000      0.46900        0.05100          0.50000         46.10000
14. 2      27.82000         176.70000      0.47000        0.06650          0.50000         46.10000
14. 3      27.82000         201.00000      0.47000        0.06440          0.50000         46.10000
14. 4      27.82000         224.70000      0.47000        0.10040          0.20000         46.10000



15. 1      47.82000         152.50000      0.47000        0.04780          0.50000         47.10000
15. 2      47.82000         176.00000      0.47000        0.06620          0.50000         47.10000
15. 3      47.82000         200.10000      0.47000        0.06280          0.50000         47.10000
15. 4      47.82000         224.40000      0.47100        0.09640          0.20000         47.10000
16. 1      77.82000         151.70000      0.47000        0.04650          0.50000         48.60000
16. 2      77.82000         175.00000      0.47000        0.06430          0.50000         48.60000
16. 3      77.82000         199.10000      0.47100        0.06060          0.50000         48.60000
16. 4      77.82000         222.90000      0.47100        0.07910          0.20000         48.60000
17. 1      117.82000        150.60000      0.47000        0.10570          0.20000         50.20000
17. 2      117.82000        174.00000      0.47100        0.06080          0.50000         50.20000
17. 3      117.82000        197.70000      0.47200        0.05760          0.50000         50.20000
17. 4      117.82000        221.80000      0.47200        0.09670          0.20000         50.20000
18. 1      177.82000        149.90000      0.47000        0.09610          0.20000         52.00000
18. 2      177.82000        173.00000      0.47100        0.13920          0.20000         52.00000
18. 3      177.82000        196.70000      0.47200        0.13200          0.20000         52.00000
18. 4      177.82000        220.60000      0.47200        0.09830          0.20000         52.00000
19. 1      277.82000        148.40000      0.47100        0.09050          0.20000         55.70000
19. 2      277.82000        171.60000      0.47200        0.12750          0.20000         55.70000
19. 3      277.82000        194.90000      0.47200        0.11980          0.20000         55.70000
19. 4      277.82000        218.70000      0.47300        0.09430          0.20000         55.70000
20. 1      477.82000        146.20000      0.47100        0.08020          0.20000         59.30000
20. 2      477.82000        169.30000      0.47200        0.11820          0.20000         59.30000
20. 3      477.82000        192.60000      0.47200        0.11940          0.20000         59.30000
20. 4      477.82000        216.20000      0.47400        0.09670          0.20000         59.30000
21. 1      927.82000        143.30000      0.47200        0.06780          0.20000         65.10000
21. 2      927.82000        165.80000      0.47300        0.10050          0.20000         65.10000
21. 3      927.82000        198.50000      0.47300        0.10730          0.20000         65.10000
21. 4      927.82000        211.90000      0.47600        0.10880          0.20000         65.10000
22. 1      1927.82000       137.10000      0.45900        0.04730          0.20000         74.40000
22. 2      1927.82000       160.20000      0.47500        0.06930          0.20000         74.40000
22. 3      1927.82000       182.50000      0.47700        0.07830          0.20000         74.40000
22. 4      1927.82000       205.30000      0.47800        0.05750          0.20000         74.40000
```

```
                                   TABLE OF RESULTS FOR  1  POSITION

          CALCULATED WAVENUMBER= 32.51607  RECIP. CM.  WAVELENGTH=0.19323  CM.  INITIAL FREQUENCY =  157.50  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2      REAL ELS.  IMAG. ELAS.

  1. 1 -10.00000    0.72005    32.51607    1.00000    50.20000    0.12320    0.95103    0.02214    -0.00016   -0.00005
  2. 1  -9.92386    0.71023    32.51700    0.99937    50.13204    0.12275    0.95103    0.02184    -0.08388    0.63453
  3. 1  -9.32180    0.71352    32.51977    0.99746    49.99613    0.12140    0.94974    0.02194    -1.12708    0.59752
  4. 1  -9.02077    0.73115    32.52250    0.99556    49.82623    0.12005    0.94911    0.02248    -2.01516   -1.49588
  5. 1  -8.77773    0.72667    32.52430    0.99429    49.65634    0.11917    0.94977    0.02234    -1.04571   -0.61433
  6. 1  -8.54365    0.74422    32.52697    0.99238    49.52042    0.11784    0.94850    0.02288    -2.49842   -4.42815
  7. 1  -8.28041    0.75297    32.52960    0.99048    49.41848    0.11653    0.94658    0.02315   -21.70729  -25.54775
  8. 1  -7.99958    0.76381    32.53134    0.98921    49.24859    0.11567    0.94726    0.02348     6.05978  -14.80077
  9. 1  -7.70902    0.77524    32.53351    0.98730    49.04471    0.11438    0.94731    0.02383    10.09662   -7.57764
 10. 1  -7.50226    0.78434    32.53476    0.98667    48.97676    0.11396    0.94733    0.02411     9.93366   -3.88592
 11. 1  -7.17258    0.79268    32.53644    0.98540    48.84084    0.11311    0.94738    0.02436     9.14663   -1.97422
 12. 1  -6.85791    0.80762    32.53854    0.98349    48.56901    0.11185    0.94878    0.02482     6.45470   -0.72723
 13. 1  -6.51494    0.82829    32.54461    0.97905    48.26320    0.10998    0.94569    0.02545     7.41315    2.23004
 14. 1  -6.17847    0.84893    32.55307    0.97206    47.58362    0.10466    0.94482    0.02608     6.47740    2.73097
 15. 1  -5.94322    0.86211    32.55744    0.96825    47.24383    0.10241    0.94379    0.02649     5.99257    3.05556
 16. 1  -5.73174    0.86184    32.56300    0.96317    46.73414    0.09953    0.94362    0.02647     5.02606    3.07973
 17. 1  -5.55161    0.87798    32.57012    0.95619    46.19048    0.09582    0.94031    0.02696     5.72103    3.56840
 18. 1  -5.37285    0.89858    32.57491    0.95111    45.57885    0.09332    0.94242    0.02759     5.16183    3.17999
 19. 1  -5.17907    0.90403    32.58248    0.94222    44.32163    0.08935    0.95046    0.02775     4.49203    1.61522
 20. 1  -4.94357    0.92186    32.59228    0.92825    43.09838    0.08417    0.94781    0.02828     4.02742    1.95151
 21. 1  -4.65537    0.95346    32.60139    0.90989    41.12760    0.07913    0.95342    0.02925     3.75124    1.71411
 22. 1  -4.33776    1.01369    32.60915    0.87048    37.96755    0.06979    0.94466    0.03109     3.85059    2.24922
```

```
                                   TABLE OF RESULTS FOR  2  POSITION

          CALCULATED WAVENUMBER= 35.79520  RECIP. CM.  WAVELENGTH=0.17553  CM.  INITIAL FREQUENCY =  181.70  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2      REAL ELS.  IMAG. ELAS.

  1. 2 -10.00000    0.81428    35.79520    1.00000    50.20000    0.23896    0.94878    0.02275    -0.00017   -0.00005
  2. 2  -9.92386    0.80869    35.79960    0.99835    50.13204    0.23779    0.94658    0.02259    -2.25611    0.59337
  3. 2  -9.32180    0.81319    35.80252    0.99725    49.99613    0.23699    0.94683    0.02271    -2.01425    0.38970
  4. 2  -9.02077    0.82160    35.80689    0.99560    49.82623    0.23578    0.94657    0.02295    -2.52349   -0.75575
  5. 2  -8.77773    0.83015    35.81124    0.99395    49.65634    0.23454    0.94631    0.02318    -2.58879   -2.09631
  6. 2  -8.54365    0.85631    35.81702    0.99174    49.52042    0.23285    0.94426    0.02391     2.27183  -39.74791
  7. 2  -8.28041    0.85465    35.81845    0.99119    49.41848    0.23262    0.94504    0.02386    -1.83230  -14.67812
  8. 2  -7.99958    0.87055    35.82419    0.98899    49.24859    0.23069    0.94364    0.02430    25.51210   -3.45919
  9. 2  -7.70502    0.88239    35.82704    0.98789    49.04471    0.22981    0.94523    0.02463     9.71244   -5.14361
 10. 2  -7.50226    0.89327    35.82985    0.98679    48.97676    0.22892    0.94421    0.02493    11.44357   -0.36710
 11. 2  -7.17258    0.91526    35.83414    0.98514    48.84084    0.22758    0.94333    0.02526    10.25744    1.99627
 12. 2  -6.85791    0.92625    35.83579    0.98294    48.56901    0.22576    0.94393    0.02584     7.99299    1.61257
 13. 2  -6.51494    0.94218    35.84820    0.97964    48.26320    0.22300    0.94289    0.02628     7.26513    2.59848
 14. 2  -6.17847    0.99124    35.86620    0.97248    47.58362    0.21688    0.94101    0.02764     5.77076    3.15267
 15. 2  -5.94322    0.99801    35.87576    0.96963    47.24383    0.21352    0.93953    0.02754     5.63429    3.49913
 16. 2  -5.73174    0.99991    35.88928    0.96313    46.73414    0.20968    0.93795    0.02758     5.39739    3.75596
 17. 2  -5.55161    0.99985    35.90282    0.95742    46.19048    0.20380    0.93713    0.02785     5.17192    3.74372
 18. 2  -5.37285    1.01839    35.91579    0.95212    45.57885    0.19888    0.93779    0.02836     5.07022    3.44154
 19. 2  -5.17907    1.03432    35.93395    0.94441    44.32163    0.19198    0.94741    0.02878     4.59056    1.82763
 20. 2  -4.94357    1.03858    35.95304    0.93176    43.09838    0.18060    0.94606    0.02888     4.67863    1.84546
 21. 2  -4.65537    1.05705    36.00540    0.91249    41.12760    0.16325    0.94747    0.02936     4.25475    1.66426
 22. 2  -4.33776    1.11307    36.06726    0.88157    37.96755    0.13583    0.95325    0.03086     3.38619    1.69576
```

```
                                   TABLE OF RESULTS FOR  3  POSITION

          CALCULATED WAVENUMBER= 39.03369  RECIP. CM.  WAVELENGTH=0.16057  CM.  INITIAL FREQUENCY =  206.70  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2      REAL ELS.  IMAG. ELAS.

  1. 3 -10.00000    0.90985    39.03369    1.00000    50.20000    0.28444    0.94687    0.02331    -0.00017   -0.00005
  2. 3  -9.92386    0.91281    39.03987    0.99855    50.13204    0.28219    0.94496    0.02338    -2.09646   -0.45361
  3. 3  -9.32180    0.92611    39.04811    0.99661    49.99613    0.27981    0.94326    0.02372    -7.19030   -1.82493
  4. 3  -9.02077    0.93330    39.05839    0.99419    49.82623    0.27764    0.94114    0.02390   -12.59371   14.51555
  5. 3  -8.77773    0.94126    39.06864    0.99178    49.65634    0.27583    0.93903    0.02409     2.61198   13.57504
  6. 3  -8.54365    0.95705    39.07069    0.99129    49.52042    0.27645    0.94054    0.02450    14.31956   26.38942
  7. 3  -8.28041    0.95904    39.07887    0.98936    49.41849    0.27880    0.93827    0.02454     6.04160   11.06600
  8. 3  -7.99958    0.97613    39.08458    0.98791    49.24859    0.28041    0.93826    0.02497     7.97756    9.34167
  9. 3  -7.70902    0.98347    39.09515    0.98549    49.04471    0.28282    0.93682    0.02516     6.45658    7.69973
 10. 3  -7.50226    0.99199    39.09718    0.98500    48.97676    0.28326    0.93705    0.02537     6.93600    7.24751
 11. 3  -7.17258    0.99781    39.10124    0.98403    48.84084    0.28409    0.93752    0.02552     7.53949    6.95882
 12. 3  -6.85791    1.01351    39.11134    0.98162    48.56901    0.28596    0.93741    0.02591     7.39278    5.93138
 13. 3  -6.51494    1.03090    39.12541    0.97823    48.26320    0.28803    0.93584    0.02635     6.24923    5.34160
 14. 3  -6.17847    1.06764    39.14932    0.97242    47.58362    0.29019    0.93626    0.02727     5.05337    4.31948
 15. 3  -5.94322    1.07552    39.16704    0.96807    47.24383    0.29073    0.93330    0.02746     5.24019    4.50668
 16. 3  -5.73174    1.08614    39.18651    0.96323    46.73414    0.29033    0.93268    0.02772     5.07715    4.38558
 17. 3  -5.55161    1.09981    39.20954    0.95743    46.19048    0.28859    0.93067    0.02805     4.70206    4.28015
 18. 3  -5.37285    1.12215    39.23219    0.95162    45.57885    0.28559    0.93015    0.02860     4.58428    4.07727
 19. 3  -5.17907    1.14396    39.26542    0.94291    44.32163    0.27932    0.93672    0.02913     5.25924    3.25007
 20. 3  -4.94357    1.14010    39.30652    0.93179    43.09838    0.27473    0.93776    0.02901     5.65093    2.96676
 21. 3  -4.65537    1.14857    39.37601    0.91195    41.12760    0.25362    0.93633    0.02917     5.33295    3.09741
 22. 3  -4.33776    1.22915    39.46961    0.89292    37.96755    0.24192    0.94397    0.03114     4.07282    1.75361
```

```
                         TABLE OF RESULTS FOR  4  POSITION

      CALCULATED WAVENUMBER= 42.12021  RECIP. CM.  WAVELENGTH=0.14917  CM.  INITIAL FREQUENCY =  231.50  HZ.

ID .K  INDEP. VAR.  CMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL FIS.  IMAG. ELAS.

 1. 4 -10.00000     1.00313    42.12021    1.00000    50.20000     0.15511    0.94528    0.02382    -0.00017    -0.00005
 2. 4  -9.92386     1.00513    42.12099    0.99957    50.13204     0.15582    0.94565    0.02386     0.33193     0.03703
 3. 4  -9.32180     1.02624    42.12507    0.99741    49.99613     0.15938    0.94390    0.02436    -0.69748    -2.21759
 4. 4  -9.02077     1.03310    42.13017    0.99492    49.82623     0.16369    0.94185    0.02452    -6.06873    -6.22831
 5. 4  -8.77773     1.04338    42.13379    0.99309    49.65634     0.16660    0.94155    0.02476    -5.43427   -11.65651
 6. 4  -8.54365     1.05769    42.13661    0.99179    49.52042     0.16880    0.94149    0.02510     3.87138   -14.47667
 7. 4  -8.29041     1.07805    42.13951    0.99050    49.41848     0.17100    0.94077    0.02558    14.55762    -5.25391
 8. 4  -7.99958     1.08306    42.14352    0.98877    49.24859     0.17396    0.94046    0.02570    15.15105    -3.34200
 9. 4  -7.70902     1.09342    42.14874    0.98661    49.04471     0.17768    0.93989    0.02574    13.77885     0.56026
10. 4  -7.50226     1.10194    42.14981    0.98618    48.97676     0.17843    0.94030    0.02614    11.55939    -0.23192
11. 4  -7.17258     1.11314    42.15158    0.98531    48.84094     0.17993    0.94112    0.02641     9.20339    -0.45777
12. 4  -6.95791     1.12470    42.16105    0.98186    48.56901     0.18595    0.93916    0.02668     9.49154     2.64667
13. 4  -6.51494     1.14259    42.16945    0.97883    48.26320     0.19126    0.93973    0.02710     8.27704     2.96159
14. 4  -6.17847     1.16284    42.19168    0.97149    47.59362     0.20420    0.93643    0.02756     7.00222     4.03660
15. 4  -5.94322     1.19069    42.19868    0.96933    47.24393     0.20799    0.93851    0.02798     6.84520     2.94358
16. 4  -5.73174     1.18804    42.22089    0.96285    46.73414     0.21927    0.93462    0.02814     6.08342     4.11051
17. 4  -5.55161     1.20638    42.23825    0.95810    46.19048     0.22737    0.93516    0.02856     5.96135     3.73871
18. 4  -5.37285     1.21236    42.25813    0.95292    45.57895     0.23591    0.93616    0.02869     5.05376     3.39414
19. 4  -5.17707     1.24036    42.29144    0.94471    44.32163     0.24850    0.94397    0.02933     4.84576     1.53171
20. 4  -4.94357     1.24794    42.33819    0.93391    43.05838     0.26108    0.94556    0.02948     4.41176     1.37994
21. 4  -4.65537     1.26177    42.42357    0.91533    41.12760     0.30982    0.94611    0.02975     4.07864     1.30174
22. 4  -4.23776     1.41919    42.55951    0.88683    37.96755     0.27691    0.95281    0.03315     3.36462     1.36517


      THE DATA USED FOR EVALUATING THE POLYNOMIALS IN SUBROUTINES AMPLTD AND PHSCCP FOLLOW--

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 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0                    ,
 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0                    ,
 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0                    ,
 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0                    ,
 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0                    ,
 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0                    ,
 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0                    ,
 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0                    ,
 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0                    ,
 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0                    ,
 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0                    ,
 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0                    ,
 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0                    ,
 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0                    ,
 0.0                    , 0.0                    , 0.0                    , 0.0                    , 0.0
&END
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                         ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA SOLUBLE IONIC SURFACTANTS - LIA (NO FILTERS) FEB 1969  RLB

EXPERIMENTS PERFORMED AT THE .01 M SODIUM SULFATE (FRESH 4X H2O)     /FRESHLY DISTILLED N HEPTANE              INTERFACE,

THE SYSTEM UNDER INVESTIGATION IS NAC14SO3 - SODIUM TETRADECYL SULFONATE (1X FROM DIST. ABS. ETHANOL) ETOH 2/6/69

                                             SYSTEM PARAMETERS

                   LOWER PHASE DENSITY  0.9980 G/ML         UPPER PHASE DENSITY  0.6780 G/ML
                             VISCOSITY  0.00896 POISES                VISCOSITY  0.00386 POISES

                                      INITIAL VALUES ASSUMED IN CALCULATION

                   REAL ELASTICITY (EP)    0.0             IMAGINARY ELASTICITY (EPP)   0.0
                   WAVENUMBER  31.00000 RECIPROCAL  CM     DAMPING COEFFICIENT   0.70000 CM
                   REFERENCE METER SCALE    1.00 MV.       INTERFACIAL TENSION 50.2000 DYNES/CM
                   REFERENCE INPUT VTG.  0.100 VT.

                                             PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.69936 CM. BASED ON RFSGN= 0.16370 RFSFN= 5.10260 DISTGN= 6.11362 DISTFN= 2.41427

                                      CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY     AMP. COEF.     WAVE NO.      WAVELENGTH      NO. WAVES   PHS.COR.WAVE NO. PR. SCL.FCTR.
    1         157.90     0.72161875    32.57157525    0.19290379    19.17720389    32.57157528     1.07113026
    2         180.80     0.81080273    35.67595058    0.17611808    21.00497051    35.67595058     1.04729118
    3         204.60     0.90199579    38.76685217    0.16207609    22.82480417    38.76685217     0.99117381
                                           INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE IS THE LOGARITHM OF THE BULK PHASE SURFACTANT CONCENTRATION (MOLES/L).
INPUT PARAMETERS ARE- WT. OF SURFACTANT =  43.80000 MG.  MOLECULAR WT. =, 304.00000 G.
MAKE-UP VOL. =    0.02500 L. TOTAL SOLUTION VOLUME =    0.49500 L
SURFACTANT SOLUTION IS ADDED TO BULK PHASE AND MIXED. THE VOLUME ADDED IN MICROLITERS IS READ IN.

                                            INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=      0.980 WEIGHT OF PLATE=      34.30MG.  WEIGHT OF WEIGHT=     171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.86461 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                         INPUT DATA

ID .K       INDEP. VAR.     FRECUENCY      INPUT VOLT.    OUTPUT VOLT.    METER SCALE     SFTN. VAR.

 1. 1       0.0             157.90000      0.52000        0.09650         0.50000         39.40000
 1. 2       0.0             180.80000      0.52000        0.13380         0.50000         39.40000
 1. 3       0.0             204.60000      0.52000        0.10200         0.50000         39.40000
 2. 1       0.00500         157.80000      0.52000        0.09830         0.50000         39.40000
 2. 2       0.00500         180.90000      0.52000        0.13270         0.50000         39.40000
 2. 3       0.00500         204.60000      0.52000        0.10220         0.50000         39.40000
 3. 1       0.02500         157.60000      0.52000        0.09500         0.50000         39.50000
 3. 2       0.02500         180.40000      0.52000        0.12600         0.50000         39.50000
 3. 3       0.02500         204.40000      0.52000        0.09740         0.50000         39.50000
 4. 1       0.05000         157.30000      0.52000        0.09390         0.50000         39.80000
 4. 2       0.05000         190.30000      0.52000        0.12790         0.50000         39.80000
 4. 3       0.05000         204.30000      0.52000        0.09750         0.50000         39.80000
 5. 1       0.10000         157.30000      0.52000        0.09040         0.50000         39.90000
 5. 2       0.10000         190.10000      0.52000        0.12090         0.50000         39.90000
 5. 3       0.10000         203.90000      0.52000        0.09060         0.50000         39.90000
 6. 1       0.25000         157.10000      0.52000        0.09180         0.50000         40.20000
 6. 2       0.25000         179.90000      0.52000        0.12120         0.50000         40.20000
 6. 3       0.25000         203.70000      0.52000        0.09030         0.50000         40.20000
 7. 1       0.50000         156.80000      0.52000        0.08660         0.50000         41.10000
 7. 2       0.50000         179.50000      0.52000        0.11630         0.50000         41.10000
 7. 3       0.50000         203.20000      0.52000        0.08650         0.50000         41.10000
 8. 1       1.00000         156.10000      0.51900        0.07890         0.50000         42.60000
 8. 2       1.00000         178.70000      0.52000        0.10440         0.50000         42.60000
 8. 3       1.00000         202.30000      0.52000        0.07790         0.50000         42.60000
 9. 1       2.00000         155.60000      0.51900        0.05900         0.50000         45.40000
 9. 2       2.00000         177.20000      0.52000        0.07810         0.50000         45.40000
 9. 3       2.00000         200.40000      0.52000        0.06010         0.50000         45.40000
10. 1       3.00000         153.00000      0.51900        0.05160         0.50000         47.80000
10. 2       3.00000         175.60000      0.52000        0.06850         0.50000         47.80000
10. 3       3.00000         199.70000      0.52000        0.04960         0.50000         47.80000
11. 1       4.50000         151.90000      0.51900        0.11290         0.20000         49.70000
11. 2       4.50000         174.30000      0.51500        0.06230         0.50000         49.70000
11. 3       4.50000         197.40000      0.51900        0.11480         0.20000         49.70000
12. 1       6.50000         151.60000      0.51900        0.11640         0.20000         50.30000
12. 2       6.50000         173.80000      0.52000        0.06310         0.50000         50.30000
12. 3       6.50000         196.90000      0.52000        0.11090         0.20000         50.30000
13. 1       11.50000        149.50000      0.51800        0.10740         0.20000         53.20000
13. 2       11.50000        172.10000      0.51500        0.13600         0.20000         53.20000
13. 3       11.50000        194.90000      0.52000        0.11150         0.20000         53.20000
14. 1       21.50000        150.20000      0.51800        0.09690         0.20000         53.30000
14. 2       21.50000        171.70000      0.51900        0.12000         0.20000         53.30000
14. 3       21.50000        194.50000      0.51900        0.09570         0.20000         53.30000
15. 1       41.50000        147.20000      0.51700        0.07900         0.20000         58.00000
15. 2       41.50000        169.20000      0.51800        0.11060         0.20000         58.00000
15. 3       41.50000        191.60000      0.51900        0.09220         0.20000         58.00000
16. 1       91.50000        144.50000      0.51900        0.06690         0.20000         65.60000
16. 2       91.50000        166.10000      0.52000        0.09420         0.20000         65.60000
16. 3       91.50000        187.50000      0.52000        0.07720         0.20000         65.60000
17. 1       271.50000       137.10000      0.50000        0.04480         0.20000         77.00000
17. 2       271.50000       158.70000      0.51900        0.06250         0.20000         77.00000
17. 3       271.50000       179.70000      0.52000        0.06630         0.20000         77.00000


                                   TABLE OF RESULTS FOR  1  POSITION

          CALCULATED WAVENUMBER= 32.57158  RECIP. CM.  WAVELENGTH=0.19290  CM.  INITIAL FREQUENCY =  157.90  HZ.

ID .K  INDEP. VAR.   DMP. COEF.  WAVE NC.     REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2        REAL ELS.  IMAG. ELAS.

 1. 1 -10.00000     0.72162    32.57158    1.00000    50.20000     0.12503    0.95099    0.02215    -0.99916   -1.99005
 2. 1 -10.23457     0.71563    32.57245    0.99917    50.20000     0.12457    0.94971    0.02197    -1.17806    0.38683
 3. 1  -9.53600     0.72287    32.57415    0.99810    50.16579     0.12366    0.94780    0.02219    -4.35133    0.67487
 4. 1  -9.23457     0.72393    32.57678    0.99620    50.06316     0.12230    0.94591    0.02219    -5.89897    5.79531
 5. 1  -8.93354     0.72330    32.57678    0.99620    50.02895     0.12230    0.94655    0.02251    -9.09397    2.75726
 6. 1  -8.53600     0.72714    32.57948    0.99493    49.92632     0.12140    0.94594    0.02232    -7.04246    5.92179
 7. 1  -8.23457     0.73990    32.58101    0.99303    49.61842     0.12005    0.94796    0.02271    -4.84416   -3.29475
 8. 1  -7.93394     0.75752    32.58675    0.98860    49.10526     0.11697    0.94883    0.02325     0.44673   -5.09939
 9. 1  -7.63291     0.82997    32.59853    0.97910    48.14737     0.11061    0.94817    0.02519     6.68073    3.15423
10. 1  -7.45682     0.84126    32.61003    0.96897    47.32631     0.10428    0.94376    0.02580     6.82769    3.79653
11. 1  -7.28073     0.86685    32.61728    0.96200    46.67631     0.10023    0.94756    0.02658     5.81482    3.36578
12. 1  -7.12103     0.85550    32.61917    0.96010    46.47105     0.09918    0.94282    0.02623     6.20096    3.43145
13. 1  -6.87325     0.87404    32.62904    0.94934    45.47894     0.09363    0.94105    0.02679     5.47389    3.59633
14. 1  -6.69151     0.89190    32.62740    0.95123    45.44473     0.09455    0.94557    0.02734     5.35185    2.33292
15. 1  -6.31550     0.92193    32.64185    0.93274    43.83683     0.08637    0.94034    0.02824     4.73918    3.17774
16. 1  -5.97252     0.95089    32.65107    0.91514    41.23683     0.08100    0.96748    0.02912     3.17926    1.83113
17. 1  -5.50017     1.00851    32.66132    0.86927    37.33682     0.06975    0.95603    0.03088     3.24699    1.73701
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                                      TABLE OF RESULTS FCR  2  POSITION

            CALCULATED WAVENUMBER= 35.67595  RECIP. CM.  WAVELENGTH=0.17612  CM.  INITIAL FREQUENCY =  180.80  HZ.

ID .K  INDEP. VAR.   DMP. COEF.  WAVE NO.     REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

 1. 2 -10.00000      0.81080     35.67595     1.00000     50.20000     0.23537     0.94885     0.02273    -0.00017    -0.00005
 2. 2 -10.23457      0.81351     35.67460     1.00055     50.20000     0.23578     0.95001     0.02280     0.79549     0.17577
 3. 2  -9.53600      0.82512     35.68132     0.99779     50.16579     0.23370     0.94488     0.02312    -0.34944    -0.60247
 4. 2  -9.23457      0.82079     35.69265     0.99723     50.06316     0.23327     0.94566     0.02300    -5.21735    -1.00006
 5. 2  -8.93394      0.83503     35.68532     0.99613     50.02895     0.23242     0.94400     0.02340   -22.66140     4.53653
 6. 2  -8.53600      0.83313     35.68758     0.99502     49.92632     0.23156     0.94363     0.02334   -17.69028    11.11415
 7. 2  -8.23457      0.84223     35.69328     0.99281     49.61842     0.22981     0.94484     0.02360   -11.07167   -11.72408
 8. 2  -7.93394      0.86716     35.70378     0.98838     49.10526     0.22622     0.94539     0.02429     7.15795     3.02520
 9. 2  -7.63291      0.93716     35.72318     0.95009     48.14737     0.21925     0.94654     0.02623     6.09338     0.73431
10. 2  -7.45682      0.96300     35.74346     0.97124     47.32631     0.21159     0.94404     0.02694     6.24715     2.05192
11. 2  -7.28073      0.97733     35.75963     0.96405     46.67631     0.20526     0.94179     0.02733     6.00296     2.89942
12. 2  -7.12103      0.97374     35.76577     0.96128     46.47105     0.20282     0.94004     0.02723     5.93772     3.45466
13. 2  -6.87325      1.00194     35.78638     0.95188     45.47894     0.19445     0.94022     0.02800     5.45516     3.12745
14. 2  -6.60151      1.03302     35.79116     0.94967     45.44473     0.19247     0.93619     0.02896     4.73089     3.57206
15. 2  -6.31590      1.03659     35.82046     0.93584     43.83683     0.18010     0.94016     0.02894     4.97712     2.99540
16. 2  -5.97252      1.05690     35.85525     0.91869     41.23693     0.16474     0.96034     0.02948     3.20889     1.43535
17. 2  -5.50017      1.10062     35.92981     0.87777     37.33682     0.12873     0.96224     0.03063     2.32713     1.83719


                                      TABLE OF RESULTS FCR  3  POSITION

            CALCULATED WAVENUMBER= 38.76685  RECIP. CM.  WAVELENGTH=0.16208  CM.  INITIAL FREQUENCY =  204.60  HZ.

ID .K  INDEP. VAR.   DMP. COEF.  WAVE NO.     REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

 1. 3 -10.00000      0.90199     38.76685     1.00000     50.20000     0.27824     0.94702     0.02326    -0.00017    -0.00005
 2. 3 -10.23457      0.90136     38.76685     1.00000     50.20000     0.27824     0.94702     0.02325    -0.00841     0.02570
 3. 3  -9.53600      0.91544     38.77064     0.99932     50.16579     0.27935     0.94554     0.02361    -1.27399    -1.40569
 4. 3  -9.23497      0.91568     38.77253     0.99853     50.06316     0.27989     0.94641     0.02362    -0.17778    -1.05495
 5. 3  -8.93394      0.93746     38.78007     0.99658     50.02895     0.28190     0.94780     0.02417   -13.49754   -19.02757
 6. 3  -8.53600      0.93923     38.78384     0.99560     49.92632     0.28282     0.94261     0.02422   -16.95535   -24.45822
 7. 3  -8.23497      0.95292     38.79323     0.99316     49.61842     0.28488     0.94313     0.02456     5.89015   -15.82877
 8. 3  -7.93394      0.98386     38.81002     0.98876     49.10526     0.28777     0.94333     0.02535     0.53098    -3.35563
 9. 3  -7.63291      1.05667     38.84500     0.97947     48.14737     0.29065     0.94157     0.02720     5.30540     2.36309
10. 3  -7.45682      1.10862     38.85770     0.97605     47.32631     0.29069     0.95025     0.02853     4.34430     1.66027
11. 3  -7.28073      1.12594     38.89663     0.96481     46.67631     0.28748     0.93849     0.02895     5.37329     3.15750
12. 3  -7.12103      1.13491     38.90736     0.96237     46.47105     0.28617     0.93723     0.02917     5.20089     3.31459
13. 3  -6.97325      1.12655     38.94163     0.95259     45.47894     0.27932     0.93585     0.02833     5.19167     3.51500
14. 3  -6.60151      1.16734     38.94835     0.95064     45.44473     0.27932     0.93223     0.02997     4.57777     3.50242
15. 3  -6.31590      1.14402     38.99584     0.93646     43.83693     0.26582     0.93439     0.02985     4.75545     3.38273
16. 3  -5.97252      1.19743     39.05318     0.91838     41.23693     0.25137     0.95111     0.03066     3.73102     1.78662
17. 3  -5.50017      1.22364     39.16869     0.87830     37.33682     0.23065     0.95230     0.03124     3.30969     1.53676


                         ANALYSIS OF EXPERIMENTAL DATA FCR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE IONIC SURFACTANTS - LIA (NO FILTERS)  FEB 1968  KLB

EXPERIMENTS PERFORMED AT THE .01 M SODIUM CHLORIDE (FRESH 4X H2O)    /FRESHLY DISTILLED N HEPTANE              INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS C18NH3CL - OCTADECYL AMMONIUM CHLORIDE (IX FROM DIST. ABS. ETHANOL) FROM 2/15/68

                                              SYSTEM PARAMETERS

                 LOWER PHASE DENSITY  0.9980 G/ML          UPPER PHASE DENSITY  0.6780 G/ML
                          VISCOSITY  0.00896 POISES                   VISCOSITY  0.00386 POISES

                                     INITIAL VALUES ASSUMED IN CALCULATION

                 REAL ELASTICITY (EP)    0.0               IMAGINARY ELASTICITY (EPP)    0.0
                 WAVENUMBER  31.00000 RECIPROCAL  CM       DAMPING COEFFICIENT    0.70000 CM
                 REFERENCE METER SCALE    1.00 MV.         INTERFACIAL TENSION 50.2000 DYNES/CM
                 REFERENCE INPUT VTG.  0.100 VT.

                                              PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 4.15873 CM. BASED ON RESGN= 0.26040 RESFN= 5.81490 DISTGN= 6.04147 DISTFN= 1.88274

                                     CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY      DMP. COFF.       WAVE NO.        WAVELENGTH       NO. WAVES    PHS.COR.WANO  GN. PR. SCL.FCTR.
    1          161.70      0.73653302     33.09656262      0.18984388     21.90602956     33.09656262      1.03642897
    2          182.30      0.81658906     35.87458724      0.17514292     23.74475494     35.87458724      1.11137164
    3          202.80      0.85504917     38.53741185      0.16304105     25.50723146     38.53741185      1.05100334

                                              INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT = 568.00000  MG.  MOLECULAR WT.= 307.00000 MAKE-UP VOLUME=0.0250 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                              INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=      0.980 WEIGHT OF PLATE=      34.30MG.  WEIGHT OF WEIGHT=     171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.85154 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                             INPUT DATA

ID .K     INDEP. VAR.    FREQUENCY     INPUT VOLT.    OUTPUT VOLT.   METER SCALE    SETN. VAR.


 1. 1      0.0          161.70000      0.51000        0.07070        0.50000        38.00000
 1. 2      0.0          182.20000      0.51100        0.09180        0.50000        38.00000
 1. 3      0.0          202.80000      0.51200        0.07450        0.50000        38.00000
 2. 1      0.20000      161.30000      0.51000        0.07170        0.50000        38.35000
 2. 2      0.20000      181.70000      0.51100        0.09440        0.50000        38.35000
 2. 3      0.20000      202.40000      0.51200        0.07740        0.50000        38.35000
 3. 1      0.30000      160.60000      0.51100        0.07060        0.50000        39.40000
 3. 2      0.30000      181.10000      0.51200        0.08760        0.50000        39.20000
 3. 3      0.30000      201.90000      0.51200        0.07600        0.50000        38.50000
 4. 1      0.50000      160.50000      0.51100        0.07000        0.50000        39.30000
 4. 2      0.50000      181.10000      0.51100        0.08870        0.50000        39.20000
 4. 3      0.50000      201.80000      0.51200        0.07440        0.50000        39.10000
 5. 1      0.80000      160.40000      0.51000        0.06580        0.50000        39.60000
 5. 2      0.80000      180.90000      0.51100        0.08630        0.50000        39.30000
 5. 3      0.80000      201.60000      0.51200        0.07390        0.50000        39.20000
 6. 1      2.20000      160.00000      0.51000        0.06000        0.50000        40.50000
 6. 2      2.20000      180.30000      0.51100        0.07630        0.50000        40.20000
 6. 3      2.20000      201.20000      0.51100        0.06550        0.50000        40.10000
 7. 1      3.20000      159.70000      0.51000        0.05770        0.50000        41.00000
 7. 2      3.20000      180.20000      0.51100        0.07520        0.50000        40.70000
 7. 3      3.20000      200.80000      0.51100        0.06370        0.50000        40.60000
 8. 1      5.20000      159.90000      0.51000        0.05800        0.50000        40.80000
 8. 2      5.20000      180.10000      0.51100        0.07380        0.50000        40.70000
 8. 3      5.20000      200.80000      0.51100        0.06430        0.50000        40.70000
 9. 1      9.20000      158.60000      0.51000        0.04700        0.50000        43.10000
 9. 2      9.20000      178.50000      0.51100        0.05970        0.50000        42.70000
 9. 3      9.20000      199.70000      0.51100        0.05270        0.50000        42.60000
10. 1     13.20000      159.00000      0.51000        0.12400        0.20000        42.50000
10. 2     13.20000      179.00000      0.51000        0.06070        0.50000        42.50000
10. 3     13.20000      199.60000      0.51000        0.13070        0.20000        42.50000
11. 1     19.20000      158.30000      0.51000        0.11110        0.20000        43.60000
11. 2     19.20000      178.70000      0.51000        0.05650        0.50000        43.50000
11. 3     19.20000      199.20000      0.51000        0.12320        0.20000        43.40000
12. 1     25.20000      156.90000      0.51000        0.08920        0.20000        46.00000
12. 2     25.20000      177.10000      0.51100        0.11550        0.20000        45.60000
12. 3     25.20000      197.90000      0.51000        0.11100        0.20000        45.40000
13. 1     31.20000      157.90000      0.51000        0.10200        0.20000        44.50000
13. 2     31.20000      177.90000      0.51000        0.12940        0.20000        44.50000
13. 3     31.20000      198.40000      0.51000        0.11460        0.20000        44.40000
14. 1     39.20000      157.20000      0.50900        0.09830        0.20000        46.00000
14. 2     39.20000      177.20000      0.51000        0.12400        0.20000        46.00000
14. 3     39.20000      157.40000      0.51000        0.11480        0.20000        46.00000
15. 1     47.20000      156.00000      0.50800        0.07880        0.20000        47.80000
15. 2     47.20000      176.90000      0.50900        0.10030        0.20000        47.70000
15. 3     47.20000      196.30000      0.51000        0.09060        0.20000        47.70000
16. 1     55.20000      155.90000      0.50900        0.07640        0.20000        48.40000
16. 2     55.20000      175.70000      0.50900        0.09760        0.20000        48.40000
16. 3     55.20000      195.90000      0.51000        0.10000        0.20000        48.40000
17. 1     65.20000      155.10000      0.50900        0.06970        0.20000        49.50000
17. 2     65.20000      174.90000      0.50900        0.09060        0.20000        49.50000
17. 3     65.20000      195.20000      0.51000        0.09550        0.20000        49.50000
18. 1     81.20000      153.40000      0.50800        0.06240        0.20000        52.20000
18. 2     81.20000      173.20000      0.50900        0.08130        0.20000        52.20000
18. 3     81.20000      193.20000      0.50900        0.07590        0.20000        52.20000
19. 1     91.20000      154.30000      0.50800        0.06510        0.20000        51.00000
19. 2     91.20000      174.00000      0.50800        0.09450        0.20000        51.00000



19. 3     91.20000      194.00000      0.50800        0.08120        0.20000        51.00000
20. 1    101.20000      153.10000      0.50700        0.06060        0.20000        53.00000
20. 2    101.20000      172.60000      0.50800        0.07780        0.20000        53.00000
20. 3    101.20000      192.60000      0.50800        0.07540        0.20000        52.90000
21. 1    111.20000      150.60000      0.50700        0.05220        0.20000        57.20000
21. 2    111.20000      170.20000      0.50700        0.06520        0.20000        56.90000
21. 3    111.20000      190.30000      0.50700        0.06870        0.20000        56.60000
22. 1    121.20000      150.30000      0.50600        0.05180        0.20000        57.70000
22. 2    121.20000      170.00000      0.50600        0.07060        0.20000        57.50000
22. 3    121.20000      189.80000      0.50700        0.06970        0.20000        57.40000
23. 1    141.20000      148.60000      0.50600        0.04870        0.20000        60.70000
23. 2    141.20000      168.20000      0.50800        0.06480        0.20000        60.30000
23. 3    141.20000      187.80000      0.50800        0.06520        0.20000        60.00000
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                                    TABLE OF RESULTS FOR  1  POSITION

        CALCULATED WAVENUMBER= 33.09656  RECIP. CM.  WAVELENGTH=0.18984  CM.  INITIAL FREQUENCY =  161.70  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. EQ.  INTERF. TENS. GEN. AMPL.     Y1           Y2       REAL ELS.   IMAG. ELAS.

 1. 1     0.0       0.73653    33.09656    1.00000    50.20000     0.14307     0.95061     0.02225    -0.00016    -0.00005
 2. 1     0.61672   0.72987    33.10008    0.99753    50.08139     0.14112     0.94785     0.02205    -2.81971     1.19798
 3. 1     0.92508   0.72823    33.10613    0.99320    49.72558     0.13774     0.94584     0.02200    -3.74101     4.22723
 4. 1     1.54180   0.72944    33.10698    0.99258    49.75947     0.13726     0.94395     0.02203    -2.13470     7.28963
 5. 1     2.46688   0.72881    33.10783    0.99196    49.65780     0.13678     0.94463     0.02201    -2.97026     6.37517
 6. 1     6.78393   0.76180    33.11122    0.98949    49.35282     0.13487     0.94544     0.02301   -20.05835    10.52963
 7. 1     9.86754   0.76864    33.11372    0.98763    49.18338     0.13344     0.94493     0.02321   -13.94470    33.35435
 8. 1    16.03474   0.76910    33.11205    0.98887    49.25116     0.13439     0.94614     0.02323   -21.65132   -19.13702
 9. 1    28.36916   0.80845    33.12271    0.98083    48.47175     0.12827     0.94487     0.02441    12.86749     2.79997
10. 1    40.70358   0.79598    33.11948    0.98330    48.67507     0.13014     0.94595     0.02417    14.75566    -3.50276
11. 1    59.20521   0.81929    33.12510    0.97897    48.30231     0.12687     0.94440     0.02473    10.26980     2.44025
12. 1    77.70684   0.86240    33.13589    0.97032    47.48902     0.12050     0.94274     0.02603     6.53376     3.53612
13. 1    96.20847   0.83632    33.12824    0.97650    47.99733     0.12503     0.94537     0.02524     9.31767     1.87642
14. 1   120.87731   0.83853    33.13363    0.97217    47.48902     0.12185     0.94654     0.02531     7.60724     0.58767
15. 1   145.54615   0.89051    33.14249    0.96475    46.87905     0.11653     0.94351     0.02657     6.09342     2.37712
16. 1   170.21498   0.88663    33.14353    0.96351    46.67572     0.11567     0.94507     0.02675     5.91729   ~~2.09472~~
17. 1   201.05103   0.90153    33.14951    0.95857    46.30296     0.11227     0.94265     0.02720     5.51265     3.12702
18. 1   250.38871   0.91341    33.15998    0.94867    45.38801     0.10581     0.96081     0.02755     5.17337     3.37417
19. 1   281.22476   0.91121    33.15421    0.95424    45.79465     0.10939     0.94392     0.02749     5.39966     2.70350
20. 1   312.06080   0.91734    33.16184    0.94692    45.11651     0.10466     0.94260     0.02766     5.25967     2.93342
21. 1   342.89695   0.93201    33.17589    0.93135    43.69364     0.09582     0.94058     0.02809     4.92123     3.14072
22. 1   373.73290   0.93097    33.17741    0.92950    43.52471     0.09487     0.94036     0.02806     4.91790     3.17444
23. 1   435.40499   0.93284    33.18525    0.91999    42.50759     0.08985     0.94052     0.02811     4.92533     3.39525

                                    TABLE OF RESULTS FOR  2  POSITION

        CALCULATED WAVENUMBER= 35.87459  RECIP. CM.  WAVELENGTH=0.17514  CM.  INITIAL FREQUENCY =  192.30  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. EQ.  INTERF. TENS. GEN. AMPL.     Y1           Y2       REAL ELS.   IMAG. ELAS.

 1. 2     0.0       0.81659    35.87459    1.00000    50.20000     0.24120     0.94873     0.02276    -0.00017    -0.00005
 2. 2     0.61672   0.83762    35.88189    0.99671    50.08139     0.23896     0.94415     0.02251    -4.17497     4.00098
 3. 2     0.92508   0.82368    35.88517    0.99342    49.79335     0.23659     0.94278     0.02296    -5.61773     9.47721
 4. 2     1.54180   0.82021    35.88913    0.99342    49.79335     0.23659     0.94278     0.02285    -4.37614     8.12122
 5. 2     2.46688   0.82597    35.89153    0.99232    49.75947     0.23578     0.94115     0.02301    -0.77321    10.39790
 6. 2     6.78393   0.85302    35.89860    0.98903    49.48448     0.23327     0.94012     0.02376     4.44054    17.07561
 7. 2     9.86754   0.85607    35.89988    0.98849    49.28504     0.23285     0.94221     0.02385     6.06354    23.46936
 8. 2    16.03474   0.86015    35.90106    0.98733    49.28504     0.23242     0.94107     0.02396     6.64925    13.60725
 9. 2    28.36916   0.90559    35.91516    0.98135    48.60730     0.22712     0.94041     0.02521     8.20744     5.87020
10. 2    40.70358   0.90169    35.91399    0.99170    48.67507     0.22758     0.94025     0.02510     9.10535     6.27634
11. 2    59.20521   0.91571    35.91749    0.98025    48.33620     0.22422     0.94339     0.02569     9.42357     1.66707
12. 2    77.70694   0.95740    35.93588    0.97148    47.62457     0.21878     0.93898     0.02666     6.13029     4.17346
13. 2    96.20847   0.93453    35.92673    0.97586    47.99733     0.22253     0.94084     0.02601     7.45458     4.02130
14. 2   120.87731   0.94120    35.93474    0.97202    47.49502     0.21924     0.94281     0.02619     7.61971     2.40644
15. 2   145.54615   0.98537    35.94831    0.96544    46.91293     0.21387     0.94044     0.02741     5.86932     3.28771
16. 2   170.21498   0.99930    35.95165    0.96380    46.67572     0.21207     0.94173     0.02758     5.85720     2.86603
17. 2   201.05103   1.00375    35.96055    0.95941    46.30296     0.20819     0.94009     0.02791     5.50477     3.28115
18. 2   250.38871   1.01998    35.97915    0.95038    45.38831     0.19987     0.93893     0.02835     5.13827     3.27092
19. 2   281.22476   1.01490    35.97045    0.95447    45.79465     0.20380     0.93989     0.02821     5.33453     3.15767
20. 2   312.06080   1.02451    35.98561    0.94679    45.11691     0.19692     0.93754     0.02853     4.87451     3.42867
21. 2   342.89685   1.03927    36.01095    0.93363    43.70531     0.18506     0.93717     0.02886     4.84659     3.33520
22. 2   373.73290   1.03269    36.01304    0.93253    43.59199     0.18407     0.93917     0.02868     5.08990     3.04001
23. 2   435.40499   1.04231    36.03144    0.92265    42.64314     0.17515     0.93841     0.02903     4.93365     3.38917

                                    TABLE OF RESULTS FOR  3  POSITION

        CALCULATED WAVENUMBER= 38.53741  RECIP. CM.  WAVELENGTH=0.16304  CM.  INITIAL FREQUENCY =  202.80  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. EQ.  INTERF. TENS. GEN. AMPL.     Y1           Y2       REAL ELS.   IMAG. ELAS.

 1. 3     0.0       0.89505    38.53741    1.00000    50.20000     0.28625     0.94715     0.02323    -0.00017    -0.00005
 2. 3     0.61672   0.88698    38.54404    0.99803    50.08139     0.28750     0.94516     0.02301    -1.91205     0.68656
 3. 3     0.92508   0.89229    38.55230    0.99556    49.89501     0.28873     0.94340     0.02315    -4.49974     1.49361
 4. 3     1.54180   0.89758    38.55395    0.99597    49.82724     0.28894     0.94363     0.02328    -4.74774     1.22920
 5. 3     2.46688   0.89952    38.55723    0.99408    49.79335     0.28932     0.94216     0.02333    -6.78696     5.21182
 6. 3     6.78393   0.92459    38.56379    0.99211    49.48837     0.28995     0.94373     0.02409    -5.05657    -7.77361
 7. 3     9.86754   0.93565    38.57031    0.99014    49.31873     0.29039     0.94273     0.02426   -13.75316   -21.24319
 8. 3    16.03474   0.93340    38.57031    0.99014    49.28504     0.29039     0.94338     0.02420    -5.91779   -11.10956
 9. 3    28.36916   0.98149    38.58811    0.98471    48.64119     0.29069     0.94411     0.02544     7.54316    -1.00713
10. 3    40.70358   0.98291    38.58571    0.98427    48.67507     0.29066     0.94239     0.02547    11.64945    -0.59786
11. 3    59.20521   0.99692    38.59612    0.98225    48.37009     0.29042     0.94407     0.02583     7.46451    -1.26571
12. 3    77.70694   1.02048    38.61670    0.97594    47.69234     0.28855     0.94352     0.02643     7.24070     0.37519
13. 3    96.20947   1.01354    38.60883    0.97810    48.03121     0.28947     0.94218     0.02625     9.51149     1.25325
14. 3   120.87731   1.01146    38.62452    0.97337    47.48902     0.28748     0.94220     0.02619     8.79987     0.79268
15. 3   145.54615   1.06575    38.64152    0.96795    46.91293     0.28434     0.94193     0.02759     6.32830     2.17961
16. 3   170.21498   1.04085    38.64764    0.96598    46.67572     0.28298     0.94241     0.02693     7.07734     1.49841
17. 3   201.05103   1.07625    38.65825    0.96252    46.30296     0.28032     0.94245     0.02784     6.00514     2.00106
18. 3   250.38871   1.10356    38.68793    0.95266    45.38801     0.27932     0.93968     0.02852     5.65624     2.93430
19. 3   281.22476   1.08686    38.67617    0.95661    45.79465     0.27932     0.93992     0.02810     5.97960     2.91854
20. 3   312.06090   1.10069    38.69665    0.94970    45.15080     0.27473     0.93812     0.02844     5.54236     3.21113
21. 3   342.89685   1.10809    38.72927    0.93836    43.89697     0.25865     0.93963     0.02861     5.64949     2.65556
22. 3   373.73290   1.10294    38.73670    0.93590    43.67587     0.25685     0.94001     0.02847     5.76941     2.51361
23. 3   435.40499   1.11374    38.76333    0.92604    42.74480     0.25081     0.93730     0.02873     5.49679     3.15300
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                         ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE MIXED IONIC SURFACTANTS / LI(INF) FEB 1968 RLB

EXPERIMENTS PERFORMED AT THE .005 M KBR, .005 NA2SO4 (FRESH 4X H2O)  /FRESHLY DISTILLED N HEPTANE             INTERFAC. .

THE SYSTEM UNDER INVESTIGATION IS NAC18SO3:OTAB - SODIUM OCTADECYL SULFONATE:OCTADECYL TRIMETHYL AM. BR (1:1)

                                       SYSTEM PARAMETERS

                LOWER PHASE DENSITY  0.9980 G/ML          UPPER PHASE DENSITY  0.6780 G/ML
                      VISCOSITY  0.00896 POISES                     VISCOSITY  0.00386 POISES

                                 INITIAL VALUES ASSUMED IN CALCULATION

                REAL ELASTICITY (EP)   0.0               IMAGINARY ELASTICITY (EPP)   0.0
                WAVENUMBER  31.00000 RECIPROCAL  CM      DAMPING COEFFICIENT   0.70000 CM
                REFERENCE METER SCALE    1.00 MV.        INTERFACIAL TENSION 50.2000 DYNES/CM
                REFERENCE INPUT VTG.  0.100 VT.

                                       PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.75571 CM. BASED ON RESGN= 0.21470 RESFN= 5.23340 DISTGN= 6.07557 DISTFF= 2.3????

                                 CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY    DMP. COEF.     WAVE NO.     WAVELENGTH    NO. WAVES    PHS.COR.WAVNO  SQ. PR. SCL.FCTR.
   1        157.10    0.71847273   32.46051923   0.19356376   17.40296414   32.46051923    0.86128572
   2        173.80    0.80694158   35.54322243   0.17677576   21.24542042   35.54322243    0.75913336
   3        253.50    1.08476511   44.76761926   0.14035100   26.75941514   44.76761926    4.41968977

                                       INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =  65.00000  MG.  MOLECULAR WT.= 366.00000 MAKE-UP VOLUME=1.0500 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                       INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=     34.30MG.  WEIGHT OF WEIGHT=    171.40 MG.  DENSITY OF WT=71.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.89194 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                        INPUT DATA

ID .K    INDEP. VAR.    FREQUENCY    INPUT VOLT.   OUTPUT VOLT.   METER SCALE   SFTN. VAR.

 1. 1    0.0            157.10000    0.62800       0.08840        0.50000       38.00000
 1. 2    0.0            179.80000    0.62800       0.10640        0.50000       38.00000
 1. 3    0.0            253.50000    1.60000       0.07900        0.20000       38.00000
 2. 1    0.00500        156.80000    0.62700       0.09490        0.50000       37.70000
 2. 2    0.00500        179.50000    0.62900       0.10590        0.50000       37.70000
 2. 3    0.00500        252.80000    1.59000       0.07630        0.20000       37.70000
 3. 1    0.02500        156.60000    0.62900       0.09940        0.50000       37.60000
 3. 2    0.02500        179.40000    0.63100       0.10710        0.50000       37.60000
 3. 3    0.02500        252.90000    1.59000       0.07870        0.20000       37.60000
 4. 1    0.05000        156.70000    0.63000       0.09300        0.50000       37.60000
 4. 2    0.05000        179.30000    0.63100       0.10390        0.50000       37.60000
 4. 3    0.05000        252.70000    1.59000       0.10700        0.20000       37.60000
 5. 1    0.10000        156.50000    0.62900       0.09660        0.50000       37.70000
 5. 2    0.10000        179.10000    0.63000       0.10450        0.50000       37.70000
 5. 3    0.10000        253.40000    1.59000       0.10750        0.20000       37.70000
 6. 1    0.20000        156.50000    0.63000       0.10090        0.50000       38.00000
 6. 2    0.20000        179.00000    0.63100       0.10550        0.50000       38.00000
 6. 3    0.20000        252.80000    1.59000       0.09750        0.20000       38.00000
 7. 1    0.50000        156.00000    0.63000       0.09330        0.50000       38.40000
 7. 2    0.50000        178.70000    0.63100       0.09980        0.50000       38.40000
 7. 3    0.50000        252.50000    1.59000       0.10720        0.20000       38.40000
 8. 1    1.00000        156.00000    0.62900       0.09070        0.50000       38.90000
 8. 2    1.00000        178.60000    0.63000       0.09490        0.50000       38.90000
 8. 3    1.00000        252.30000    1.59000       0.10920        0.20000       38.90000
 9. 1    2.00000        155.50000    0.62900       0.08520        0.50000       40.10000
 9. 2    2.00000        177.90000    0.63000       0.09380        0.50000       40.10000
 9. 3    2.00000        251.40000    1.59000       0.10610        0.20000       40.10000
10. 1    3.50000        154.60000    0.62800       0.06640        0.50000       44.40000
10. 2    3.50000        177.10000    0.63000       0.07860        0.50000       44.40000
10. 3    3.50000        250.60000    1.59000       0.10100        0.20000       44.40000
11. 1    4.50000        154.00000    0.62900       0.06380        0.50000       45.60000
11. 2    4.50000        176.30000    0.63000       0.07360        0.50000       45.60000
11. 3    4.50000        250.00000    1.59000       0.06100        0.20000       45.60000
12. 1    6.00000        152.70000    0.62900       0.05390        0.50000       47.70000
12. 2    6.00000        174.90000    0.62900       0.05740        0.50000       47.70000
12. 3    6.00000        247.20000    1.59000       0.08750        0.20000       47.70000
13. 1    8.00000        152.00000    0.62800       0.04790        0.50000       50.70000
13. 2    8.00000        172.80000    0.62900       0.05220        0.50000       50.70000
13. 3    8.00000        243.40000    1.59000       0.06740        0.20000       50.70000
14. 1    10.50000       148.60000    0.62800       0.10700        0.20000       54.50000
14. 2    10.50000       170.40000    0.62800       0.12320        0.20000       54.50000
14. 3    10.50000       241.20000    1.58000       0.06650        0.20000       54.50000
15. 1    13.00000       146.00000    0.62700       0.08690        0.20000       59.30000
15. 2    13.00000       167.30000    0.62800       0.11950        0.20000       59.30000
15. 3    13.00000       235.70000    1.58000       0.11270        0.20000       59.30000
16. 1    15.50000       143.20000    0.62400       0.08650        0.20000       64.60000
16. 2    15.50000       164.30000    0.62700       0.11430        0.20000       64.60000
16. 3    15.50000       232.50000    1.58000       0.10830        0.20000       64.60000
17. 1    18.00000       139.70000    0.60300       0.06600        0.20000       70.00000
17. 2    19.00000       160.90000    0.62300       0.09320        0.21000       70.00000
17. 3    18.00000       228.10000    1.57000       0.07400        0.20000       70.00000
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                                          TABLE OF RESULTS FOR  1  POSITION

              CALCULATED WAVENUMBER= 32.46052  RECIP. CM.  WAVELENGTH=0.19356  CM.  INITIAL FREQUENCY =  157.10  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1           Y2        REAL ELS.  IMAG. ELAS.

 1. 1   0.0          0.71847     32.46052    1.00000    50.20000     0.12140     0.95108     0.02211    -0.00015    -0.00315
 2. 1   0.00074      0.69620     32.46301    0.99809    50.30166     0.12005     0.94531     0.02145    -1.86564     5.40322
 3. 1   0.00370      0.68542     32.46466    0.99682    50.33555     0.11917     0.94213     0.02111     0.64371     5.17124
 4. 1   0.00740      0.70186     32.46384    0.99745    50.33555     0.11961     0.94340     0.02162    -0.44483     7.04624
 5. 1   0.01480      0.68935     32.46547    0.99618    50.30166     0.11872     0.94149     0.02123     0.59071     6.29554
 6. 1   0.02960      0.68056     32.46547    0.99619    50.20000     0.11872     0.94339     0.02095     0.01747     5.63069
 7. 1   0.07400      0.69493     32.46950    0.99300    50.06445     0.11653     0.93956     0.02149     1.65277     6.17234
 8. 1   0.14800      0.70117     32.46950    0.99300    49.89501     0.11653     0.94275     0.02159     0.10356     6.86106
 9. 1   0.29599      0.70976     32.47343    0.98982    49.48837     0.11439     0.94407     0.02184    -1.50743     7.04243
10. 1   0.51799      0.76990     32.48026    0.98409    48.03121     0.11061     0.96098     0.02370     2.74343     1.51911
11. 1   0.66598      0.77503     32.48464    0.98027    47.62457     0.10819     0.96119     0.02394     2.75193     1.54444
12. 1   0.88798      0.80725     32.49360    0.97199    46.91293     0.10315     0.95857     0.02494     3.05921     1.22834
13. 1   1.18397      0.83212     32.49811    0.96754    45.89632     0.10059     0.97044     0.02561     2.94891     2.10415
14. 1   1.55396      0.83158     32.51684    0.94589    44.60860     0.08989     0.95264     0.02557     3.75431     1.33671
15. 1   1.92395      0.87055     32.52741    0.92934    42.98201     0.08376     0.95346     0.02676     3.79575     3.95922
16. 1   2.29394      0.85210     32.53519    0.91152    41.18599     0.07899     0.95655     0.02613     2.97451     1.51444
17. 1   2.66393      0.89882     32.54039    0.88924    39.35607     0.07433     0.95224     0.02762     3.63455     1.55351


                                          TABLE OF RESULTS FOR  2  POSITION

              CALCULATED WAVENUMBER= 35.54322  RECIP. CM.  WAVELENGTH=0.17674  CM.  INITIAL FREQUENCY =  172.80  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1           Y2        REAL ELS.  IMAG. ELAS.

 1. 2   0.0          0.80694     35.54322    1.00000    50.20000     0.23112     0.94874     0.02270    -0.00117    -0.00725
 2. 2   0.00074      0.80710     35.54713    0.99933    50.30166     0.22981     0.94355     0.02271    -5.71171     6.67734
 3. 2   0.00370      0.80443     35.54843    0.99778    50.33555     0.22936     0.94176     0.02263    -1.64431     9.65672
 4. 2   0.00740      0.81199     35.54973    0.99722    50.33555     0.22992     0.94061     0.02284     0.77347     9.50694
 5. 2   0.01480      0.80899     35.55232    0.99611    50.30166     0.22803     0.93874     0.02275     2.07262     4.37337
 6. 2   0.02960      0.80636     35.55361    0.99555    50.20000     0.22759     0.93969     0.02263     1.36241     9.30657
 7. 2   0.07400      0.81955     35.55748    0.99388    50.06445     0.22622     0.93877     0.02395     2.67271     4.23671
 8. 2   0.14800      0.83200     35.55877    0.99333    49.89501     0.22576     0.94080     0.02340     2.65771    11.69511
 9. 2   0.29599      0.83127     35.56772    0.98943    49.48837     0.22253     0.94040     0.02332     2.44544    11.74574
10. 2   0.51799      0.87381     35.57785    0.99498    48.03121     0.21878     0.95942     0.02455     2.84696     1.61050
11. 2   0.66598      0.88662     35.58788    0.98053    47.62457     0.21494     0.95838     0.02491     2.95452     1.45117
12. 2   0.88798      0.94295     35.60517    0.97275    46.91293     0.20819     0.95543     0.02449     3.51474     1.35331
13. 2   1.18397      0.95566     35.63054    0.96107    45.89632     0.19790     0.95155     0.02682     4.03671     1.67314
14. 2   1.55396      0.95412     35.65868    0.94772    44.60860     0.18605     0.94986     0.02676     4.21152     3.63247
15. 2   1.92395      0.93929     35.69365    0.93048    42.98201     0.17063     0.94747     0.02632     4.51151    -1.44711
16. 2   2.29394      0.92645     35.72579    0.91379    41.18599     0.15583     0.95107     0.02553     2.76447     3.29774
17. 2   2.66393      0.94960     35.75979    0.89498    39.35607     0.13919     0.95141     0.02555     2.79152     3.59451


                                          TABLE OF RESULTS FOR  3  POSITION

              CALCULATED WAVENUMBER= 44.76762  RECIP. CM.  WAVELENGTH=0.14035  CM.  INITIAL FREQUENCY =  253.50  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1           Y2        REAL ELS.  IMAG. ELAS.

 1. 3   0.0          1.08477     44.76762    1.00000    50.20000     0.01314     0.94405     0.02423    -0.00117    -0.00015
 2. 3   0.00074      1.19655     44.76762    0.99724    50.30166     0.01943     0.93694     0.02673     9.72177     4.67411
 3. 3   0.00370      1.17601     44.76762    0.99763    50.33555     0.01955     0.93705     0.02627    11.61764     6.11034
 4. 3   0.00740      1.11818     44.76762    0.99684    50.33555     0.02030     0.93557     0.02433     3.83145    12.47477
 5. 3   0.01480      1.01917     44.76762    0.99961    50.30166     0.01406     0.94140     0.02276    -0.55707     3.12234
 6. 3   0.02960      1.13127     44.76762    0.99724    50.20000     0.01943     0.93984     0.02527   364.61335  -388.56913
 7. 3   0.07400      1.13934     44.76762    0.99606    50.06445     0.02202     0.93915     0.02545    33.70755   -34.22032
 8. 3   0.14800      1.15414     44.76762    0.99527    49.89501     0.02371     0.94085     0.02578     7.02174    -7.43072
 9. 3   0.29599      1.23332     44.76762    0.99172    49.48837     0.03102     0.94182     0.02755     6.62013     0.61711
10. 3   0.51799      1.29427     44.76762    0.98956    48.03121     0.03712     0.96423     0.02491     3.46456     2.39154
11. 3   0.66598      1.45812     44.75709    0.98619    47.62457     0.04149     0.96849     0.03259     3.64559     2.63575
12. 3   0.88798      1.46008     44.77628    0.97515    46.91293     0.05795     0.96005     0.03261     3.77855     2.46620
13. 3   1.18397      1.63156     44.78584    0.96016    45.89632     0.08205     0.95077     0.03543     3.98071     2.71451
14. 3   1.55396      1.65239     44.78827    0.95148    44.60860     0.09440     0.96045     0.03683     3.69413     2.62641
15. 3   1.92395      1.59091     44.79964    0.92978    42.98201     0.12700     0.95113     0.03551     3.80351     2.46575
16. 3   2.29394      1.64324     44.81522    0.91716    41.18599     0.14814     0.96493     0.03667     3.39194     2.45159
17. 3   2.66393      1.79398     44.85083    0.89980    39.35607     0.17993     0.96953     0.04000     3.24757     2.48519
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                        ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE STRAIGHT CHAIN ACIDS - LIA(NF) FEB 1968 RLH

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)           /FRESHLY DISTILLED N HEPTANE               INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS C14OOH   - TETRADECANOIC ACID (1X FROM ABS. DIST. ETOH) IN ETOH 2/12/68

                                             SYSTEM PARAMETERS

                    LOWER PHASE DENSITY  0.9980 G/ML          UPPER PHASE DENSITY  0.6790 G/ML
                             VISCOSITY  0.00896 POISES                  VISCOSITY  0.00386 POISES

                                     INITIAL VALUES ASSUMED IN CALCULATION

                    REAL ELASTICITY (EP)   0.0              IMAGINARY ELASTICITY (EPP)   0.0
                    WAVENUMBER  31.00000 RECIPROCAL  CM     DAMPING COEFFICIENT   0.70000 CM
                    REFERENCE METER SCALE    1.00 MV.       INTERFACIAL TENSION 50.2000 DYNES/CM
                    REFERENCE INPUT VTG.  0.100 VT.

                                             PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.57156 CM. BASED ON RESGN= 0.28390 RESFN= 5.04970 DISTGN= 6.02401 DISTFN= 2.45245

                                     CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY     DMP. COEF.       WAVE NO.        WAVELENGTH        NO. WAVES   PHS.COR.WANO  SN. PR. SCL.FCTR.
    1          160.60    0.73222067     32.94501807      0.19071715      18.72700401     32.94501807       1.31693517
    2          183.90    0.82275406     36.08586986      0.17411746      20.51236482     36.08586986       0.84500451
    3          207.90    0.91439864     39.18576411      0.16034343      22.27444405     39.18576411       1.77735811
    4          232.10    1.00537415     42.19348919      0.14891350      23.98413137     42.19348919       0.85268536

                                          INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT = 535.00000  MG.  MOLECULAR WT.= 230.00000 MAKE-UP VOLUME=1.3500 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                          INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=     34.30MG.  WEIGHT OF WEIGHT=    171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.87632 CM.  CALCULATED FRACTION IN LOWER PHASE=0.201
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                                   INPUT DATA

 ID .K       INDEP. VAR.      FREQUENCY      INPUT VOLT.     OUTPUT VOLT.     METER SCALE      SFTN. VAR.


   1. 1        0.0            160.60000        0.51100         0.09340         0.50000         38.80000
   1. 2        0.0            183.90000        0.51200         0.11290         0.50000         38.80000
   1. 3        0.0            207.90000        0.51300         0.09030         0.50000         38.80000
   1. 4        0.0            232.10000        0.51400         0.09120         0.20000         38.80000
   2. 1        0.10000        160.60000        0.51200         0.09560         0.50000         38.80000
   2. 2        0.10000        183.80000        0.51200         0.11300         0.50000         38.80000
   2. 3        0.10000        207.90000        0.51300         0.08840         0.50000         38.80000
   2. 4        0.10000        232.00000        0.51400         0.09130         0.20000         38.80000
   3. 1        1.00000        160.40000        0.51100         0.09410         0.50000         38.95000
   3. 2        1.00000        183.60000        0.51200         0.11420         0.50000         38.95000
   3. 3        1.00000        207.70000        0.51200         0.08820         0.50000         38.95000
   3. 4        1.00000        231.70000        0.51300         0.09050         0.20000         38.95000
   4. 1       24.00000        160.20000        0.51200         0.09270         0.50000         39.50000
   4. 2       24.00000        183.20000        0.51200         0.11180         0.50000         39.50000
   4. 3       24.00000        207.20000        0.51300         0.08530         0.50000         39.50000
   4. 4       24.00000        231.20000        0.51500         0.08940         0.20000         39.50000
   5. 1       55.00000        159.80000        0.51200         0.08950         0.50000         40.20000
   5. 2       55.00000        182.80000        0.51200         0.10990         0.50000         40.20000
   5. 3       55.00000        206.80000        0.51200         0.08220         0.50000         40.20000
   5. 4       55.00000        230.50000        0.51300         0.09010         0.20000         40.20000
   6. 1       85.00000        159.60000        0.51200         0.08780         0.50000         40.50000
   6. 2       85.00000        182.60000        0.51200         0.10830         0.50000         40.50000
   6. 3       85.00000        206.50000        0.51300         0.08130         0.50000         40.50000
   6. 4       85.00000        230.40000        0.51300         0.08930         0.20000         40.50000
   7. 1      165.00000        159.00000        0.51100         0.08320         0.50000         41.70000
   7. 2      165.00000        181.90000        0.51200         0.10350         0.50000         41.70000
   7. 3      165.00000        205.70000        0.51300         0.07740         0.50000         41.70000
   7. 4      165.00000        229.60000        0.51300         0.08970         0.20000         41.70000
   8. 1      235.00000        158.70000        0.51100         0.07930         0.50000         42.40000
   8. 2      235.00000        181.60000        0.51200         0.10010         0.50000         42.40000
   8. 3      235.00000        205.20000        0.51200         0.07450         0.50000         42.40000
   8. 4      235.00000        229.20000        0.51300         0.08870         0.20000         42.40000
   9. 1      335.00000        157.90000        0.51100         0.07530         0.50000         43.60000
   9. 2      335.00000        181.00000        0.51200         0.09710         0.50000         43.60000
   9. 3      335.00000        204.50000        0.51200         0.07170         0.50000         43.60000
   9. 4      335.00000        228.20000        0.51300         0.09010         0.20000         43.60000
  10. 1      415.00000        157.70000        0.51100         0.07200         0.50000         44.20000
  10. 2      415.00000        180.60000        0.51200         0.09240         0.50000         44.20000
  10. 3      415.00000        204.00000        0.51200         0.06920         0.50000         44.20000
  10. 4      415.00000        227.80000        0.51300         0.08720         0.20000         44.20000
  11. 1      515.00000        157.30000        0.51100         0.06750         0.50000         45.05000
  11. 2      515.00000        180.10000        0.51200         0.08800         0.50000         45.05000
  11. 3      515.00000        203.50000        0.51200         0.06650         0.50000         45.05000
  11. 4      515.00000        227.30000        0.51300         0.08630         0.20000         45.05000
  12. 1      615.00000        156.80000        0.51200         0.06410         0.50000         45.90000
  12. 2      615.00000        179.60000        0.51300         0.08610         0.50000         45.90000
  12. 3      615.00000        203.00000        0.51300         0.06560         0.50000         45.90000
  12. 4      615.00000        226.60000        0.51300         0.08600         0.20000         45.90000
  13. 1      715.00000        156.40000        0.51100         0.06090         0.50000         46.90000
  13. 2      715.00000        179.10000        0.51200         0.08190         0.50000         46.90000
  13. 3      715.00000        202.40000        0.51200         0.06440         0.50000         46.90000
  13. 4      715.00000        226.10000        0.51300         0.08520         0.20000         46.80000
  14. 1      815.00000        155.90000        0.51100         0.05740         0.50000         47.50000
  14. 2      815.00000        178.60000        0.51200         0.07730         0.50000         47.45000
  14. 3      815.00000        201.90000        0.51200         0.06140         0.50000         47.35000
  14. 4      815.00000        225.30000        0.51200         0.08450         0.20000         47.35000



  15. 1      965.00000        155.50000        0.51000         0.13780         0.20000         48.70000
  15. 2      965.00000        178.00000        0.51100         0.07430         0.50000         48.70000
  15. 3      965.00000        201.20000        0.51200         0.06070         0.50000         48.50000
  15. 4      965.00000        224.60000        0.51200         0.08390         0.20000         48.40000
  16. 1     1115.00000        154.90000        0.51000         0.13050         0.20000         49.30000
  16. 2     1115.00000        177.40000        0.51100         0.06950         0.50000         49.30000
  16. 3     1115.00000        200.60000        0.51200         0.05940         0.50000         49.30000
  16. 4     1115.00000        223.90000        0.51200         0.08210         0.20000         49.30000
  17. 1     1315.00000        154.20000        0.51000         0.11900         0.20000         50.80000
  17. 2     1315.00000        176.70000        0.51100         0.06570         0.50000         50.70000
  17. 3     1315.00000        199.70000        0.51100         0.05580         0.50000         50.70000
  17. 4     1315.00000        222.90000        0.51100         0.08100         0.20000         50.70000
  18. 1     1515.00000        153.40000        0.51000         0.11400         0.20000         51.90000
  18. 2     1515.00000        176.10000        0.51100         0.06380         0.50000         51.80000
  18. 3     1515.00000        199.00000        0.51200         0.13400         0.20000         51.70000
  18. 4     1515.00000        222.30000        0.51200         0.07940         0.20000         51.70000
  19. 1     1815.00000        152.80000        0.51000         0.10390         0.20000         53.20000
  19. 2     1815.00000        175.20000        0.51000         0.05760         0.50000         53.20000
  19. 3     1815.00000        198.10000        0.51100         0.12270         0.20000         53.10000
  19. 4     1815.00000        221.30000        0.51200         0.07730         0.20000         53.10000
  20. 1     2215.00000        151.90000        0.51000         0.09740         0.20000         55.10000
  20. 2     2215.00000        174.00000        0.51000         0.13500         0.20000         55.10000
  20. 3     2215.00000        196.70000        0.51100         0.11660         0.20000         55.10000
  20. 4     2215.00000        219.90000        0.51100         0.07720         0.20000         55.10000
  21. 1     2815.00000        150.40000        0.51000         0.08600         0.20000         57.80000
  21. 2     2815.00000        172.40000        0.51000         0.12270         0.20000         57.70000
  21. 3     2815.00000        195.00000        0.51100         0.10890         0.20000         57.65000
  21. 4     2815.00000        217.90000        0.51200         0.07800         0.20000         57.60000
  22. 1     3615.00000        148.40000        0.51000         0.12760         0.10000         61.00000
  22. 2     3615.00000        170.50000        0.51000         0.09100         0.20000         60.90000
  22. 3     3615.00000        193.00000        0.51000         0.07970         0.20000         60.80000
  22. 4     3615.00000        215.90000        0.51100         0.12060         0.10000         60.60000
  23. 1     4615.00000        147.80000        0.51000         0.11700         0.10000         64.00000
  23. 2     4615.00000        168.70000        0.51100         0.08290         0.20000         64.00000
  23. 3     4615.00000        191.00000        0.51100         0.06690         0.20000         63.80000
  23. 4     4615.00000        214.00000        0.51100         0.11270         0.10000         63.70000
```

```
                                   TABLE OF RESULTS FOR  1  POSITION

          CALCULATED WAVENUMBER= 32.94502  RECIP. CM.  WAVELENGTH=0.19072  CM.  INITIAL FREQUENCY =  160.60  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

 1. 1     0.0        0.73222    32.94502    1.00000    50.20000     0.13774    0.95072     0.02223    -0.00015   -0.00025
 2. 1     0.19384    0.72625    32.94502    1.00000    50.20000     0.13774    0.95072     0.02204    -0.07311    0.38031
 3. 1     1.93841    0.72817    32.94701    0.99875    50.14889     0.13678    0.94914     0.02210    -1.51749    0.26277
 4. 1    46.52174    0.73095    32.94898    0.99751    49.96150     0.13583    0.95016     0.02218    -0.45511    0.07739
 5. 1   106.61232    0.73682    32.95289    0.99502    49.72300     0.13392    0.94962     0.02235    -0.97567   -0.40163
 6. 1   164.76449    0.74020    32.95483    0.99377    49.62079     0.13297    0.94903     0.02246    -1.61995   -0.81677
 7. 1   319.83696    0.74869    32.96057    0.99004    49.21193     0.13014    0.94923     0.02271    -1.01796   -1.54266
 8. 1   455.52536    0.75909    32.96335    0.98817    48.97343     0.12873    0.95002     0.02303     0.51043   -1.77217
 9. 1   649.36594    0.76653    32.97077    0.98319    48.56458     0.12503    0.94774     0.02325    -2.17655   -6.44207
10. 1   804.43841    0.77591    32.97258    0.98194    48.36015     0.12411    0.94918     0.02353     1.61537   -3.54134
11. 1   998.27899    0.78943    32.97616    0.97945    48.07055     0.12230    0.94975     0.02394     3.14327   -2.54573
12. 11192.11957      0.79968    32.98054    0.97634    47.78094     0.12005    0.94907     0.02425     4.46315   -2.93970
13. 11385.96014      0.80977    32.98398    0.97385    47.44023     0.11828    0.95072     0.02455     3.51397   -1.02830
14. 11579.80072      0.81970    32.98820    0.97073    47.23580     0.11610    0.94837     0.02485     6.12032   -1.59232
15. 11870.56159      0.82729    32.99150    0.96824    46.82694     0.11439    0.95146     0.02509     4.06651   -0.13152
16. 12161.32246      0.83627    32.99633    0.96451    46.62252     0.11195    0.94786     0.02534     6.43579   -0.26723
17. 12549.00362      0.85482    33.00177    0.96015    46.11145     0.10899    0.94925     0.02563     5.27523    0.42653
18. 12936.68478      0.85858    33.00772    0.95517    45.73666     0.10581    0.94661     0.02601     6.47064    1.14236
19. 13518.20652      0.87842    33.01201    0.95143    45.29174     0.10352    0.94804     0.02661     5.41949    1.22470
20. 14293.56884      0.88748    33.01811    0.94583    44.64638     0.10023    0.94996     0.02689     4.71297    1.10479
21. 15456.61232      0.90785    33.02743    0.93649    43.72646     0.09519    0.95008     0.02743     4.51140    1.24421
22. 17007.33696      0.97375    33.03812    0.92403    42.63618     0.08935    0.94771     0.02847     4.28312    2.15258
23. 18945.74275      0.99316    33.04093    0.92030    41.61404     0.08781    0.96291     0.03005     3.74712    1.96152
```

```
                                   TABLE OF RESULTS FOR  2  POSITION

          CALCULATED WAVENUMBER= 36.08587  RECIP. CM.  WAVELENGTH=0.17412  CM.  INITIAL FREQUENCY =  183.90  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

 1. 2     0.0        0.82275    36.08587    1.00000    50.20000     0.24644    0.94860     0.02280    -0.00017   -1.00315
 2. 2     0.19384    0.82218    36.08733    0.99946    50.20000     0.24615    0.94745     0.02278    -1.07952   -0.14470
 3. 2     1.93841    0.81854    36.09024    0.99837    50.14889     0.24555    0.94612     0.02269    -2.73780    0.57324
 4. 2    46.52174    0.82305    36.09603    0.99619    49.96150     0.24430    0.94508     0.02280    -4.59593    1.31348
 5. 2   106.61232    0.82632    36.10178    0.99402    49.72300     0.24297    0.94502     0.02287    -4.88736    1.06670
 6. 2   164.76449    0.82962    36.10465    0.99293    49.62079     0.24227    0.94467     0.02299    -5.97203    1.36412
 7. 2   319.83696    0.83935    36.11461    0.98912    49.21193     0.23972    0.94445     0.02324    -8.14193    0.23717
 8. 2   455.52536    0.84736    36.11884    0.98749    48.97343     0.23857    0.94559     0.02346    -3.99459   -3.36617
 9. 2   649.36594    0.85249    36.12726    0.98423    48.56458     0.23619    0.94660     0.02360    -1.06724   -2.76369
10. 2   804.43841    0.86499    36.13284    0.98206    48.36015     0.23454    0.94596     0.02394    -0.44555   -5.49935
11. 2   998.27899    0.87611    36.13976    0.97934    48.07055     0.23242    0.94596     0.02424     1.93135   -6.33660
12. 21192.11957      0.88014    36.14663    0.97667    47.78094     0.23025    0.94577     0.02435     2.56174   -6.35721
13. 21385.96014      0.89123    36.15345    0.97390    47.44023     0.22803    0.94673     0.02465     3.55731   -3.51046
14. 21579.80072      0.90428    36.16023    0.97118    47.25294     0.22576    0.94466     0.02501     9.00325   -4.37958
15. 21870.56159      0.91136    36.16831    0.96792    46.82694     0.22300    0.94622     0.02521     5.50195   -2.62715
16. 22161.32246      0.92652    36.17632    0.96465    46.62252     0.22019    0.94335     0.02561     9.71417    0.48253
17. 22549.00362      0.93801    36.18558    0.96095    46.14557     0.21689    0.94497     0.02593     7.20532   -3.41515
18. 22936.68478      0.94249    36.19346    0.95759    45.77074     0.21400    0.94553     0.02604     6.78634   -0.49017
19. 23518.20652      0.96482    36.20516    0.95269    45.29374     0.20965    0.94683     0.02665     6.33933    0.74839
20. 24293.56884      0.97495    36.22055    0.94617    44.64638     0.20380    0.94424     0.02697     6.30471    1.14544
21. 25456.61232      0.99182    36.24070    0.93747    43.76051     0.19593    0.94414     0.02717     5.87445    1.34411
22. 27007.33696      1.06062    36.26409    0.92713    42.67029     0.18654    0.94521     0.02925     4.64678    1.67576
23. 28745.74275      1.07356    36.28568    0.91735    41.61404     0.17763    0.94715     0.02957     4.28472    1.78782
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```
                                   TABLE OF RESULTS FOR  3  POSITION

          CALCULATED WAVENUMBER= 39.18576  RECIP. CM.  WAVELENGTH=0.16034  CM.  INITIAL FREQUENCY =  207.90  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

 1. 3     0.0        0.91440    39.18576    1.00000    50.20000     0.29665    0.94679     0.02333    -0.00017   -0.00035
 2. 3     0.19384    0.92035    39.18576    1.00000    50.20000     0.29665    0.94679     0.02343     0.11796   -0.33676
 3. 3     1.93841    0.91829    39.18973    0.99904    50.14889     0.29439    0.94564     0.02343    -1.03951   -1.59428
 4. 3    46.52174    0.92403    39.19965    0.99663    49.96150     0.28902    0.94391     0.02357    -4.08054   -0.97222
 5. 3   106.61232    0.92922    39.20757    0.99471    49.72300     0.28529    0.94421     0.02370    -3.27563   -1.72636
 6. 3   164.76449    0.93050    39.21351    0.99327    49.62079     0.28290    0.94298     0.02373    -7.20159   -0.81950
 7. 3   319.83696    0.93980    39.22932    0.98942    49.21193     0.27842    0.94232     0.02396   -11.91374   -1.03930
 8. 3   455.52536    0.94806    39.23917    0.98701    48.97343     0.27655    0.94160     0.02416   -23.00243    4.24343
 9. 3   649.36594    0.96105    39.25292    0.98365    48.56458     0.27850    0.94207     0.02449   -15.90587  -23.45196
10. 3   804.43841    0.97360    39.26270    0.98124    48.36015     0.28141    0.94073     0.02480    15.44479   22.94032
11. 3   998.27899    0.98657    39.27245    0.97884    48.07055     0.28369    0.94106     0.02512    24.09717    0.14925
12. 31192.11957      0.99325    39.28216    0.97643    47.78094     0.28561    0.94142     0.02529    18.25654   -3.62375
13. 31385.96014      0.99972    39.29375    0.97354    47.47430     0.28750    0.94108     0.02544    16.75266   -0.35789
14. 31579.80072      1.01336    39.30336    0.97114    47.28691     0.28873    0.93945     0.02578    11.26745    5.36622
15. 31870.56159      1.01866    39.31674    0.96777    46.89509     0.28995    0.93979     0.02591    11.47619    4.16465
16. 32161.32246      1.02529    39.32813    0.96489    46.62252     0.29054    0.93884     0.02607     9.69527    5.19331
17. 32549.00362      1.04240    39.34506    0.96056    46.14552     0.29069    0.93883     0.02649     8.67137    4.17504
18. 32936.68478      1.05377    39.35810    0.95719    45.80491     0.29024    0.93827     0.02677     7.80997    4.12983
19. 33518.20652      1.07666    39.37469    0.95286    45.32781     0.28897    0.93840     0.02734     6.99870    3.45619
20. 34293.56884      1.06765    39.40009    0.94613    44.64638     0.28559    0.93748     0.02761     6.54416    3.65331
21. 35456.61232      1.10056    39.43024    0.93795    43.77757     0.27932    0.93748     0.02791     6.33449    3.41128
22. 37007.33696      1.18743    39.46468    0.92833    42.70432     0.27934    0.93897     0.03009     4.91851    2.65111
23. 38745.74275      1.22283    39.49802    0.91871    41.68218     0.26199    0.93977     0.03096     4.56732    2.50494
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```
                              TABLE OF RESULTS FOR  4  POSITION

        CALCULATED WAVENUMBER= 42.19349 RECIP. CM.  WAVELENGTH=0.14891  CM.  INITIAL FREQUENCY =  232.10  HZ.

IO .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELA.

 1. 4     0.0        1.00537    42.19349    1.00000    50.20000    0.15091    0.94524    0.02383    -0.[illegible]   [illegible]
 2. 4     0.19384    1.00636    42.19418    0.99957    50.20000    0.15161    0.94438    0.02395    -0.76[illegible]  -3.24[illegible]
 3. 4     1.93841    1.01213    42.19631    0.99828    50.14989    0.15371    0.94276    0.02379    -3.1[illegible]   [illegible]
 4. 4    46.52174    1.02300    42.20004    0.99612    49.96150    0.15724    0.94196    0.02424    -5.66[illegible]  -2.[illegible]
 5. 4   106.61232    1.02851    42.20564    0.99311    49.72300    0.16225    0.94039    0.02437   -14.[illegible]   [illegible]
 6. 4   164.76449    1.03225    42.20648    0.99269    49.62079    0.16297    0.94145    0.02445    -4.27[illegible]  [illegible]
 7. 4   319.83696    1.04083    42.21351    0.98923    49.21193    0.16990    0.94222    0.02455    -3.25[illegible]  [illegible]
 8. 4   455.52536    1.04881    42.21725    0.98751    48.97343    0.17174    0.94326    0.02444     0.[illegible]    [illegible]
 9. 4   649.36594    1.05630    42.22722    0.98320    48.56459    0.17719    0.94225    0.02591    -0.41[illegible]  [illegible]
10. 4   904.43841    1.07011    42.23146    0.98147    48.36015    0.18219    0.94264    0.02534     2.[illegible]    [illegible]
11. 4   998.27899    1.07876    42.23697    0.97932    48.07055    0.18595    0.94179    0.02554     3.1[illegible]   [illegible]
12. 41192.11957      1.08761    42.24504    0.97630    47.78094    0.19126    0.94313    0.02575     4.1[illegible]   [illegible]
13. 41385.96014      1.09574    42.25106    0.97415    47.47430    0.19506    0.94463    0.02[illegible]   3.[illegible]    [illegible]
14. 41579.80072      1.10611    42.26114    0.97070    47.28671    0.20115    0.94100    0.0261[illegible] [illegible]  [illegible]
15. 41870.56159      1.11542    42.27038    0.96769    46.92916    0.20641    0.94168    0.02633     7.[illegible]    [illegible]
16. 42161.32246      1.12859    42.28001    0.96467    46.62252    0.21174    0.94133    0.0265[illegible] 7.8[illegible] -1.[illegible]
17. 42549.00362      1.14156    42.29441    0.96036    46.14552    0.21927    0.94162    0.0269[illegible] 7.11[illegible] [illegible]
18. 42936.68478      1.15330    42.30339    0.95778    45.80481    0.22371    0.942[illegible] 0.027[illegible] 5.77[illegible] [illegible]
19. 43518.20652      1.16975    42.31851    0.95347    45.32791    0.23097    0.94375    0.027[illegible] 5.4[illegible]  [illegible]
20. 44293.56884      1.18114    42.34170    0.94744    44.64638    0.24072    0.94404    0.027[illegible] 4.9[illegible]  [illegible]
21. 45456.61232      1.19517    42.37616    0.93492    43.79460    0.25521    0.9425[illegible] 0.024[illegible] 5.3[illegible] [illegible]
22. 47007.33696      1.27386    42.41247    0.93020    42.77245    0.26184    0.94511    [illegible]  4.41[illegible]  1.[illegible]
23. 48945.74275      1.31105    42.44829    0.92272    41.71625    0.27944    0.94367    [illegible]  3.74[illegible]  1.[illegible]

                        ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE STRAIGHT CHAIN ACIDS - LEAINEI FEB 1963 RLH

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)            /FRESHLY DISTILLED N-HEPTANE                INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS C220CH     - DOCOSANOIC ACID [illegible] FROM ABS. DIST. [illegible] IN [illegible]

                                          SYSTEM PARAMETERS

               LOWER PHASE DENSITY  0.9980 G/ML          UPPER PHASE DENSITY  0.6790 G/ML
                         VISCOSITY  0.00896 POISES                  VISCOSITY  0.00386 POISES

                                   INITIAL VALUES ASSUMED IN CALCULATION

               REAL ELASTICITY (EP)   0.0               IMAGINARY ELASTICITY (EPP)   0.0
               WAVENUMBER  31.00000 RECIPROCAL  CM      DAMPING COEFFICIENT   0.70010 CM
               REFERENCE METER SCALE    1.00 MV.        INTERFACIAL TENSION 50.2000 DYNES/CM
               REFERENCE INPUT VTG.  0.100 VT.

                                         PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.97258 CM. BASED ON RESGN= 0.27830 RESFN= 5.58530 DISTGN= 0.02411 DISTFN= [illegible]

                                 CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY      DMP. COEF.       WAVE NO.       WAVELENGTH        NO. WAVES     PHS.COR.WANO  GN. PR. SCL.FCTR.
   1        159.70      0.72868941     32.82077052     0.19143314     20.75112303     32.82077052      0.97821271
   2        180.70      0.81041675     35.66268874     0.17619358     22.54794235     35.66268874      1.05922213
   3        202.20      0.89276849     38.46078201     0.16336589     24.31705317     38.46078201      0.77553843

                                        INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT = 610.00000  MG.  MOLECULAR WT.= 322.00000 MAKE-UP VOLUME=0.1500 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                        INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=      0.980 WEIGHT OF PLATE=      34.30MG.  WEIGHT OF WEIGHT=     171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.89780 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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```
                                            INPUT DATA
ID .K      INDEP. VAR.     FREQUENCY      INPUT VOLT.    OUTPUT VOLT.    METER SCALE     SFTN. VAR.

 1. 1        0.0           159.70000        0.50900        0.07350        0.50000        37.70000
 1. 2        0.0           180.70000        0.51000        0.09190        0.50000        37.70000
 1. 3        0.0           202.20000        0.51100        0.06580        0.50000        37.70000
 2. 1        0.50000       159.60000        0.51000        0.07130        0.50000        37.50000
 2. 2        0.50000       180.60000        0.51100        0.09350        0.50000        37.60000
 2. 3        0.50000       202.20000        0.51200        0.07040        0.50000        37.60000
 3. 1        5.50000       159.50000        0.51100        0.07510        0.50000        37.70000
 3. 2        5.50000       180.60000        0.51200        0.09250        0.50000        37.70000
 3. 3        5.50000       202.10000        0.51200        0.06970        0.50000        37.70000
 4. 1       35.00000       159.20000        0.51200        0.07440        0.50000        38.20000
 4. 2       35.00000       180.10000        0.51300        0.09070        0.50000        38.20000
 4. 3       35.00000       201.60000        0.51300        0.06840        0.50000        38.20000
 5. 1       65.00000       159.00000        0.51200        0.07350        0.50000        38.60000
 5. 2       65.00000       179.80000        0.51500        0.09020        0.50000        38.60000
 5. 3       65.00000       201.40000        0.51400        0.07240        0.50000        38.61000
 6. 1      115.00000       158.60000        0.51200        0.07020        0.50000        39.10000
 6. 2      115.00000       179.50000        0.51500        0.08830        0.50000        39.10000
 6. 3      115.00000       201.10000        0.51600        0.07090        0.50000        39.10000
 7. 1      165.00000       158.50000        0.51300        0.07100        0.50000        39.40000
 7. 2      165.00000       179.30000        0.51700        0.08840        0.50000        39.40000
 7. 3      165.00000       200.90000        0.51600        0.07270        0.50000        39.40000
 8. 1      225.00000       158.40000        0.51300        0.06570        0.50000        39.60000
 8. 2      225.00000       179.30000        0.51800        0.08520        0.50000        39.60000
 8. 3      225.00000       200.80000        0.51800        0.07130        0.50000        39.60000
 9. 1      325.00000       157.80000        0.51500        0.06510        0.50000        40.50000
 9. 2      325.00000       178.70000        0.51800        0.08010        0.50000        40.60000
 9. 3      325.00000       200.10000        0.51800        0.07040        0.50000        40.60000
10. 1      425.00000       157.40000        0.51400        0.06050        0.50000        41.10000
10. 2      425.00000       178.20000        0.51700        0.07770        0.50000        41.10000
10. 3      425.00000       199.70000        0.51800        0.06510        0.50000        41.10000
11. 1      525.00000       157.20000        0.51400        0.05620        0.50000        41.90000
11. 2      525.00000       177.90000        0.51800        0.07430        0.50000        41.70000
11. 3      525.00000       199.30000        0.51800        0.05770        0.50000        41.50000
12. 1      635.00000       156.90000        0.51700        0.05930        0.50000        42.40000
12. 2      635.00000       177.50000        0.51900        0.07210        0.50000        42.30000
12. 3      635.00000       198.90000        0.51800        0.06040        0.50000        42.20000
13. 1      785.00000       156.50000        0.51200        0.05470        0.50000        43.20000
13. 2      785.00000       177.10000        0.51500        0.07190        0.50000        43.20000
13. 3      785.00000       198.30000        0.51400        0.06120        0.50000        43.20000
14. 1      935.00000       156.10000        0.51200        0.05120        0.50000        43.70000
14. 2      935.00000       176.80000        0.51300        0.06640        0.50000        43.70000
14. 3      935.00000       198.00000        0.51300        0.05970        0.50000        43.70000
15. 1     1135.00000       155.70000        0.51200        0.12740        0.20000        44.60000
15. 2     1135.00000       176.40000        0.51300        0.06590        0.50000        44.55000
15. 3     1135.00000       197.50000        0.51300        0.05700        0.50000        44.50000
16. 1     1385.00000       155.20000        0.51200        0.11990        0.20000        45.30000
16. 2     1385.00000       175.80000        0.51200        0.06510        0.50000        45.30000
16. 3     1385.00000       196.90000        0.51200        0.05910        0.50000        45.30000
17. 1     1685.00000       154.70000        0.51000        0.11930        0.20000        46.40000
17. 2     1685.00000       175.20000        0.51100        0.06230        0.50000        46.40000
17. 3     1695.00000       196.40000        0.51200        0.13690        0.20000        46.40000
18. 1     1985.00000       153.90000        0.51200        0.10860        0.20000        48.00000
18. 2     1985.00000       174.20000        0.51100        0.05850        0.50000        47.90000
18. 3     1985.00000       195.20000        0.51100        0.13300        0.20000        47.90000
19. 1     2285.00000       153.50000        0.51000        0.10650        0.20000        48.70000
19. 2     2285.00000       173.80000        0.51000        0.05730        0.50000        48.70000


19. 3     2285.00000       195.00000        0.51000        0.13300        0.20000        48.70000
20. 1     2585.00000       153.10000        0.51000        0.09550        0.20000        49.60000
20. 2     2585.00000       173.40000        0.51000        0.13220        0.20000        49.50000
20. 3     2585.00000       194.40000        0.51100        0.12790        0.20000        49.40000
21. 1     3085.00000       152.40000        0.51000        0.09470        0.20000        51.20000
21. 2     3085.00000       172.50000        0.51000        0.12390        0.20000        51.10000
21. 3     3085.00000       193.40000        0.51100        0.11840        0.20000        51.10000
22. 1     3785.00000       151.20000        0.51000        0.08030        0.20000        53.00000
22. 2     3785.00000       171.30000        0.51000        0.11010        0.20000        53.00000
22. 3     3785.00000       192.10000        0.51100        0.10540        0.20000        52.90000
23. 1     4785.00000       149.70000        0.51000        0.07350        0.20000        55.90000
23. 2     4785.00000       170.00000        0.51000        0.10580        0.20000        55.80000
23. 3     4785.00000       190.40000        0.51000        0.09800        0.20000        55.80000
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                              TABLE OF RESULTS FOR  1  POSITION

         CALCULATED WAVENUMBER= 32.82077  RECIP. CM.  WAVELENGTH=0.19144  CM.  INITIAL FREQUENCY =  159.70  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1         Y2       REAL FLS.  IMAG. FLAS.

 1. 1      0.0       0.72869    32.82077    1.00000    50.20000    0.13344    0.95081    0.02227    -0.00015   -0.00015
 2. 1      0.78934   0.73594    32.82164    0.99937    50.23382    0.13297    0.94890    0.02247    -2.14702   -1.17256
 3. 1      8.68271   0.72179    32.82251    0.99875    50.20000    0.13249    0.94828    0.02199    -2.59407    1.00170
 4. 1     55.25362   0.72260    32.82509    0.99687    50.03091    0.13108    0.94768    0.02201    -3.27046    1.55047
 5. 1    102.61387   0.72385    32.82680    0.99562    49.89563    0.13014    0.94772    0.02205    -3.26117    1.41372
 6. 1    181.54762   0.73177    32.83018    0.99311    49.72654    0.12827    0.94587    0.02227    -6.03224    5.07854
 7. 1    260.48137   0.72850    32.83101    0.99249    49.62509    0.12780    0.94654    0.02217    -5.00321    3.10774
 8. 1    355.20186   0.74711    32.83185    0.99186    49.55744    0.12734    0.94656    0.02275   -11.39914   -0.52533
 9. 1    513.06936   0.74487    32.83678    0.98810    49.21926    0.12457    0.94543    0.02269    -9.88241    9.26770
10. 1    670.93685   0.75912    32.84001    0.98560    49.05016    0.12275    0.94361    0.02312     2.21092   15.11155
11. 1    828.80435   0.77582    32.84161    0.98435    48.81343    0.12185    0.94564    0.02362    41.97667   -5.20137
12.    11002.45859   0.76098    32.84397    0.98247    48.61052    0.12050    0.94576    0.02317   -31.51993    2.92100
13.    11239.25983   0.77512    32.84708    0.97996    48.33997    0.11872    0.94594    0.02360    26.77513  -37.78616
14.    11476.06108   0.78801    32.85013    0.97746    48.17087    0.11697    0.94415    0.02399    14.13425    9.56218
15.    11791.79607   0.78544    32.85313    0.97495    47.86650    0.11524    0.94504    0.02391    24.59115    5.24427
16.    12186.46480   0.79602    32.85679    0.97192    47.62977    0.11311    0.94333    0.02423    10.37335    4.11377
17.    12660.06729   0.79246    32.86036    0.96869    47.25777    0.11102    0.94433    0.02413    16.23371    4.44131
18.    13133.66977   0.80878    32.86588    0.96368    46.71667    0.10779    0.94494    0.02461    12.52057    2.04144
19.    13607.27226   0.80901    32.86854    0.96118    46.47993    0.10620    0.94459    0.02461    12.60554    3.15433
20.    14080.87474   0.83250    32.87114    0.95867    46.17556    0.10466    0.94564    0.02533     8.31633    1.16833
21.    14870.21222   0.82850    32.87551    0.95429    45.63446    0.10204    0.94775    0.02523     6.44317   -1.13231
22.    15975.28468   0.85936    32.88257    0.94678    45.02573    0.09781    0.94448    0.02611     6.00167    3.12544
23.    17553.95963   0.86901    32.89048    0.93738    44.04498    0.09302    0.94617    0.02642     5.15261    1.38637


                              TABLE OF RESULTS FOR  2  POSITION

         CALCULATED WAVENUMBER= 35.66269  RECIP. CM.  WAVELENGTH=0.17618  CM.  INITIAL FREQUENCY =  180.70  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1         Y2       REAL FLS.  IMAG. FLAS.

 1. 2      0.0       0.81042    35.66269    1.00000    50.20000    0.23495    0.94496    0.02272    -0.00017   -0.00015
 2. 2      0.78934   0.80612    35.66394    0.99945    50.23382    0.23454    0.94708    0.02261    -1.82172    1.26011
 3. 2      8.68271   0.80932    35.66394    0.99945    50.20000    0.23454    0.94771    0.02263    -1.09345   -0.73576
 4. 2     55.25362   0.81247    35.67016    0.99668    50.03091    0.23242    0.94516    0.02271    -5.27442    1.43636
 5. 2    102.61387   0.81343    35.67387    0.99502    49.89563    0.23112    0.94428    0.02289    -6.41731    3.43662
 6. 2    181.54762   0.81736    35.67757    0.99336    49.72654    0.22991    0.94403    0.02291    -7.37673    4.55447
 7. 2    260.48137   0.81737    35.68003    0.99225    49.62508    0.22992    0.94366    0.02293    -6.93375    5.05664
 8. 2    355.20186   0.82684    35.68003    0.99225    49.55744    0.22832    0.94495    0.02317    -8.07427   -0.67815
 9. 2    513.06936   0.83939    35.68736    0.98893    49.21926    0.22622    0.94450    0.02352   -14.84144   -4.97531
10. 2    670.93685   0.84400    35.69342    0.98616    49.05016    0.22373    0.94198    0.02365     0.87153   14.33151
11. 2    828.40435   0.85418    35.69703    0.98450    48.84725    0.22253    0.94743    0.02393     9.41124   25.66617
12.    21002.45859   0.86011    35.70184    0.98224    48.64434    0.22066    0.94173    0.02401     5.64990   15.94934
13.    21239.25983   0.85670    35.70461    0.98008    48.33997    0.21879    0.94301    0.02393    17.73443   63.05833
14.    21476.06106   0.87411    35.71018    0.97842    48.17087    0.21735    0.94294    0.02443    21.14111    6.83342
15.    21791.79607   0.87379    35.71491    0.97620    47.88341    0.21544    0.94344    0.02447    20.64797   -9.16367
16.    22186.46480   0.86914    35.72196    0.97288    47.62977    0.21254    0.94196    0.02433    13.32057   15.63175
17.    22660.06729   0.88008    35.72896    0.96956    47.25777    0.20955    0.94275    0.02463    17.34475    8.94131
18.    23133.66977   0.88957    35.74051    0.96403    46.75048    0.20477    0.94072    0.02483     9.63417    8.33492
19.    23607.27226   0.89231    35.74508    0.96182    46.47993    0.20282    0.94150    0.02496    12.25773    7.30845
20.    24080.87474   0.91006    35.74964    0.95960    46.20938    0.20085    0.94229    0.02546    10.74121    3.09962
21.    24870.21222   0.92077    35.75979    0.95462    45.66828    0.19642    0.94278    0.02575     9.57313    1.73435
22.    25975.28468   0.94279    35.77315    0.94798    45.02573    0.19050    0.94192    0.02615     7.73561    2.68457
23.    27553.95963   0.94417    35.78738    0.94079    44.07930    0.18407    0.94448    0.02633     5.37133   -1.21217


                              TABLE OF RESULTS FOR  3  POSITION

         CALCULATED WAVENUMBER= 38.46078  RECIP. CM.  WAVELENGTH=0.16337  CM.  INITIAL FREQUENCY =  202.20  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1         Y2       REAL FLS.  IMAG. FLAS.

 1. 3      0.0       0.89277    38.46078    1.00000    50.20000    0.28803    0.94719    0.02321    -0.00017   -0.00015
 2. 3      0.78934   0.87625    38.46078    1.00000    50.23382    0.28803    0.94675    0.02278    -0.54793    0.88974
 3. 3      8.68271   0.87826    38.46251    0.99951    50.20000    0.28827    0.94513    0.02293    -0.90127    0.84367
 4. 3     55.25362   0.88512    38.47113    0.99703    50.03091    0.28932    0.94400    0.02301    -3.34374    1.56817
 5. 3    102.61387   0.87160    38.47456    0.99604    49.89563    0.28966    0.94443    0.02265    -1.93754    2.33178
 6. 3    181.54762   0.87821    38.47970    0.99456    49.72654    0.29007    0.94444    0.02282    -2.21506    1.73476
 7. 3    260.48137   0.87209    38.48312    0.99357    49.62508    0.29029    0.94474    0.02266    -1.95571    2.23794
 8. 3    355.20186   0.87593    38.48482    0.99308    49.55744    0.29039    0.94446    0.02276    -1.57492    1.89183
 9. 3    513.06936   0.88153    38.49670    0.98961    49.21926    0.29073    0.94346    0.02290    -2.92155    2.56646
10. 3    670.93685   0.90120    38.50345    0.98764    49.05016    0.29069    0.94243    0.02341    -6.45363    3.57241
11. 3    828.80435   0.92580    38.51016    0.98566    48.88107    0.29043    0.94141    0.02404   -17.33713   17.04607
12.    31002.45859   0.91958    38.51684    0.98368    48.67815    0.29014    0.94106    0.02387    -9.49726   12.91792
13.    31239.25983   0.91361    38.52679    0.98071    48.33997    0.28931    0.94120    0.02371    -7.87525    8.60737
14.    31476.06108   0.92187    38.53174    0.97923    48.17087    0.28878    0.94129    0.02392   -11.42973   10.14447
15.    31791.79607   0.92962    38.53993    0.97676    47.90032    0.28772    0.94123    0.02412   -15.66977   13.70587
16.    32186.46480   0.92296    38.54969    0.97379    47.62977    0.28617    0.94012    0.02394    -4.35694   12.54882
17.    32660.06729   0.93672    38.55776    0.97132    47.25777    0.28467    0.94217    0.02429   -17.01847   -4.46780
18.    33133.66977   0.93945    38.57688    0.96538    46.75048    0.28032    0.93935    0.02435     0.21016   15.11522
19.    33607.27226   0.93805    38.58003    0.96439    46.47993    0.27932    0.94265    0.02431    -8.39567   -4.36744
20.    34080.87474   0.94859    38.58943    0.96142    46.24320    0.27932    0.94096    0.02454   -31.19741   24.28231
21.    34870.21222   0.96782    38.60489    0.95648    45.66828    0.27932    0.94190    0.02507     9.55993  -22.97015
22.    35975.28468   0.98840    38.62461    0.95005    45.05954    0.26984    0.94039    0.02559    18.01201    3.76535
23.    37553.95963   0.99597    38.64977    0.94164    44.07990    0.25905    0.94253    0.02577     7.72695   -4.01551
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                         ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA SOL. & INSOL. STRAIGHT CHAIN ALCOHOLS - LIA (NF) FEB 1969 PLB

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)           /FRESHLY DISTILLED N HEPTANE                   INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS C6OH(1) - HEXANOL (DISTILLED BEFORE USE)  ETOH & PURE  2/7/68

                                             SYSTEM PARAMETERS

                    LOWER PHASE DENSITY  0.9980 G/ML         UPPER PHASE DENSITY  0.6780 G/ML
                                VISCOSITY  0.00896 POISES                   VISCOSITY  0.00386 POISES

                                        INITIAL VALUES ASSUMED IN CALCULATION

                    REAL ELASTICITY (EP)    0.0              IMAGINARY ELASTICITY (EPP)    0.0
                    WAVENUMBER  31.00000 RECIPROCAL  CM      DAMPING COEFFICIENT   0.70000 CM
                    REFERENCE METER SCALE    1.00 MV.        INTERFACIAL TENSION 50.2000 DYNES/CM
                    REFERENCE INPUT VTG.  0.100 VT.

                                             PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.27810 CM. BASED ON RESGN= 0.34250 RESEN= 4.71110 DISTGN= 5.34014 DISTEN= 2.70293

                                        CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY     DMP. COEF.      WAVE NO.      WAVELENGTH      NO. WAVES   PHS.COR.WANO  GN. PR. SCL.FCTR.
    1         158.20     0.72279795    32.61317309    0.19265773    17.01517363    32.61317309     0.96693252
    2         182.30     0.81658906    35.87458724    0.17514292    18.71674152    35.87458724     0.95080877
    3         206.90     0.91060971    39.05905520    0.16086359    20.37816450    39.05905520     1.01782269
    4         232.20     1.00574735    42.20569591    0.14887043    22.01985199    42.20569591     0.86971733
                                             INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE IS THE LOGARITHIM OF THE BULK PHASE SURFACTANT CONCENTRATION (MOLES/L).
INPUT PARAMETERS ARE- WT. OF SURFACTANT =8190.00000 MG.  MOLECULAR WT. =. 102.20000 G.
MAKE-UP VOL. =    0.01000 L. TOTAL SOLUTION VOLUME =    0.49500 L
SURFACTANT SOLUTION IS ADDED TO BULK PHASE AND MIXED. THE VOLUME ADDED IN MICROLITERS IS READ IN.


                                             INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=      0.980 WEIGHT OF PLATE=      34.30MG.  WEIGHT OF WEIGHT=     171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.87242 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                   TABLE OF RESULTS FOR  1  POSITION

        CALCULATED WAVENUMBER= 32.61317 RECIP. CM.  WAVELENGTH=0.19266 CM.  INITIAL FREQUENCY =  158.20  HZ.

ID .K  INDEP. VAR.   DMP. COEF.   WAVE NO.    RFL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 1 -10.00000     0.72280     32.61317     1.00000    50.20000     0.12641     0.93096     0.02215    -0.00215   -3.00996
 2. 1  -8.09180     0.72573     32.61616     0.99810    50.06353     0.12501     0.94968     0.02225    -1.19537   -3.42938
 3. 1  -7.48974     0.72556     32.61715     0.99747    49.96118     0.12457     0.95033     0.02224    -0.47144   -3.25437
 4. 1  -6.94567     0.73003     32.61715     0.99747    49.96118     0.12457     0.95033     0.02239    -0.36781   -3.63444
 5. 1  -6.11867     0.73873     32.61813     0.99684    49.82471     0.12411     0.95164     0.02245     0.94733   -4.54333
 6. 1  -5.39808     0.74253     32.62009     0.99558    49.75647     0.12320     0.95036     0.02274     0.25444   -1.57924
 7. 1  -4.35191     0.74024     32.62203     0.99431    49.55177     0.12230     0.95170     0.02269     0.63473   -3.59115
 8. 1  -3.68536     0.76021     32.62869     0.98989    49.21059     0.11917     0.94920     0.02331     1.17154   -4.27644
 9. 1  -3.15987     0.76612     32.63333     0.98673    48.73294     0.11697     0.95199     0.02349     2.26735   -3.66134
10. 1  -2.66775     0.78714     32.64487     0.97851    47.96824     0.11144     0.95051     0.02411     3.57145   -1.75747
11. 1  -2.20786     0.84914     32.69500     0.93110    43.17178     0.08660     0.95147     0.02554     4.14433   [illegible]
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                                              INPUT DATA

ID .K       INDEP. VAR.     FREQUENCY      INPUT VCLT.    OUTPUT VOLT.    METER SCALE    SETN. VAR.

 1. 1       0.0            158.20000       0.47900        0.09920        0.50000        39.00000
 1. 2       0.0            182.30000       0.48000        0.13550        0.50000        39.00000
 1. 3       0.0            206.90000       0.48000        0.14130        0.50000        39.00000
 1. 4       0.0            232.20000       0.48000        0.11600        0.20000        39.00000
 2. 1       0.00050        157.90000       0.48000        0.09640        0.50000        39.40000
 2. 2       0.00050        182.00000       0.48000        0.13370        0.50000        39.40000
 2. 3       0.00050        206.90000       0.48000        0.13700        0.50000        39.40000
 2. 4       0.00050        232.00000       0.48100        0.11460        0.20000        39.40000
 3. 1       0.00200        157.80000       0.48000        0.09410        0.50000        39.70000
 3. 2       0.00200        181.90000       0.48000        0.13090        0.50000        39.70000
 3. 3       0.00200        206.80000       0.48000        0.13370        0.50000        39.70000
 3. 4       0.00200        231.70000       0.48100        0.11580        0.20000        39.70000
 4. 1       0.00700        157.80000       0.48000        0.09470        0.50000        39.70000
 4. 2       0.00700        181.80000       0.48000        0.12920        0.50000        39.70000
 4. 3       0.00700        206.70000       0.48000        0.13170        0.50000        39.70000
 4. 4       0.00700        231.70000       0.48100        0.11470        0.20000        39.70000
 5. 1       0.04700        157.70000       0.48000        0.09170        0.50000        40.10000
 5. 2       0.04700        181.70000       0.48000        0.12750        0.50000        40.10000
 5. 3       0.04700        206.60000       0.48100        0.12750        0.50000        40.10000
 5. 4       0.04700        231.70000       0.48200        0.11270        0.20000        40.10000
 6. 1       0.24700        157.50000       0.48000        0.08970        0.50000        40.30000
 6. 2       0.24700        181.60000       0.48100        0.12560        0.50000        40.30000
 6. 3       0.24700        206.40000       0.48200        0.12550        0.50000        40.30000
 6. 4       0.24700        231.20000       0.48300        0.12130        0.20000        40.30000
 7. 1       2.74700        157.30000       0.48100        0.09010        0.50000        40.90000
 7. 2       2.74700        181.30000       0.48200        0.12260        0.50000        40.90000
 7. 3       2.74700        206.20000       0.48300        0.12000        0.50000        40.90000
 7. 4       2.74700        231.70000       0.48300        0.11650        0.20000        40.90000
 8. 1      12.74700        156.60000       0.48200        0.08240        0.50000        41.90000
 8. 2      12.74700        180.90000       0.48200        0.11630        0.50000        41.90000
 8. 3      12.74700        205.60000       0.48300        0.10700        0.50000        41.90000
 8. 4      12.74700        230.20000       0.48400        0.11460        0.20000        41.90000
 9. 1      42.74700        156.10000       0.48000        0.07990        0.50000        43.30000
 9. 2      42.74700        179.90000       0.48200        0.10840        0.50000        43.30000
 9. 3      42.74700        204.90000       0.48300        0.09310        0.50000        43.30000
 9. 4      42.74700        229.10000       0.48400        0.11430        0.20000        43.30000
10. 1     132.74700        154.80000       0.48100        0.07040        0.50000        45.60000
10. 2     132.74700        178.70000       0.48300        0.09940        0.50000        45.60000
10. 3     132.74700        203.30000       0.48300        0.07700        0.50000        45.60000
10. 4     132.74700        227.70000       0.48400        0.11230        0.20000        45.60000
11. 1     382.74700        147.30000       0.48200        0.04190        0.50000        59.60000
11. 2     382.74700        169.90000       0.48300        0.05950        0.50000        59.60000
11. 3     382.74700        193.20000       0.48300        0.05100        0.50000        59.60000
11. 4     382.74700        217.50000       0.48700        0.10850        0.20000        59.60000
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                                         TABLE OF RESULTS FOR  4  POSITION

                CALCULATED WAVENUMBER= 42.20570  RECIP. CM.  WAVELENGTH=0.14887  CM.  INITIAL FREQUENCY =  232.20  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.   INTERF. TENS. GEN. AMPL.     Y1          Y2        REAL FLS.   IMAG. FLAS.

  1. 4 -10.00000     1.00575    42.20570    1.00000    50.20000     0.15022     0.94524     0.02383    -0.00117    -0.00031
  2. 4  -8.09180     1.01290    42.20719    0.99914    50.06353     0.15161     0.94608     0.02400     0.77315    -0.61872
  3. 4  -7.48974     1.01392    42.20951    0.99785    49.96118     0.15371     0.94541     0.02402     0.23651    -0.26849
  4. 4  -6.94567     1.01683    42.20951    0.99785    49.96118     0.15371     0.94541     0.02403     0.36172    -0.40733
  5. 4  -6.11867     1.02283    42.20951    0.99785    49.82471     0.15171     0.94830     0.02423     1.69711     0.41368
  6. 4  -5.39808     1.00796    42.21357    0.99569    49.75647     0.15724     0.94494     0.02389    -0.16832    -0.01844
  7. 4  -4.35191     1.02027    42.21357    0.99569    49.55177     0.15724     0.94844     0.02417     1.62311     0.77376
  8. 4  -3.68536     1.03954    42.22245    0.99139    49.21059     0.16442     0.94657     0.02462     1.60455    -0.37794
  9. 4  -3.15987     1.05334    42.23335    0.98665    48.73294     0.17248     0.94011     0.02495     1.84935    -0.87341
 10. 4  -2.66775     1.07828    42.24899    0.98062    47.94824     0.18293     0.94872     0.02557     2.75911     0.34517
 11. 4  -2.20786     1.19645    42.41323    0.93669    43.17179     0.25875     0.95027     0.02421     3.44514     1.17461


                                         TABLE OF RESULTS FOR  3  POSITION

                CALCULATED WAVENUMBER= 39.05906  RECIP. CM.  WAVELENGTH=0.16086  CM.  INITIAL FREQUENCY =  204.90  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.   INTERF. TENS. GEN. AMPL.     Y1          Y2        REAL FLS.   IMAG. FLAS.

  1. 3 -10.00000     0.91061    39.05906    1.00000    50.20000     0.28615     0.94446     0.02331    -0.00017    -0.00016
  2. 3  -8.09180     0.92004    39.05906    1.00000    50.06353     0.28615     0.94944     0.02355     1.41254     0.44530
  3. 3  -7.49974     0.92654    39.06121    0.99952    49.96118     0.29528     0.95031     0.02377     1.65445     0.54295
  4. 3  -6.94567     0.93024    39.06337    0.99903    49.96118     0.28444     0.94923     0.02391     1.64551     0.16516
  5. 3  -6.11867     0.93991    39.06553    0.99855    49.82471     0.28355     0.95975     0.02405     2.20445     0.54138
  6. 3  -5.39808     0.94380    39.06784    0.99758    49.75647     0.28219     0.94990     0.02416     2.14434     0.21444
  7. 3  -4.35191     0.95672    39.07415    0.99667    49.55177     0.28071     0.95166     0.02449     2.60554     0.22247
  8. 3  -3.69536     0.98853    39.08706    0.99372    49.21059     0.27902     0.95175     0.02524     3.16614     0.69542
  9. 3  -3.15987     1.02926    39.10207    0.99033    48.73294     0.27645     0.95344     0.02637     3.55441     1.21164
 10. 3  -2.66775     1.09593    39.13613    0.98260    47.94824     0.24443     0.95148     0.02800     4.17721     1.62443
 11. 3  -2.20786     1.21601    39.33764    0.93378    43.17178     0.27932     0.93977     0.03091     4.41335     2.64411


                                         TABLE OF RESULTS FOR  2  POSITION

                CALCULATED WAVENUMBER= 35.87459  RECIP. CM.  WAVELENGTH=0.17514  CM.  INITIAL FREQUENCY =  182.30  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.   INTERF. TENS. GEN. AMPL.     Y1          Y2        REAL FLS.   IMAG. FLAS.

  1. 2 -10.00000     0.81659    35.87459    1.00000    50.20000     0.24120     0.94873     0.02274    -0.00717    -0.00016
  2. 2  -8.09180     0.81927    35.87923    0.99835    50.06353     0.24010     0.94782     0.02283    -0.77039    -0.32453
  3. 2  -7.48974     0.82524    35.88077    0.99791    49.96118     0.23972     0.94859     0.02300     0.09741    -0.49915
  4. 2  -6.94567     0.82875    35.88232    0.99726    49.96118     0.23934     0.94743     0.02310    -1.01252    -1.31390
  5. 2  -6.11867     0.83230    35.88385    0.99671    49.82471     0.23896     0.94886     0.02313     0.51917    -0.73020
  6. 2  -5.39808     0.83702    35.88539    0.99616    49.75647     0.23857     0.94899     0.02332     0.82419    -0.87214
  7. 2  -4.35191     0.84352    35.88999    0.99451    49.55177     0.23739     0.94940     0.02359     1.31174    -0.81451
  8. 2  -3.68536     0.85753    35.89608    0.99232    49.21059     0.23578     0.95128     0.02383     2.24631    -0.03549
  9. 2  -3.15987     0.87348    35.91118    0.98683    48.73294     0.23156     0.94492     0.02432     2.77703    -1.54776
 10. 2  -2.66775     0.89143    35.92901    0.98025    47.94924     0.22622     0.95011     0.02487     3.32686    -0.47012
 11. 2  -2.20786     0.98626    36.05154    0.93198    43.17178     0.18357     0.94417     0.02736     5.86994     1.29314
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                    ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA SOL. & INSOL. STRAIGHT CHAIN ALCOHOLS - LIA (NF) FEB 1968 RLB

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)          /FRESHLY DISTILLED N HEPTANE               INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS C6OH(2)   - HEXANOL (DISTILLED BEFORE USE)  ETCH & PURE  2/7/68

                                   SYSTEM PARAMETERS

               LOWER PHASE DENSITY  0.9980 G/ML        UPPER PHASE DENSITY  0.6780 G/ML
                     VISCOSITY  0.00896 POISES                  VISCOSITY  0.00386 POISES

                               INITIAL VALUES ASSUMED IN CALCULATION

               REAL ELASTICITY (EP)   0.0              IMAGINARY ELASTICITY (EPP)   0.0
               WAVENUMBER  31.00000 RECIPROCAL  CM     DAMPING COEFFICIENT   0.70000 CM
               REFERENCE METER SCALE    1.00 MV.       INTERFACIAL TENSION 50.2000 DYNES/CM
               REFERENCE INPUT VTG.  0.100 VT.

                                   PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.34071 CM, BASED ON RESGN= 0.25870 HESFN= 4.71110 DISTGN= 6.04274 DISTFN= 2.70203

                              CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY    CMP. COEF.     WAVE NO.      WAVELENGTH     NO. WAVES    PHS.COR.WAVE NO. PR. SCL.FCTR.
   1        158.30     0.72319095    32.62703320    0.19257589    17.34747713    32.62703320     0.97693829
   2        183.90     0.82275406    36.08586986    0.17411746    19.18650794    36.08586986     0.99385405
   3        210.10     0.92272509    39.46381554    0.15921370    20.98252800    39.46381554     1.02013954
   4        236.90     1.02326372    42.77746685    0.14688060    22.74436427    42.77746685     1.22764294

                                   INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE IS THE LOGARITHIM OF THE BULK PHASE SURFACTANT CONCENTRATION (MOLES/L).
INPUT PARAMETERS ARE- WT. OF SURFACTANT =8190.00000 MG.  MOLECULAR WT. =, 102.20000 G.
MAKE-UP VOL. =    0.01000 L. TOTAL SOLUTION VOLUME =    0.49500 L
SURFACTANT SOLUTION IS ADDED TO BULK PHASE AND MIXED, THE VOLUME ADDED IN MICROLITERS IS READ IN.


                                   INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=     34.30MG.  WEIGHT OF WEIGHT=    171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.92709 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.

                                   INPUT DATA

ID .K        INDEP. VAR.     FREQUENCY      INPUT VOLT.    OUTPUT VOLT.     METER SCALE     SETN. VAR.

  1. 1        0.0           158.30000       0.49900        0.11270         0.50000         36.20000
  1. 2        0.0           183.90000       0.50000        0.07840         1.00000         36.20000
  1. 3        0.0           210.10000       0.50100        0.07400         1.00000         36.20000
  1. 4        0.0           236.90000       0.50500        0.12140         0.20000         36.20000
  2. 1       50.00000       156.40000       0.50000        0.09610         0.50000         41.80000
  2. 2       50.00000       181.60000       0.50100        0.12820         0.50000         41.80000
  2. 3       50.00000       207.90000       0.50200        0.10310         0.50000         41.80000
  2. 4       50.00000       234.10000       0.50400        0.11830         0.20000         41.80000
  3. 1      100.00000       155.60000       0.50100        0.08990         0.50000         43.10000
  3. 2      100.00000       180.80000       0.50200        0.12320         0.50000         43.10000
  3. 3      100.00000       207.10000       0.50300        0.09130         0.50000         43.10000
  3. 4      100.00000       232.90000       0.50300        0.12060         0.20000         43.10000
  4. 1      200.00000       153.90000       0.50100        0.06710         0.50000         48.40000
  4. 2      200.00000       177.50000       0.50300        0.09120         0.50000         48.40000
  4. 3      200.00000       203.20000       0.50300        0.05640         0.50000         48.40000
  4. 4      200.00000       229.00000       0.50300        0.10840         0.20000         48.40000
  5. 1      275.00000       150.80000       0.50200        0.05730         0.50000         52.40000
  5. 2      275.00000       175.10000       0.50300        0.08270         0.50000         52.40000
  5. 3      275.00000       200.40000       0.50300        0.05570         0.50000         52.40000
  5. 4      275.00000       226.00000       0.50300        0.12030         0.20000         52.40000
  6. 1      375.00000       148.30000       0.50200        0.11840         0.20000         56.60000
  6. 2      375.00000       172.60000       0.50300        0.06950         0.50000         56.60000
  6. 3      375.00000       197.60000       0.50300        0.11270         0.20000         56.60000
  6. 4      375.00000       222.80000       0.50400        0.12730         0.20000         56.60000
  7. 1      500.00000       145.50000       0.50100        0.09490         0.20000         61.80000
  7. 2      500.00000       169.70000       0.50200        0.05670         0.50000         61.80000
  7. 3      500.00000       194.10000       0.50300        0.09700         0.20000         61.80000
  7. 4      500.00000       219.80000       0.50400        0.10410         0.20000         61.80000
  8. 1      700.00000       141.50000       0.48300        0.07150         0.20000         67.80000
  8. 2      700.00000       166.10000       0.50200        0.12030         0.20000         67.80000
  8. 3      700.00000       189.80000       0.50300        0.08230         0.20000         67.80000
  8. 4      700.00000       216.00000       0.50400        0.06740         0.20000         67.80000
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                                        TABLE OF RESULTS FOR  1  POSITION

              CALCULATED WAVENUMBER= 32.62703  RECIP. CM.  WAVELENGTH=0.19258  CM.  INITIAL FREQUENCY =  158.10  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

 1. 1 -10.00000     0.72319    32.62703    1.00000    50.20000    0.12687     0.95095     0.02217    -0.03315   [illegible]
 2. 1  -3.09180     0.75050    32.64508    0.98800    48.32509    0.11929     0.96268     0.02293     2.71441   [illegible]
 3. 1  -2.79077     0.76515    32.65223    0.98234    47.88985    0.11481     0.96058     0.02343     2.64238   [illegible]
 4. 1  -2.48974     0.83078    32.66651    0.97220    46.11538    0.10779     0.97489     0.02543     2.55462   [illegible]
 5. 1  -2.35144     0.84548    32.68899    0.95262    44.77617    0.09649     0.96202     0.02595     3.02307   [illegible]
 6. 1  -2.21674     0.87866    32.70347    0.93693    43.36999    0.08709     0.95928     0.02687     3.22341   [illegible]
 7. 1  -2.09180     0.92233    32.71565    0.91914    41.62900    0.08278     0.96094     0.02813     3.14293   [illegible]
 8. 1  -1.94567     0.97325    32.72600    0.89397    39.62018    0.07467     0.95401     0.02974     3.57125   [illegible]


                                        TABLE OF RESULTS FOR  2  POSITION

              CALCULATED WAVENUMBER= 36.08587  RECIP. CM.  WAVELENGTH=0.17412  CM.  INITIAL FREQUENCY =  183.70  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

 1. 2 -10.00000     0.82275    36.08587    1.00000    50.20000    0.24644     0.94860     0.02291    -0.03317   [illegible]
 2. 2  -3.09180     0.87392    36.12112    0.98749    48.32509    0.23057     0.95809     0.02414     2.75141   [illegible]
 3. 2  -2.79077     0.88237    36.13311    0.98314    47.88985    0.23517     0.95735     0.02442     2.77535   [illegible]
 4. 2  -2.48974     0.95369    36.18115    0.96520    46.11538    0.22065     0.95441     0.02636     3.44211   [illegible]
 5. 2  -2.35144     0.96095    36.21478    0.95215    44.77617    0.20917     0.95390     0.02671     3.43514   [illegible]
 6. 2  -2.21674     1.00094    36.24873    0.93455    43.36999    0.19692     0.95422     0.02761     3.49424   [illegible]
 7. 2  -2.09180     1.03465    36.28674    0.92278    41.62900    0.18258     0.95748     0.02862     3.21154   [illegible]
 8. 2  -1.94567     1.05698    36.33170    0.90321    39.62018    0.16474     0.96072     0.02903     3.03465   [illegible]


                                        TABLE OF RESULTS FOR  3  POSITION

              CALCULATED WAVENUMBER= 39.46387  RECIP. CM.  WAVELENGTH=0.15921  CM.  INITIAL FREQUENCY =  210.10  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

 1. 3 -10.00000     0.92273    39.46382    1.00000    50.20000    0.31594     0.94654     0.02334    -0.03317   [illegible]
 2. 3  -3.09180     1.01720    39.51045    0.98953    48.32509    0.29665     0.95347     0.02563     4.07325   [illegible]
 3. 3  -2.79077     1.03929    39.52741    0.98572    47.88985    0.28803     0.95952     0.02623     3.13455   [illegible]
 4. 3  -2.48974     1.18182    39.60935    0.96716    46.11538    0.28484     0.95333     0.02744     3.94215   [illegible]
 5. 3  -2.35144     1.19156    39.66669    0.95383    44.77617    0.29065     0.95043     0.03034     4.04193   [illegible]
 6. 3  -2.21674     1.25156    39.72219    0.94050    43.36999    0.28735     0.95063     0.03151     3.93435   [illegible]
 7. 3  -2.09180     1.28788    39.78853    0.92395    41.62900    0.27932     0.95164     0.03337     3.77311   [illegible]
 8. 3  -1.94567     1.30980    39.86510    0.90338    39.62018    0.25685     0.94958     0.03286     3.66317   [illegible]


                                        TABLE OF RESULTS FOR  4  POSITION

              CALCULATED WAVENUMBER= 42.77747  RECIP. CM.  WAVELENGTH=0.14688  CM.  INITIAL FREQUENCY =  236.90  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

 1. 4 -10.00000     1.02326    42.77747    1.00000    50.20000    0.11953     0.94496     0.02393    -0.03317   [illegible]
 2. 4  -3.09180     1.07134    42.78935    0.98819    48.32509    0.13736     0.95776     0.02505     2.85182   [illegible]
 3. 4  -2.79077     1.08269    42.79660    0.98312    47.88985    0.14540     0.95639     0.02531     2.84211   [illegible]
 4. 4  -2.48974     1.16592    42.82962    0.96665    46.11538    0.17322     0.95769     0.02727     3.17442   [illegible]
 5. 4  -2.35144     1.17256    42.86503    0.95339    44.77617    0.19592     0.95828     0.02735     3.07517   [illegible]
 6. 4  -2.21674     1.19110    42.91164    0.94048    43.36999    0.22002     0.95860     0.02774     3.02536   [illegible]
 7. 4  -2.09180     1.27938    42.96241    0.92782    41.62900    0.24140     0.96834     0.02977     3.06188    2.25444
 8. 4  -1.94567     1.43118    43.03429    0.91178    39.62018    0.26193     0.97764     0.03333     3.03344    2.30733
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                         ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA SOL. & INSOL. STRAIGHT CHAIN ALCOHOLS - LIA (NF) FEB 1968 RLR

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)          /FRESHLY DISTILLED N HEPTANE                 INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS C10OH    - DECANOL (DISTILLED BEFORE USE)  ETOH & PURE  2/8/68

                                        SYSTEM PARAMETERS

              LOWER PHASE DENSITY  0.9980 G/ML          UPPER PHASE DENSITY  0.6780 G/ML
                    VISCOSITY  0.00896 POISES                     VISCOSITY  0.00386 POISES

                                   INITIAL VALUES ASSUMED IN CALCULATION

              REAL ELASTICITY (EP)   0.0             IMAGINARY ELASTICITY (EPP)   0.0
              WAVENUMBER  31.00000 RECIPROCAL  CM    DAMPING COEFFICIENT   0.70000 CM
              REFERENCE METER SCALE    1.00 MV.      INTERFACIAL TENSION 50.2000 DYNES/CM
              REFERENCE INPUT VTG.  0.100 VT.

                                        PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.36940 CM. BASED ON RESGN= 0.29810 RESFN= 4.78930 DISTGN= 6.01334 DISTFN= 2.64394

                                   CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY     DMP. COEF.      WAVE NO.      WAVELENGTH      NO. WAVES   PHS.COR.WANO  GN. PB. SCL.FCTR.
    1         160.20     0.73065155   32.88982556     0.19103719    17.63738323    32.88982556      0.86766196
    2         184.60     0.82544896   36.17811418     0.17367351    19.40074943    36.17811418      0.83346730
    3         210.00     0.92234744   39.45119782     0.15926462    21.15596186    39.45119782      0.91413793
    4         235.30     1.01730597   42.58324641     0.14755052    22.83554331    42.58324641      1.00216609

                                        INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE IS THE LOGARITHIM OF THE BULK PHASE SURFACTANT CONCENTRATION (MOLES/L).
INPUT PARAMETERS ARE- WT. OF SURFACTANT =8292.00000 MG.  MOLECULAR WT. =, 158.30000 G.
MAKE-UP VOL. =   0.01000 L. TOTAL SOLUTION VOLUME =   0.49500 L
SURFACTANT SOLUTION IS ADDED TO BULK PHASE AND MIXED, THE VOLUME ADDED IN MICROLITERS IS READ IN.


                                        INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=     34.30MG.  WEIGHT OF WEIGHT=    171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.88413 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATICNS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                        INPLT DATA

ID .K     INDEP. VAR.     FREQUENCY     INPUT VOLT.     OUTPUT VOLT.     METER SCALE     SFTN. VAR.

 1. 1      0.0            160.20000      0.50100         0.10070         0.50000         38.40000
 1. 2      0.0            184.60000      0.50300         0.12900         0.50000         38.40000
 1. 3      0.0            210.00000      0.50300         0.12970         0.50000         38.40000
 1. 4      0.0            235.30000      0.50400         0.10620         0.20000         38.40000
 2. 1      0.00050        160.30000      0.50200         0.10370         0.50000         38.50000
 2. 2      0.00050        184.60000      0.50300         0.12780         0.50000         38.50000
 2. 3      0.00050        210.00000      0.50300         0.12820         0.50000         38.50000
 2. 4      0.00050        235.40000      0.50600         0.10680         0.20000         38.50000
 3. 1      0.00550        160.20000      0.50200         0.10290         0.50000         38.50000
 3. 2      0.00550        184.40000      0.50300         0.12550         0.50000         38.50000
 3. 3      0.00550        209.90000      0.50300         0.12630         0.50000         38.50000
 3. 4      0.00550        235.00000      0.50400         0.10900         0.20000         38.50000
 4. 1      0.05550        160.10000      0.50200         0.09970         0.50000         38.60000
 4. 2      0.05550        184.30000      0.50300         0.12390         0.50000         38.60000
 4. 3      0.05550        209.90000      0.50300         0.12350         0.50000         38.60000
 4. 4      0.05550        235.00000      0.50400         0.10740         0.20000         38.60000
 5. 1      0.55550        160.00000      0.50200         0.09900         0.50000         38.80000
 5. 2      0.55550        184.30000      0.50200         0.12250         0.50000         38.80000
 5. 3      0.55550        209.80000      0.50300         0.12300         0.50000         38.80000
 5. 4      0.55550        234.60000      0.50300         0.10810         0.20000         38.80000
 6. 1     10.50000        159.60000      0.50200         0.09430         0.50000         39.60000
 6. 2     10.50000        183.90000      0.50300         0.11690         0.50000         39.60000
 6. 3     10.50000        209.40000      0.50300         0.11740         0.50000         39.60000
 6. 4     10.50000        234.40000      0.50400         0.09800         0.20000         39.60000
 7. 1     50.50000        159.10000      0.50400         0.08950         0.50000         40.40000
 7. 2     50.50000        183.40000      0.50300         0.11340         0.50000         40.40000
 7. 3     50.50000        208.80000      0.50300         0.10610         0.50000         40.40000
 7. 4     50.50000        233.60000      0.50400         0.09320         0.20000         40.40000
 8. 1    130.50000        157.60000      0.50300         0.08010         0.50000         43.40000
 8. 2    130.50000        181.70000      0.50300         0.10340         0.50000         43.40000
 8. 3    130.50000        207.10000      0.50300         0.07510         0.50000         43.40000
 8. 4    130.50000        237.00000      0.50400         0.09400         0.20000         43.40000
 9. 1    210.50000        156.40000      0.50200         0.07300         0.50000         45.90000
 9. 2    210.50000        180.20000      0.50300         0.09690         0.50000         45.90000
 9. 3    210.50000        205.20000      0.50300         0.06070         0.50000         45.90000
 9. 4    210.50000        229.90000      0.50300         0.09900         0.20000         45.90000
10. 1    390.50000        152.20000      0.50100         0.05350         0.50000         54.10000
10. 2    390.50000        175.60000      0.50200         0.07630         0.50000         54.10000
10. 3    390.50000        199.80000      0.50300         0.05950         0.50000         54.10000
10. 4    390.50000        224.10000      0.50300         0.11480         0.20000         54.10000
11. 1    590.50000        148.00000      0.50000         0.09330         0.20000         63.90000
11. 2    590.50000        171.00000      0.50200         0.05730         0.50000         63.90000
11. 3    590.50000        194.40000      0.50300         0.12990         0.20000         63.90000
11. 4    590.50000        218.30000      0.50300         0.11140         0.20000         63.90000
12. 1    790.50000        144.60000      0.50000         0.08410         0.20000         70.20000
12. 2    790.50000        167.20000      0.50200         0.12000         0.20000         70.20000
12. 3    790.50000        190.10000      0.50200         0.10400         0.20000         70.20000
12. 4    790.50000        213.70000      0.50300         0.10400         0.20000         70.20000
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                                        TABLE OF RESULTS FOR  1  POSITION

              CALCULATED WAVENUMBER= 32.88983  RECIP. CM.  WAVELENGTH=0.19104  CM.  INITIAL FREQUENCY =  160.20  HZ.

ID .K  INDEP. VAR.   DMP. COEF.   WAVE NO.     REL. FQ.   INTERF. TENS. GEN. AMPL.     Y1            Y2        REAL ELS.   IMAG. ELAS.

 1. 1 -10.00000      0.73069     32.88983     1.00000     50.20000     0.13983     0.95076     0.02222    -0.00016    -0.00135
 2. 1  -8.27646      0.72358     32.88978     1.00062     50.16602     0.13630     0.95268     0.02200     0.95354     0.72874
 3. 1  -7.23506      0.72483     32.88983     1.00000     50.16602     0.13983     0.95140     0.02204     0.36792     0.46562
 4. 1  -6.23113      0.73316     32.89087     0.99938     50.13204     0.13535     0.95077     0.02224     0.09364    -0.13984
 5. 1  -5.23074      0.73420     32.89191     0.99875     50.06408     0.13487     0.95078     0.02232     0.03172    -0.18134
 6. 1  -3.95424      0.76447     32.89603     0.99625     49.79225     0.13297     0.95044     0.02241     0.44751    -2.71412
 7. 1  -3.27214      0.75579     32.90110     0.99313     49.52042     0.13061     0.94944     0.02297     0.12542    -2.91142
 8. 1  -2.85982      0.77191     32.91579     0.98377     48.50105     0.12366     0.95013     0.02345     1.68049    -2.21441
 9. 1  -2.65217      0.78567     32.92693     0.97628     47.65157     0.11028     0.95143     0.02184     2.59831    -0.53844
10. 1  -2.34381      0.83134     32.96099     0.95006     44.86529     0.10131     0.95401     0.02527     3.21496     0.49634
11. 1  -2.20421      0.89489     32.98632     0.92385     41.53535     0.08831     0.97216     0.02711     2.87795     2.05165
12. 1  -2.07752      0.90197     32.99990     0.90262     39.39467     0.08117     0.97722     0.02711     2.61837     2.10117


                                        TABLE OF RESULTS FOR  2  POSITION

              CALCULATED WAVENUMBER= 36.17811  RECIP. CM.  WAVELENGTH=0.17367  CM.  INITIAL FREQUENCY =  184.63  HZ.

ID .K  INDEP. VAR.   DMP. COEF.   WAVE NO.     REL. FQ.   INTERF. TENS. GEN. AMPL.     Y1            Y2        REAL ELS.   IMAG. ELAS.

 1. 2 -10.00000      0.82565     36.17811     1.00000     50.20000     0.24831     0.94454     0.02283    -0.00117    [illegible]
 2. 2  -8.27646      0.82822     36.17811     1.00000     50.16602     0.24831     0.94918     0.02284    [illegible] [illegible]
 3. 2  -7.23506      0.83101     36.18124     0.99807     50.16602     0.24781     0.94658    [illegible] [illegible] [illegible]
 4. 2  -6.23113      0.83651     36.18279     0.99837     50.13204     0.24755     0.94637     0.02112    [illegible] [illegible]
 5. 2  -5.23074      0.83929     36.18279     0.99437     50.06408     0.24755     0.94786     0.02121    [illegible] [illegible]
 6. 2  -3.95424      0.85244     36.18900     0.99621     49.79225     0.24644     0.94921     0.02155     0.81527    [illegible]
 7. 2  -3.27214      0.85860     36.19670     0.99350     49.52042     0.24494     0.94763    [illegible]  0.82191    [illegible]
 8. 2  -2.85982      0.87971     36.22746     0.98429     48.50105     0.23896     0.94767     0.02423     2.41334    [illegible]
 9. 2  -2.65217      0.89129     36.24465     0.97616     47.65157     0.23285     0.94698     0.02451     3.21371    [illegible]
10. 2  -2.34381      0.93322     36.30995     0.95125     44.86529     0.21159     0.94094     0.02571     3.14584    [illegible]
11. 2  -2.20421      0.96473     36.37145     0.92633     41.53535     0.18902     0.96811     0.02707     2.81514    [illegible]
12. 2  -2.07752      1.00615     36.41939     0.90574     39.39467     0.17019     0.97231     0.02763    [illegible] [illegible]


                                        TABLE OF RESULTS FOR  3  POSITION

              CALCULATED WAVENUMBER= 39.45120  RECIP. CM.  WAVELENGTH=0.15926  CM.  INITIAL FREQUENCY =  210.00  HZ.

ID .K  INDEP. VAR.   DMP. COEF.   WAVE NO.     REL. FQ.   INTERF. TENS. GEN. AMPL.     Y1            Y2        REAL ELS.   IMAG. ELAS.

 1. 3 -10.00000      0.92235     39.45120     1.00000     50.20000     0.31551     0.94665     0.02333    -0.00117    [illegible]
 2. 3  -8.27646      0.92580     39.45120     1.00000     50.16602     0.31551     0.94729     0.02367    [illegible] [illegible]
 3. 3  -7.23506      0.92844     39.45330     0.99952     50.16602     0.31510     0.94623    [illegible] [illegible] [illegible]
 4. 3  -6.23113      0.93650     39.45330     0.99952     50.13204     0.31510     0.94647     0.02174    [illegible] [illegible]
 5. 3  -5.23074      0.93726     39.45539     0.99905     50.06408     0.31463     0.94711    [illegible] [illegible] [illegible]
 6. 3  -3.95424      0.94468     39.46179     0.99714     49.79225     0.31204     0.94434     0.02404    [illegible] [illegible]
 7. 3  -3.27214      0.97353     39.47640     0.99429     49.52042     0.30669     0.94648    [illegible] [illegible] [illegible]
 8. 3  -2.85982      1.05747     39.51215     0.98619     48.50105     0.28803     0.94453     0.02676     4.47341    [illegible]
 9. 3  -2.65217      1.10858     39.55195     0.97714     47.65157     0.27655     0.94415     0.02903     5.41111    [illegible]
10. 3  -2.34381      1.12933     39.66720     0.95143     44.86529     0.29072     0.96359     0.02947    [illegible] [illegible]
11. 3  -2.20421      1.15768     39.76555     0.92571     41.53535     0.27932     0.95738     0.02911    [illegible] [illegible]
12. 3  -2.07752      1.19938     39.84184     0.90524     39.39467     0.25788     0.95971    [illegible] [illegible] [illegible]


                                        TABLE OF RESULTS FOR  4  POSITION

              CALCULATED WAVENUMBER= 42.58325  RECIP. CM.  WAVELENGTH=0.14755  CM.  INITIAL FREQUENCY =  235.30  HZ.

ID .K  INDEP. VAR.   DMP. COEF.   WAVE NO.     REL. FQ.   INTERF. TENS. GEN. AMPL.     Y1            Y2        REAL ELS.   IMAG. ELAS.

 1. 4 -10.00000      1.01731     42.58325     1.00000     50.20000     0.12954     0.94505     0.02383    -0.00117    -0.00135
 2. 4  -8.27646      1.01534     42.58281     1.00042     50.16602     0.12891     0.94653     0.02344     0.86831     0.45662
 3. 4  -7.23506      1.01396     42.58459     0.99873     50.16602     0.13147     0.94320     0.02381    -1.95124     0.11551
 4. 4  -6.23113      1.01725     42.58459     0.99873     50.13204     0.13147     0.94383     0.02383    -1.15565    -0.14933
 5. 4  -5.23074      1.02163     42.58651     0.99793     50.06408     0.13406     0.94177     0.02433    -4.75611    [illegible]
 6. 4  -3.95424      1.05621     42.58752     0.99618     49.79225     0.13537     0.94523     0.02475     1.43376    -1.41636
 7. 4  -3.27214      1.08051     42.59192     0.99278     49.52042     0.14067     0.94365     0.02537     3.22744    [illegible]
 8. 4  -2.85982      1.10020     42.60250     0.98538     48.50105     0.15161     0.94963     0.02582     3.06644    [illegible]
 9. 4  -2.65217      1.11722     42.62012     0.97705     47.65157     0.16660     0.94796     0.02613     3.21413    [illegible]
10. 4  -2.34381      1.13735     42.65052     0.95240     44.86529     0.21026     0.95135     0.02664     2.95443     1.21741
11. 4  -2.20421      1.19093     42.78792     0.92775     41.53535     0.25109     0.96908     0.02807     2.83554    [illegible]
12. 4  -2.07752      1.25571     42.87795     0.90820     39.39467     0.28393     0.97298     0.02923     2.84257    [illegible]
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                              ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA SOL. & INSOL. STRAIGHT CHAIN ALCOHOLS - LIA (NP) FEB 1966 RLB

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)           /FRESHLY DISTILLED N HEPTANE            INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS C14OH    - TETRADECANOL (1X FROM ABS. DIST. ETHANOL) IN ETOH  2/9/69

                                             SYSTEM PARAMETERS

                     LOWER PHASE DENSITY  0.9980 G/ML        UPPER PHASE DENSITY  0.6780 G/ML
                            VISCOSITY  0.00896 POISES                  VISCOSITY  0.00386 POISES

                                       INITIAL VALUES ASSUMED IN CALCULATION

                     REAL ELASTICITY (EP)   0.0            IMAGINARY ELASTICITY (EPP)   0.0
                     WAVENUMBER  31.00000 RECIPROCAL  CM    DAMPING COEFFICIENT   0.70000 CM
                     REFERENCE METER SCALE    1.00 MV.      INTERFACIAL TENSION 50.2000 DYNES/CM
                     REFERENCE INPUT VTG.  0.100 VT.

                                             PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.36472 CM. BASED ON RESGN= 0.28340 RESFN= 4.76820 DISTGN= 6.02431 DISTFN= 2.65959

                                       CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY      DMP. COEF.       WAVE NO.        WAVELENGTH       NO. WAVES    PHS.COR.WANO  GN. PB. SCL.FCTR.
    1         161.20     0.73457336    33.02772131       0.19023959      17.68672684     33.02772131       0.84450857
    2         185.70     0.82968103    36.32283556       0.17298154      19.45129864     36.32283556       0.74251879
    3         211.30     0.92726277    39.61507338       0.15860579      21.21433008     39.61507338       0.77466264

                                             INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT = 212.00000  MG.  MOLECULAR WT.= 214.30000 MAKE-UP VOLUME=0.0500 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                             INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=     34.30MG.  WEIGHT OF WEIGHT=    171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.90365 CM.  CALCULATED FRACTION IN LOWER PHASE=0.700
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                              INPUT DATA

ID .K      INDEP. VAR.      FREQUENCY      INPUT VOLT.     OUTPUT VOLT.     METER SCALE     SFYN. VAR.

 1. 1        0.0            161.20000        0.50100         0.10050         0.50000        37.40000
 1. 2        0.0            185.70000        0.50300         0.11320         0.50000        37.40000
 1. 3        0.0            211.30000        0.50700         0.10750         0.50000        37.40000
 2. 1        0.00500        161.00000        0.50200         0.09360         0.50000        37.40000
 2. 2        0.00500        185.70000        0.50200         0.11300         0.50000        37.40000
 2. 3        0.00500        211.10000        0.50300         0.10670         0.50000        37.40000
 3. 1        0.05500        160.80000        0.50200         0.09170         0.50000        37.40000
 3. 2        0.05500        185.60000        0.50300         0.11050         0.50000        37.40000
 3. 3        0.05500        211.10000        0.50300         0.10240         0.50000        37.40000
 4. 1        0.55500        160.90000        0.50200         0.09870         0.50000        37.50000
 4. 2        0.55500        185.50000        0.50400         0.11620         0.50000        37.50000
 4. 3        0.55500        211.00000        0.50400         0.10350         0.50000        37.50000
 5. 1       15.55500        160.90000        0.50700         0.09480         0.50000        37.70000
 5. 2       15.55500        185.30000        0.50400         0.11050         0.50000        37.70000
 5. 3       15.55500        210.70000        0.50700         0.10510         0.50000        37.70000
 6. 1       65.50000        160.50000        0.50300         0.09320         0.50000        38.10000
 6. 2       65.50000        185.00000        0.50300         0.11010         0.50000        38.10000
 6. 3       65.50000        210.40000        0.50400         0.10480         0.50000        38.10000
 7. 1      115.50000        160.40000        0.50300         0.09130         0.50000        38.50000
 7. 2      115.50000        184.80000        0.50300         0.10690         0.50000        38.50000
 7. 3      115.50000        210.40000        0.50800         0.09770         0.50000        38.50000
 8. 1      225.50000        159.90000        0.50300         0.09150         0.50000        39.20000
 8. 2      225.50000        184.20000        0.50400         0.10390         0.50000        39.20000
 8. 3      225.50000        209.90000        0.50500         0.09540         0.50000        39.20000
 9. 1      371.00000        159.90000        0.50300         0.08270         0.50000        39.40000
 9. 2      371.00000        184.10000        0.50300         0.10140         0.50000        39.40000
 9. 3      371.00000        209.60000        0.50500         0.10030         0.50000        39.40000
10. 1      663.00000        159.50000        0.50300         0.08150         0.50000        40.20000
10. 2      663.00000        183.80000        0.50300         0.09850         0.50000        40.20000
10. 3      663.00000        209.30000        0.50600         0.09900         0.50000        40.20000
11. 1     1833.00000        159.10000        0.50300         0.07850         0.50000        41.30000
11. 2     1833.00000        183.20000        0.50400         0.09490         0.50000        41.30000
11. 3     1833.00000        208.80000        0.50600         0.08290         0.50000        41.30000
12. 1     2563.00000        157.80000        0.50400         0.07090         0.50000        43.90000
12. 2     2563.00000        181.90000        0.50600         0.08890         0.50000        43.70000
12. 3     2563.00000        207.40000        0.50700         0.07690         0.50000        43.60000
13. 1     3478.00000        157.10000        0.50300         0.06450         0.50000        45.20000
13. 2     3478.00000        181.20000        0.50300         0.08500         0.50000        45.00000
13. 3     3478.00000        206.40000        0.50600         0.06420         0.50000        44.90000
14. 1     4868.00000        155.30000        0.50200         0.05730         0.50000        48.50000
14. 2     4868.00000        179.20000        0.50400         0.07500         0.50000        48.30000
14. 3     4868.00000        204.30000        0.50300         0.05140         0.50000        48.30000
15. 1     6688.00000        153.60000        0.50200         0.11750         0.20000        51.80000
15. 2     6688.00000        177.30000        0.50700         0.06500         0.50000        51.60000
15. 3     6688.00000        202.10000        0.50600         0.10360         0.20000        51.40000
16. 1     9608.00000        151.80000        0.50300         0.09820         0.20000        57.20000
16. 2     9608.00000        174.20000        0.50300         0.13700         0.20000        57.00000
16. 3     9608.00000        198.40000        0.50500         0.09650         0.20000        56.80000
17. 1    13258.00000        148.10000        0.48700         0.08450         0.20000        61.80000
17. 2    13258.00000        171.40000        0.50300         0.11440         0.20000        61.40000
17. 3    13258.00000        195.10000        0.50600         0.09260         0.20000        61.20000
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                                        TABLE OF RESULTS FOR  1  POSITION

                 CALCULATED WAVENUMBER= 33.02772  RECIP. CM.  WAVELENGTH=0.19024  CM.  INITIAL FREQUENCY =  161.20  HZ.

ID .K   INDEP. VAR.   DMP. COEF.   WAVE NC.     REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 1     0.0          0.73457     33.02772     1.00000     50.20000     0.14064     0.95066     0.02224    -0.00016    -0.00005
 2. 1     0.00412      0.75439     33.02987     0.99876     50.20000     0.13967     0.94811     0.02284    -3.12271    -4.19539
 3. 1     0.04534      0.75829     33.03200     0.99752     50.20000     0.13871     0.94558     0.02296   -25.77172    15.50068
 4. 1     0.45754      0.73746     33.03094     0.99814     50.16625     0.13919     0.94748     0.02233    -4.52470     0.36413
 5. 1    12.82338      0.74944     33.03094     0.99814     50.09875     0.13919     0.94876     0.02269    -1.85717    -2.31069
 6. 1    53.99751      0.75099     33.03818     0.99866     49.96375     0.13726     0.94623     0.02273   -12.54496     1.40936
 7. 1    95.21699      0.75603     33.03623     0.99804     49.82874     0.13678     0.94752     0.02259    -5.27075    -4.90137
 8. 1   185.69983      0.78014     33.04148     0.99194     49.59249     0.13439     0.94866     0.02270   -11.34147     6.07978
 9. 1   305.84850      0.78019     33.04148     0.99194     49.52499     0.13439     0.94695     0.02361     7.69768   -13.08493
10. 1   546.57023      0.78030     33.04556     0.98948     49.25498     0.13249     0.94703     0.02361     5.95143   -12.66950
11.  11511.10593      0.78718     33.04962     0.98697     48.88373     0.13061     0.94909     0.02382     3.49250    -3.68826
12.  12112.91025      0.80778     33.06242     0.97891     48.00421     0.12457     0.94961     0.02443     4.51682    -1.85949
13.  12867.22663      0.82383     33.06905     0.97457     47.56746     0.12140     0.94931     0.02491     5.27985    -1.01249
14.  14013.12801      0.83851     33.08519     0.96340     46.45369     0.11353     0.94854     0.02534     5.77517    -0.46660
15.  15513.51688      0.87866     33.09913     0.95285     45.33992     0.10659     0.94948     0.02655     4.96563     0.95270
16.  17920.73417      0.91325     33.11241     0.94169     43.51739     0.09988     0.96503     0.02759     3.10277     1.89123
17.  1**********      0.91257     33.13447     0.91873     41.96496     0.08857     0.95064     0.02754     4.29449     1.13430
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                                        TABLE OF RESULTS FOR  2  POSITION

                 CALCULATED WAVENUMBER= 36.32284  RECIP. CM.  WAVELENGTH=0.17298  CM.  INITIAL FREQUENCY =  185.70  HZ.

ID .K   INDEP. VAR.   DMP. COEF.   WAVE NO.     REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 2     0.0          0.82968     36.32284     1.00000     50.20000     0.24714     0.94845     0.02284    -0.00017    -0.00075
 2. 2     0.00412      0.82962     36.32284     1.00000     50.20000     0.24714     0.94845     0.02284    -0.00125     0.00389
 3. 2     0.04534      0.83711     36.32443     0.99946     50.20000     0.24735     0.94730     0.02305    -0.97935    -3.89640
 4. 2     0.45754      0.82305     36.32602     0.59897     50.16625     0.24760     0.94679     0.02266    -1.58673     0.45756
 5. 2    12.82338      0.83872     36.32919     0.99785     50.09875     0.24820     0.94578     0.02309    -3.77725    -1.19473
 6. 2    53.99751      0.84045     36.33393     0.99623     49.96375     0.24923     0.94490     0.02313    -6.28149    -0.49860
 7. 2    95.21699      0.84868     36.33707     0.99515     49.82874     0.24878     0.94516     0.02334    -5.87161    -3.19162
 8. 2   185.69983      0.85621     36.34645     0.99192     49.59249     0.24728     0.94278     0.02354   -14.74204    17.75715
 9. 2   305.84850      0.86224     36.34801     0.99138     49.52499     0.24701     0.94292     0.02372   -24.35771    28.78794
10. 2   546.57023      0.86984     36.35265     0.98977     49.25498     0.24615     0.94464     0.02393    -3.66711   -14.21233
11.  21511.10593      0.87925     36.36189     0.98654     48.88373     0.24430     0.94489     0.02419     2.67105   -11.77267
12.  22112.91025      0.89455     36.38161     0.97954     48.07371     0.23972     0.94568     0.02459     4.63291    -5.66627
13.  22867.22663      0.89925     36.39207     0.97577     47.63436     0.23699     0.94624     0.02471     4.08615    -4.04782
14.  24013.12801      0.92928     36.42140     0.96500     46.52119     0.22847     0.94534     0.02551     6.73705    -2.00789
15.  25513.51688      0.96197     36.44853     0.95477     45.40742     0.21972     0.94598     0.02639     5.74526    -0.02725
16.  27920.73417      0.98941     36.49136     0.93807     43.58499     0.20477     0.94803     0.02711     4.47761     0.54833
17.  2**********      1.02228     36.52860     0.92299     42.09986     0.19099     0.94727     0.02799     4.52165     1.01703
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                                        TABLE OF RESULTS FOR  3  POSITION

                 CALCULATED WAVENUMBER= 39.61507  RECIP. CM.  WAVELENGTH=0.15861  CM.  INITIAL FREQUENCY =  211.30  HZ.

ID .K   INDEP. VAR.   DMP. COEF.   WAVE NO.     REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 3     0.0          0.92726     39.61507     1.00000     50.20000     0.31388     0.94656     0.02341    -0.00017    -0.00035
 2. 3     0.00412      0.93195     39.61925     0.99905     50.20000     0.31498     0.94447     0.02352    -2.43366    -0.64750
 3. 3     0.04534      0.94417     39.61925     0.99905     50.20000     0.31499     0.94447     0.02383    -2.26314    -2.43075
 4. 3     0.45754      0.94200     39.62134     0.99858     50.16625     0.31542     0.94406     0.02379    -3.31413    -2.21966
 5. 3    12.82338      0.94000     39.62761     0.99716     50.09875     0.31627     0.94220     0.02372    -9.51843     1.72320
 6. 3    53.99751      0.93921     39.63390     0.99574     49.96375     0.31640     0.94161     0.02370    -9.68258     5.11550
 7. 3    95.21699      0.96065     39.63390     0.99574     49.82874     0.31640     0.94416     0.02424    -1.34150    -5.11645
 8. 3   185.69983      0.96651     39.64439     0.99337     49.59249     0.31510     0.94340     0.02438    -2.26022    -8.43970
 9. 3   305.84850      0.95009     39.65070     0.99195     49.52499     0.31348     0.94154     0.02396   -14.21389     4.61948
10. 3   546.57023      0.95248     39.65701     0.99053     49.25498     0.31130     0.94354     0.02402    -4.09404    -3.28261
11.  31511.10593      1.00114     39.66753     0.98817     48.86375     0.30668     0.94542     0.02524     4.07150    -2.67394
12.  32112.91025      1.00819     39.69702     0.98154     48.10746     0.29109     0.94572     0.02540     3.81915    -2.07955
13.  32867.22663      1.05203     39.71805     0.97681     47.66871     0.28219     0.94375     0.02649     6.69758    -0.28559
14.  34013.12801      1.11391     39.76193     0.96687     46.52119     0.27989     0.94431     0.02801     5.47768     1.42431
15.  35513.51688      1.18847     39.80724     0.95646     45.47492     0.28827     0.94212     0.02986     4.97572     2.41634
16.  37920.73417      1.21021     39.88119     0.93895     43.65239     0.28947     0.94060     0.03035     4.82899     2.49875
17.  3**********      1.21308     39.94413     0.92333     42.16736     0.27992     0.93716     0.03037     4.84214     2.83645
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                         ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA SOL. & INSOL. STRAIGHT CHAIN ALCOHOLS - LIA (NF) FEB 1968 RLB

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)          /FRESHLY DISTILLED N HEPTANE           INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS C20OH    - EICOSANOL (1X FROM ABS. DIST. ETHANOL) IN ETOH  2/9/68

                                           SYSTEM PARAMETERS

                 LOWER PHASE DENSITY  0.9980 G/ML        UPPER PHASE DENSITY  0.6780 G/ML
                           VISCOSITY  0.00896 POISES                VISCOSITY  0.00386 POISES

                                     INITIAL VALUES ASSUMED IN CALCULATION

                 REAL ELASTICITY (EP)   0.0             IMAGINARY ELASTICITY (EPP)   0.0
                 WAVENUMBER  31.00000 RECIPROCAL  CM     DAMPING COEFFICIENT   0.70000 CM
                 REFERENCE METER SCALE    1.00 MV.       INTERFACIAL TENSION 50.2000 DYNES/CM
                 REFERENCE INPUT VTG.  0.100 VT.

                                           PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.55023 CM. BASED ON KFSGN= 0.30920 RESEN= 5.04640 DISTGN= 6.00506 DISTEN= 2.4549

                                     CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY      DMP. COEF.      WAVE NO.       WAVELENGTH      NO. WAVES   PHS.CCR.WANO  SN. PR. SCL.FCTR.
    1        162.10      0.73810016     33.15158478     0.18952880     18.73185636    33.15158478     0.89567214
    2        185.70      0.82968103     36.32283556     0.17298154     20.52372889    36.32283556     0.92085249
    3        209.90      0.92196917     39.43857812     0.15931558     22.28423724    39.43857812     0.90583063
    4        234.20      1.01320687     42.44946635     0.14801552     23.99549908    42.44946635     1.13864934

                                           INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT = 952.00000  MG.  MOLECULAR WT.= 298.00000 MAKE-UP VOLUME=0.0500 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                          INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=      34.30MG.  WEIGHT OF WEIGHT=     171.40 MG.  DENSITY OF WT=21.41000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETERCF PLATE= 2.88656 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                        INPUT DATA
ID .K     INDEP. VAR.      FREQUENCY      INPUT VOLT.    OUTPUT VOLT.    METER SCALE     SFTN. VAR.

 1. 1       0.0           162.10000       0.50200        0.09490        0.50000        39.30000
 1. 2       0.0           185.70000       0.50400        0.12060        0.50000        39.30000
 1. 3       0.0           209.90000       0.50400        0.10900        0.50000        39.30000
 1. 4       0.0           234.20000       0.50600        0.10790        0.20000        39.30000
 2. 1       0.02000       161.90000       0.50200        0.09560        0.50000        39.40000
 2. 2       0.02000       185.50000       0.50300        0.11610        0.50000        39.40000
 2. 3       0.02000       209.70000       0.50300        0.10450        0.50000        39.40000
 2. 4       0.02000       234.00000       0.50300        0.09740        0.20000        39.40000
 3. 1       0.07000       162.00000       0.50100        0.09840        0.50000        39.50000
 3. 2       0.07000       185.30000       0.50200        0.11680        0.50000        39.50000
 3. 3       0.07000       209.60000       0.50300        0.10690        0.50000        39.50000
 3. 4       0.07000       233.60000       0.50400        0.10830        0.20000        39.50000
 4. 1       0.47000       161.80000       0.50700        0.10000        0.50000        39.80000
 4. 2       0.47000       185.10000       0.50300        0.11750        0.50000        39.80000
 4. 3       0.47000       209.40000       0.50300        0.10610        0.50000        39.80000
 4. 4       0.47000       233.60000       0.50300        0.10520        0.20000        39.80000
 5. 1      21.00000       161.50000       0.50200        0.09240        0.50000        40.20000
 5. 2      21.00000       185.00000       0.50300        0.11230        0.50000        40.20000
 5. 3      21.00000       209.30000       0.50800        0.10060        0.50000        40.20000
 5. 4      21.00000       233.20000       0.50300        0.09550        0.20000        40.20000
 6. 1     121.00000       160.80000       0.50200        0.08900        0.50000        41.40000
 6. 2     121.00000       184.20000       0.50200        0.10730        0.50000        41.40000
 6. 3     121.00000       208.30000       0.50300        0.09550        0.50000        41.40000
 6. 4     121.00000       232.30000       0.50400        0.09830        0.20000        41.40000
 7. 1     321.00000       160.20000       0.50300        0.08420        0.50000        42.70000
 7. 2     321.00000       183.50000       0.50300        0.10330        0.50000        42.70000
 7. 3     321.00000       207.70000       0.50400        0.08990        0.50000        42.70000
 7. 4     321.00000       231.70000       0.50600        0.09750        0.20000        42.70000
 8. 1     721.00000       159.30000       0.50200        0.07750        0.50000        44.40000
 8. 2     721.00000       182.60000       0.50200        0.09390        0.50000        44.40000
 8. 3     721.00000       206.60000       0.50200        0.07770        0.50000        44.40000
 8. 4     721.00000       230.60000       0.50300        0.10250        0.20000        44.40000
 9. 1    1100.00000       158.50000       0.50000        0.07100        0.50000        46.00000
 9. 2    1100.00000       181.60000       0.50100        0.08730        0.50000        46.00000
 9. 3    1100.00000       205.70000       0.50200        0.06840        0.50000        46.00000
 9. 4    1100.00000       229.10000       0.50400        0.10500        0.20000        46.00000
10. 1    1800.00000       157.00000       0.50100        0.06100        0.50000        48.80000
10. 2    1800.00000       179.90000       0.50200        0.07970        0.50000        48.80000
10. 3    1800.00000       203.50000       0.50300        0.05770        0.50000        48.80000
10. 4    1800.00000       227.30000       0.50400        0.10330        0.20000        48.80000
11. 1    2800.00000       154.60000       0.50000        0.12330        0.20000        52.50000
11. 2    2800.00000       177.30000       0.50100        0.06620        0.50000        52.50000
11. 3    2800.00000       200.50000       0.50200        0.12290        0.20000        52.40000
11. 4    2800.00000       223.90000       0.50200        0.10620        0.20000        52.40000
12. 1    3800.00000       153.30000       0.50000        0.11670        0.20000        56.10000
12. 2    3800.00000       175.80000       0.50100        0.06180        0.50000        56.10000
12. 3    3800.00000       199.00000       0.50200        0.12200        0.20000        56.10000
12. 4    3800.00000       222.40000       0.50200        0.10240        0.20000        56.10000
13. 1    4800.00000       151.90000       0.50000        0.09700        0.20000        59.30000
13. 2    4800.00000       174.20000       0.50200        0.13420        0.20000        59.20000
13. 3    4800.00000       197.00000       0.50200        0.10820        0.20000        59.00000
13. 4    4800.00000       220.50000       0.50300        0.09750        0.20000        59.00000
14. 1    5800.00000       147.70000       0.50000        0.06940        0.20000        66.90000
14. 2    5800.00000       169.60000       0.50000        0.09870        0.20000        66.80000
14. 3    5800.00000       192.10000       0.50100        0.08520        0.20000        66.70000
14. 4    5800.00000       215.90000       0.50200        0.06930        0.20000        66.60000
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                                          TABLE OF RESULTS FOR  1  POSITION

              CALCULATED WAVENUMBER= 33.15158  RECIP. CM.  WAVELENGTH=0.18953  CM.  INITIAL FREQUENCY =  162.10  HZ.

 ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL FLS.  IMAG. FLAS.

  1. 1     0.0        0.73810    33.15158    1.00000    50.20000    0.14502    0.95057    0.02226    -0.00016    -0.00005
  2. 1     0.05324    0.73413    33.15367    0.99877    50.16581    0.14404    0.94869    0.02214    -1.89615     0.33310
  3. 1     0.18635    0.72639    33.15263    0.99938    50.13163    0.14453    0.95060    0.02191    -0.06345     0.73188
  4. 1     1.25123    0.72050    33.15471    0.99815    50.02906    0.14355    0.95002    0.02173    -0.38410     1.11634
  5. 1    55.90604    0.73989    33.15781    0.99630    49.89231    0.14210    0.94883    0.02231    -1.74737    -0.21152
  6. 1 322.12528     0.74365    33.16494    0.99198    49.48207    0.13871    0.94781    0.02242    -3.34977    -0.11449
  7. 1 854.56376     0.75391    33.17093    0.98828    49.03763    0.13583    0.94876    0.02273    -1.52466    -1.47964
  8. 11919.44072     0.76769    33.17972    0.98273    48.45645    0.13155    0.94863    0.02314    -0.78685    -3.05173
  9. 12928.41163     0.78310    33.18731    0.97779    47.90945    0.12780    0.94919    0.02360     1.50764    -3.06512
 10. 14791.94631     0.81090    33.20093    0.96854    46.95221    0.12095    0.94913    0.02442     4.14117    -2.38726
 11. 17454.13870     0.84504    33.22094    0.95373    45.68728    0.11061    0.94411    0.02544     8.62288     2.61542
 12. 1**********     0.84701    33.23076    0.94571    44.45654    0.10542    0.95315    0.02543     3.37817     0.41078
 13. 1**********     0.88487    33.24048    0.93708    43.36254    0.10023    0.95859    0.02462     3.15625     1.41264
 14. 1**********     0.94111    33.26389    0.91117    40.76431    0.08756    0.96204    0.02823     3.05393     1.71520


                                          TABLE OF RESULTS FOR  2  POSITION

              CALCULATED WAVENUMBER= 36.32284  RECIP. CM.  WAVELENGTH=0.17298  CM.  INITIAL FREQUENCY =  185.70  HZ.

 ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL FLS.  IMAG. FLAS.

  1. 2     0.0        0.82968    36.32284    1.00000    50.20000    0.24714    0.94945    0.02294    -0.00117    -0.00035
  2. 2     0.05324    0.84036    36.32585    0.99892    50.16581    0.24760    0.94682    0.02313    -1.59125    -1.42174
  3. 2     0.18635    0.83879    36.32886    0.99795    50.13163    0.24820    0.94519    0.02303    -5.37325    -0.75014
  4. 2     1.25123    0.83851    36.33185    0.99677    50.02906    0.24894    0.94485    0.02309    -6.27577     0.01037
  5. 2    55.90604    0.85159    36.33335    0.99623    49.89231    0.24923    0.94630    0.02344    -1.96391    -3.26549
  6. 2 322.12528     0.86164    36.34522    0.99192    49.48207    0.24728    0.94498    0.02371    -5.44235    -8.31407
  7. 2 854.56376     0.87058    36.35548    0.98815    49.03763    0.24525    0.94551    0.02395    -0.66523    -7.41266
  8. 21919.44072     0.89345    36.36852    0.98331    48.45645    0.24227    0.94467    0.02457     3.97940    -4.05617
  9. 22928.41163     0.90908    36.38280    0.97792    47.90945    0.23857    0.94570    0.02497     6.32229    -3.57651
 10. 24791.94631     0.92636    36.40799    0.96823    46.95221    0.23112    0.94379    0.02544     9.43039    -1.33663
 11. 27454.13870     0.96383    36.44196    0.95477    45.68728    0.21972    0.94070    0.02445     7.50037     3.42876
 12. 2**********     0.97386    36.46180    0.94669    44.45654    0.21256    0.94890    0.02671     4.24742     0.43049
 13. 2**********     1.00360    36.48255    0.93807    43.39673    0.20477    0.95293    0.02751     3.59937     1.18531
 14. 2**********     1.05594    36.53985    0.91330    40.79850    0.18209    0.95618    0.02897     3.27722     1.58172


                                          TABLE OF RESULTS FOR  3  POSITION

              CALCULATED WAVENUMBER= 39.43858  RECIP. CM.  WAVELENGTH=0.15932  CM.  INITIAL FREQUENCY =  209.90  HZ.

 ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL FLS.  IMAG. FLAS.

  1. 3     0.0        0.92197    39.43858    1.00000    50.20000    0.31510    0.94665    0.02339    -0.00017    -0.00035
  2. 3     0.05324    0.92703    39.44256    0.99905    50.16581    0.31409    0.94521    0.02350    -1.41575    -0.67713
  3. 3     0.18635    0.92570    39.44455    0.99857    50.13163    0.31348    0.94481    0.02347    -1.59350    -0.54373
  4. 3     1.25123    0.92576    39.44854    0.99762    50.02906    0.31208    0.94465    0.02347    -2.19432    -0.46665
  5. 3    55.90604    0.94058    39.45053    0.99714    49.89231    0.31130    0.94619    0.02384     0.14265    -1.17643
  6. 3 322.12528     0.94598    39.47049    0.99238    49.48207    0.30124    0.94351    0.02397    -4.77758    -3.50393
  7. 3 854.56376     0.95739    39.48247    0.98952    49.03763    0.29439    0.94572    0.02425     0.55135    -2.11435
  8. 31919.44072     0.98585    39.50440    0.98428    48.45645    0.28365    0.94538    0.02496     2.82010    -3.67051
  9. 32928.41163     1.01724    39.52230    0.97979    47.90945    0.27942    0.94657    0.02574     4.13443    -1.05358
 10. 34791.94631     1.07099    39.56568    0.96951    46.95221    0.28369    0.94221    0.02707     7.01510     1.27672
 11. 37454.13970     1.12233    39.62360    0.95522    45.72147    0.29060    0.93515    0.02832     5.44704     3.85129
 12. 3**********     1.12405    39.65185    0.94807    44.45654    0.29024    0.94539    0.02935     4.83936     1.22366
 13. 3**********     1.15416    39.68866    0.93854    43.46510    0.28645    0.94499    0.02909     4.74340     1.55715
 14. 3**********     1.20409    39.77430    0.91520    40.83268    0.26984    0.95032    0.03027     3.71033     1.63556
```

```
                                   TABLE OF RESULTS FOR  4  POSITION

          CALCULATED WAVENUMBER= 42.44947  RECIP. CM.  WAVELENGTH=0.14802  CM.  INITIAL FREQUENCY =  234.20  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2       REAL ELS.  IMAG. ELAS.

  1. 4    0.0          1.01321     42.44947    1.00000    50.20000    0.13668    0.94512    0.02387   -0.00017   -0.00035
  2. 4    0.05324      1.04308     42.45049    0.99915    50.16581    0.13801    0.94408    0.02457    0.21679   -2.53946
  3. 4    0.18635      1.01914     42.45265    0.99744    50.13163    0.14007    0.94135    0.02401   -6.22950    0.77582
  4. 4    1.28123      1.02676     42.45265    0.99744    50.02906    0.14067    0.94328    0.02419   -1.85245   -1.95517
  5. 4   55.90604      1.05935     42.45494    0.99573    49.89231    0.14336    0.94248    0.02495    0.63935   -7.27171
  6. 4  322.12528      1.06362     42.46063    0.99189    49.48207    0.14932    0.94259    0.02505    1.19429   -6.52107
  7. 4  854.56376      1.07482     42.46483    0.98933    49.03763    0.15571    0.94595    0.02531    2.61105   -1.06896
  8.  41919.44072      1.07304     42.47339    0.98463    48.45645    0.16153    0.94765    0.02524    2.49493   -0.01497
  9.  42920.41163      1.08528     42.48685    0.97822    47.90945    0.17248    0.94514    0.02554    2.70061   -1.47673
 10.  44791.94631      1.11107     42.50575    0.97054    46.95221    0.18595    0.94805    0.02614    3.12300    0.24775
 11.  47454.13870      1.13878     42.54903    0.95602    45.72147    0.21178    0.94179    0.02676    6.61323   -1.53356
 12.  ***********      1.16356     42.57103    0.94962    44.45654    0.22298    0.95417    0.02733    5.11412    1.51488
 13.  ***********      1.19465     42.60113    0.94150    43.46510    0.23661    0.95730    0.02804    3.11071    1.79584
 14.  ***********      1.31978     42.68229    0.92196    40.86687    0.26184    0.97056    0.03090    3.05059    2.29009


                          ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE OCTADECYL SURFACTANTS - LIAINF) FEB 1968  RLB

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)            /FRESHLY DISTILLED N HEPTANE               INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS C18SCAHD - OCTADECYL SUCCINIC ANHYDRIDE (1X FROM ABS. DIST. ETOH) IN ETOH2/15/68

                                          SYSTEM PARAMETERS

               LOWER PHASE DENSITY  0.9980 G/ML          UPPER PHASE DENSITY  0.6780 G/ML
                     VISCOSITY  0.C0896 POISES                  VISCOSITY  0.00386 POISES

                                    INITIAL VALUES ASSUMED IN CALCULATION

               REAL ELASTICITY (EP)    0.C              IMAGINARY ELASTICITY (EPP)    0.0
               WAVENUMBER  31.00000 RECIPROCAL  CM      DAMPING COEFFICIENT   0.70000 CM
               REFERENCE METER SCALE    1.00 MV.        INTERFACIAL TENSION 50.2000 DYNES/CM
               REFERENCE INPUT VTG.  0.100 VT.

                                          PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 4.07173 CM. BASED CN RESGN= 0.15520 RESFN= 5.5950C DISTGN= 6.11936 DISTFN= 2.04824

                                   CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY     DMP. COEF.      WAVE NO.       WAVELENGTH      NO. WAVES    PHS.COR.WANO  GN. PR. SCL.FCTR.
    1        160.20     0.73065155    32.88982556     0.19103719    21.31379081     32.88982556     0.91486078
    2        181.30     0.81273223    35.74222331     0.17579153    23.16224727     35.74222331     0.89599733
    3        203.00     0.89580920    38.56293843     0.16293312    24.99017215     38.56293843     0.73930753

                                        INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =1904.00000  MG.  MOLECULAR WT.= 352.60000 MAKE-UP VOLUME=0.0250 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                        INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=     34.30MG.  WEIGHT OF WEIGHT=    171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.86852 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                                  INPUT DATA

ID .K       INDEP. VAR.     FREQUENCY      INPUT VOLT.     OUTPUT VOLT.     METER SCALE     SFTN. VAR.

  1. 1        0.0            160.20000       0.51000         0.06470          0.50000        39.20000
  1. 2        0.0            181.30000       0.51000         0.07840          0.50000        39.20000
  1. 3        0.0            203.00000       0.51000         0.14030          0.20000        39.20000
  2. 1        0.40000        160.00000       0.50900         0.06130          0.50000        39.40000
  2. 2        0.40000        181.10000       0.51000         0.07300          0.50000        39.40000
  2. 3        0.40000        202.70000       0.51000         0.13250          0.20000        39.40000
  3. 1        1.00000        159.60000       0.50900         0.05740          0.50000        40.30000
  3. 2        1.00000        180.80000       0.50900         0.07200          0.50000        39.90000
  3. 3        1.00000        202.40000       0.51000         0.13610          0.20000        39.80000
  4. 1        1.80000        159.80000       0.51000         0.06000          0.50000        40.00000
  4. 2        1.80000        180.90000       0.51000         0.07290          0.50000        40.00000
  4. 3        1.80000        202.50000       0.51100         0.13650          0.20000        40.00000
  5. 1        3.80000        159.20000       0.51000         0.05940          0.50000        41.20000
  5. 2        3.80000        180.30000       0.51000         0.07280          0.50000        41.10000
  5. 3        3.80000        202.00000       0.51000         0.05650          0.50000        40.90000
  6. 1        5.80000        158.50000       0.51000         0.04990          0.50000        42.50000
  6. 2        5.80000        179.70000       0.51000         0.06260          0.50000        42.00000
  6. 3        5.80000        201.50000       0.51000         0.05110          0.50000        41.70000
  7. 1        7.80000        158.80000       0.51000         0.05130          0.50000        42.00000
  7. 2        7.80000        179.80000       0.51000         0.06360          0.50000        42.00000
  7. 3        7.80000        201.40000       0.51000         0.04990          0.50000        42.00000
  8. 1        9.80000        158.20000       0.51000         0.11560          0.20000        43.20000
  8. 2        9.80000        179.30000       0.51000         0.05790          0.50000        43.00000
  8. 3        9.80000        200.80000       0.51000         0.11740          0.20000        42.90000
  9. 1       11.80000        157.80000       0.50900         0.10710          0.20000        43.90000
  9. 2       11.80000        178.70000       0.51000         0.05390          0.50000        43.80000
  9. 3       11.80000        200.40000       0.51000         0.10870          0.20000        43.70000
 10. 1       14.60000        157.80000       0.51000         0.09720          0.20000        45.10000
 10. 2       14.60000        178.00000       0.51000         0.12130          0.20000        44.80000
 10. 3       14.60000        199.50000       0.51000         0.09610          0.20000        44.70000
 11. 1       18.60000        156.40000       0.50400         0.08930          0.20000        46.50000
 11. 2       18.60000        177.10000       0.51000         0.11170          0.20000        46.40000
 11. 3       18.60000        198.40000       0.51000         0.08590          0.20000        46.20000
 12. 1       22.60000        155.50000       0.50900         0.08000          0.20000        47.90000
 12. 2       22.60000        176.30000       0.51000         0.09990          0.20000        47.80000
 12. 3       22.60000        197.40000       0.51000         0.07520          0.20000        47.70000
 13. 1       26.60000        153.40000       0.50900         0.06970          0.20000        51.20000
 13. 2       26.60000        174.10000       0.50900         0.08920          0.20000        50.90000
 13. 3       26.60000        195.10000       0.51000         0.06900          0.20000        50.60000
 14. 1       30.60000        152.20000       0.50800         0.06650          0.20000        53.20000
 14. 2       30.60000        172.50000       0.50900         0.08640          0.20000        53.00000
 14. 3       30.60000        193.30000       0.50900         0.07150          0.20000        53.00000
 15. 1       33.60000        151.00000       0.50900         0.06330          0.20000        55.10000
 15. 2       33.60000        171.30000       0.50900         0.08220          0.20000        55.10000
 15. 3       33.60000        192.00000       0.51000         0.06880          0.20000        55.10000
 16. 1       37.60000        149.10000       0.50800         0.05750          0.20000        58.70000
 16. 2       37.60000        169.30000       0.50800         0.07790          0.20000        58.40000
 16. 3       37.60000        189.80000       0.50800         0.06510          0.20000        58.20000
 17. 1       43.60000        146.30000       0.50800         0.04760          0.20000        65.90000
 17. 2       43.60000        167.80000       0.50900         0.06850          0.20000        65.20000
 17. 3       43.60000        186.90000       0.50900         0.06170          0.20000        64.80000
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                                   TABLE OF RESULTS FOR  1  POSITION

          CALCULATED WAVENUMBER= 32.88983  RECIP. CM.  WAVELENGTH=0.19104  CM.  INITIAL FREQUENCY =  160.20  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2       REAL ELS.  IMAG. ELAS.

  1. 1   0.0         0.73065    32.88983    1.00000    50.20000     0.13583    0.95076    0.02222    -0.00016   -0.00035
  2. 1   3.59992     0.74169    32.89155    0.99875    50.13167     0.13487    0.94953    0.02255    -0.94224   -1.37410
  3. 1   8.99981     0.75435    32.89496    0.99625    49.82420     0.13297    0.95032    0.02293     0.68524   -1.74404
  4. 1  16.19966     0.74570    32.89326    0.99750    49.92669     0.13392    0.95090    0.02267     0.58099   -0.81617
  5. 1  34.19928     0.74290    32.89832    0.99376    49.51672     0.13108    0.95114    0.02258     0.58909   -0.38761
  6. 1  52.19890     0.77948    32.90410    0.98939    49.07259     0.12780    0.95083    0.02369     2.71745   -1.69751
  7. 1  70.19853     0.77536    32.90164    0.99126    49.24341     0.12980    0.95133    0.02357     2.46929   -1.28632
  8. 1  88.19815     0.79551    32.90653    0.98752    48.83344     0.12641    0.95144    0.02417     3.49086   -0.81974
  9. 1 106.19777     0.81018    32.90973    0.98502    48.59429     0.12457    0.95124    0.02462     4.20555   -0.60961
 10. 1 131.39724     0.82905    32.91444    0.98127    48.18432     0.12185    0.95164    0.02519     4.43600    0.11995
 11. 1 167.39648     0.84050    32.92053    0.97628    47.70603     0.11828    0.95090    0.02553     4.79105    0.32115
 12. 1 203.39573     0.86087    32.92712    0.97066    47.22773     0.11436    0.94893    0.02614     5.49111    1.02493
 13. 1 239.39497     0.88094    32.94135    0.95755    46.10032     0.10581    0.94483    0.02674     5.92394    2.45993
 14. 1 275.39421     0.87598    32.94872    0.95006    45.41704     0.10131    0.94347    0.02659     6.12665    2.89849
 15. 1 302.39365     0.87824    32.95545    0.94257    44.76792     0.09714    0.94154    0.02665     5.82640    3.51216
 16. 1 338.39289     0.88606    32.96494    0.93071    43.53802     0.09127    0.94311    0.02688     5.95403    2.79801
 17. 1 392.39176     0.91319    32.97594    0.91323    41.07821     0.08438    0.96143    0.02769     3.03392    1.63224
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                                   TABLE OF RESULTS FOR  2  POSITION

          CALCULATED WAVENUMBER= 35.74222  RECIP. CM.  WAVELENGTH=0.17579  CM.  INITIAL FREQUENCY =  181.30  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2       REAL ELS.  IMAG. ELAS.

  1. 2   0.0         0.81273    35.74222    1.00000    50.20000     0.23739    0.94881    0.02274    -0.00017   -0.00005
  2. 2   3.59992     0.82943    35.74468    0.99890    50.13167     0.23659    0.94781    0.02320    -0.40395   -1.70376
  3. 2   8.99981     0.83106    35.74836    0.99724    49.96055     0.23537    0.94761    0.02325    -0.56617   -1.90679
  4. 2  16.19966     0.82892    35.74713    0.99779    49.92669     0.23578    0.94941    0.02319     0.86520   -0.55250
  5. 2  34.19928     0.82663    35.75444    0.99448    49.55058     0.23327    0.94969    0.02312     0.89977   -0.20145
  6. 2  52.19890     0.86097    35.76169    0.99117    49.24341     0.23069    0.94870    0.02408     2.39757   -1.90690
  7. 2  70.19853     0.85754    35.76049    0.99173    49.24341     0.23112    0.94985    0.02398     2.27942   -0.91002
  8. 2  88.19815     0.87825    35.76649    0.98897    48.90177     0.22892    0.95069    0.02456     3.12561   -0.37772
  9. 2 106.19777     0.89291    35.77364    0.98566    48.62846     0.22622    0.94908    0.02496     4.06504   -0.95775
 10. 2 131.39724     0.91522    35.78191    0.98180    48.28681     0.22300    0.94766    0.02558     5.48195   -0.50217
 11. 2 167.39648     0.93034    35.79243    0.97683    47.74019     0.21878    0.94801    0.02599     5.26319    0.11566
 12. 2 203.39573     0.95388    35.80168    0.97242    47.26199     0.21496    0.94824    0.02664     5.11052    0.82554
 13. 2 239.39497     0.97147    35.82662    0.96029    46.20281     0.20429    0.94394    0.02712     6.12404    1.97476
 14. 2 275.39421     0.96690    35.84432    0.95146    45.48537     0.19642    0.93989    0.02697     6.25145    3.56774
 15. 2 302.39365     0.97162    35.85735    0.94484    44.76792     0.19050    0.94069    0.02710     6.35757    3.14437
 16. 2 338.39289     0.97122    35.87861    0.93381    43.64051     0.18060    0.94092    0.02707     6.59512    2.92761
 17. 2 392.39176     0.99296    35.89414    0.92554    41.31736     0.17316    0.97502    0.02766     2.81654    2.21223
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                                   TABLE OF RESULTS FOR  3  POSITION

          CALCULATED WAVENUMBER= 38.56294  RECIP. CM.  WAVELENGTH=0.16293  CM.  INITIAL FREQUENCY =  203.00  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2       REAL ELS.  IMAG. ELAS.

  1. 3   0.0         0.89581    38.56294    1.00000    50.20000     0.28561    0.94713    0.02323    -0.00017   -0.00005
  2. 3   3.59992     0.91072    38.56803    0.99852    50.13167     0.28661    0.94525    0.02361    -1.90294   -1.98831
  3. 3   8.99981     0.90489    38.57311    0.99704    49.99502     0.28750    0.94466    0.02346    -3.15225   -1.09271
  4. 3  16.19966     0.90441    38.57142    0.99754    49.92669     0.28722    0.94701    0.02345     0.09012   -0.42372
  5. 3  34.19928     0.89663    38.57986    0.99507    49.61921     0.28851    0.94755    0.02324     0.33224    0.25850
  6. 3  52.19890     0.92214    38.58826    0.99261    49.34590     0.28949    0.94747    0.02390     0.99679   -0.83740
  7. 3  70.19853     0.92811    38.58993    0.99212    49.24341     0.28966    0.94838    0.02405     1.61159   -0.47245
  8. 3  88.19815     0.94364    38.59994    0.98916    48.93593     0.29039    0.94792    0.02445     2.11149   -0.99072
  9. 3 106.19777     0.96277    38.60658    0.98719    48.66262     0.29065    0.94896    0.02494     2.92221   -0.40312
 10. 3 131.39724     0.99300    38.62139    0.98276    48.32098     0.29061    0.94602    0.02571     5.15792   -1.32158
 11. 3 167.39648     1.01960    38.63928    0.97734    47.80852     0.28947    0.94433    0.02639     6.65703    0.00907
 12. 3 203.39573     1.05057    38.65530    0.97241    47.29606     0.28748    0.94379    0.02718     6.25170    1.26689
 13. 3 239.39497     1.06515    38.69129    0.96108    46.30530     0.27992    0.93902    0.02753     6.45893    3.78828
 14. 3 275.39421     1.05541    38.71858    0.95222    45.48537     0.27932    0.93641    0.02726     6.13465    4.30265
 15. 3 302.39365     1.05607    38.73779    0.94581    44.76792     0.26897    0.93727    0.02726     6.53745    4.06885
 16. 3 338.39289     1.05661    38.76937    0.93498    43.70884     0.25685    0.93582    0.02725     6.10366    4.51562
 17. 3 392.39176     1.06174    38.80925    0.92069    41.45401     0.24733    0.95385    0.02736     3.00201    1.24925
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                         ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE OCTADECYL SURFACTANTS - LIAINE) FEB 1968  PLR

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)            /FRESHLY DISTILLED N HEPTANE               INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS C18ALD   - OCTADECYL ALDEHYDE (1X FROM DIST. ABS. ETOH) IN ETOH   2/13/69

                                        SYSTEM PARAMETERS

                 LOWER PHASE DENSITY  0.9980 G/ML         UPPER PHASE DENSITY  0.6780 G/ML
                           VISCOSITY  0.00896 POISES                 VISCOSITY  0.00386 POISES

                                 INITIAL VALUES ASSUMED IN CALCULATION

                 REAL ELASTICITY (EP)   0.0              IMAGINARY ELASTICITY (EPP)   0.0
                 WAVENUMBER  31.00000 RECIPROCAL  CM     DAMPING COEFFICIENT   0.70000 CM
                 REFERENCE METER SCALE    1.00 MV.       INTERFACIAL TENSION 50.2000 DYNES/CM
                 REFERENCE INPUT VTG.  0.100 VT.

                                        PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.08779 CM. BASED ON RESGN= 0.25730 RESEN= 5.58470 DISTGN= 6.04378 DISTEN= 2.0555

                                 CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY      DMP. COFF.       WAVE NO.       WAVELENGTH       NO. WAVES   PHS.COR.WAN) GN. PH. SCL.FCTR.
    1        159.80     0.72508190     32.83458726     0.19135958     20.83338370    32.83458726     0.84478872
    2        180.90     0.81118869     35.68920998     0.17605265     22.65114937    35.68920998     0.80646393
    3        202.30     0.89314866     38.47355888     0.16331164     24.41931381    38.47355888     0.64751263

                                        INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT = 114.00000  MG.  MOLECULAR WT.= 269.00000 MAKE-UP VOLUME=0.0250 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                        INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=     34.33MG.  WEIGHT OF WEIGHT=    171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.90365 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
```

INPUT DATA

ID .K	INDEP. VAR.	FREQUENCY	INPUT VOLT.	OUTPUT VOLT.	METER SCALE	SETN. VAR.
1. 1	0.0	159.80000	0.50900	0.06290	0.50000	37.40000
1. 2	0.0	180.90000	0.50900	0.07620	0.50000	37.40000
1. 3	0.0	202.30000	0.51000	0.13490	0.20000	37.40000
2. 1	10.00000	159.70000	0.50900	0.06340	0.50000	37.30000
2. 2	10.00000	180.60000	0.51000	0.07500	0.50000	37.30000
2. 3	10.00000	202.10000	0.51000	0.13700	0.20000	37.30000
3. 1	40.00000	159.40000	0.51000	0.06130	0.50000	37.60000
3. 2	40.00000	180.30000	0.51000	0.07280	0.50000	37.60000
3. 3	40.00000	201.90000	0.51000	0.13280	0.20000	37.60000
4. 1	90.00000	159.00000	0.51000	0.06100	0.50000	38.20000
4. 2	90.00000	179.40000	0.51000	0.07080	0.50000	38.20000
4. 3	90.00000	201.40000	0.51000	0.13150	0.20000	38.20000
5. 1	170.00000	158.70000	0.50900	0.05950	0.50000	39.00000
5. 2	170.00000	179.60000	0.51000	0.06960	0.50000	39.00000
5. 3	170.00000	201.20000	0.51000	0.13060	0.20000	39.00000
6. 1	270.00000	158.20000	0.50900	0.05660	0.50000	40.00000
6. 2	270.00000	179.00000	0.51000	0.06800	0.50000	40.00000
6. 3	270.00000	200.60000	0.51000	0.12800	0.20000	40.00000
7. 1	370.00000	157.90000	0.50900	0.13780	0.20000	40.80000
7. 2	370.00000	178.70000	0.51000	0.06700	0.50000	40.60000
7. 3	370.00000	200.30000	0.51000	0.12970	0.20000	40.50000
8. 1	500.00000	157.60000	0.50900	0.13240	0.20000	41.20000
8. 2	500.00000	178.30000	0.51000	0.06460	0.50000	41.20000
8. 3	500.00000	199.80000	0.51000	0.12180	0.20000	41.20000
9. 1	650.00000	157.30000	0.50900	0.12590	0.20000	41.90000
9. 2	650.00000	177.90000	0.51000	0.06140	0.50000	41.80000
9. 3	650.00000	199.50000	0.51000	0.11690	0.20000	41.70000
10. 1	800.00000	156.80000	0.50900	0.12300	0.20000	42.80000
10. 2	800.00000	177.60000	0.51000	0.06040	0.50000	42.70000
10. 3	800.00000	198.90000	0.50900	0.11480	0.20000	42.60000
11. 1	950.00000	156.60000	0.50800	0.12740	0.20000	43.50000
11. 2	950.00000	177.20000	0.50900	0.06190	0.50000	43.40000
11. 3	950.00000	198.60000	0.50900	0.12050	0.20000	43.30000
12. 1	1000.00000	156.70000	0.50900	0.12200	0.20000	43.20000
12. 2	1000.00000	177.40000	0.50900	0.06240	0.50000	43.10000
12. 3	1000.00000	198.70000	0.50900	0.11650	0.20000	43.10000
13. 1	1100.00000	156.90000	0.50900	0.12130	0.20000	43.60000
13. 2	1100.00000	177.10000	0.50900	0.05960	0.50000	43.50000
13. 3	1100.00000	198.50000	0.50900	0.11530	0.20000	43.50000
14. 1	1250.00000	155.90000	0.50800	0.11530	0.20000	44.60000
14. 2	1250.00000	176.70000	0.50800	0.05630	0.50000	44.50000
14. 3	1250.00000	198.00000	0.50800	0.10430	0.20000	44.40000
15. 1	1400.00000	155.50000	0.50800	0.09900	0.20000	45.40000
15. 2	1400.00000	176.00000	0.50900	0.12170	0.20000	45.30000
15. 3	1400.00000	197.40000	0.50900	0.09150	0.20000	45.20000
16. 1	1550.00000	155.20000	0.50800	0.09790	0.20000	46.10000
16. 2	1550.00000	175.70000	0.50900	0.12210	0.20000	46.00000
16. 3	1550.00000	196.50000	0.50900	0.09560	0.20000	45.90000
17. 1	1750.00000	154.50000	0.50800	0.08780	0.20000	47.10000
17. 2	1750.00000	175.00000	0.50800	0.11320	0.20000	47.10000
17. 3	1750.00000	196.20000	0.50800	0.08290	0.20000	47.00000
18. 1	2000.00000	154.00000	0.50700	0.08550	0.20000	48.20000
18. 2	2000.00000	174.30000	0.50700	0.10650	0.20000	48.10000
18. 3	2000.00000	195.40000	0.50800	0.07540	0.20000	48.00000
19. 1	2300.00000	152.90000	0.50600	0.06790	0.20000	49.90000
19. 2	2300.00000	173.20000	0.50700	0.08520	0.20000	49.80000
19. 3	2300.00000	194.20000	0.50700	0.05890	0.20000	49.70000
20. 1	2700.00000	151.90000	0.50600	0.07080	0.20000	52.10000
20. 2	2700.00000	172.00000	0.50800	0.08600	0.20000	51.90000
20. 3	2700.00000	192.90000	0.50800	0.06330	0.20000	51.80000
21. 1	3300.00000	150.10000	0.50400	0.12180	0.10000	55.40000
21. 2	3300.00000	170.00000	0.50700	0.07470	0.20000	55.20000
21. 3	3300.00000	190.90000	0.50700	0.10780	0.10000	55.00000
22. 1	4300.00000	148.50000	0.50700	0.11260	0.10000	59.30000
22. 2	4300.00000	168.20000	0.50700	0.07430	0.20000	59.00000
22. 3	4300.00000	188.50000	0.50800	0.10530	0.10000	58.90000

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                                TABLE OF RESULTS FOR  2  POSITION

          CALCULATED WAVENUMBER= 35.68921  RECIP. CM.  WAVELENGTH=0.17605  CM.  INITIAL FREQUENCY =  180.90  HZ.

ID .K  INDEP. VAR.  DMP. COFF.  WAVE NO.   REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1           Y2        REAL ELS.  IMAG. ELAS.

  1. 2    0.0         0.81119   35.68921   1.00000    50.20000     0.23578    0.94885     0.02273    -0.00017    -0.00005
  2. 2    7.06320     0.82112   35.69295   0.99834    50.23375     0.23454    0.94477     0.02301    -8.43599     1.09130
  3. 2   28.25279     0.82345   35.69667   0.99668    50.13250     0.23327    0.94324     0.02298    -7.53188     9.10829
  4. 2   63.56877     0.82558   35.70162   0.99447    49.93000     0.23156    0.94748     0.02312    -4.78517    12.47614
  5. 2  120.07435     0.82845   35.70530   0.99281    49.65999     0.23025    0.94415     0.02320   -11.87311     3.11820
  6. 2  190.70632     0.83115   35.71263   0.98950    49.32249     0.22758    0.94369     0.02328   -12.83762     6.65904
  7. 2  261.33825     0.83357   35.71628   0.98784    49.11998     0.22622    0.94412     0.02334   -13.06448     1.91823
  8. 2  353.15985     0.84068   35.72111   0.98563    48.91748     0.22439    0.94340     0.02353   -19.66133    12.46885
  9. 2  459.10781     0.85134   35.72592   0.98342    48.71497     0.22253    0.94270     0.02383    -0.47567    33.18631
 10. 2  565.05576     0.85397   35.72951   0.98176    48.41122     0.22113    0.94513     0.02390    -3.09051   -11.12010
 11. 2  671.00372     0.84578   35.73427   0.97955    48.17457     0.21925    0.94511     0.02365    -6.27513    -5.94488
 12. 2  706.31970     0.84414   35.73189   0.98065    48.27622     0.22019    0.94545     0.02362    -4.41278    -5.10147
 13. 2  776.95167     0.85404   35.73546   0.97899    48.14122     0.21978    0.94467     0.02390    -7.65196   -14.53279
 14. 2  882.89963     0.86564   35.74019   0.97678    47.80371     0.21688    0.94662     0.02427     2.03402    -4.71011
 15. 2  988.84758     0.88869   35.74842   0.97291    47.53370     0.21352    0.94381     0.02514    11.34892    -0.44413
 16.  21034.79554     0.89567   35.75192   0.97125    47.25745     0.21207    0.94502     0.02505     8.69795    -3.26536
 17.  21236.05548     0.91069   35.76004   0.96739    46.92619     0.20868    0.94428     0.02546     9.13015    -0.48957
 18.  21412.63541     0.92127   35.76808   0.96352    46.58869     0.20526    0.94289     0.02576     9.08249     1.99930
 19.  21624.53532     0.97055   35.78058   0.95744    46.01493     0.19987    0.94165     0.02717     6.26042     2.98851
 20.  21507.06320     0.96117   35.79601   0.95090    45.30617     0.19396    0.94211     0.02685     6.71860     2.57851
 21.  22330.85502     0.99287   35.81552   0.93975    44.19240     0.18407    0.94179     0.02744     6.07391     2.57496
 22.  23037.17472     0.97176   35.83512   0.92980    42.90988     0.17515    0.94798     0.02712     4.52875     0.53869
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                                TABLE OF RESULTS FOR  1  POSITION

          CALCULATED WAVENUMBER= 32.83459  RECIP. CM.  WAVELENGTH=0.19136  CM.  INITIAL FREQUENCY =  159.80  HZ.

ID .K  INDEP. VAR.  DMP. COFF.  WAVE NO.   REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1           Y2        REAL ELS.  IMAG. ELAS.

  1. 1    0.0         0.72508   32.83459   1.00000    50.20000     0.13392    0.95080     0.02220    -0.00018    -0.00005
  2. 1    7.06320     0.72620   32.83546   0.99937    50.23375     0.13344    0.94889     0.02212    -1.98836     0.10710
  3. 1   28.25279     0.73246   32.83905   0.99750    50.13250     0.13202    0.94702     0.02231    -5.82757     1.49467
  4. 1   63.56877     0.73039   32.84146   0.99499    49.93000     0.13014    0.94580     0.02223    -5.73125     5.34431
  5. 1  120.07435     0.73311   32.84399   0.99312    49.65999     0.12873    0.94714     0.02232    -5.11639     1.25257
  6. 1  190.70632     0.74108   32.84814   0.98999    49.32249     0.12641    0.94726     0.02256    -4.79588    -0.41385
  7. 1  261.33829     0.74437   32.85060   0.98811    49.05248     0.12503    0.94865     0.02268    -2.13085    -1.68731
  8. 1  353.15595     0.75223   32.85302   0.98623    48.91748     0.12366    0.94745     0.02290    -5.61728    -3.86205
  9. 1  459.10781     0.76208   32.85542   0.98436    48.68122     0.12230    0.94822     0.02319    -1.37046    -5.21283
 10. 1  565.05576     0.76328   32.85775   0.98123    48.37747     0.12005    0.94777     0.02323    -2.45820    -6.26601
 11. 1  671.00372     0.75211   32.86090   0.97997    48.14122     0.11917    0.94986     0.02289    -0.07758    -1.23213
 12. 1  706.31970     0.76440   32.86013   0.98049    48.24247     0.11961    0.94915     0.02326     0.27269    -3.16063
 13. 1  776.95167     0.76348   32.86167   0.97935    48.10746     0.11872    0.94925     0.02323     0.20629    -2.82669
 14. 1  882.89963     0.77060   32.86621   0.97559    47.76996     0.11610    0.94825     0.02345     0.00143    -5.28523
 15. 1  988.84758     0.80763   32.86516   0.97309    47.49995     0.11438    0.94849     0.02457     5.94174    -2.30007
 16.  11094.79554     0.83509   32.87134   0.97121    47.26370     0.11311    0.94937     0.02449     4.69668    -2.04623
 17.  11236.05548     0.82595   32.87629   0.96693    46.92619     0.11020    0.94717     0.02512     7.45805    -0.36810
 18.  11412.63941     0.82736   32.87572   0.96370    46.55494     0.10818    0.94825     0.02516     6.19156    -0.76099
 19.  11624.53532     0.87364   32.88753   0.95620    45.98119     0.10352    0.94451     0.02656     6.11813     2.56201
 20.  11907.06320     0.85417   32.89359   0.94994    45.23867     0.09988    0.94696     0.02597     6.36928     0.84373
 21.  12330.85502     0.87637   32.90250   0.93930    44.12450     0.09424    0.94844     0.02664     5.20492     0.97674
 22.  13037.17472     0.89474   32.91049   0.92929    42.80862     0.08962    0.95621     0.02689     3.37986     1.23096
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                                        TABLE OF RESULTS FOR 3 POSITION

                CALCULATED WAVENUMBER= 38.47356 RECIP. CM.  WAVELENGTH=0.16331  CM.  INITIAL FREQUENCY =  202.30  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 3      0.0        0.89315    38.47356    1.00000    50.20000    0.28777    0.94718    0.02321   -0.00017   -0.20005
 2. 3      7.04320    0.88971    38.47700    0.99991    50.23375    0.28827    0.94667    0.02317   -3.28188    0.43474
 3. 3     28.25279    0.89792    38.48044    0.99802    50.13730    0.28873    0.94620    0.02333   -6.10669   -0.21824
 4. 3     63.56977    0.90119    38.48901    0.99555    49.93000    0.28966    0.94271    0.02341   -7.09378    0.32411
 5. 3    120.07435    0.90316    38.49242    0.99456    49.65999    0.28995    0.94571    0.02366   -1.27415   -0.48130
 6. 3    193.70632    0.90871    38.50262    0.99160    49.32249    0.29054    0.94576    0.02360   -1.02607   -1.15060
 7. 3    261.33829    0.90650    38.50769    0.99011    49.15373    0.29069    0.94575    0.02354   -1.00073   -0.91366
 8. 3    353.15985    0.92132    38.51611    0.98764    48.91748    0.29072    0.94500    0.02392   -1.60071   -2.00487
 9. 3    459.10791    0.93174    38.52113    0.98616    48.74873    0.29061    0.94506    0.02413   -0.66916   -1.97465
10. 3    565.05576    0.93517    38.53113    0.98319    48.44497    0.29014    0.94454    0.02427   -1.02169   -4.03167
11. 3    671.00372    0.92270    38.53605    0.99171    48.20877    0.28977    0.94594    0.02394   -0.22507   -1.65810
12. 3    706.31970    0.93128    38.53444    0.99220    48.27622    0.28990    0.94560    0.02417    0.00057   -2.46166
13. 3    776.95167    0.93364    38.53774    0.99122    48.14122    0.28967    0.94619    0.02423    0.17060   -1.77333
14. 3    882.39363    0.95755    38.54557    0.97874    47.83746    0.28878    0.94680    0.02494    2.61117   -1.09216
15. 3    988.84158    0.98075    38.55576    0.97579    47.56746    0.28748    0.94560    0.02567    5.06610   -1.21379
16. 31094.79554    0.97712    38.56385    0.97331    47.33120    0.28617    0.94501    0.02536    4.74271   -1.20260
17. 31236.05948    1.01096    38.57509    0.96995    46.95555    0.28401    0.94499    0.02621    6.03300   -1.22041
18. 31412.63541    1.03217    38.59772    0.96599    46.62744    0.28111    0.94306    0.02675    7.04761    0.33617
19. 31624.53532    1.09270    38.60683    0.95596    46.04869    0.27932    0.94174    0.02829    5.73246    2.35725
20. 31907.05320    1.07335    38.62644    0.95353    45.33992    0.27812    0.94224    0.02770    6.03555    1.16517
21. 32330.85502    1.09716    38.65771    0.94315    44.25990    0.26092    0.94204    0.02838    5.43513    2.00615
22. 33037.17472    1.09643    38.69072    0.93178    42.94363    0.25367    0.94523    0.02834    4.86067    1.14413


                               ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE OCTADECYL SURFACTANTS - LIAINE) FEB 1969  RLB

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)              /FRESHLY DISTILLED N HEPTANE                INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS C18-3ONE - 3-OCTADECANONE (1X FROM DIST. ABS. ETOH) IN ETOH  2/14/69

                                                  SYSTEM PARAMETERS

                  LOWER PHASE DENSITY  0.9980 G/ML          UPPER PHASE DENSITY  0.6780 G/ML
                            VISCOSITY  0.00895 POISES                 VISCOSITY  0.00386 POISES

                                          INITIAL VALUES ASSUMED IN CALCULATION

                  REAL ELASTICITY (EP)    0.0               IMAGINARY ELASTICITY (EPP)    0.0
                  WAVENUMBER  31.00000 RECIPROCAL  CM       DAMPING COEFFICIENT    0.70000 CM
                  REFERENCE METER SCALE    1.00 MV.         INTERFACIAL TENSION 50.2000 DYNES/CM
                  REFERENCE INPUT VTG.  0.100 VT.

                                                 PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.04107 CM. BASED ON RESGN= 0.28160 RESEN= 5.54670 DISTGN= 6.02566 DISTEN= 2.00456

                                       CALCULATION OF ZERO FLASTICITY PARAMETERS

POS. NO.  FREQUENCY      DMP. COEF.       WAVE NO.       WAVELENGTH       NO. WAVES   PHS.COR.WAN.  GN. RQ. SCL.FCTR.
   1        162.10      0.73810016     33.15159478     0.18952980     20.79602096     33.15159478     0.92066966
   2        183.40      0.92082824     36.01990976     0.17443631     22.59315093     36.01990976     0.87621211
   3        205.30      0.99454225     38.85589814     0.16170467     24.37199807     38.85589814     0.78039516

                                              INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =1174.00000  MG.  MOLECULAR WT.= 269.00000 MAKE-UP VOLUME=0.0250 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                              INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=      34.30MG.  WEIGHT OF WEIGHT=     171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.90561 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                           INPUT DATA

ID .K        INDEP. VAR.     FREQUENCY      INPUT VOLT.    OUTPUT VOLT.    METER SCALE     SETN. VAR.


  1. 1          0.0          162.10000       0.50800        0.07470         0.50000        37.30000
  1. 2          0.0          183.40000       0.50900        0.08600         0.50000        37.30000
  1. 3          0.0          205.30000       0.51000        0.06310         0.50000        37.30000
  2. 1          2.00000      161.90000       0.50800        0.07400         0.50000        37.40000
  2. 2          2.00000      183.20000       0.50500        0.08460         0.50000        37.40000
  2. 3          2.00000      205.20000       0.50900        0.06270         0.50000        37.40000
  3. 1         32.00000      161.70000       0.50800        0.07350         0.50000        37.50000
  3. 2         32.00000      183.00000       0.50900        0.08480         0.50000        37.50000
  3. 3         32.00000      205.00000       0.51000        0.06150         0.50000        37.50000
  4. 1        132.00000      161.20000       0.50800        0.07090         0.50000        38.20000
  4. 2        132.00000      182.80000       0.50800        0.08100         0.50000        38.20000
  4. 3        132.00000      204.40000       0.51000        0.05920         0.50000        38.20000
  5. 1        232.00000      161.10000       0.50800        0.06960         0.50000        39.00000
  5. 2        232.00000      182.40000       0.50900        0.08230         0.50000        39.00000
  5. 3        232.00000      204.30000       0.51000        0.05890         0.50000        39.00000
  6. 1        382.00000      160.70000       0.50800        0.06730         0.50000        39.50000
  6. 2        382.00000      182.00000       0.50800        0.08020         0.50000        39.50000
  6. 3        382.00000      203.50000       0.50900        0.05790         0.50000        39.50000
  7. 1        582.00000      160.30000       0.50800        0.06480         0.50000        40.20000
  7. 2        582.00000      181.50000       0.50900        0.07790         0.50000        40.20000
  7. 3        582.00000      203.30000       0.50900        0.05590         0.50000        40.20000
  8. 1        882.00000      160.00000       0.50800        0.06830         0.50000        41.00000
  8. 2        882.00000      181.10000       0.50900        0.08050         0.50000        41.00000
  8. 3        882.00000      202.70000       0.51000        0.06040         0.50000        41.00000
  9. 1       1230.00000      159.40000       0.50900        0.06530         0.50000        42.20000
  9. 2       1230.00000      180.20000       0.50900        0.07720         0.50000        42.20000
  9. 3       1230.00000      202.00000       0.51000        0.05970         0.50000        42.20000
 10. 1       1550.00000      158.90000       0.50900        0.05860         0.50000        43.00000
 10. 2       1550.00000      179.90000       0.50900        0.07220         0.50000        43.00000
 10. 3       1550.00000      201.40000       0.51000        0.05980         0.50000        43.00000
 11. 1       1900.00000      158.40000       0.50900        0.05730         0.50000        44.00000
 11. 2       1900.00000      179.30000       0.51000        0.06960         0.50000        44.00000
 11. 3       1900.00000      200.90000       0.51000        0.05500         0.50000        44.00000
 12. 1       2300.00000      158.00000       0.50900        0.05530         0.50000        44.70000
 12. 2       2300.00000      178.80000       0.51000        0.06800         0.50000        44.70000
 12. 3       2300.00000      200.30000       0.51000        0.13500         0.20000        44.70000
 13. 1       2800.00000      157.50000       0.51000        0.13220         0.20000        45.90000
 13. 2       2800.00000      178.30000       0.51000        0.06590         0.50000        45.90000
 13. 3       2800.00000      199.70000       0.51000        0.13250         0.20000        45.90000
 14. 1       3300.00000      156.90000       0.50800        0.12600         0.20000        47.00000
 14. 2       3300.00000      177.70000       0.51000        0.06530         0.50000        47.00000
 14. 3       3300.00000      199.00000       0.51000        0.13180         0.20000        47.00000
 15. 1       3800.00000      156.30000       0.50800        0.12340         0.20000        48.20000
 15. 2       3800.00000      176.90000       0.50900        0.06430         0.50000        48.20000
 15. 3       3800.00000      198.20000       0.50900        0.13360         0.20000        48.20000
 16. 1       4300.00000      155.40000       0.50800        0.11600         0.20000        49.50000
 16. 2       4300.00000      176.00000       0.50900        0.06150         0.50000        49.50000
 16. 3       4300.00000      197.30000       0.50900        0.13010         0.20000        49.50000
 17. 1       5000.00000      154.60000       0.50800        0.10960         0.20000        51.10000
 17. 2       5000.00000      175.20000       0.50900        0.05890         0.50000        51.10000
 17. 3       5000.00000      196.30000       0.51000        0.12550         0.20000        51.10000
 18. 1       6000.00000      153.30000       0.50800        0.10010         0.20000        53.50000
 18. 2       6000.00000      173.90000       0.50800        0.13510         0.20000        53.50000
 18. 3       6000.00000      194.80000       0.50800        0.11750         0.20000        53.50000
 19. 1       7000.00000      152.30000       0.50800        0.09000         0.20000        55.70000
 19. 2       7000.00000      172.60000       0.50900        0.12400         0.20000        55.60000



 19. 3       7000.00000      193.40000       0.51000        0.10990         0.20000        55.50000
 20. 1       8000.00000      151.10000       0.50800        0.07900         0.20000        57.80000
 20. 2       8000.00000      171.50000       0.50900        0.10780         0.20000        57.70000
 20. 3       8000.00000      192.20000       0.50900        0.09390         0.20000        57.50000
 21. 1       9000.00000      150.60000       0.50900        0.07600         0.20000        58.70000
 21. 2       9000.00000      170.90000       0.50900        0.10470         0.20000        58.60000
 21. 3       9000.00000      191.40000       0.50900        0.08790         0.20000        58.60000
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                                   TABLE OF RESULTS FOR  1  POSITION

          CALCULATED WAVENUMBER= 33.15158  RECIP. CM.  WAVELENGTH=0.18953  CM.  INITIAL FREQUENCY =  162.10  HZ.

ID .K   INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 1     0.0         0.73910    33.15158    1.00000    50.20000     0.14502     0.95057     0.02226    -0.00016    -0.00005
 2. 1   14.54771      0.73878    33.15346    0.99877    50.16627     0.14404     0.94870     0.02228    -2.00636    -0.20543
 3. 1  232.76332      0.73878    33.15533    0.99753    50.13254     0.14307     0.94683     0.02228    -5.18648     1.75825
 4. 1  960.14870      0.74357    33.15596    0.99445    49.89645     0.14064     0.94504     0.02242    -6.19739     7.58801
 5. 11687.53408       0.74739    33.16088    0.99383    49.62663     0.14016     0.94892     0.02254    -1.52787    -0.97889
 6. 12778.61214       0.75240    33.16452    0.99136    49.45799     0.13823     0.94717     0.02269    -5.96474    -1.34377
 7. 14233.38290       0.75845    33.16812    0.98890    49.22189     0.13630     0.94663     0.02287    -9.06939    -2.33613
 8. 16415.53903       0.74242    33.17079    0.98705    48.95207     0.13487     0.94806     0.02238    -2.54358     0.19834
 9. 18946.84015       0.74890    33.17606    0.98334    48.54733     0.13202     0.94835     0.02257    -2.10347    -0.91436
10. 1**********       0.77190    33.18037    0.98026    48.27751     0.12967     0.94731     0.02326    -3.61774    -6.63464
11. 1**********       0.77289    33.18461    0.97717    47.94023     0.12734     0.94762     0.02329    -2.37635    -5.27144
12. 1**********       0.77820    33.18794    0.97471    47.70414     0.12549     0.94722     0.02345    -2.43629    -2.53802
13. 1**********       0.78539    33.19203    0.97162    47.29940     0.12320     0.94894     0.02366     1.33939    -3.25231
14. 1**********       0.79095    33.19683    0.96792    46.92839     0.12050     0.94875     0.02383     1.93115    -3.55043
15. 1**********       0.79058    33.20151    0.96422    46.52366     0.11784     0.94930     0.02391     1.65358    -2.57511
16. 1**********       0.79776    33.20829    0.95867    46.08520     0.11396     0.94675     0.02402     3.07320    -0.73603
17. 1**********       0.80460    33.21406    0.95373    45.54555     0.11061     0.94763     0.02422     3.22095    -5.79617
18. 1**********       0.81543    33.22291    0.94571    44.73608     0.10542     0.94786     0.02454     3.07552    -3.59317
19. 1**********       0.83322    33.22925    0.93954    43.95407     0.10167     0.95077     0.02507     3.34375    -0.61063
20. 1**********       0.85559    33.23630    0.93214    43.28578     0.09747     0.95056     0.02574     3.91076    -3.15757
21. 1**********       0.86159    33.23905    0.92906    42.98223     0.09502     0.95071     0.02592     3.93191     0.01280


                                   TABLE OF RESULTS FOR  2  POSITION

          CALCULATED WAVENUMBER= 36.01991  RECIP. CM.  WAVELENGTH=0.17444  CM.  INITIAL FREQUENCY =  183.40  HZ.

ID .K   INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 2     0.0         0.82093    36.01991    1.00000    50.20000     0.24494     0.94864     0.02279    -0.00017    -0.00008
 2. 2   14.54771      0.82233    36.02253    0.99991    50.16627     0.24430     0.94700     0.02283    -1.59013    -1.37666
 3. 2  232.76332      0.82305    36.02514    0.99782    50.13254     0.24364     0.94536     0.02288    -4.60544     0.58530
 4. 2  960.14870      0.83239    36.03164    0.99509    49.89645     0.24192     0.94414     0.02310    -9.19944     7.77646
 5. 21687.53408       0.82847    36.03293    0.99455    49.62663     0.24156     0.94813     0.02299    -0.21847    -0.69437
 6. 22778.61214       0.83298    36.03808    0.99237    49.45799     0.24010     0.94679     0.02311    -1.74714    -1.14437
 7. 24233.38290       0.83893    36.04448    0.98964    49.22189     0.23818     0.94561     0.02327    -4.39233    -2.05600
 8. 26415.53903       0.82880    36.04957    0.98746    48.95207     0.23659     0.94673     0.02299    -2.44077    -0.23012
 9. 28946.84015       0.83537    36.06091    0.98255    48.54733     0.23285     0.94377     0.02317    -7.55939     3.54277
10. 2**********       0.85095    36.06466    0.98092    48.27751     0.23156     0.94559     0.02360    -3.49955    -3.72132
11. 2**********       0.85785    36.07210    0.97764    47.94023     0.22892     0.94532     0.02378    -3.65702    -5.64777
12. 2**********       0.86125    36.07826    0.97492    47.70414     0.22667     0.94422     0.02387   -11.09423    -0.10401
13. 2**********       0.84320    36.08438    0.97219    47.29940     0.22439     0.94650     0.02397    -0.29011    -3.22350
14. 2**********       0.86579    36.09167    0.96892    46.92839     0.22160     0.94700     0.02399     0.36735    -2.46515
15. 2**********       0.86495    36.10130    0.96456    46.52366     0.21783     0.94590     0.02396    -1.32596    -3.49580
16. 2**********       0.87108    36.11201    0.95965    46.08520     0.21352     0.94437     0.02412    -5.96374    -7.84549
17. 2**********       0.87740    36.12143    0.95529    45.54555     0.20965     0.94615     0.02429     0.18492    -3.47030
18. 2**********       0.89034    36.13769    0.94766    44.73608     0.20282     0.94666     0.02464     1.55484    -2.73191
19. 2**********       0.90510    36.15138    0.94111    44.02779     0.19692     0.94757     0.02504     2.50229    -1.65510
20. 2**********       0.93353    36.16375    0.93511    43.31951     0.19149     0.94986     0.02581     3.16618    -3.35648
21. 2**********       0.93697    36.17047    0.93184    43.01596     0.18852     0.94935     0.02590     3.24309    -0.19713


                                   TABLE OF RESULTS FOR  3  POSITION

          CALCULATED WAVENUMBER= 38.85590  RECIP. CM.  WAVELENGTH=0.16170  CM.  INITIAL FREQUENCY =  205.30  HZ.

ID .K   INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 3     0.0         0.90454    38.85590    1.00000    50.20000     0.27691     0.94697     0.02328    -0.00017    -0.00005
 2. 3   14.54771      0.90533    38.85768    0.99951    50.16627     0.27655     0.94655     0.02330    -0.32980    -0.12851
 3. 3  232.76332      0.91007    38.86125    0.99854    50.13254     0.27583     0.94508     0.02342    -2.06390    -0.75467
 4. 3  960.14870      0.92296    38.87191    0.99562    49.89645     0.27935     0.94323     0.02374    -7.95379    -2.18084
 5. 31687.53408       0.92473    38.87369    0.99513    49.62663     0.27989     0.94730     0.02379     0.77336    -0.68101
 6. 32778.61214       0.93039    38.88077    0.99318    49.45799     0.28190     0.94629     0.02393     0.27788    -1.57408
 7. 34233.38290       0.94164    38.89136    0.99026    49.22189     0.28449     0.94447     0.02421    -1.15046    -5.08720
 8. 36415.53903       0.92438    38.90190    0.98734    48.95207     0.28661     0.94332     0.02376    -5.96935    -1.72844
 9. 38946.84015       0.92971    38.91411    0.98393    48.54733     0.28851     0.94373     0.02387    -4.33030    -2.16261
10. 3**********       0.94716    38.92457    0.98100    48.27751     0.28966     0.94262     0.02433   -10.48655   -10.80004
11. 3**********       0.95139    38.93314    0.97857    47.94023     0.29029     0.94392     0.02444    -1.43970    -5.95606
12. 3**********       0.95638    38.94343    0.97565    47.70414     0.29069     0.94219     0.02456   -12.07039   -20.09017
13. 3**********       0.96113    38.95364    0.97272    47.29940     0.29069     0.94382     0.02467    -0.01003    -6.51706
14. 3**********       0.96207    38.96546    0.96931    46.92839     0.29024     0.94377     0.02469    -0.34948    -6.18072
15. 3**********       0.95718    38.97883    0.96542    46.52366     0.28915     0.94337     0.02456    -2.76914    -5.68760
16. 3**********       0.96223    38.99371    0.96103    46.08520     0.28724     0.94263     0.02468    -5.11772    -9.45532
17. 3**********       0.96929    39.01001    0.95616    45.54555     0.28434     0.94297     0.02485    -1.95951    -7.40493
18. 3**********       0.98049    39.03400    0.94886    44.73608     0.27932     0.94368     0.02512     0.79493    -4.96864
19. 3**********       0.99845    39.05275    0.94301    44.06152     0.27932     0.94499     0.02557     2.62591    -7.45554
20. 3**********       1.03023    39.07425    0.93619    43.35324     0.27074     0.94503     0.02637     4.20998    -1.43756
21. 3**********       1.04073    39.08630    0.93229    43.01596     0.26443     0.94366     0.02663     5.53316    -1.58394
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                   ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE OCTADECYL SURFACTANTS - LIAINE) FEB 1969 RLB

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)          /FRESHLY DISTILLED N HEPTANE          INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS C1800ET - OCTADECYL ACETATE (1X FROM DIST. ABS. ETOH) IN ETOH 2/14/69

                                        SYSTEM PARAMETERS

               LOWER PHASE DENSITY  0.9980 G/ML         UPPER PHASE DENSITY  0.6780 G/ML
                         VISCOSITY  0.00896 POISES                 VISCOSITY  0.00386 POISES

                                INITIAL VALUES ASSUMED IN CALCULATION

               REAL ELASTICITY (ER)   0.0              IMAGINARY ELASTICITY (ERI)   0.0
               WAVENUMBER  31.00000 RECIPROCAL  CM     DAMPING COEFFICIENT   0.70000 CM
               REFERENCE METER SCALE    1.00 MV.       INTERFACIAL TENSION 50.2000 DYNES/CM
               REFERENCE INPUT VTG.  0.100 VT.
                                        PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 4.05228 CM. BASED ON RESGN= 0.13380 RESFN= 5.54550 DISTGN= 6.13817 DISTFN= 2.09516

                                CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY      DMP. COEF.       WAVE NO.       WAVELENGTH      NO. WAVES   PHS.COR.WANO  GN. RA. SCL.FCTR.
   1         161.20      0.73557334     33.02772131     0.19023959     21.20461636    33.02772131      0.97773518
   2         182.50      0.81736005     35.90103110     0.17501391     23.15805220    35.90103110      0.95486800
   3         204.20      0.99316725     38.71592337     0.16228930     24.57380568    38.71592337      0.89773761

                                       INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =2995.00000  MG.  MOLECULAR WT.= 312.50000 MAKE-UP VOLUME=0.0250 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM

                                       INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     [illegible].180 WEIGHT OF PLATE=     34.33MG.  WEIGHT OF WEIGHT=    171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20100 CALCULATED PERIMETERCE PLATE= 2.91146 CM.  CALCULATED FRACTION IN LOWER PHASE=0.700
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                              INPUT DATA

ID .K      INDEP. VAR.      FREQUENCY      INPUT VOLT.     OUTPUT VOLT.     METER SCALE ,   SETN. VAR.

 1. 1        0.0           161.20000        0.50400         0.07060          0.50000        37.00000
 1. 2        0.0           182.50000        0.50700         0.08530          0.50000        37.00000
 1. 3        0.0           204.20000        0.50700         0.06640          0.50000        37.00000
 2. 1        3.00000       161.00000        0.50300         0.07290          0.50000        37.30000
 2. 2        3.00000       182.20000        0.50400         0.08150          0.50000        37.30000
 2. 3        3.00000       204.20000        0.50600         0.06190          0.50000        37.30000
 3. 1        8.00000       160.90000        0.50300         0.07320          0.50000        37.60000
 3. 2        8.00000       182.10000        0.50500         0.08160          0.50000        37.60000
 3. 3        8.00000       203.90000        0.50600         0.06320          0.50000        37.60000
 4. 1       18.00000       160.60000        0.50300         0.07820          0.50000        37.90000
 4. 2       18.00000       181.70000        0.50400         0.08000          0.50000        37.90000
 4. 3       18.00000       203.70000        0.50500         0.06220          0.50000        37.90000
 5. 1       43.00000       160.20000        0.50300         0.06980          0.50000        38.70000
 5. 2       43.00000       181.40000        0.50300         0.07790          0.50000        38.70000
 5. 3       43.00000       203.30000        0.50400         0.06070          0.50000        38.70000
 6. 1       83.00000       159.80000        0.50300         0.06670          0.50000        39.60000
 6. 2       83.00000       180.90000        0.50600         0.07750          0.50000        39.60000
 6. 3       83.00000       202.70000        0.50700         0.05820          0.50000        39.60000
 7. 1      115.00000       159.30000        0.50300         0.06220          0.50000        40.60000
 7. 2      115.00000       180.30000        0.50400         0.07380          0.50000        40.60000
 7. 3      115.00000       202.20000        0.50600         0.05570          0.50000        40.60000
 8. 1      145.00000       159.20000        0.50300         0.06110          0.50000        41.10000
 8. 2      145.00000       180.20000        0.50300         0.07230          0.50000        41.10000
 8. 3      145.00000       201.90000        0.50400         0.05520          0.50000        41.10000
 9. 1      190.00000       158.70000        0.50300         0.14200          0.20000        42.30000
 9. 2      190.00000       179.60000        0.50300         0.06850          0.50000        42.20000
 9. 3      190.00000       201.30000        0.50400         0.12720          0.20000        42.10000
10. 1      230.00000       158.40000        0.50200         0.13310          0.20000        42.70000
10. 2      230.00000       179.30000        0.50300         0.06270          0.50000        42.60000
10. 3      230.00000       201.00000        0.50300         0.11920          0.20000        42.50000
11. 1      280.00000       157.80000        0.50200         0.11920          0.20000        43.80000
11. 2      280.00000       178.80000        0.50300         0.05980          0.50000        43.60000
11. 3      280.00000       200.30000        0.50300         0.11050          0.20000        43.50000
12. 1      330.00000       157.90000        0.50200         0.11720          0.20000        44.60000
12. 2      330.00000       178.20000        0.50300         0.13230          0.20000        44.50000
12. 3      330.00000       199.90000        0.50300         0.10050          0.20000        44.30000
13. 1      380.00000       157.10000        0.50200         0.10280          0.20000        45.30000
13. 2      380.00000       177.80000        0.50400         0.12660          0.20000        45.20000
13. 3      380.00000       199.40000        0.50300         0.09240          0.20000        45.10000
14. 1      440.00000       156.50000        0.50000         0.09260          0.20000        46.20000
14. 2      440.00000       177.10000        0.50200         0.11570          0.20000        46.10000
14. 3      440.00000       198.70000        0.50100         0.08510          0.20000        46.00000
15. 1      500.00000       156.40000        0.50000         0.08950          0.20000        46.10000
15. 2      500.00000       177.30000        0.50200         0.11430          0.20000        46.10000
15. 3      500.00000       198.60000        0.50100         0.08560          0.20000        46.10000
16. 1      600.00000       155.20000        0.50000         0.07920          0.20000        48.30000
16. 2      600.00000       176.00000        0.50000         0.10110          0.20000        48.20000
16. 3      600.00000       197.20000        0.50000         0.07580          0.20000        48.10000
17. 1      700.00000       154.50000        0.50000         0.07440          0.20000        49.60000
17. 2      700.00000       175.00000        0.50000         0.09160          0.20000        49.50000
17. 3      700.00000       196.40000        0.50100         0.07250          0.20000        49.30000
18. 1      850.00000       153.50000        0.49900         0.06930          0.20000        51.50000
18. 2      850.00000       173.90000        0.50000         0.08830          0.20000        51.30000
18. 3      850.00000       195.10000        0.50000         0.07150          0.20000        51.00000
19. 1     1050.00000       152.50000        0.50000         0.12970          0.10000        53.10000
19. 2     1050.00000       172.90000        0.50100         0.08390          0.20000        53.00000



19. 3     1050.00000       193.50000        0.50100         0.07200          0.20000        52.90000
20. 1     1350.00000       150.30000        0.50000         0.11460          0.10000        56.90000
20. 2     1350.00000       170.60000        0.50000         0.07700          0.20000        56.80000
20. 3     1350.00000       191.40000        0.50100         0.12670          0.10000        56.60000
21. 1     1650.00000       148.80000        0.50000         0.10510          0.10000        59.40000
21. 2     1650.00000       169.00000        0.50000         0.07070          0.20000        59.30000
21. 3     1650.00000       189.70000        0.50000         0.12160          0.10000        59.10000
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                                   TABLE OF RESULTS FOR  1  POSITION

          CALCULATED WAVENUMBER= 33.02772  RECIP. CM.  WAVELENGTH=0.19024  CM.  INITIAL FREQUENCY =  161.20  HZ.

ID .K   INDEP. VAR.  DMP. COEFF.  WAVE NO.    REL. FQ.  INTERF. TENS.  GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 1     0.0         0.73457    33.02772    1.00000    50.20000      0.14064     0.95066     0.02224    -0.00016    -0.00005
 2. 1   47.92000      0.72447    33.02550    0.99976    50.09902      0.13967     0.95006     0.02193    -0.51083     0.68748
 3. 1  127.79667      0.72260    33.03039    0.99914    49.99804      0.13919     0.95072     0.02188    -0.03178     0.77983
 4. 1  287.52000      0.72342    33.03304    0.99628    49.89706      0.13774     0.94886     0.02190    -1.45672     1.04641
 5. 1  680.35333      0.72830    33.03653    0.99380    49.62778      0.13583     0.94896     0.02205    -1.43020     0.69438
 6.  11325.78667      0.73602    33.03998    0.99132    49.32484      0.13392     0.94973     0.02228    -0.69918     0.06839
 7.  11836.93333      0.74885    33.04422    0.98821    48.98824      0.13155     0.94992     0.02266    -0.23732    -0.90758
 8.  12210.13333      0.75236    33.04507    0.98759    48.81994      0.13108     0.95192     0.02277     1.16073    -0.07401
 9.  13034.93333      0.76592    33.04923    0.98449    48.41602      0.12873     0.95349     0.02318     1.97413     0.24474
10.  13673.86667      0.77871    33.05165    0.98263    48.28138      0.12734     0.95232     0.02356     2.23477    -0.41865
11.  14472.53333      0.80050    33.05653    0.97891    47.91112      0.12457     0.95200     0.02427     3.13996    -0.54699
12.  15271.20000      0.81271    33.05851    0.97705    47.64184      0.12320     0.95354     0.02458     3.29083     0.21258
13.  16069.86667      0.83065    33.06203    0.97457    47.40622      0.12140     0.95315     0.02512     3.73964     0.35101
14.  17029.26667      0.84936    33.06662    0.97094    47.10328      0.11872     0.95157     0.02570     4.44404     0.47146
15.  17986.66667      0.85744    33.06737    0.97022    47.13694      0.11828     0.94961     0.02593     5.23862     0.64012
16.  19584.00000      0.87657    33.07614    0.96278    46.39641      0.11311     0.94927     0.02650     5.15461     1.12402
17.  1**********      0.88557    33.08101    0.95844    45.95883      0.11020     0.94926     0.02677     5.03945     1.27159
18.  1**********      0.89348    33.08765    0.95223    45.31929      0.10620     0.94966     0.02700     4.82273     1.30230
19.  1**********      0.90137    33.09390    0.94603    44.78073      0.10241     0.94806     0.02724     5.07372     1.56981
20.  1**********      0.91314    33.10618    0.93238    43.50165      0.09487     0.94693     0.02758     5.06938     1.76027
21.  1**********      0.92258    33.11334    0.92308    42.66015      0.09043     0.94582     0.02786     5.05294     1.97061

                                   TABLE OF RESULTS FOR  2  POSITION

          CALCULATED WAVENUMBER= 35.90103  RECIP. CM.  WAVELENGTH=0.17501  CM.  INITIAL FREQUENCY =  182.50  HZ.

ID .K   INDEP. VAR.  DMP. COEFF.  WAVE NO.    REL. FQ.  INTERF. TENS.  GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 2     0.0         0.81736    35.90103    1.00000    50.20000      0.24192     0.94871     0.02277    -0.00017    -0.00005
 2. 2   47.92000      0.82513    35.90480    0.99836    50.09902      0.24084     0.94720     0.02298    -1.45192    -0.98859
 3. 2  127.79667      0.82594    35.90605    0.99791    49.99804      0.24047     0.94798     0.02300    -0.46109    -0.73385
 4. 2  287.52000      0.82968    35.91104    0.99562    49.85706      0.23996     0.94533     0.02308    -5.73513    -3.90020
 5. 2  680.85333      0.83396    35.91476    0.99397    49.62778      0.23779     0.94703     0.02322    -1.27723    -1.77844
 6.  21325.78667      0.83419    35.92093    0.99123    49.32484      0.23578     0.94711     0.02322    -1.20622    -1.52722
 7.  21836.93333      0.84264    35.92828    0.98795    48.98824      0.23327     0.94672     0.02345    -1.35426    -2.62653
 8.  22210.13333      0.84677    35.92949    0.98740    48.81994      0.23285     0.94884     0.02357     1.02627    -1.01251
 9.  23034.93333      0.85732    35.93677    0.98411    48.44968      0.23025     0.94916     0.02386     1.64180    -1.03004
10.  23673.86667      0.87772    35.94038    0.98247    48.31504      0.22892     0.94834     0.02442     2.39731    -1.94293
11.  24472.53333      0.88657    35.94637    0.97973    47.97844      0.22667     0.94920     0.02467     3.18002    -1.08137
12.  25271.20000      0.91417    35.95381    0.97644    47.67550      0.22393     0.94826     0.02543     4.66998    -0.77707
13.  26069.86667      0.92381    35.95823    0.97425    47.43988      0.22207     0.94833     0.02560     4.80359    -0.39359
14.  27029.26667      0.94037    35.96644    0.97041    47.13694      0.21878     0.94627     0.02616     6.09895     0.27180
15.  27945.56667      0.94504    35.96410    0.97151    47.13654      0.21972     0.94860     0.02629     4.87856     0.37878
16.  29584.00000      0.96727    35.97919    0.96438    46.43007      0.21352     0.94777     0.02688     5.10533     0.99892
17.  2**********      0.98536    35.99162    0.95890    45.99249      0.20868     0.94505     0.02739     5.66696     1.70515
18.  2**********      0.98857    36.00303    0.95288    45.38661      0.20331     0.94469     0.02746     5.68769     1.72357
19.  2**********      0.99564    36.01415    0.94740    44.81439      0.19939     0.94490     0.02765     5.49792     1.67815
20.  2**********      1.00174    36.03920    0.93479    43.53531      0.18704     0.94498     0.02780     5.33990     1.51306
21.  2**********      1.01216    36.05616    0.92603    42.69381      0.17911     0.94428     0.02807     5.29466     1.67696

                                   TABLE OF RESULTS FOR  3  POSITION

          CALCULATED WAVENUMBER= 38.71592  RECIP. CM.  WAVELENGTH=0.16229  CM.  INITIAL FREQUENCY =  204.20  HZ.

ID .K   INDEP. VAR.  DMP. COEFF.  WAVE NO.    REL. FQ.  INTERF. TENS.  GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 3     0.0         0.91937    38.71592    1.00000    50.20000      0.28041     0.94705     0.02326    -0.00017    -0.00005
 2. 3   47.92000      0.91715    38.71592    1.00000    50.09902      0.28041     0.94896     0.02369     1.46034     0.01847
 3. 3  127.79667      0.91337    38.72105    0.99853    49.99804      0.28190     0.94770     0.02359     0.75814    -0.34975
 4. 3  287.52000      0.91762    38.72452    0.99755    49.89706      0.28282     0.94751     0.02370     0.77519    -0.50359
 5. 3  680.85333      0.92461    38.73138    0.99559    49.62778      0.28449     0.94841     0.02387     1.42229    -0.30299
 6.  31325.78667      0.93829    38.74163    0.99265    49.32484      0.28661     0.94785     0.02422     1.72689    -0.87464
 7.  31836.93333      0.94985    38.75012    0.99021    48.98824      0.28803     0.94904     0.02451     2.35842    -0.37784
 8.  32210.13333      0.95170    38.75520    0.98874    48.81994      0.28873     0.94911     0.02456     2.39083    -0.25551
 9.  33034.93333      0.97272    38.76521    0.98580    48.48334      0.28981     0.94929     0.02509     3.02535    -0.17702
10.  33673.86667      0.98858    38.77034    0.98433    48.34870      0.29019     0.94873     0.02550     3.57403    -0.27758
11.  34472.53333      1.00770    38.78201    0.98090    48.01210      0.29069     0.94788     0.02598     4.26246    -0.23290
12.  35271.20000      1.03115    38.79464    0.97894    47.74282      0.29073     0.94894     0.02658     4.28403     0.52091
13.  36069.86667      1.05173    38.77688    0.97649    47.47354      0.29056     0.94895     0.02711     4.43466     0.87592
14.  37029.26667      1.07050    38.80833    0.97307    47.17060      0.28990     0.94751     0.02758     4.83338     1.12220
15.  37986.66667      1.08834    38.80995    0.97258    47.13694      0.28977     0.94711     0.02754     4.93736     1.09978
16.  39584.00000      1.09606    38.83250    0.96572    46.46373      0.28698     0.94569     0.02823     5.11003     1.56912
17.  3**********      1.10554    38.84518    0.96180    46.05981      0.28467     0.94533     0.02846     5.38218     1.68464
18.  3**********      1.11432    38.86546    0.95544    45.48759      0.27992     0.94311     0.02841     5.48093     1.92661
19.  3**********      1.10257    38.88392    0.94956    44.84805      0.27932     0.94349     0.02836     5.41790     1.70731
20.  3**********      1.12063    38.92094    0.93732    43.60263      0.26443     0.94288     0.02879     5.24849     1.83829
21.  3**********      1.12280    38.94531    0.92919    42.76113      0.25654     0.94266     0.02883     5.23456     1.75354
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                                 ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE OCTADECYL SURFACTANTS - LIANE) FEB 1969  RLB

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)            /FRESHLY DISTILLED N HEPTANE                 INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS CLEAND - OCTADECYL AMIDE (1X FROM COT. ABS. ETHANOL) IN ETOH  2/19/69

                                                    SYSTEM PARAMETERS

                        LOWER PHASE DENSITY  0.9980 G/ML          UPPER PHASE DENSITY  0.6780 G/ML
                                VISCOSITY  0.01894 POISES                     VISCOSITY  0.00386 POISES

                                           INITIAL VALUES ASSUMED IN CALCULATION

                        REAL ELASTICITY (EP)    0.0              IMAGINARY ELASTICITY (EPP)    0.0
                        WAVENUMBER  31.00000 RECIPROCAL  CM      DAMPING COEFFICIENT   0.70000 CM
                        REFERENCE METER SCALE    1.00 MV.        INTERFACIAL TENSION 50.2000 DYNES/CM
                        REFERENCE INPUT VTG.  0.100 VT.

                                                    PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 4.19705 CM. BASED ON RESGN= 0.20540 RESFN= 5.81130 DISTGN= 6.08251 DISTFN= 1.88545

                                          CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY      CMP. COEF.       WAVE NO.        WAVELENGTH        NO. WAVES   PHS.COR.WANO  GN. PR. SCL.FCTR.
    1        163.30     0.74279844     33.31638143      0.18859131      22.25476283     33.31638143     0.82626621
    2        183.80     0.82236856     36.07268260      0.17419111      24.09592403     36.07268260     0.80327916
    3        204.80     0.90264492     38.79230412      0.16196976      25.91258386     38.79230412     0.63285617

                                                INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =1374.00000  MG.  MOLECULAR WT.= 285.00000 MAKE-UP VOLUME=0.0250 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                                 INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=     34.30MG.  WEIGHT OF WEIGHT=     171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETERCE PLATE= 2.89585 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF   50.20000 DYNES/CM.
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                                           INPUT DATA

ID.K     INDEP. VAR.    FREQUENCY     INPUT VOLT.    OUTPUT VOLT.    METER SCALE    SETN. VAR.

 1. 1    0.0            163.30000     0.49900        0.13770         0.20000        37.80000
 1. 2    0.0            183.80000     0.50100        0.06280         0.50000        37.80000
 1. 3    0.0            204.80000     0.50100        0.09940         0.20000        37.80000
 2. 1    0.04000        163.10000     0.50000        0.13730         0.20000        37.80000
 2. 2    0.04000        183.80000     0.50100        0.06440         0.50000        37.80000
 2. 3    0.04000        204.70000     0.50200        0.10240         0.20000        37.80000
 3. 1    0.16000        163.20000     0.50200        0.14380         0.20000        37.80000
 3. 2    0.16000        183.60000     0.50200        0.06750         0.50000        37.80000
 3. 3    0.16000        204.70000     0.50300        0.10440         0.20000        37.80000
 4. 1    0.28000        163.10000     0.50500        0.15090         0.20000        37.80000
 4. 2    0.28000        183.50000     0.50600        0.06570         0.50000        37.80000
 4. 3    0.28000        204.70000     0.50700        0.10840         0.20000        37.80000
 5. 1    0.40000        163.10000     0.50500        0.14570         0.20000        37.80000
 5. 2    0.40000        183.40000     0.50700        0.06650         0.50000        37.80000
 5. 3    0.40000        204.50000     0.50700        0.10890         0.20000        37.80000
 6. 1    0.60000        163.00000     0.50600        0.14550         0.20000        37.85000
 6. 2    0.60000        183.50000     0.50800        0.06580         0.50000        37.85000
 6. 3    0.60000        204.50000     0.50800        0.11150         0.20000        37.85000
 7. 1    1.00000        163.10000     0.50700        0.14690         0.20000        38.10000
 7. 2    1.00000        183.40000     0.50800        0.06510         0.50000        38.10000
 7. 3    1.00000        204.50000     0.50900        0.11120         0.20000        38.10000
 8. 1    1.40000        162.60000     0.50700        0.14070         0.20000        38.60000
 8. 2    1.40000        183.00000     0.50800        0.06350         0.50000        38.60000
 8. 3    1.40000        204.10000     0.50800        0.11500         0.20000        38.60000
 9. 1    1.80000        162.70000     0.50700        0.13920         0.20000        38.60000
 9. 2    1.80000        183.10000     0.50700        0.06300         0.50000        38.60000
 9. 3    1.80000        204.00000     0.50800        0.11090         0.20000        38.60000
10. 1    3.00000        162.40000     0.50700        0.13400         0.20000        39.00000
10. 2    3.00000        183.00000     0.50700        0.06200         0.50000        39.00000
10. 3    3.00000        203.90000     0.50900        0.10710         0.20000        39.00000
11. 1    5.00000        161.60000     0.50800        0.11840         0.20000        40.60000
11. 2    5.00000        182.40000     0.50900        0.05770         0.50000        40.10000
11. 3    5.00000        203.20000     0.50900        0.10320         0.20000        39.80000
12. 1    8.20000        161.90000     0.50800        0.12900         0.20000        40.20000
12. 2    8.20000        182.30000     0.50800        0.06090         0.50000        40.20000
12. 3    8.20000        203.10000     0.50900        0.10930         0.20000        40.10000
13. 1    10.60000       161.50000     0.50400        0.12340         0.20000        41.00000
13. 2    10.60000       181.80000     0.50400        0.05590         0.50000        40.90000
13. 3    10.60000       202.50000     0.50700        0.10830         0.20000        40.70000
14. 1    14.60000       160.90000     0.50300        0.10880         0.20000        42.00000
14. 2    14.60000       181.30000     0.50700        0.05050         0.50000        41.90000
14. 3    14.60000       202.20000     0.50700        0.09250         0.20000        41.80000
15. 1    17.80000       160.90000     0.50600        0.11150         0.20000        42.10000
15. 2    17.80000       181.20000     0.50800        0.04970         0.50000        42.20000
15. 3    17.80000       201.90000     0.50800        0.09990         0.20000        42.30000
16. 1    23.80000       159.80000     0.50600        0.09970         0.20000        44.40000
16. 2    23.80000       179.90000     0.50700        0.11400         0.20000        44.20000
16. 3    23.80000       201.70000     0.50700        0.08990         0.20000        44.10000
17. 1    27.80000       159.50000     0.50600        0.09390         0.20000        44.90000
17. 2    27.80000       179.70000     0.50800        0.10990         0.20000        44.80000
17. 3    27.80000       200.30000     0.50800        0.08300         0.20000        44.70000
18. 1    33.80000       158.60000     0.50600        0.08190         0.20000        46.40000
18. 2    33.80000       178.70000     0.50800        0.09700         0.20000        46.30000
18. 3    33.80000       199.30000     0.50800        0.07550         0.20000        46.20000
19. 1    39.80000       157.80000     0.50400        0.06870         0.20000        47.50000
19. 2    39.80000       177.90000     0.50700        0.08560         0.20000        47.40000


19. 3    39.80000       198.50000     0.50700        0.07100         0.20000        47.40000
20. 1    47.00000       157.10000     0.50600        0.06500         0.20000        47.90000
20. 2    47.00000       177.10000     0.50800        0.08300         0.20000        47.90000
20. 3    47.00000       197.50000     0.50800        0.06180         0.20000        47.80000
21. 1    55.00000       156.00000     0.50600        0.13070         0.10000        50.10000
21. 2    55.00000       175.80000     0.50700        0.09140         0.20000        50.00000
21. 3    55.00000       196.00000     0.50700        0.06760         0.20000        50.00000
22. 1    63.00000       155.10000     0.50500        0.11290         0.10000        51.30000
22. 2    63.00000       175.00000     0.50500        0.07520         0.20000        51.20000
22. 3    63.00000       194.90000     0.50600        0.05750         0.20000        51.20000
23. 1    75.00000       153.70000     0.50400        0.11970         0.10000        53.70000
23. 2    75.00000       173.30000     0.50600        0.07770         0.20000        53.60000
23. 3    75.00000       193.60000     0.50700        0.13280         0.10000        53.50000
24. 1    91.00000       149.70000     0.50300        0.09230         0.10000        61.00000
24. 2    91.00000       168.70000     0.50400        0.05870         0.20000        61.00000
24. 3    91.00000       188.30000     0.50400        0.09940         0.10000        61.00000
```

TABLE OF RESULTS FOR 1 POSITION

CALCULATED WAVENUMBER= 33.31638 RECIP. CM. WAVELENGTH=0.18859 CM. INITIAL FREQUENCY = 183.30 HZ.

ID.K	INDEP. VAR.	DMP. COEF.	WAVE NO.	REL. FQ.	INTERF. TENS.	GEN. AMPL.	Y1	Y2	REAL ELS.	IMAG. ELAS.
1. 1	0.0	0.74280	33.31638	1.00000	50.20000	0.15090	0.95045	0.02230	-0.00018	-0.00008
2. 1	0.32140	0.74241	33.31820	0.99878	50.20000	0.14992	0.94797	0.02228	-2.94846	0.16557
3. 1	1.28561	0.73312	33.31729	0.99939	50.20000	0.15041	0.94921	0.02200	-1.08784	0.66949
4. 1	2.24982	0.72228	33.31820	0.99878	50.20000	0.14992	0.94797	0.02168	-1.47542	1.98812
5. 1	3.21404	0.73063	33.31820	0.99878	50.20000	0.14992	0.94797	0.02193	-2.19294	1.47893
6. 1	4.82105	0.73045	33.31910	0.99816	50.18308	0.14962	0.94705	0.02193	-3.01613	2.34473
7. 1	8.03509	0.72962	33.31820	0.99878	50.09848	0.14992	0.94989	0.02190	-0.45799	0.94319
8. 1	11.24912	0.73596	33.32270	0.99371	49.92927	0.14748	0.94089	0.02209	-3.59276	2.20241
9. 1	14.46316	0.73931	33.32181	0.99633	49.92927	0.14795	0.94813	0.02219	-2.38554	0.57507
10. 1	24.10526	0.74600	33.32449	0.99449	49.75390	0.14648	0.94697	0.02239	-4.77386	0.96072
11. 1	40.17544	0.76953	33.33154	0.98959	49.23244	0.14258	0.94737	0.02309	-4.12325	-5.55768
12. 1	65.88772	0.75072	33.32979	0.99081	49.38780	0.14355	0.94727	0.02252	-4.35079	-0.07847
13. 1	85.17193	0.75698	33.33242	0.98898	49.11707	0.14210	0.94874	0.02271	-1.43536	-1.27768
14. 1	117.31228	0.78158	33.33759	0.98530	48.77865	0.13919	0.94779	0.02344	0.03051	-6.45235
15. 1	143.02456	0.77716	33.33795	0.98530	48.74481	0.13919	0.94845	0.02331	-0.09130	-4.84094
16. 1	191.23509	0.79481	33.34685	0.97857	47.96646	0.13392	0.94991	0.02383	2.41401	-2.03837
17. 1	223.37544	0.80680	33.34932	0.97673	47.79725	0.13249	0.94949	0.02419	3.55372	-2.32209
18. 1	271.58596	0.83119	33.35638	0.97122	47.28962	0.12827	0.94826	0.02492	3.95001	-1.44398
19. 1	319.79649	0.86516	33.36283	0.96632	46.91737	0.12457	0.94584	0.02593	6.90399	1.69824
20. 1	377.64912	0.87318	33.36818	0.96203	46.78200	0.12140	0.93953	0.02617	5.63575	4.30100
21. 1	441.92982	0.86213	33.37618	0.95530	46.03749	0.11653	0.94072	0.02583	6.53240	4.44801
22. 1	506.21053	0.88054	33.38249	0.94979	45.63139	0.11269	0.93764	0.02662	5.03172	4.19463
23. 1	602.63158	0.86176	33.39164	0.94121	44.81919	0.10699	0.93671	0.02581	4.81799	4.59204
24. 1	731.19298	0.88980	33.41366	0.91672	42.34875	0.09302	0.93856	0.02663	5.14023	4.19144

TABLE OF RESULTS FOR 2 POSITION

CALCULATED WAVENUMBER= 36.07268 RECIP. CM. WAVELENGTH=0.17418 CM. INITIAL FREQUENCY = 193.80 HZ.

ID.K	INDEP. VAR.	DMP. COEF.	WAVE NO.	REL. FQ.	INTERF. TENS.	GEN. AMPL.	Y1	Y2	REAL ELS.	IMAG. ELAS.
1. 2	0.0	0.82237	36.07268	1.00000	50.20000	0.24615	0.94860	0.02280	-0.00017	-0.00005
2. 2	0.32140	0.81637	36.07268	1.00000	50.20000	0.24615	0.94860	0.02263	-0.07226	0.35171
3. 2	1.28561	0.80507	36.07516	0.99891	50.20000	0.24556	0.94635	0.02232	-1.80242	1.59187
4. 2	2.24982	0.81310	36.07639	0.99837	50.20000	0.24525	0.94522	0.02254	-3.48802	2.02232
5. 2	3.21404	0.81039	36.07763	0.99782	50.20000	0.24494	0.94409	0.02246	-3.83189	4.02407
6. 2	4.82105	0.81368	36.07639	0.99837	50.18308	0.24525	0.94554	0.02255	-3.18051	1.57765
7. 2	8.03509	0.81593	36.07763	0.99782	50.09848	0.24494	0.94600	0.02262	-2.71690	0.94191
8. 2	11.24912	0.81910	36.08254	0.99565	49.92927	0.24364	0.94469	0.02270	-4.57985	2.44768
9. 2	14.46316	0.82233	36.08131	0.99619	49.92927	0.24397	0.94582	0.02279	-3.30574	0.44480
10. 2	24.10526	0.82582	36.08254	0.99565	49.79390	0.24364	0.94726	0.02289	-1.21116	-0.32292
11. 2	40.17544	0.84184	36.08585	0.99238	49.42164	0.24156	0.94757	0.02333	-0.35284	-1.50224
12. 2	65.88772	0.82816	36.09106	0.99184	49.38780	0.24120	0.94708	0.02295	-1.32148	-0.34317
13. 2	85.17193	0.84526	36.09710	0.98912	49.15091	0.23934	0.94596	0.02342	-3.02723	-2.59610
14. 2	117.31228	0.86851	36.10305	0.98640	48.81250	0.23739	0.94681	0.02406	1.54400	-4.16011
15. 2	143.02456	0.87238	36.10429	0.98585	48.71097	0.23699	0.94765	0.02416	2.16660	-2.75365
16. 2	191.23509	0.88690	36.11964	0.97878	48.03414	0.23156	0.94605	0.02455	4.36465	-5.11541
17. 2	223.37544	0.89541	36.12198	0.97769	47.83109	0.23069	0.94777	0.02479	3.73531	-7.06064
18. 2	271.58596	0.92028	36.13357	0.97225	47.32347	0.22622	0.94640	0.02547	5.97311	-1.43010
19. 2	319.79649	0.94569	36.14273	0.96790	46.95121	0.22253	0.94486	0.02617	7.09615	0.60001
20. 2	377.64912	0.94945	36.15180	0.96255	46.78200	0.21878	0.93886	0.02626	6.56391	4.56789
21. 2	441.92982	0.94675	36.16633	0.95647	46.07133	0.21256	0.93827	0.02618	6.41541	4.88480
22. 2	506.21053	0.96030	36.17515	0.95212	45.66523	0.20868	0.93733	0.02655	5.85022	4.60713
23. 2	602.63158	0.94328	36.19360	0.94287	44.85303	0.20036	0.93442	0.02606	4.82588	5.11750
24. 2	731.19298	0.98046	36.24147	0.91785	42.34875	0.17763	0.93413	0.02705	4.80954	4.48756

TABLE OF RESULTS FOR 3 POSITION

CALCULATED WAVENUMBER= 38.79230 RECIP. CM. WAVELENGTH=0.16197 CM. INITIAL FREQUENCY = 204.80 HZ.

ID.K	INDEP. VAR.	DMP. COEF.	WAVE NO.	REL. FQ.	INTERF. TENS.	GEN. AMPL.	Y1	Y2	REAL ELS.	IMAG. ELAS.
1. 3	0.0	0.90264	38.79230	1.00000	50.20000	0.27706	0.94701	0.02327	-0.00017	-0.00005
2. 3	0.32140	0.89655	38.79357	0.99951	50.20000	0.27766	0.94596	0.02311	-0.97130	0.27219
3. 3	1.28561	0.89241	38.79397	0.99951	50.20000	0.27766	0.94596	0.02300	-0.94115	0.55986
4. 3	2.24982	0.88534	38.79397	0.99951	50.20000	0.27766	0.94596	0.02282	-0.84789	0.95768
5. 3	3.21404	0.88522	38.79731	0.99854	50.20000	0.27880	0.94387	0.02282	-2.56266	2.19034
6. 3	4.82105	0.88007	38.79731	0.99854	50.18308	0.27880	0.94419	0.02268	-2.06320	2.16752
7. 3	8.03509	0.88118	38.79731	0.99854	50.09848	0.27880	0.94578	0.02271	-0.87627	1.29431
8. 3	11.24912	0.87451	38.80397	0.99698	49.92927	0.28092	0.94479	0.02254	-1.28017	2.05700
9. 3	14.46316	0.88380	38.80564	0.99609	49.92927	0.28141	0.94374	0.02277	-2.47520	2.35759
10. 3	24.10526	0.89276	38.80730	0.99561	49.79390	0.28190	0.94526	0.02301	-1.48667	0.83157
11. 3	40.17544	0.90411	38.81889	0.99219	49.52317	0.28488	0.94307	0.02329	-4.89901	2.00089
12. 3	65.88772	0.89074	38.82054	0.99170	49.42164	0.28525	0.94395	0.02295	-2.47579	1.85851
13. 3	85.17193	0.89258	38.82384	0.99072	49.21859	0.28596	0.94574	0.02299	-0.86362	0.90990
14. 3	117.31228	0.93084	38.83533	0.98730	48.84634	0.28803	0.94554	0.02397	-0.49507	-2.00762
15. 3	143.02456	0.91458	38.84024	0.98584	48.67713	0.28873	0.94566	0.02355	-0.89625	-0.38956
16. 3	191.23509	0.93984	38.84350	0.98486	48.06798	0.28914	0.95551	0.02420	2.55916	1.50041
17. 3	223.37544	0.96035	38.86613	0.97803	47.86493	0.29069	0.94463	0.02471	1.60728	-4.90808
18. 3	271.58596	0.98276	38.88207	0.97314	47.35731	0.29049	0.94409	0.02528	5.31637	-4.88427
19. 3	319.79649	0.99622	38.89468	0.96924	46.95121	0.28963	0.94371	0.02561	6.88978	-3.67058
20. 3	377.64912	1.02818	38.91025	0.96436	46.81584	0.28772	0.93580	0.02642	6.21347	5.34630
21. 3	441.92982	1.00267	38.93315	0.95703	46.07133	0.28333	0.93488	0.02575	5.49251	6.41210
22. 3	506.21053	1.03736	38.94969	0.95166	45.66523	0.27932	0.93145	0.02663	4.69949	5.09467
23. 3	602.63158	1.00354	38.96882	0.94531	44.88687	0.27932	0.93363	0.02575	4.82126	6.20613
24. 3	731.19298	1.04778	39.04270	0.91943	42.34875	0.25323	0.93084	0.02684	4.43106	4.98670

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                 ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE POLYMERIC SURFACTANTS - L(AIN) FEB 1968 RLR
EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (AX)          /FRESHLY DISTILLED N HEPTANE            INTERFACE.
THE SYSTEM UNDER INVESTIGATION IS PVAC(1) - POLYVINYL ACETATE (AS RECD. CITY CHEM. NY) IN ACETONE  2/20/68

                                    SYSTEM PARAMETERS

                 LOWER PHASE DENSITY  0.9980 G/ML        UPPER PHASE DENSITY  0.6780 G/ML
                         VISCOSITY  0.00976 POISES                  VISCOSITY  0.00386 POISES

                            INITIAL VALUES ASSUMED IN CALCULATION

                 REAL ELASTICITY (EP)   0.0            IMAGINARY ELASTICITY (EPP)   0.0
                 WAVENUMBER  31.00000 RECIPROCAL  CM    DAMPING COEFFICIENT   0.70000 CM
                 REFERENCE METER SCALE    1.00 MV.      INTERFACIAL TENSION 50.2000 DYNES/CM
                 REFERENCE INPUT VTG.  0.100 VT.

                                    PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 4.89813 CM. BASED ON RESGN= 0.31330 RESFN= 6.04860 DISTGN= 6.00200 DISTFN= 1.70687

                            CALCULATION OF ZERO ELASTICITY PARAMETERS

RNG. NO.  FREQUENCY      DMP. COEF.      WAVE NO.       WAVELENGTH       NO. WAVES   PHS.COR.WANO  GN. PB.  SCL.FCTR.
    1         162.50     0.73700677    33.20838186     0.18921301     32.59774361    33.20838186     0.95198309
    2         182.07     0.81843231    35.83690340     0.17533688     24.49645930    35.83490340     0.92956646
    3         202.00     0.89200809    38.43522200     0.16347455     26.27401673    38.43522200     0.75825130

                                INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =2130.00000  MG.  MOLECULAR WT.=  86.00000 MAKE-UP VOLUME=0.0500 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=     34.30MG.  WEIGHT OF WEIGHT=    171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.90951 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.


                                      INPUT DATA

ID ,K       INDEP. VAR.      FREQUENCY      INPUT VOLT.    OUTPUT VOLT.     METER SCALE    SFTN. VAR.

  1. 1       0.0             162.50000       0.46900        0.13680         0.20000        37.10000
  1. 2       0.0             182.00000       0.47000        0.06320         0.50000        37.10000
  1. 3       0.0             202.00000       0.47100        0.11170         0.20000        37.10000
  2. 1       0.02000         162.10000       0.47000        0.12880         0.20000        37.10000
  2. 2       0.02000         181.80000       0.47100        0.06330         0.50000        37.10000
  2. 3       0.02000         201.90000       0.47200        0.10770         0.20000        37.10000
  3. 1       0.04000         162.10000       0.47100        0.13580         0.20000        37.20000
  3. 2       0.04000         181.70000       0.47200        0.06260         0.50000        37.20000
  3. 3       0.04000         201.90000       0.47200        0.11060         0.20000        37.20000
  4. 1       0.24000         161.50000       0.47100        0.13190         0.20000        37.50000
  4. 2       0.24000         181.50000       0.47200        0.06050         0.50000        37.70000
  4. 3       0.24000         201.60000       0.47200        0.09880         0.20000        37.80000
  5. 1       0.36000         161.70000       0.47100        0.12930         0.20000        38.80000
  5. 2       0.36000         181.30000       0.47200        0.06070         0.50000        38.80000
  5. 3       0.36000         201.20000       0.47300        0.11500         0.20000        38.90000
  6. 1       0.40000         160.70000       0.47100        0.09230         0.20000        39.80000
  6. 2       0.40000         180.00000       0.47200        0.04060         0.50000        40.00000
  6. 3       0.40000         200.00000       0.47200        0.05300         0.20000        40.30000
  7. 1       0.42000         161.30000       0.47200        0.10180         0.20000        39.80000
  7. 2       0.42000         180.40000       0.47200        0.05080         0.50000        40.20000
  7. 3       0.42000         200.30000       0.47300        0.08870         0.20000        40.20000
  8. 1       0.44000         160.20000       0.47200        0.09480         0.20000        41.10000
  8. 2       0.44000         179.50000       0.47300        0.11060         0.20000        41.30000
  8. 3       0.44000         199.30000       0.47300        0.08130         0.20000        41.40000
  9. 1       0.48000         158.70000       0.47200        0.08810         0.20000        43.40000
  9. 2       0.48000         177.80000       0.47200        0.10710         0.20000        43.60000
  9. 3       0.48000         197.10000       0.47300        0.08330         0.20000        43.70000
 10. 1       0.50000         156.00000       0.47200        0.07580         0.20000        48.30000
 10. 2       0.50000         175.60000       0.47200        0.09720         0.20000        48.60000
 10. 3       0.50000         194.00000       0.47200        0.07700         0.20000        48.90000
 11. 1       0.52000         153.90000       0.47200        0.06390         0.20000        53.10000
 11. 2       0.52000         172.50000       0.47200        0.08230         0.20000        53.30000
 11. 3       0.52000         191.50000       0.47300        0.06730         0.20000        53.50000
 12. 1       0.54000         150.70000       0.47200        0.10340         0.10000        58.50000
 12. 2       0.54000         169.20000       0.47200        0.07170         0.20000        58.80000
 12. 3       0.54000         187.70000       0.47300        0.11940         0.10000        59.00000
 13. 1       0.56000         146.40000       0.47000        0.07740         0.10000        66.10000
 13. 2       0.56000         163.50000       0.47100        0.11070         0.10000        66.30000
 13. 3       0.56000         181.60000       0.47200        0.11750         0.10000        66.50000
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                                  TABLE OF RESULTS FOR  1  POSITION

             CALCULATED WAVENUMBER= 33.20656  RECIP. CM.  WAVELENGTH=0.18922  CM.  INITIAL FREQUENCY =  162.50  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERP. TENS. GEN. AMPL.      Y1          Y2      REAL ELS.  IMAG. ELAS.

 1. 1    0.0         0.73767    33.20656    1.00000    50.20000    0.14697    0.95093    0.02227   -0.30016   -0.00009
 2. 1    0.41667     0.74127    33.21004    0.99756    50.20000    0.14502    0.94556    0.02262  -10.43423    6.61124
 3. 1    0.83333     0.73929    33.21064    0.99754    50.16632    0.14702    0.94619    0.02226   -9.67914    3.42978
 4. 1    5.00000     0.74517    33.21176    0.99431    50.06927    0.14404    0.94902    0.02244   -7.41112    9.49679
 5. 1    7.50000     0.73483    33.21347    0.99508    49.62740    0.14307    0.98146    0.02273    1.00389   -0.31948
 6. 1    8.33333     0.81798    33.22191    0.98892    49.29097    0.13823    0.94543    0.02482   10.93979    1.99437
 7. 1    8.75000     0.80096    33.21687    0.99262    49.29097    0.14112    0.95293    0.02411    3.17739   -0.14618
 8. 1    9.16667     0.80818    33.22609    0.98945    48.85269    0.13388    0.94762    0.02432    7.43919   -3.41679
 9. 1   10.00000     0.81278    33.23801    0.97682    48.07799    0.12873    0.94997    0.02445   11.87461    9.34999
10. 1   10.41667     0.82499    33.25798    0.96000    46.42784    0.11653    0.94280    0.02479    9.54110    5.99184
11. 1   10.83333     0.84616    33.27181    0.94708    44.81078    0.10778    0.94951    0.02543    4.98019   -0.41999
12. 1   11.25000     0.84890    33.28479    0.92738    42.99192    0.09615    0.94741    0.02610    9.67630   -0.07132
13. 1   11.66667     0.89997    33.31031    0.89477    40.43304    0.08240    0.93605    0.02702    4.95314    4.10304

                                  TABLE OF RESULTS FOR  2  POSITION

             CALCULATED WAVENUMBER= 35.83490  RECIP. CM.  WAVELENGTH=0.17534  CM.  INITIAL FREQUENCY =  182.00  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERP. TENS. GEN. AMPL.      Y1          Y2      REAL ELS.  IMAG. ELAS.

 1. 2    0.0         0.81943    35.83490    1.00000    50.20000    0.24010    0.94875    0.02276   -0.00017   -0.00005
 2. 2    0.41667     0.81482    35.83726    0.99890    50.20000    0.23934    0.94648    0.02274   -2.60637    0.33900
 3. 2    0.83333     0.81793    35.83849    0.99835    50.16632    0.23896    0.94598    0.02281   -3.61099    0.00174
 4. 2    5.00000     0.82472    35.84078    0.99725    49.99790    0.23818    0.94690    0.02301   -1.95897   -1.19492
 5. 2    7.50000     0.82318    35.84311    0.99615    49.62740    0.23739    0.95168    0.02297    1.53686    0.62744
 6. 2    8.33333     0.91141    35.85814    0.98901    49.22320    0.23199    0.94459    0.02542    8.67148    0.48119
 7. 2    8.75000     0.84098    35.85395    0.99121    49.15984    0.23370    0.95046    0.02401    2.35960   -0.49933
 8. 2    9.16667     0.88976    35.86385    0.98626    48.78533    0.22981    0.94733    0.02481    4.92567   -2.41290
 9. 2   10.00000     0.88878    35.88296    0.97692    48.31063    0.22237    0.94296    0.02477   16.36330    7.30697
10. 2   10.41667     0.89688    35.91382    0.96184    46.32690    0.20868    0.94429    0.02497   10.30309   -3.71120
11. 2   10.83333     0.92193    35.93990    0.94780    44.74341    0.19642    0.94788    0.02564    4.07477   -1.00921
12. 2   11.25000     0.93344    35.97339    0.92967    42.89087    0.18010    0.94869    0.02595    3.69919   -0.49106
13. 2   11.66667     0.95392    36.02728    0.89835    40.36467    0.15188    0.93707    0.02647    6.05844    5.47804

                                  TABLE OF RESULTS FOR  3  POSITION

             CALCULATED WAVENUMBER= 38.43522  RECIP. CM.  WAVELENGTH=0.16347  CM.  INITIAL FREQUENCY =  202.00  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERP. TENS. GEN. AMPL.      Y1          Y2      REAL ELS.  IMAG. ELAS.

 1. 3    0.0         0.69231    38.43522    1.00000    50.20000    0.28851    0.94720    0.02371   -0.00017   -0.00005
 2. 3    0.41667     0.90117    38.43682    0.99950    50.20000    0.28873    0.94615    0.02345   -0.03162   -0.98847
 3. 3    0.83333     0.99498    38.43682    0.99950    50.16632    0.28873    0.94678    0.02328   -0.29756   -0.27514
 4. 3    5.00000     0.97173    38.44159    0.99802    49.96422    0.28932    0.94744    0.02399    1.25437   -1.30568
 5. 3    7.50000     0.84737    38.44754    0.99604    49.59371    0.28995    0.95026    0.02308    1.39473    0.99459
 6. 3    8.33333     1.06787    38.46681    0.99010    49.12214    0.29074    0.94658    0.02776    5.28365    1.63702
 7. 3    8.75000     0.94842    38.46212    0.99158    49.15584    0.29069    0.94912    0.02466    2.67338   -0.41529
 8. 3    9.16667     0.96855    38.47770    0.98663    48.75165    0.29049    0.94630    0.02517    4.19675   -2.19410
 9. 3   10.00000     0.96066    38.50523    0.97772    47.97695    0.28772    0.94277    0.02495   18.19480  -11.24780
10. 3   10.41667     0.97152    38.55676    0.96040    46.22545    0.27932    0.93984    0.02520   15.24379   12.07743
11. 3   10.83333     0.99126    38.59184    0.94802    44.67605    0.26511    0.94495    0.02569    3.85138   -2.69724
12. 3   11.25000     1.00576    38.64243    0.92921    42.82350    0.25028    0.94338    0.02603    4.99641   -3.91019
13. 3   11.66667     0.99795    38.71737    0.89401    40.29731    0.23857    0.93298    0.02577    3.73899    6.42179
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                        ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE POLYMERIC SURFACTANTS - L1(INF)  FEB 1968  RLB

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)            /FRESHLY DISTILLED N HEPTANE              INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS PVAC(2) - POLYVINYL ACETATE (AS RECD. CITY CHEM. NY) IN ACETONE  2/20/68

                                              SYSTEM PARAMETERS

                    LOWER PHASE DENSITY  0.9980 G/ML         UPPER PHASE DENSITY  0.6780 G/ML
                              VISCOSITY  0.00896 POISES                 VISCOSITY  0.00386 POISES

                                        INITIAL VALUES ASSUMED IN CALCULATION

                    REAL ELASTICITY (EP)   0.0              IMAGINARY ELASTICITY (EPP)   0.0
                    WAVENUMBER  31.00000 RECIPROCAL  CM     DAMPING COEFFICIENT   0.70000 CM
                    REFERENCE METER SCALE    1.00 MV.       INTERFACIAL TENSION 50.2000 DYNES/CM
                    REFERENCE INPUT VTG.  0.100 VT.

                                              PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 4.29512 CM. BASED ON RESGA= 0.31330 RESEN= 6.04860 DISTGN= 6.00200 DISTEN= 1.70687

                                        CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY     DMP. COEF.      WAVE NO.       WAVELENGTH      NO. WAVES    PHS.COR.WANO  GN. PR. SCL.FCTR.
   1         162.00     0.72770942     33.13783347     0.18960745     22.65276342     33.13783347     0.94402520
   2         181.60     0.81339359     35.78195796     0.17559632     24.46026614     35.78195786     0.96255554
   3         201.60     0.87348685     38.38407681     0.16369236     26.23905427     38.38407681     0.91058213

                                              INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =2150.00000  MG.  MOLECULAR WT.=  86.00000 MAKE-UP VOLUME=0.0500 L.
THE AREA IS KEPT CONST. AT 243.00000 SQ. CM


                                              INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=      0.980 WEIGHT OF PLATE=      34.30MG.  WEIGHT OF WEIGHT=     171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.89575 CM.  CALCULATED FRACTION IN LOWER PHASE=0.230
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20010 DYNES/CM.
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                                             INPUT DATA

ID .K     INDEP. VAR.    FREQUENCY      INPUT VOLT.    OUTPUT VOLT.    METER SCALE    SPTN. VAR.

 1. 1     0.0            162.00000      0.47000        0.13500         0.20000        37.60000
 1. 2     0.0            181.60000      0.47100        0.06980         0.50000        37.60000
 1. 3     0.0            201.60000      0.47200        0.12940         0.20000        37.60000
 2. 1     0.02000        162.00000      0.47000        0.13800         0.20000        37.60000
 2. 2     0.02000        181.60000      0.47100        0.06820         0.50000        37.60000
 2. 3     0.02000        201.50000      0.47100        0.13270         0.20000        37.60000
 3. 1     0.04000        161.50000      0.47000        0.13820         0.20000        37.60000
 3. 2     0.04000        181.60000      0.47000        0.06730         0.50000        37.60000
 3. 3     0.04000        201.50000      0.47100        0.13120         0.20000        37.60000
 4. 1     0.06000        161.90000      0.47000        0.13880         0.20000        37.60000
 4. 2     0.06000        181.50000      0.47000        0.06800         0.50000        37.60000
 4. 3     0.06000        201.40000      0.47100        0.13080         0.20000        37.60000
 5. 1     0.08000        161.80000      0.47000        0.12990         0.20000        37.60000
 5. 2     0.08000        181.50000      0.47000        0.06270         0.50000        37.60000
 5. 3     0.08000        201.50000      0.47000        0.12290         0.20000        37.60000
 6. 1     0.10000        161.40000      0.47000        0.12770         0.20000        37.60000
 6. 2     0.10000        181.50000      0.47000        0.06310         0.50000        37.60000
 6. 3     0.10000        201.50000      0.47000        0.12280         0.20000        37.60000
 7. 1     0.12000        161.80000      0.47000        0.12550         0.20000        37.80000
 7. 2     0.12000        181.90000      0.47000        0.06210         0.50000        37.80000
 7. 3     0.12000        201.20000      0.47000        0.12150         0.20000        37.80000
 8. 1     0.14000        161.70000      0.47000        0.12380         0.20000        38.00000
 8. 2     0.14000        181.40000      0.47000        0.06030         0.50000        38.00000
 8. 3     0.14000        201.30000      0.47000        0.12210         0.20000        38.00000
 9. 1     0.18000        161.70000      0.47000        0.12350         0.20000        38.15000
 9. 2     0.18000        181.30000      0.47000        0.06090         0.50000        38.15000
 9. 3     0.18000        201.20000      0.47000        0.12170         0.20000        38.15000
10. 1     0.24000        161.70000      0.46900        0.12090         0.20000        38.30000
10. 2     0.24000        181.30000      0.46900        0.05920         0.50000        38.30000
10. 3     0.24000        201.20000      0.47000        0.12050         0.20000        38.30000
11. 1     0.30000        161.60000      0.47000        0.12010         0.20000        38.40000
11. 2     0.30000        181.30000      0.46900        0.05560         0.50000        38.40000
11. 3     0.30000        201.20000      0.47000        0.12110         0.20000        38.40000
12. 1     0.38000        161.90000      0.46800        0.11450         0.20000        38.50000
12. 2     0.38000        181.10000      0.46900        0.05700         0.50000        38.50000
12. 3     0.38000        201.00000      0.46900        0.11660         0.20000        38.50000
13. 1     0.48000        161.40000      0.46800        0.11150         0.20000        38.90000
13. 2     0.48000        181.00000      0.46900        0.05480         0.50000        38.90000
13. 3     0.48000        201.00000      0.46900        0.11400         0.20000        38.90000
14. 1     0.60000        161.30000      0.46800        0.10720         0.20000        39.10000
14. 2     0.60000        180.90000      0.46900        0.05330         0.50000        39.10000
14. 3     0.60000        200.70000      0.46900        0.10790         0.20000        39.10000
15. 1     0.80000        161.10000      0.46900        0.09880         0.20000        39.50000
15. 2     0.80000        180.60000      0.46900        0.12050         0.20000        39.50000
15. 3     0.80000        200.50000      0.46900        0.09890         0.20000        39.50000
16. 1     0.90000        160.40000      0.46800        0.09340         0.20000        39.80000
16. 2     0.90000        180.50000      0.46900        0.11470         0.20000        39.80000
16. 3     0.90000        200.30000      0.46500        0.09420         0.20000        39.80000
17. 1     1.02000        160.50000      0.46700        0.08160         0.20000        40.60000
17. 2     1.02000        180.00000      0.46800        0.10150         0.20000        40.60000
17. 3     1.02000        199.50000      0.46900        0.08130         0.20000        40.60000
18. 1     1.08000        160.20000      0.46700        0.07770         0.20000        41.00000
18. 2     1.08000        179.80000      0.46800        0.09640         0.20000        41.00000
18. 3     1.08000        199.60000      0.46800        0.07730         0.20000        41.00000
19. 1     1.14000        160.10000      0.46700        0.07720         0.20000        41.10000
19. 2     1.14000        179.60000      0.46900        0.09360         0.20000        41.10000


19. 3     1.14000        199.50000      0.46900        0.07740         0.20000        41.10000
20. 1     1.20000        160.00000      0.46800        0.07530         0.20000        41.40000
20. 2     1.20000        179.40000      0.46900        0.09200         0.20000        41.40000
20. 3     1.20000        199.20000      0.46900        0.07540         0.20000        41.40000
21. 1     1.30000        159.60000      0.46700        0.07180         0.20000        42.00000
21. 2     1.30000        178.90000      0.46800        0.08760         0.20000        42.00000
21. 3     1.30000        199.70000      0.46800        0.07340         0.20000        42.00000
22. 1     1.40000        159.00000      0.46700        0.07010         0.20000        43.00000
22. 2     1.40000        179.40000      0.46700        0.08800         0.20000        43.00000
22. 3     1.40000        198.10000      0.46800        0.07460         0.20000        43.00000
23. 1     1.60000        158.60000      0.46500        0.06840         0.20000        43.40000
23. 2     1.60000        178.00000      0.46700        0.08590         0.20000        43.40000
23. 3     1.60000        197.70000      0.46800        0.07450         0.20000        43.40000
24. 1     1.80000        158.20000      0.46600        0.06930         0.20000        44.20000
24. 2     1.80000        177.40000      0.46900        0.08430         0.20000        44.20000
24. 3     1.80000        197.10000      0.46800        0.07550         0.20000        44.20000
25. 1     2.00000        157.70000      0.46600        0.06780         0.20000        45.10000
25. 2     2.00000        176.80000      0.46700        0.08550         0.20000        45.10000
25. 3     2.00000        196.40000      0.46700        0.07590         0.20000        45.10000
26. 1     2.40000        156.20000      0.46300        0.05180         0.20000        47.30000
26. 2     2.40000        175.20000      0.46500        0.06460         0.20000        47.30000
26. 3     2.40000        194.70000      0.46700        0.05590         0.20000        47.30000
27. 1     3.60000        153.20000      0.46500        0.09030         0.10000        53.00000
27. 2     3.60000        171.60000      0.46600        0.11260         0.10000        53.20000
27. 3     3.60000        190.90000      0.46400        0.10170         0.10000        53.40000
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                                             TABLE OF RESULTS FOR  1  POSITION

                 CALCULATED WAVENUMBER= 33.13783  RECIP. CM.  WAVELENGTH=0.18961  CM.  INITIAL FREQUENCY =  162.00  HZ.

ID .K  INDEP. VAR.  CMP. COFF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 1   0.0           0.73771   33.13783    1.00000   50.20000     0.14483     0.95058     0.02228    -0.00016    -0.00005
 2. 1   0.41667       0.73259   33.13783    1.00000   50.20000     0.14483     0.95058     0.02211    -0.06627     0.33582
 3. 1   0.83333       0.73147   33.13869    0.99938   50.20000     0.14404     0.94933     0.02207    -1.14411     0.39280
 4. 1   1.25000       0.73046   33.13869    0.99918   50.20000     0.14404     0.94933     0.02204    -1.12902     0.47846
 5. 1   1.66667       0.74238   33.13995    0.99877   50.20000     0.14335     0.94808     0.02270    -3.34897    -2.77735
 6. 1   2.08333       0.74938   33.13995    0.99877   50.20000     0.14335     0.94808     0.02280    -3.41000    -1.97891
 7. 1   2.50000       0.75312   33.13995    0.99877   50.13241     0.14335     0.94938     0.02273    -0.69177    -1.87064
 8. 1   2.91667       0.75931   33.14041    0.99819   50.06482     0.14307     0.94939     0.02280    -0.48930    -2.00785
 9. 1   3.75000       0.75407   33.14041    0.99815   50.01412     0.14307     0.95038     0.02281     0.50685    -1.24730
10. 1   5.00000       0.76093   33.14041    0.99815   49.96343     0.14307     0.95132     0.02294     1.31653    -0.93043
11. 1   6.25000       0.76178   33.14128    0.99733   49.92963     0.14258     0.95071     0.02299     1.08910    -1.37451
12. 1   7.91667       0.77111   33.14211    0.99691   49.89584     0.14210     0.95011     0.02327     1.96471    -2.10447
13. 1  10.00000       0.77640   33.14294    0.99610   49.76045     0.14161     0.95144     0.02343     2.29442    -1.10894
14. 1  12.50000       0.78485   33.14381    0.99548   49.69308     0.14112     0.95148     0.02368     2.76595    -1.10878
15. 1  15.66667       0.80274   33.14550    0.99444   49.55788     0.14016     0.95158     0.02422     3.70831    -0.77456
16. 1  18.75000       0.81192   33.14801    0.99299   49.45649     0.13871     0.94975     0.02449     4.09080    -1.34767
17. 1  21.25000       0.84085   33.15050    0.99074   49.18612     0.13726     0.95120     0.02536     4.81434     0.35875
18. 1  22.50000       0.85037   33.15258    0.98889   49.05094     0.13583     0.95004     0.02565     5.32535     0.62970
19. 1  23.75000       0.85175   33.15378    0.98827   49.01714     0.13535     0.94944     0.02567     5.54765     0.48045
20. 1  25.00000       0.85433   33.15460    0.98745   48.91575     0.13487     0.95015     0.02583     5.24417     0.81407
21. 1  27.08333       0.86391   33.15783    0.98519   48.71298     0.13297     0.94906     0.02605     5.87558     1.12413
22. 1  29.16667       0.86457   33.16260    0.98148   48.37902     0.13014     0.94811     0.02606     5.88848     1.24505
23. 1  33.33333       0.86572   33.16572    0.97901   48.23983     0.12827     0.94573     0.02610     6.43880     2.16049
24. 1  37.50000       0.85978   33.16889    0.97654   47.96946     0.12641     0.94600     0.02592     6.71599     1.59981
25. 1  41.66667       0.86061   33.17259    0.97344   47.88530     0.12411     0.94571     0.02594     6.76517     1.96311
26. 1  50.00000       0.90884   33.18348    0.96470   46.92179     0.11741     0.94157     0.02739     5.31151     3.30203
27. 1  75.00000       0.91592   33.20301    0.94548   44.99541     0.10504     0.94287     0.02759     5.37905     2.96771
                                             TABLE OF RESULTS FOR  2  POSITION

                 CALCULATED WAVENUMBER= 35.78196  RECIP. CM.  WAVELENGTH=0.17560  CM.  INITIAL FREQUENCY =  181.60  HZ.

ID .K  INDEP. VAR.  CMP. COFF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 2   0.0           0.81349   35.78196    1.00000   50.20000     0.23857     0.94879     0.02275    -0.00017    -0.00005
 2. 2   0.41667       0.80494   35.78196    1.00000   50.20000     0.23857     0.94879     0.02249    -0.09020     0.52599
 3. 2   0.83333       0.80744   35.78196    1.00000   50.20000     0.23857     0.94879     0.02257    -0.07579     0.39040
 4. 2   1.25000       0.80465   35.78313    0.99945   50.20000     0.23818     0.94765     0.02249    -1.01593     0.56709
 5. 2   1.66667       0.82354   35.78313    0.99945   50.20000     0.23818     0.94765     0.02301    -0.90575    -1.12993
 6. 2   2.08333       0.82208   35.78313    0.99945   50.20000     0.23818     0.94765     0.02297    -0.94825    -0.97883
 7. 2   2.50000       0.82578   35.78313    0.99945   50.13241     0.23818     0.94893     0.02308     0.42486    -0.43925
 8. 2   2.91667       0.83224   35.78430    0.99890   50.06482     0.23779     0.94907     0.02326     0.78831    -0.88576
 9. 2   3.75000       0.82955   35.78547    0.99835   50.01412     0.23739     0.94889     0.02318     0.54080    -0.82645
10. 2   5.00000       0.83565   35.78547    0.99835   49.96343     0.23739     0.94985     0.02335     1.32826    -0.53660
11. 2   6.25000       0.83408   35.78547    0.99835   49.92963     0.23739     0.95050     0.02331     1.50712    -0.16766
12. 2   7.91667       0.84367   35.78780    0.99725   49.89584     0.23659     0.94886     0.02357     1.29225    -1.50423
13. 2  10.00000       0.85244   35.78894    0.99670   49.76069     0.23619     0.95029     0.02382     2.17590    -0.43459
14. 2  12.50000       0.85850   35.79012    0.99615   49.69306     0.23578     0.95044     0.02399     2.45891    -0.59869
15. 2  15.66667       0.88369   35.79359    0.99449   49.55788     0.23454     0.94960     0.02460     3.60045    -0.97892
16. 2  18.75000       0.89176   35.79675    0.99394   49.45649     0.23412     0.95040     0.02491     3.79779    -0.33392
17. 2  21.25000       0.91740   35.80049    0.99119   49.18612     0.23199     0.94988     0.02563     4.56956     0.15400
18. 2  22.50000       0.92873   35.80274    0.99039   49.05094     0.23117     0.95020     0.02594     4.58518     0.49749
19. 2  23.75000       0.93520   35.80506    0.98899   49.01714     0.23025     0.94856     0.02612     5.25965     0.55254
20. 2  25.00000       0.93892   35.80734    0.98789   48.91575     0.22936     0.94823     0.02620     5.29188     0.64157
21. 2  27.08333       0.94695   35.81309    0.98513   48.71298     0.22712     0.94643     0.02644     6.04608     1.14057
22. 2  29.16667       0.94305   35.81862    0.98238   48.37502     0.22485     0.94727     0.02633     5.70455     0.75674
23. 2  33.33333       0.94675   35.82309    0.98018   48.23983     0.22300     0.94532     0.02643     6.47009     1.35794
24. 2  37.50000       0.94918   35.82975    0.97697   47.96946     0.22019     0.94372     0.02649     6.85309     2.10199
25. 2  41.66667       0.94187   35.83636    0.97357   47.88530     0.21735     0.94281     0.02628     7.35794     2.51807
26. 2  50.00000       0.99773   35.85373    0.96476   46.92179     0.20965     0.93913     0.02783     5.42549     3.47097
27. 2  75.00000       1.00975   35.89153    0.94493   44.92782     0.19198     0.93794     0.02813     5.18291     3.48173
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                              TABLE OF RESULTS FOR  3  POSITION

        CALCULATED WAVENUMBER= 38.38408  RECIP. CM.  WAVELENGTH=0.16369  CM.  INITIAL FREQUENCY =  201.40  HZ.

ID ,K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FG.  INTERP. TENS.  GEN. AMPL.    Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 3   0.0          0.89049    38.38408    1.00000   50.20000     0.28932    0.94723    0.02370    -0.00017   -0.00005
 2. 3   0.41667      0.89372    38.38367    0.99950   50.20000     0.28949    0.94618    0.02332    -0.92476   -0.60307
 3. 3   0.83333      0.89796    38.38367    0.99950   50.20000     0.28949    0.94618    0.02359    -0.87632   -0.83794
 4. 3   1.25000      0.89880    38.38725    0.99901   50.20000     0.28966    0.94512    0.02341    -2.90248   -1.19144
 5. 3   1.66667      0.91344    38.38367    0.99950   50.20000     0.28949    0.94618    0.02380    -0.13331   -2.29066
 6. 3   2.08333      0.91287    38.38367    0.99850   50.20000     0.28949    0.94618    0.02378    -0.17552   -2.29110
 7. 3   2.50000      0.91571    38.39042    0.99902   50.13241     0.28995    0.94420    0.02385    -4.23741   -5.36291
 8. 2   2.91667      0.91445    38.38884    0.99831   50.01412     0.28981    0.94661    0.02382     0.35137   -1.80223
 9. 3   3.75000      0.91593    38.39042    0.99802   50.01412     0.28995    0.94657    0.02384     0.30990   -1.92297
10. 3   5.00000      0.91764    38.39042    0.99802   49.96343     0.28995    0.94740    0.02390     1.11717   -1.19845
11. 3   6.25000      0.91648    38.39042    0.99802   49.92903     0.28993    0.94812    0.02387     1.36057   -0.71212
12. 3   7.91667      0.92100    38.39359    0.99702   49.89584     0.29019    0.94664    0.02409     1.11975   -2.77727
13. 3  10.00000      0.92023    38.39389    0.99702   49.78081     0.29019    0.94921    0.02423     2.19729   -0.34806
14. 3  12.50000      0.94327    38.39838    0.99554   49.69306     0.29047    0.94732    0.02457     2.67347   -1.81997
15. 3  16.66667      0.96366    38.40146    0.99484   49.55788     0.29060    0.94778    0.02509     3.75846   -1.14349
16. 3  18.75000      0.97570    38.40480    0.99315   49.45849     0.29069    0.94759    0.02539     4.24897   -0.93000
17. 2  21.25000      1.00939    38.41086    0.99157   49.13812     0.29073    0.94834    0.02628     4.66288    0.36075
18. 3  22.50000      1.02058    38.41523    0.99008   49.05094     0.29066    0.94795    0.02657     4.93824    0.96017
19. 3  23.75000      1.02074    38.41708    0.98958   49.01714     0.29061    0.94754    0.02657     5.07094    0.97916
20. 3  25.00000      1.02668    38.42173    0.98810   48.91573     0.29042    0.94631    0.02672     5.60428    0.49026
21. 3  27.08333      1.03202    38.42945    0.98562   48.71298     0.28990    0.94491    0.02685     6.19010    1.02349
22. 3  29.16667      1.02750    38.43361    0.98264   48.37302     0.28897    0.94510    0.02673     6.09717    0.77379
23. 3  33.33333      1.02717    38.44469    0.98065   48.23983     0.28817    0.94348    0.02672     6.84941    1.20437
24. 3  37.50000      1.02289    38.45374    0.97768   47.96946     0.28672    0.94238    0.02660     7.55695    1.61929
25. 3  41.66667      1.01979    38.46420    0.97421   47.66530     0.28467    0.94090    0.02651     8.07518    2.70065
26. 3  50.00000      1.00828    38.48916    0.96977   46.92179     0.27932    0.93751    0.02822     5.60224    3.53812
27. 3  75.00000      1.09142    38.54253    0.94692   44.86023     0.26144    0.93878    0.02832     5.76658    3.09972
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                         ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE POLYMERIC SURFACTANTS - L(AINF)  PER 1568  RLB
EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)          /FRESHLY DISTILLED N HEPTANE               INTERFACE.
THE SYSTEM UNDER INVESTIGATION IS PVSTE(1) -POLYVINYL STEARATE (AS RECD. AIRCO) IN TRICHLOROETHYLENE  2/19/69

                                         SYSTEM PARAMETERS

               LOWER PHASE DENSITY  0.9980 G/ML        UPPER PHASE DENSITY  0.6780 G/ML
                       VISCOSITY  0.00896 POISES                      VISCOSITY  0.00386 POISES

                                  INITIAL VALUES ASSUMED IN CALCULATION

               REAL ELASTICITY (EP)    0.0              IMAGINARY ELASTICITY (EPP)    0.0
               WAVENUMBER  31.00000 RECIPROCAL  CM      DAMPING COEFFICIENT   0.70000 CM
               REFERENCE METER SCALE    1.00 MV.        INTERFACIAL TENSION 50.2000 DYNES/CM
               REFERENCE INPUT VTG.  0.100 VT.

                                         PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 4.26563 CM. BASED ON RESGN= 0.92400 RESFN= 6.02000 DISTGN= 5.99401 DISTFN= 1.72839

                                  CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. N.I.  FREQUENCY      DMP. COEF.      WAVE NO.      WAVELENGTH      NO. WAVES    PHS.COR.WANO  GN. PR. SCL.FCTR.
    1         162.73      0.74044588    33.23403355     0.18905060     22.56244838    33.23403355     1.36323459
    2         182.33      0.81658906    35.87458724     0.17514292     24.35510939    35.87458724     1.40144367
    3         202.13      0.89238829    38.44800305     0.16342019     26.10219077    38.44800305     1.50326423

                                         INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =2500.00000  MG.  MOLECULAR WT.= 310.00000 MAKE-UP VOLUME=0.0250 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM

                                         INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=     94.30MG.  WEIGHT OF WEIGHT=    171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.83142 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                                  INPUT DATA

10 .K      INDEP. VAR.     FREQUENCY     INPUT VOLT.    OUTPUT VOLT.    METER SCALE    SPTH. VAR.

 1. 1      0.0             162.70000     0.50000        0.08870         0.50000        41.10000
 1. 2      0.0             182.30000     0.50000        0.10380         0.50000        41.10000
 1. 3      0.0             202.10000     0.50100        0.09650         0.50000        41.10000
 2. 1      0.00200         162.70000     0.50000        0.08240         0.50000        41.20000
 2. 2      0.00200         182.30000     0.50000        0.09880         0.50000        41.20000
 2. 3      0.00200         202.10000     0.50000        0.09090         0.50000        41.20000
 3. 1      0.00400         162.50000     0.50000        0.07780         0.50000        41.45000
 3. 2      0.00400         182.10000     0.50000        0.09830         0.50000        41.45000
 3. 3      0.00400         202.00000     0.50100        0.08330         0.50000        41.45000
 4. 1      0.01400         162.50000     0.50000        0.07480         0.50000        41.55000
 4. 2      0.01400         182.10000     0.50000        0.08870         0.50000        41.55000
 4. 3      0.01400         201.90000     0.50000        0.07860         0.50000        41.55000
 5. 1      0.02400         162.40000     0.49900        0.06880         0.50000        41.80000
 5. 2      0.02490         181.80000     0.50000        0.09030         0.50000        41.90000
 5. 3      0.02800         201.90000     0.50000        0.06780         0.50000        41.80000
 6. 1      0.04200         162.30000     0.48900        0.05580         0.50000        41.90000
 6. 2      0.04200         181.80000     0.49900        0.07790         0.50000        41.90000
 6. 3      0.04230         201.80000     0.50000        0.06580         0.50000        41.90000
 7. 1      0.06200         162.00000     0.49900        0.04070         0.50000        42.10000
 7. 2      0.06200         181.50000     0.49900        0.06980         0.50000        42.10000
 7. 3      0.06200         201.60000     0.49900        0.05980         0.50000        42.10000
 8. 1      0.10000         158.60000     0.49900        0.04830         0.50000        47.00000
 8. 2      0.10000         178.10000     0.49900        0.08970         0.50000        47.00000
 8. 3      0.10000         197.80000     0.50000        0.09040         0.50000        47.00000
 9. 1      0.11600         153.60000     0.49900        0.09280         0.20000        56.60000
 9. 2      0.11600         172.40000     0.49900        0.12160         0.20000        56.50000
 9. 3      0.11630         191.60000     0.50000        0.10640         0.20000        56.40000
10. 1      0.13270         152.00000     0.49800        0.08193         0.20000        59.10000
10. 2      0.13200         170.70000     0.49900        0.10560         0.20000        59.10000
10. 3      0.13200         189.80000     0.50000        0.10050         0.20000        59.10000



                                        TABLE OF RESULTS FOR  2  POSITION

          CALCULATED WAVENUMBER= 35.87459  RECIP. CM.  WAVELENGTH=0.17514  CM.  INITIAL FREQUENCY =  182.30  HZ.

10 .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1         Y2       REAL FLS.  IMAG. FLAS.

 1. 2  0.0          0.81659     35.87459    1.00000   50.20000      0.24120     0.94872    0.02276   -0.00017   -0.00005
 2. 2  0.02688      0.82816     35.87459    1.00000   50.16539      0.24120     0.94938    0.02308    0.75074   -0.38991
 3. 2  0.10753      0.84340     35.87697    0.99890   50.07886      0.24047     0.94875    0.02351    1.11284   -1.49304
 4. 2  0.21505      0.85273     35.87697    0.99890   50.04425      0.24047     0.94961    0.02377    1.96217   -1.22857
 5. 2  0.37634      0.87437     35.88053    0.99726   49.95772      0.23934     0.94764    0.02437    4.02589   -3.07597
 6. 2  0.56452      0.88159     35.88053    0.99726   49.92311      0.23934     0.94829    0.02457    4.19527   -1.96064
 7. 2  0.83333      0.90619     35.88407    0.99561   49.85388      0.23818     0.94620    0.02525    7.22843   -0.91893
 8. 2  1.34409      0.92788     35.92318    0.97896   48.15792      0.22346     0.94009    0.02583    7.30117    4.45609
 9. 2  1.55914      0.94509     35.98492    0.94549   44.86482      0.19593     0.94057    0.02626    7.74776    3.80165
10. 2  1.77419      0.94764     36.00246    0.93637   43.96992      0.18755     0.93961    0.02658    6.35580    3.63772
                                                   ....

                                        TABLE OF RESULTS FOR  1  POSITION

          CALCULATED WAVENUMBER= 33.23403  RECIP. CM.  WAVELENGTH=0.18906  CM.  INITIAL FREQUENCY =  162.70  HZ.

10 .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1         Y2       REAL FLS.  IMAG. FLAS.

 1. 1  0.0          0.74048     33.23403    1.00000   50.20000      0.14795     0.95051    0.02228   -0.00016   -0.00005
 2. 1  0.02688      0.74946     33.23403    1.00000   50.16539      0.14795     0.95116    0.02256    0.69215   -0.31295
 3. 1  0.10753      0.76156     33.23580    0.99877   50.07886      0.14697     0.95031    0.02291    0.71338   -1.44543
 4. 1  0.21505      0.77078     33.23580    0.99877   50.04425      0.14697     0.95097    0.02319    1.68483   -1.31765
 5. 1  0.37634      0.77913     33.23667    0.99816   49.95772      0.14648     0.95137    0.02374    2.95053   -1.15798
 6. 1  0.56452      0.79890     33.23755    0.99754   49.92311      0.14599     0.95078    0.02403    3.70691   -1.41789
 7. 1  0.83333      0.81535     33.24016    0.99570   49.85388      0.14453     0.94836    0.02453    6.77711   -1.61110
 8. 1  1.34409      0.84167     33.26668    0.97603   48.15792      0.12920     0.94110    0.02530    6.62424    4.91953
 9. 1  1.55914      0.85926     33.30338    0.94407   44.83521      0.10659     0.94261    0.02580    7.47120    3.64652
10. 1  1.77419      0.87450     33.31273    0.93423   43.96992      0.10059     0.94045    0.02625    6.07565    4.13608

                                        TABLE OF RESULTS FOR  3  POSITION

          CALCULATED WAVENUMBER= 38.44800  RECIP. CM.  WAVELENGTH=0.16342  CM.  INITIAL FREQUENCY =  202.10  HZ.

10 .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1         Y2       REAL FLS.  IMAG. FLAS.

 1. 3  0.0          0.89239     38.44800    1.00000   50.20000      0.28827     0.94720    0.02321   -0.00017   -0.00005
 2. 3  0.02688      0.90593     38.44800    1.00000   50.16539      0.28827     0.94785    0.02356    0.79262   -0.43975
 3. 3  0.10753      0.92706     38.44561    0.99951   50.07886      0.28851     0.94843    0.02411    1.90608   -0.76553
 4. 3  0.21505      0.94039     38.45122    0.99901   50.04425      0.28873     0.94803    0.02446    2.52609   -1.22737
 5. 3  0.37634      0.97504     38.45122    0.99901   49.95772      0.28873     0.94967    0.02536    3.73338   -0.01877
 6. 3  0.56452      0.98223     38.45282    0.99852   49.92311      0.28894     0.94927    0.02594    4.01242   -0.04341
 7. 3  0.83333      1.00566     38.45603    0.99753   49.85388      0.28932     0.94847    0.02615    4.73506    0.29529
 8. 3  1.34409      1.04428     38.51993    0.97872   48.15792      0.28838     0.94083    0.02711    6.87684    2.82384
 9. 3  1.55914      1.06482     38.60553    0.94805   44.90443      0.26582     0.94010    0.02758    6.61563    2.63242
10. 3  1.77419      1.07015     38.63050    0.93914   43.96992      0.25685     0.94033    0.02770    6.55727    2.34975
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                         ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE POLYMERIC SURFACTANTS - LI(INF)  FEB 1968  MLR

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (4X)          /FRESHLY DISTILLED N HEPTANE            INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS PVSTE(2) -POLYVINYL STEARATE (AS RECD. AIRCO) IN TRICHLOROETHYLENE  2/19/68

                                           SYSTEM PARAMETERS

                LOWER PHASE DENSITY  0.9980 G/ML        UPPER PHASE DENSITY  0.6780 G/ML
                       VISCOSITY  0.00896 POISES                   VISCOSITY  0.00386 POISES

                                    INITIAL VALUES ASSUMED IN CALCULATION

                REAL ELASTICITY (EP)   0.0             IMAGINARY ELASTICITY (EPP)   0.0
                WAVENUMBER  31.00000 RECIPROCAL  CM     DAMPING COEFFICIENT   0.70000 CM
                REFERENCE METER SCALE    1.00 MV.       INTERFACIAL TENSION 50.2000 DYNES/CM
                REFERENCE INPUT VTG.  0.100 VT.

                                           PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 4.25448 CM. BASED ON RESON= 0.34190 RESFN= 6.02220 DISTON= 5.98066 DISTFN= 1.72598

                                    CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY     DMP. COEF.     WAVE NO.      WAVELENGTH     NO. WAVES    PHS.COR.WAND  GN. PR. SCL.FCTR.
    1       164.80      0.74266470    33.52181293    0.18743557    22.69941532    33.52181293     0.86044068
    2       184.80      0.82421868    36.20444838    0.17354718    24.51597150    36.20444838     0.97391744
    3       204.80      0.90264492    38.79230412    0.16196976    26.26874728    38.79230412     0.95462542

                                         INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =2500.00000  MG.  MOLECULAR WT.= 310.00000 MAKE-UP VOLUME=0.0250 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                          INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=      34.30MG.  WEIGHT OF WEIGHT=     171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.07242 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                      INPUT DATA
IJ,K     INDEF. VAR.    FREQUENCY     INPUT VOLT.   OUTPUT VOLT.   METER SCALE    SPTN. VAR.

 1. 1     0.0           164.80000     0.49200       0.13860        0.20000        39.00000
 1. 2     0.0           184.80000     0.49300       0.06740        0.50000        39.00000
 1. 3     0.0           204.80000     0.49300       0.14080        0.20000        39.00000
 2. 1     0.00800       164.50000     0.49200       0.14190        0.20000        39.00000
 2. 2     0.00800       184.40000     0.49300       0.06590        0.50000        39.00000
 2. 3     0.00800       204.60000     0.49700       0.13490        0.20000        39.00000
 3. 1     0.01600       163.50000     0.49300       0.11080        0.20000        41.40000
 3. 2     0.01600       183.40000     0.49400       0.12750        0.20000        41.40000
 3. 3     0.01600       203.50000     0.49600       0.10550        0.20000        41.40000
 4. 1     0.02000       163.10000     0.49300       0.10740        0.20000        42.00000
 4. 2     0.02000       153.00000     0.49600       0.12490        0.20000        42.00000
 4. 3     0.02000       202.80000     0.49700       0.09970        0.20000        42.00000
 5. 1     0.02100       162.30000     0.49300       0.10590        0.20000        42.90000
 5. 2     0.02100       182.10000     0.49400       0.12240        0.20000        42.90000
 5. 3     0.02100       201.90000     0.49600       0.10010        0.20000        42.90000
 6. 1     0.02200       161.80000     0.49300       0.10430        0.20000        44.00000
 6. 2     0.02200       181.40000     0.49400       0.12320        0.20000        44.00000
 6. 3     0.02200       201.30000     0.49700       0.10230        0.20000        44.00000
 7. 1     0.02300       161.60000     0.49300       0.10350        0.20000        44.10000
 7. 2     0.02300       181.20000     0.49600       0.12300        0.20000        44.10000
 7. 3     0.02300       201.10000     0.49700       0.10370        0.20000        44.10000
 8. 1     0.02500       160.90000     0.49300       0.10430        0.20000        45.20000
 8. 2     0.02500       180.30000     0.49600       0.12280        0.20000        45.20000
 8. 3     0.02500       200.30000     0.49700       0.10450        0.20000        45.20000
 9. 1     0.02600       160.10000     0.49300       0.09830        0.20000        46.40000
 9. 2     0.02600       179.50000     0.49600       0.12070        0.20000        46.40000
 9. 3     0.02600       159.30000     0.49700       0.10480        0.20000        46.40000
10. 1     0.02700       159.70000     0.49300       0.09690        0.20000        47.30000
10. 2     0.02700       178.90000     0.49600       0.11550        0.20000        47.30000
10. 3     0.02700       198.60000     0.49700       0.10180        0.20000        47.30000
11. 1     0.02900       158.50000     0.49300       0.09160        0.20000        49.60000
11. 2     0.02900       177.50000     0.49600       0.11340        0.20000        49.60000
11. 3     0.02900       197.10000     0.49600       0.10160        0.20000        49.60000
12. 1     0.03000       157.60000     0.49300       0.08450        0.20000        50.70000
12. 2     0.03000       176.90000     0.49500       0.10720        0.20000        50.70000
12. 3     0.03000       196.40000     0.49600       0.09730        0.20000        50.70000
13. 1     0.03200       157.00000     0.49300       0.08170        0.20000        51.90000
13. 2     0.03200       176.10000     0.49400       0.10150        0.20000        51.90000
13. 3     0.03200       195.60000     0.49700       0.09470        0.20000        51.90000
14. 1     0.03400       155.90000     0.49200       0.07850        0.20000        52.80000
14. 2     0.03400       174.80000     0.49300       0.09880        0.20000        52.80000
14. 3     0.03400       194.40000     0.49700       0.09220        0.20000        52.80000
15. 1     0.03700       154.70000     0.49200       0.07080        0.20000        54.80000
15. 2     0.03700       173.80000     0.49600       0.09270        0.20000        54.80000
15. 3     0.03700       193.20000     0.49700       0.08640        0.20000        54.80000
16. 1     0.04000       154.30000     0.49400       0.06850        0.20000        55.80000
16. 2     0.04000       173.20000     0.49600       0.08870        0.20000        55.70000
16. 3     0.04000       192.60000     0.49700       0.08100        0.20000        55.60000
17. 1     0.05000       154.20000     0.49300       0.06480        0.20000        56.30000
17. 2     0.05000       173.00000     0.49400       0.08620        0.20000        56.20000
17. 3     0.05000       192.20000     0.49700       0.07780        0.20000        56.10000
18. 1     0.06500       153.20000     0.49200       0.09630        0.10000        57.40000
18. 2     0.06500       172.00000     0.49300       0.12260        0.10000        57.40000
18. 3     0.06500       191.10000     0.49400       0.10330        0.10000        57.40000
19. 1     0.10500       151.70000     0.49200       0.09050        0.10000        58.40000
19. 2     0.10500       170.20000     0.49300       0.11410        0.10000        58.40000



19. 3     0.10500       188.50000     0.49300       0.09390        0.10000        58.40000
20. 1     0.90500       150.30000     0.49200       0.07910        0.10000        60.90000
20. 2     0.90500       168.50000     0.49300       0.09840        0.10000        60.90000
20. 3     0.90500       187.30000     0.49400       0.08480        0.10000        60.90000
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                                        TABLE OF RESULTS FOR  1  POSITION

           CALCULATED WAVENUMBER= 33.52181  RECIP. CM.  WAVELENGTH=0.18744  CM.  INITIAL FREQUENCY =  164.80  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERP. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

  1. 1     0.0          0.74846   33.52181    1.00000   50.20000      0.15830     0.95030     0.02133    -0.00016    -0.00008
  2. 1     0.10753      0.74082   33.52489    0.99818   50.20000      0.15882     0.94661     0.02210    -3.87818     2.64277
  3. 1     0.21505      0.74203   33.53371    0.99211   49.38110      0.15180     0.94987     0.02342     2.20477    -7.20761
  4. 1     0.26882      0.74629   33.53731    0.98960   49.17467      0.14992     0.94885     0.02374     7.76189    -5.73905
  5. 1     0.28226      0.74337   33.54439    0.98603   48.86941      0.14599     0.94687     0.02365    59.07027    22.14503
  6. 1     0.29570      0.74299   33.54875    0.98180   48.49412      0.14358     0.94596     0.02346     1.46545   -24.12830
  7. 1     0.30914      0.74328   33.55047    0.98058   48.46000      0.14258     0.94424     0.02344    19.22489    29.59290
  8. 1     0.33602      0.74571   33.55446    0.97613   48.08471      0.13919     0.94278     0.02342     7.88442    14.66340
  9. 1     0.34946      0.79398   33.56111    0.97148   47.67530      0.13535     0.94088     0.02363     4.41679     9.47986
 10. 1     0.36290      0.79512   33.56658    0.96905   47.36824      0.13344     0.94148     0.02363     4.42544    11.99810
 11. 1     0.38978      0.79618   33.57353    0.96177   46.88354      0.12780     0.94270     0.02371     3.94482    15.09724
 12. 1     0.40323      0.80740   33.58285    0.95631   46.20824      0.12366     0.93902     0.02404     4.42485     7.30885
 13. 1     0.43011      0.81011   33.58782    0.95267   45.79883      0.12095     0.93984     0.02412     4.80287     9.02673
 14. 1     0.45699      0.82941   33.59521    0.94800   45.45177      0.11610     0.93811     0.02408     3.48344     6.99864
 15. 1     0.49731      0.82317   33.60328    0.93871   44.80942      0.11102     0.93331     0.02430     3.51955     6.79135
 16. 1     0.53763      0.82858   33.60599    0.93429   44.46825      0.10939     0.93340     0.02445     3.71659     5.73310
 17. 1     0.67204      0.84309   33.60660    0.93183   44.25746      0.10898     0.93572     0.02500     4.25061     5.16280
 18. 1     0.87366      0.90076   33.61281    0.92961   43.92237      0.10504     0.93100     0.02680     3.95002     4.73961
 19. 1     1.41129      0.90270   33.62141    0.92051   43.58119      0.09995     0.91930     0.02644     3.28448     5.45603
 20. 1    12.16398      0.97308   33.67863    0.91201   42.72825      0.09687     0.91983     0.02745     3.29159     5.43687

                                        TABLE OF RESULTS FOR  2  POSITION

           CALCULATED WAVENUMBER= 36.20445  RECIP. CM.  WAVELENGTH=0.17355  CM.  INITIAL FREQUENCY =  184.80  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERP. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

  1. 2     0.0          0.82622   36.20445    1.00000   50.20000      0.24878     0.94892     0.02282    -0.00017    -0.00009
  2. 2     0.10753      0.83201   36.20940    0.99784   50.20000      0.24781     0.94403     0.02298    -7.74934     3.44758
  3. 2     0.21505      0.84857   36.22145    0.99242   49.38110      0.24494     0.94834     0.02455     3.52655    -1.44494
  4. 2     0.26882      0.85311   36.22649    0.99026   49.17467      0.24164     0.94776     0.02465     4.02950    -2.74213
  5. 2     0.28226      0.85783   36.23729    0.98539   48.86941      0.24047     0.94351     0.02467    16.67403    -2.10321
  6. 2     0.29570      0.88967   36.24534    0.98160   48.49412      0.23779     0.94287     0.02455    27.66920     7.54282
  7. 2     0.30914      0.89021   36.24795    0.98052   48.46000      0.23699     0.94127     0.02456    11.96136    10.55407
  8. 2     0.33602      0.88697   36.25148    0.97565   48.08471      0.23327     0.93840     0.02446     5.56886     9.21873
  9. 2     0.34946      0.88741   36.26770    0.97132   47.67530      0.22981     0.93736     0.02447     6.09544     7.48219
 10. 2     0.36290      0.89500   36.27456    0.96907   47.36824      0.22712     0.93661     0.02467     4.87055     6.55015
 11. 2     0.38978      0.89253   36.29038    0.96050   46.98354      0.22066     0.93632     0.02459     4.49677     6.90185
 12. 2     0.40323      0.90223   36.29704    0.95725   46.20624      0.21703     0.93703     0.02486     5.11558     7.29541
 13. 2     0.43011      0.91047   36.30586    0.95292   45.79883      0.21400     0.93620     0.02508     4.94491     6.47252
 14. 2     0.45699      0.91927   36.32001    0.94589   45.43177      0.20771     0.92757     0.02504     3.57175     4.66044
 15. 2     0.49731      0.92028   36.33074    0.94048   44.80942      0.20282     0.93012     0.02553     3.78434     4.99549
 16. 2     0.53763      0.92701   36.33710    0.93723   44.50234      0.19907     0.92980     0.02551     3.77991     4.78347
 17. 2     0.67204      0.93142   36.33922    0.93615   44.33178      0.19880     0.93086     0.02564     3.94927     4.91377
 18. 2     0.87366      1.00574   36.34969    0.93074   43.92237      0.19396     0.92790     0.02768     3.94613     4.06087
 19. 2     1.41129      1.01121   36.38020    0.92100   43.58119      0.18506     0.91430     0.02780     3.30826     3.58228
 20. 2    12.16398      1.03576   36.38926    0.91180   42.72825      0.17663     0.91273     0.02845     3.29441     3.54196

                                        TABLE OF RESULTS FOR  3  POSITION

           CALCULATED WAVENUMBER= 38.79230  RECIP. CM.  WAVELENGTH=0.16197  CM.  INITIAL FREQUENCY =  204.80  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERP. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

  1. 3     0.0          0.90244   38.79230    1.00000   50.20000      0.27706     0.94701     0.02327    -0.00017    -0.00005
  2. 3     0.10753      0.91540   38.79560    0.99902   50.20000      0.27824     0.94492     0.02360    -2.39691    -1.86203
  3. 3     0.21505      0.97746   38.81364    0.99365   49.38110      0.28368     0.94896     0.02518     3.59916    -0.34125
  4. 3     0.26882      0.99338   38.82904    0.99023   49.17467      0.28629     0.96597     0.02555     5.68089    -1.68328
  5. 3     0.28226      0.99395   38.83955    0.98586   48.86941      0.28873     0.96199     0.02559    11.46607     0.27990
  6. 3     0.29570      0.99019   38.84927    0.98291   48.49412      0.28981     0.94294     0.02549    10.03998    -2.74735
  7. 3     0.30914      0.98721   38.85241    0.98195   48.46000      0.29007     0.94150     0.02541    14.09702     0.78356
  8. 3     0.33602      0.98590   38.86913    0.97803   48.08471      0.29069     0.94019     0.02537    14.15835     5.42009
  9. 3     0.34946      0.98907   38.89286    0.97314   47.67530      0.29049     0.93768     0.02534     7.87938     8.15998
 10. 3     0.36290      0.99131   38.89175    0.96973   47.36824      0.28977     0.93659     0.02549     6.46269     7.17738
 11. 3     0.38978      0.98882   38.91474    0.96240   46.98354      0.28672     0.93674     0.02541     6.10610     7.97047
 12. 3     0.40323      0.99729   38.92930    0.95898   46.20824      0.28467     0.93648     0.02562     6.51347     7.26510
 13. 3     0.43011      1.00192   38.93724    0.95508   45.79883      0.28188     0.93631     0.02573     6.44343     7.07203
 14. 3     0.45699      1.00596   38.95486    0.94922   45.45177      0.27932     0.92984     0.02592     4.10796     5.29807
 15. 3     0.49731      1.02123   38.97216    0.94336   44.80942      0.27932     0.93114     0.02620     4.43172     5.24879
 16. 3     0.53763      1.03250   38.98648    0.94043   44.53448      0.27473     0.93043     0.02649     4.98182     5.02738
 17. 3     0.67204      1.03854   38.98631    0.93848   44.36999      0.27074     0.92972     0.02644     4.79447     4.87222
 18. 3     0.87366      1.12419   39.00161    0.93311   43.92237      0.26256     0.92730     0.02888     4.18326     3.96547
 19. 3     1.41129      1.14075   39.03128    0.92236   43.58119      0.25447     0.91108     0.02923     3.78214     3.63051
 20. 3    12.16398      1.15946   39.05235    0.91455   42.72825      0.24893     0.91212     0.02970     3.38007     3.57834
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                    ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE MIXED [illegible]-IONIC SURFACTANTS-[illegible] FEB 1980 [illegible]

MEASUREMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (AS)          /FRESHLY DISTILLED N HEPTANE          INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS [illegible] (1:1) SODIUM CETYLSULPHONATE/CHOLESTEROL IN ETOH & TCE  2/21/80

                                      SYSTEM PARAMETERS

               LOWER PHASE DENSITY  0.9980 G/ML        UPPER PHASE DENSITY  0.6790 G/ML
                       VISCOSITY  0.00996 POISES                  VISCOSITY  0.00396 POISES

                                INITIAL VALUES ASSUMED IN CALCULATION

               REAL ELASTICITY (EP)   0.0            IMAGINARY ELASTICITY (EPP)   0.0
               WAVENUMBER  31.00000 RECIPROCAL  CM    DAMPING COEFFICIENT   0.70000 CM
               REFERENCE METER SCALE    1.00 MV.     INTERFACIAL TENSION 50.2000 DYNES/CM
               REFERENCE INPUT VTG.  0.103 VT.

                                      PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 4.33185 CM. BASED ON RESON= 0.3129? RESFN= 6.C8700 DISTON= 6.00230 DISTFN= 1.67044

                               CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY      CMP. CORR.      WAVE NO.       WAVELENGTH       NO. WAVES    PHS.COR.WANC  CN. RE. SCL.FCTR.
   1         182.23      0.73949196    33.16533327      0.18945023     22.86539790     33.16537327      1.02067817
   2         193.82      0.81466100    35.80843546      0.17546669     24.69764921     35.80843546      1.07201296
   3         201.73      0.59946722    38.39686625      0.16363793     26.47220837     38.39886625      1.17676642

                                   INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =  31.00000  MG.  MOLECULAR WT.= 485.00000 MAKE-UP VOLUME=0.0250 L.
THE AREA IS KEPT CONST. AT 740.00000 SQ. CM

                                   INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     [illegible] WEIGHT OF PLATE=     34.30MG.  WEIGHT OF WEIGHT=   171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.22000 CALCULATED PERIMETER OF PLATE= 2.01362 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                              INPUT DATA
IC .K      INDEP. VAR.     FREQUENCY       INPUT VOLT.     OUTPUT VOLT.     METER SCALE     SETN. VAR.

  1. 1     0.0             162.20000       0.47000         0.14240          0.20000         36.90000
  1. 2     0.0             181.90000       0.47100         0.07090          0.50000         36.90000
  1. 3     0.0             201.70000       0.47200         0.06770          0.50000         36.90000
  2. 1     0.00200         162.00000       0.47100         0.14450          0.20000         36.90000
  2. 2     0.00200         181.70000       0.47200         0.07160          0.50000         36.90000
  2. 3     0.00200         201.70000       0.47300         0.06720          0.50000         36.90000
  3. 1     0.00400         162.10000       0.47100         0.15430          0.20000         36.90000
  3. 2     0.00400         181.70000       0.47200         0.07460          0.50000         36.90000
  3. 3     0.00400         201.70000       0.47300         0.07010          0.50000         36.90000
  4. 1     0.01000         162.00000       0.47100         0.14130          0.20000         36.90000
  4. 2     0.01000         181.50000       0.47200         0.06660          0.50000         36.90000
  4. 3     0.01000         201.40000       0.47300         0.06070          0.50000         36.90000
  5. 1     0.01400         161.90000       0.47200         0.13860          0.20000         37.00000
  5. 2     0.01400         181.50000       0.47400         0.06800          0.50000         37.00000
  5. 3     0.01400         201.40000       0.47600         0.06160          0.50000         37.00000
  6. 1     0.02000         161.90000       0.47200         0.14120          0.20000         37.00000
  6. 2     0.02000         181.50000       0.47500         0.06800          0.50000         37.00000
  6. 3     0.02000         201.40000       0.47600         0.06230          0.50000         37.00000
  7. 1     0.03000         161.70000       0.47200         0.13430          0.20000         37.00000
  7. 2     0.03000         181.50000       0.47600         0.06500          0.50000         37.00000
  7. 3     0.03000         201.40000       0.47700         0.06020          0.50000         37.00000
  8. 1     0.04000         161.80000       0.47300         0.13520          0.20000         37.00000
  8. 2     0.04000         181.50000       0.47600         0.06520          0.50000         37.00000
  8. 3     0.04000         201.40000       0.47700         0.06020          0.50000         37.00000
  9. 1     0.06000         161.80000       0.47300         0.13300          0.20000         37.05000
  9. 2     0.06000         181.40000       0.47600         0.06510          0.50000         37.05000
  9. 3     0.06000         201.30000       0.47800         0.06010          0.50000         37.05000
 10. 1     0.08000         161.70000       0.47400         0.13290          0.20000         37.15000
 10. 2     0.08000         181.30000       0.47600         0.06470          0.50000         37.15000
 10. 3     0.08000         201.30000       0.47700         0.06060          0.50000         37.15000
 11. 1     0.16000         161.60000       0.47500         0.13090          0.20000         37.35000
 11. 2     0.16000         181.30000       0.47600         0.06440          0.50000         37.35000
 11. 3     0.16000         201.20000       0.47800         0.06060          0.50000         37.35000
 12. 1     0.24000         161.60000       0.47500         0.13190          0.20000         37.40000
 12. 2     0.24000         181.20000       0.47600         0.06490          0.50000         37.40000
 12. 3     0.24000         201.10000       0.47800         0.06080          0.50000         37.40000
 13. 1     0.44000         161.50000       0.47600         0.13100          0.20000         37.60000
 13. 2     0.44000         181.10000       0.47700         0.06420          0.50000         37.60000
 13. 3     0.44000         201.10000       0.47800         0.06080          0.50000         37.60000
 14. 1     0.74000         161.50000       0.47600         0.13020          0.20000         37.80000
 14. 2     0.74000         181.10000       0.47800         0.06480          0.50000         37.80000
 14. 3     0.74000         201.00000       0.47800         0.06090          0.50000         37.80000
 15. 1     1.14000         161.20000       0.47700         0.12700          0.20000         38.15000
 15. 2     1.14000         180.80000       0.47800         0.06290          0.50000         38.15000
 15. 3     1.14000         200.70000       0.47800         0.06020          0.50000         38.15000
 16. 1     1.74000         161.00000       0.47600         0.12590          0.20000         38.50000
 16. 2     1.74000         180.80000       0.47800         0.06330          0.50000         38.50000
 16. 3     1.74000         200.60000       0.47800         0.05980          0.50000         38.50000
 17. 1     2.74000         161.00000       0.47800         0.12460          0.20000         38.70000
 17. 2     2.74000         180.60000       0.47800         0.06250          0.50000         38.70000
 17. 3     2.74000         200.50000       0.47800         0.05530          0.50000         38.70000
 18. 1     5.74000         160.50000       0.47700         0.11990          0.20000         39.40000
 18. 2     5.74000         180.20000       0.47800         0.06130          0.50000         39.40000
 18. 3     5.74000         200.20000       0.47900         0.05770          0.50000         39.40000
 19. 1     9.74000         160.20000       0.47700         0.11440          0.20000         40.00000
 19. 2     9.74000         179.90000       0.47800         0.05890          0.50000         39.90000



 19. 3     9.74000         199.70000       0.47900         0.05630          0.50000         39.80000
 20. 1    15.74000         160.10000       0.47700         0.11260          0.20000         40.50000
 20. 2    15.74000         179.60000       0.47800         0.05750          0.50000         40.40000
 20. 3    15.74000         199.50000       0.47900         0.13740          0.20000         40.40000
 21. 1    25.74000         159.70000       0.47700         0.10670          0.20000         41.50000
 21. 2    25.74000         179.00000       0.47800         0.05470          0.50000         41.40000
 21. 3    25.74000         199.00000       0.47900         0.13300          0.20000         41.40000
 22. 1    35.74000         159.30000       0.47700         0.10300          0.20000         42.20000
 22. 2    35.74000         178.80000       0.47800         0.13310          0.20000         42.20000
 22. 3    35.74000         198.40000       0.47900         0.12350          0.20000         42.20000
 23. 1    47.74000         159.10000       0.47800         0.09860          0.20000         42.80000
 23. 2    47.74000         178.40000       0.47900         0.12780          0.20000         42.80000
 23. 3    47.74000         198.30000       0.47900         0.12200          0.20000         42.80000
 24. 1    60.00000         158.60000       0.47800         0.04520          0.20000         43.80000
 24. 2    60.00000         177.90000       0.47900         0.05200          0.20000         43.80000
 24. 3    60.00000         197.60000       0.47900         0.03660          0.20000         43.80000
 25. 1    71.74000         157.80000       0.47800         0.05060          0.20000         44.70000
 25. 2    71.74000         177.30000       0.47900         0.05850          0.20000         44.60000
 25. 3    71.74000         137.00000       0.47900         0.04880          0.20000         44.40000
 26. 1    90.00000         157.80000       0.47800         0.03780          0.20000         45.50000
 26. 2    90.00000         177.10000       0.47900         0.04550          0.20000         45.30000
 26. 3    90.00000         197.60000       0.48000         0.03380          0.20000         45.20000
 27. 1   130.00000         156.40000       0.47800         0.03290          0.20000         47.40000
 27. 2   130.00000         175.70000       0.48000         0.04110          0.20000         47.40000
 27. 3   130.00000         195.50000       0.48000         0.03300          0.20000         47.30000
 28. 1   190.00000         155.40000       0.47800         0.05790          0.10000         49.60000
 28. 2   190.00000         174.50000       0.48000         0.07270          0.10000         49.50000
 28. 3   190.00000         194.10000       0.48000         0.05080          0.10000         49.40000
 29. 1   290.00000         153.50000       0.47800         0.04990          0.10000         53.00000
 29. 2   290.00000         172.70000       0.47900         0.06070          0.10000         52.50000
 29. 3   290.00000         191.90000       0.48000         0.04620          0.10000         52.30000
 30. 1   450.00000         149.50000       0.47800         0.03940          0.10000         59.50000
 30. 2   450.00000         169.60000       0.48200         0.04990          0.10000         57.90000
 30. 3   450.00000         189.80000       0.48600         0.03520          0.10000         56.90000
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TABLE OF RESULTS FOR 2 POSITION

CALCULATED WAVENUMBER= 35.80866 RECIP. CM. WAVELENGTH=0.17547 CM. INITIAL FREQUENCY = 181.80 HZ.

NO. N	INITL. VAR.	DMP. COEF.	WAVE NO.	REL. FQ.	INTERF. TENS.	DEV. AMPL.	Y1	Y2	REAL ELS.	IMAG. ELAS.
1. 2	0.	0.81488	35.80866	1.00000	50.20000	0.23934	0.94877	0.02279	-0.00017	-0.00009
2. 2	0.50021	0.81291	35.83960	0.99945	50.20000	0.23896	0.94763	0.02260	-1.08839	-0.33901
3. 2	0.33363	0.87314	35.83960	0.99948	50.20000	0.23996	0.94763	0.02243	-3.37099	1.73168
4. 2	0.30107	0.92867	35.81192	0.99939	50.20000	0.23818	0.94537	0.02313	-6.60889	-1.90068
5. 2	0.40169	0.87469	35.81192	0.99815	50.16676	0.23518	0.94600	0.02303	-4.07129	-1.44148
6. 2	0.50219	0.82313	35.81192	0.99933	50.16636	0.23818	0.94600	0.02304	-4.34093	-1.94738
7. 2	0.60310	0.85433	35.81192	0.99939	50.16676	0.23818	0.94600	0.02339	-3.89120	-4.64880
8. 2	0.71520	0.83937	35.81152	0.99835	50.14636	0.23818	0.94600	0.02333	-1.42159	-4.28847
9. 2	0.83410	0.83530	35.81308	0.99740	50.14994	0.23779	0.94910	0.02332	-8.27075	-4.07346
10. 2	0.90092	0.84284	35.81824	0.99779	50.11891	0.23739	0.94468	0.02330	-12.77740	-4.33317
11. 2	1.01714	0.81741	35.81824	0.99728	50.04083	0.23799	0.94494	0.02338	-1.89891	-6.72901
12. 2	1.27397	0.81527	35.81940	0.99670	50.03181	0.23689	0.94514	0.02332	-4.37728	-4.20585
13. 2	1.26087	0.83747	35.81439	0.99619	49.90454	0.23659	0.94427	0.02339	-7.28681	-5.84602
14. 2	1.17143	0.83317	35.81825	0.99619	49.85726	0.23659	0.94654	0.02335	-2.14117	-3.33732
15. 2	1.12144	0.84144	35.82000	0.99490	49.77953	0.23537	0.94537	0.02350	-6.10883	-6.37774
16. 2	1.14936	0.84038	35.82000	0.99450	49.64180	0.23337	0.94761	0.02360	-0.01697	-2.36311
17. 2	1.27119	0.84280	35.82230	0.99340	49.59453	0.23494	0.94662	0.02352	-1.39046	-1.87031
18. 2	1.27168	0.84530	35.82687	0.99120	49.35906	0.23285	0.94696	0.02399	-1.08196	-4.22003
19. 2	1.31794	0.85291	35.83141	0.98900	49.19088	0.23112	0.94523	0.02380	-1.24859	-10.15744
20. 2	1.67477	0.86748	35.83347	0.98790	49.02269	0.23028	0.94818	0.02393	0.66626	-4.67637
21. 2	2.74776	0.86631	35.84042	0.98650	48.69631	0.22758	0.94593	0.02417	2.87610	-7.67591
22. 2	1.43715	0.87144	35.84266	0.98350	48.41721	0.22667	0.94878	0.02432	2.47222	-1.51397
23. 2	5.04510	0.87944	35.84711	0.98130	48.21939	0.22485	0.94814	0.02456	1.29967	-7.17808
24. 2	6.31179	1.03493	35.85265	0.97895	47.87901	0.22793	0.94802	0.03026	4.40913	2.63033
25. 2	7.44741	1.05471	35.85974	0.97525	47.60991	0.21972	0.94744	0.02961	4.56565	2.14827
26. 2	9.59763	1.11133	35.86143	0.97419	47.37449	0.21870	0.94982	0.03100	4.24804	2.64537
27. 2	11.49493	1.17893	35.87692	0.96849	46.86806	0.21207	0.94781	0.03146	4.23810	2.96184
28. 2	21.24099	1.19962	35.89735	0.95993	45.96168	0.20624	0.94827	0.03289	4.11667	2.59374
29. 2	33.85347	1.19168	35.90814	0.96994	44.95299	0.19741	0.94817	0.03290	3.98739	2.96120
30. 2	47.91914	1.21969	35.93747	0.93789	43.17813	0.18209	0.95045	0.03365	3.76717	2.61096

TABLE OF RESULTS FOR 1 POSITION

CALCULATED WAVENUMBER= 33.18533 RECIP. CM. WAVELENGTH=0.18945 CM. INITIAL FREQUENCY = 182.20 HZ.

NO. N	INITL. VAR.	DMP. COEF.	WAVE NO.	REL. FQ.	INTERF. TENS.	GEN. AMPL.	Y1	Y2	REAL ELS.	IMAG. ELAS.
1. 1	0.	0.73849	33.18533	1.00000	50.20000	0.14991	0.95096	0.02227	-0.00016	-0.00008
2. 1	0.33321	0.73415	33.18705	0.99977	50.20000	0.14453	0.94807	0.02213	-2.70475	0.69957
3. 1	0.30143	0.71969	33.18019	0.99918	50.20000	0.14507	0.94971	0.02170	-0.86760	1.30064
4. 1	0.30137	0.72932	33.18765	0.99877	50.20000	0.14493	0.94807	0.02229	-3.07675	0.31303
5. 1	0.50145	0.74334	33.16790	0.99418	50.16636	0.14404	0.94746	0.02241	-4.44719	-0.12611
6. 1	0.59217	0.73939	33.16750	0.99815	50.16636	0.14404	0.94744	0.02228	-4.05369	0.53140
7. 1	0.61390	0.74939	33.16860	0.99692	50.16636	0.14307	0.94497	0.02259	-7.85066	9.83521
8. 1	0.63636	0.74892	33.16875	0.99753	50.16636	0.14355	0.94627	0.02258	-5.38874	2.43140
9. 1	0.71916	0.75291	33.16879	0.95799	50.14994	0.14395	0.94693	0.02269	-9.09590	-0.07770
10. 1	0.93352	0.79269	33.16960	0.99692	50.11591	0.14307	0.94593	0.02269	-12.31367	1.97792
11. 1	0.01704	0.79595	33.17749	0.99670	50.04863	0.14258	0.94599	0.02278	-14.73735	2.07155
12. 1	1.32557	0.75342	33.17045	0.99610	50.03191	0.14258	0.94627	0.02273	-11.44246	0.64691
13. 1	1.04517	0.78521	33.17179	0.99569	49.98454	0.14210	0.94630	0.02277	-11.70196	-0.74137
14. 1	1.37443	0.75662	33.17129	0.99568	49.89726	0.14210	0.94758	0.02281	-4.78799	-3.59540
15. 1	1.12144	0.74049	33.17381	0.99383	49.77593	0.14066	0.94608	0.02292	-16.89806	-0.08410
16. 1	1.14936	0.75161	33.17548	0.99260	49.60180	0.13967	0.94582	0.02292	-17.84751	2.74640
17. 1	0.78144	0.74877	33.17548	0.99240	49.59453	0.13967	0.94711	0.02302	-6.80097	-6.08738
18. 1	3.01168	0.76919	33.17940	0.99552	49.35906	0.13728	0.94537	0.02315	-33.37956	17.16752
19. 1	1.31795	0.77455	33.19205	0.98767	49.19774	0.13583	0.94890	0.02340	-203.13490	-263.56344
20. 1	1.67477	0.77940	33.18296	0.98708	48.99909	0.13539	0.96749	0.02349	0.89012	-9.09682
21. 1	2.74216	0.79959	33.19608	0.98459	48.65268	0.13344	0.94900	0.02376	2.11719	-3.72158
22. 1	1.57738	0.77340	33.18525	0.98212	48.41721	0.13195	0.94858	0.02391	3.61312	-4.29820
23. 1	5.04570	0.80270	33.19022	0.98059	48.21939	0.13061	0.95092	0.02417	3.62994	-1.09893
24. 1	6.15178	0.97814	33.19470	0.97781	47.87901	0.12827	0.95036	0.02947	4.29091	2.38275
25. 1	7.84261	0.94978	33.20076	0.97287	47.57628	0.12457	0.94626	0.02947	4.85501	2.55267
26. 1	9.59751	1.01271	33.20076	0.97287	47.30718	0.12457	0.95165	0.03050	4.15918	2.63723
27. 1	11.34808	1.02280	33.21291	0.96424	46.64836	0.11828	0.94677	0.03110	4.20862	2.64508
28. 1	21.24348	1.04277	33.21778	0.95808	45.92804	0.11396	0.94917	0.03177	4.03792	2.58481
29. 1	33.97167	1.07178	33.22988	0.94636	44.78436	0.10620	0.94872	0.03225	3.83492	2.55271
30. 1	47.61914	1.07429	33.25051	0.97170	42.59799	0.09243	0.94431	0.03291	3.81919	2.61727

```
                               TABLE OF RESULTS FOR  3  POSITION

        CALCULATED WAVENUMBER= 38.39687  RECIP. CM.  WAVELENGTH=0.16364  CM.  INITIAL FREQUENCY =  201.70  HZ.

ID. R.  INCR. VAR.  CMP. COEF.  WAVE NO.    REL. FQ.  INTERP. TENS. DEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

 1.  1   0.0        0.99087    38.39687    1.00000    50.20000    0.28914    0.94723    0.02320    -0.00017    -0.00000
 2.  1   0.03321    0.83397    38.39687    1.00000    50.20000    0.28914    0.94723    0.02326     0.03015    -0.12994
 3.  3   0.06108    0.88931    38.39687    1.00000    50.20000    0.28914    0.94723    0.02300    -0.00257     0.41970
 4.  1   0.09997    0.91417    38.40155    0.99991    50.20000    0.28966    0.94406    0.02388    -5.17251    -6.39416
 5.  2   0.33148    0.91503    38.40159    0.99891    50.16836    0.28986    0.94469    0.02393    -2.83090    -4.39661
 6.  1   0.09219    0.91242    38.40159    0.99891    50.16836    0.28966    0.94469    0.02376    -3.09086    -3.78049
 7.  1   0.31327    0.97092    38.40159    0.99891    50.16836    0.28966    0.94469    0.02399    -1.97261    -5.66923
 8.  1   0.31427    0.92332    38.40159    0.99851    50.16836    0.28966    0.94469    0.02398    -1.97263    -3.66923
 9.  3   0.62418    0.93191    38.40317    0.99802    50.14896    0.28981    0.94396    0.02400    -4.65950    -9.93394
10.  1   0.69997    1.01961    38.40317    0.99802    50.11991    0.28981    0.94439    0.02394    -2.51996    -9.93164
11.  1   0.31704    0.95279    38.40474    0.99712    50.04863    0.28993    0.94481    0.02396    -1.85389    -9.03914
12.  1   0.03857    0.91834    38.40631    0.99703    50.03181    0.29007    0.94407    0.02394    -6.68673    -6.73167
13.  1   0.09997    0.91919    38.40631    0.99703    49.96959    0.29007    0.94424    0.02399    -0.09700    -9.71970
14.  2   1.07889    0.91706    38.40787    0.99613    49.89726    0.29019    0.94556    0.02391    -0.84916    -1.24232
15.  1   1.12146    1.92195    38.41286    0.99524    49.77993    0.29047    0.94462    0.02400    -2.11352    -8.54097
16.  2   0.19919    0.92396    38.41412    0.99455    49.66100    0.29094    0.94580    0.02404     0.16758    -3.19887
17.  1   1.49189    0.97599    38.41569    0.99405    49.59493    0.29060    0.94602    0.02409     0.56189    -2.97549
18.  1   0.61164    0.99242    38.42033    0.99756    49.39908    0.29071    0.96735    0.02427     1.74915    -1.99959
19.  1   1.33756    0.91907    38.42908    0.97008    49.22451    0.29069    0.94463    0.02461     1.18675    -6.65335
20.  2   1.57077    0.94597    38.43117    0.98909    49.02209    0.29061    0.94639    0.02455     2.27916    -2.67291
21.  1   2.76236    0.75425    38.43884    0.98661    48.68631    0.29074    0.94759    0.02487     2.97986    -1.33549
22.  1   3.63734    0.58719    38.46757    0.99364    48.41721    0.28967    0.94645    0.02916     3.90051    -2.00270
23.  1   3.19970    0.96094    38.44944    0.98914    48.21939    0.28931    0.94934    0.02925     9.29223    -0.17742
24.  2   6.39179    1.24692    38.46004    0.97967    47.87901    0.28795    0.94849    0.03247     4.29219     2.67491
25.  1   7.66761    1.17970    38.46901    0.97870    47.67719    0.28665    0.94607    0.03069     4.57154     2.90960
26.  3   7.59769    1.26547    38.46304    0.97967    47.40809    0.28795    0.95791    0.03291     3.87013     2.99810
27.  1  11.44980    1.24597    38.49107    0.96926    46.70170    0.28150    0.94954    0.03289     4.10949     2.97459
28.  1  23.24099    1.37461    38.51121    0.96212    45.99531    0.27932    0.94688    0.03660     3.99577     2.84602
29.  1  33.64347    1.33779    38.54194    0.95141    45.01983    0.26913    0.94532    0.01469     3.97937     2.71979
30.  1  47.91914    1.24289    38.57025    0.94100    43.47250    0.29685    0.95555    0.03611     3.63673     2.59492

                       ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE MIXED BIOLOGICAL-IONIC SURFACTANTS-LI(A)(AF) FEB 1968 RLP

EXPERIMENTS PERFORMED AT THE FRESHLY DISTILLED WATER (AK)          /FRESHLY DISTILLED N HEPTANE            INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS NAC16SO3(CHOL(2) 1:1 SODIUM CETYLSULFONATE(CHOLESTEROL IN ETOH & TCE  2/21/68

                                          SYSTEM PARAMETERS

                 LOWER PHASE DENSITY  0.9980 G/ML        UPPER PHASE DENSITY  0.6780 G/ML
                         VISCOSITY  0.00896 POISES                 VISCOSITY  0.00386 POISES

                                   INITIAL VALUES ASSUMED IN CALCULATION

                 REAL ELASTICITY (EP)   0.0           IMAGINARY ELASTICITY (EPP)   0.0
                 WAVENUMBER  31.00000 RECIPROCAL  CM    DAMPING COEFFICIENT   0.70000 CM
                 REFERENCE METER SCALE    1.00 MV.      INTERFACIAL TENSION 50.2000 DYNES/CM
                 REFERENCE INPUT VTG.  0.100 VT.
                                          PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 4.28954 CM. BASED ON RESON= 0.31290 RESFN= 6.03280 DISTGN= 6.00230 DISTFN= 1.71875

                                CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY     CMP. COEF.     WAVE NO.       WAVELENGTH     NO. WAVES     PHS.COR.WANO  GN. PB. SCL.FCTR.
   1         167.20     0.73845186    33.16593327     0.18945023    22.61037496    33.16593327     0.70432541
   2         181.50     0.81504667    35.82167064     0.17540165    24.42132567    35.82167064     0.98143785
   3         202.20     0.89274869    38.46078201     0.16336989    26.22053261    38.46078201     0.36795986
                                       INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =  31.00000  MG.  MOLECULAR WT.= 485.00000 MAKE-UP VOLUME=0.0250 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM

                                       INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=     34.30MG.  WEIGHT OF WEIGHT=     171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.70000 CALCULATED PERIMETER PLATE= 2.89194 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                              INPUT DATA

ID .K      INDEP. VAR.     FREQUENCY      INPUT VOLT.    OUTPUT VOLT.    METER SCALE     SPTN. VAR.

  1.  1      0.0           162.20000       0.48000        0.10400         0.20000         38.00000
  1.  2      0.0           181.90000       0.48000        0.10190         0.20000         38.00000
  1.  3      0.0           202.20000       0.48100        0.11120         0.10000         38.00000
  2.  1      2.00000       161.50000       0.48000        0.09850         0.20000         39.10000
  2.  2      2.00000       181.10000       0.48000        0.10000         0.20000         39.10000
  2.  3      2.00000       201.50000       0.48100        0.11170         0.10000         39.10000
  3.  1      8.00000       160.90000       0.48000        0.09280         0.20000         40.40000
  3.  2      8.00000       180.50000       0.48100        0.09570         0.20000         40.40000
  3.  3      8.00000       201.00000       0.48100        0.10920         0.10000         40.40000
  4.  1     18.00000       160.40000       0.48000        0.08850         0.20000         41.80000
  4.  2     18.00000       179.70000       0.48100        0.08920         0.20000         41.60000
  4.  3     18.00000       200.20000       0.48200        0.10300         0.10000         41.50000
  5.  1     28.00000       160.20000       0.48000        0.08690         0.20000         42.20000
  5.  2     28.00000       179.70000       0.48100        0.09040         0.20000         42.10000
  5.  3     28.00000       199.90000       0.48200        0.10120         0.10000         41.90000
  6.  1     38.00000       160.20000       0.48000        0.08470         0.20000         42.40000
  6.  2     38.00000       179.50000       0.48000        0.08750         0.20000         42.30000
  6.  3     38.00000       199.90000       0.48000        0.09800         0.10000         42.20000
  7.  1     48.00000       160.10000       0.48000        0.08470         0.20000         42.40000
  7.  2     48.00000       179.60000       0.48000        0.08850         0.20000         42.30000
  7.  3     48.00000       199.70000       0.48000        0.09830         0.10000         42.20000
  8.  1     58.00000       159.80000       0.48000        0.08050         0.20000         43.10000
  8.  2     58.00000       179.10000       0.48100        0.08200         0.20000         43.00000
  8.  3     58.00000       199.40000       0.48100        0.09260         0.10000         42.80000
  9.  1     68.00000       159.70000       0.48000        0.07790         0.20000         43.20000
  9.  2     68.00000       179.10000       0.48100        0.08300         0.20000         43.10000
  9.  3     68.00000       199.30000       0.48100        0.09030         0.10000         43.00000
 10.  1     78.00000       159.90000       0.48000        0.08200         0.20000         43.40000
 10.  2     78.00000       179.20000       0.48100        0.08550         0.20000         43.40000
 10.  3     78.00000       199.20000       0.48100        0.09450         0.10000         43.40000
 11.  1     88.00000       159.20000       0.48000        0.07400         0.20000         44.40000
 11.  2     88.00000       178.60000       0.48100        0.07860         0.20000         44.30000
 11.  3     88.00000       198.90000       0.48200        0.08800         0.10000         44.20000
 12.  1     98.00000       159.10000       0.48000        0.07250         0.20000         45.00000
 12.  2     98.00000       178.40000       0.48100        0.07700         0.20000         44.70000
 12.  3     98.00000       198.70000       0.48200        0.08460         0.10000         44.40000
 13.  1    114.00000       159.20000       0.48200        0.07340         0.20000         44.60000
 13.  2    114.00000       178.40000       0.48300        0.07650         0.20000         44.50000
 13.  3    114.00000       198.50000       0.48300        0.08320         0.10000         44.40000
 14.  1    130.00000       158.50000       0.48100        0.06590         0.20000         45.90000
 14.  2    130.00000       177.80000       0.48200        0.06990         0.20000         45.80000
 14.  3    130.00000       197.90000       0.48300        0.07530         0.10000         45.50000
 15.  1    140.00000       158.40000       0.48100        0.06340         0.20000         46.10000
 15.  2    140.00000       177.70000       0.48200        0.06840         0.20000         46.10000
 15.  3    140.00000       197.60000       0.48200        0.06890         0.10000         46.00000
 16.  1    160.00000       157.90000       0.48100        0.06140         0.20000         47.20000
 16.  2    160.00000       177.10000       0.48300        0.06500         0.20000         47.00000
 16.  3    160.00000       197.00000       0.48300        0.06240         0.10000         46.90000
 17.  1    180.00000       157.50000       0.48200        0.05660         0.20000         47.90000
 17.  2    190.00000       176.60000       0.48300        0.05920         0.20000         47.80000
 17.  3    180.00000       197.60000       0.48300        0.05830         0.10000         47.60000
 18.  1    220.00000       156.70000       0.48200        0.05200         0.20000         49.30000
 18.  2    220.00000       175.70000       0.48300        0.05150         0.20000         49.00000
 18.  3    220.00000       195.70000       0.48400        0.04950         0.10000         49.80000
 19.  1    270.00000       155.30000       0.48200        0.08430         0.10000         51.40000
 19.  2    270.00000       174.50000       0.48300        0.09670         0.10000         51.20000



 19.  3    270.00000       194.20000       0.48300        0.03870         0.10000         50.90000
 20.  1    330.00000       155.00000       0.48200        0.08490         0.10000         52.20000
 20.  2    330.00000       173.70000       0.48400        0.09060         0.10000         52.00000
 20.  3    330.00000       193.50000       0.48400        0.03600         0.10000         51.90000
 21.  1    430.00000       153.40000       0.48200        0.07940         0.10000         55.30000
 21.  2    430.00000       171.90000       0.48300        0.08020         0.10000         54.90000
 21.  3    430.00000       191.50000       0.48300        0.03330         0.10000         54.60000
 22.  1    590.00000       151.90000       0.48200        0.06950         0.10000         57.20000
 22.  2    590.00000       170.70000       0.48300        0.07920         0.10000         57.10000
 22.  3    590.00000       189.90000       0.48500        0.03310         0.10000         56.80000
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                              TABLE OF RESULTS FOR  1  POSITION

          CALCULATED WAVENUMBER= 33.16833  RECIP. CM.  WAVELENGTH=0.18943  CM.  INITIAL FREQUENCY =  162.84  HZ.

ID .K  INDEP. VAR.  DEP. COEF.  WAVE NO.    REL. FQ.  INTERP. TENS. GEN. AMPL.    Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 1    0.0         0.79969    33.16833    1.00000    50.20000     0.14881     0.98098     0.02297    -0.00018   -0.00008
 2. 1    0.21376     0.74904    33.17136    0.99988    49.82724     0.14210     0.94880     0.02248    -1.61898   -0.49986
 3. 1    0.99223     0.79473    33.17843    0.99198    49.38671     0.13919     0.94983     0.02279    -0.12944   -1.18979
 4. 1    1.91753     0.78174    33.18079    0.98890    48.91288     0.13678     0.95273     0.02298     1.48184    0.97758
 5. 1    2.98282     0.76638    33.18224    0.98767    48.77673     0.13983     0.95248     0.02306     1.74799    0.10729
 6. 1    4.04911     0.77534    33.18824    0.98767    48.70096     0.13983     0.95418     0.02322     2.19131    0.64664
 7. 1    5.11340     0.76982    33.19004    0.98730    48.70896     0.13835     0.98242     0.02319     1.91917    0.08016
 8. 1    6.17869     0.77991    33.19330    0.98820    48.47173     0.13392     0.95379     0.02347     2.30792    0.28656
 9. 1    7.24399     0.78579    33.19481    0.98459    48.41786     0.13144     0.95519     0.02348     2.44799   -0.79971
10. 1    8.30928     0.77941    33.19409    0.98802    48.37009     0.13439     0.98768     0.02337     2.47991    1.10748
11. 1    9.37457     0.79336    33.19932    0.98130    48.03121     0.13108     0.95491     0.02391     2.47777    0.54544
12. 1   10.43986     0.79822    33.19111    0.98099    47.82799     0.13081     0.95789     0.02399     2.74976    1.19995
13. 1   12.14455     0.79443    33.19091    0.98150    47.96344     0.13108     0.95626     0.02400     2.74981    0.98443
14. 1   13.44990     0.81920    33.19501    0.97719    47.32291     0.12780     0.95419     0.02456     3.01741    0.98974
15. 1   14.51409     0.82199    33.19888    0.97687    47.45513     0.12734     0.95827     0.02480     3.13831    0.95555
16. 1   17.04467     0.82680    33.20041    0.97349    47.08237     0.12303     0.95743     0.02480     3.07448    1.13987
17. 1   19.17976     0.84268    33.20341    0.97152    46.84316     0.12320     0.95719     0.02598     3.24416    1.16511
18. 1   21.41645     0.85993    33.20798    0.96697    46.37076     0.11981     0.95809     0.02576     3.79975    1.16711
19. 1   27.74295     0.87738    33.21904    0.95746    45.45911     0.11393     0.95343     0.02686     4.04397    1.22017
20. 1   35.15996     0.88811    33.22109    0.95941    45.30001     0.11327     0.95525     0.02673     3.71754    1.24777
21. 1   45.80756     0.89997    33.27122    0.94875    44.33790     0.10941     0.94842     0.02478     3.62997    1.34878
22. 1   62.49223     0.90937    33.23988    0.93610    43.69364     0.10023     0.95151     0.02731     4.21661    1.29407
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                              TABLE OF RESULTS FOR  2  POSITION

          CALCULATED WAVENUMBER= 35.82187  RECIP. CM.  WAVELENGTH=0.17540  CM.  INITIAL FREQUENCY =  181.90  HZ.

ID .K  INDEP. VAR.  DEP. COEF.  WAVE NO.    REL. FQ.  INTERP. TENS. GEN. AMPL.    Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 2    0.0         0.41535    35.82187    1.00000    50.20000     0.23572     0.94876     0.02279    -0.00017   -0.00008
 2. 2    0.21376     0.81437    35.83106    0.99560    49.82724     0.23659     0.94673     0.02278    -2.12656   -0.06933
 3. 2    0.99223     0.82467    35.83803    0.99210    49.38671     0.23412     0.94830     0.02301    -0.14419   -0.49003
 4. 2    1.91753     0.93756    35.84723    0.98791    48.98006     0.23069     0.94699     0.02337    -1.17699   -2.08920
 5. 2    2.98282     0.83492    35.84723    0.99791    48.81062     0.23069     0.95277     0.02328     1.27789    0.04755
 6. 2    4.04911     0.86073    35.84921    0.98681    48.74285     0.22981     0.94930     0.02345     1.09461   -0.59124
 7. 2    5.11340     0.83855    35.84837    0.98736    48.74285     0.23025     0.95044     0.02359     1.44349    0.33909
 8. 2    6.17869     0.85458    35.85408    0.98461    48.50566     0.22803     0.94933     0.02383     1.67591   -0.99516
 9. 2    7.24399     0.85175    35.85406    0.98461    48.47175     0.22803     0.94999     0.02376     1.79072   -0.47571
10. 2    8.30928     0.84634    35.85255    0.98516    48.37909     0.22847     0.95314     0.02398     2.14722    0.78567
11. 2    9.37457     0.88214    35.85571    0.98186    48.00910     0.22976     0.95274     0.02404     2.38165    0.27587
12. 2   10.43986     0.88599    35.86196    0.98076    47.92955     0.22485     0.95261     0.02415     2.44299    0.49142
13. 2   12.14455     0.84868    35.86196    0.99076    47.99735     0.22485     0.95127     0.02427     2.45093   -0.01207
14. 2   13.44990     0.89616    35.86868    0.97746    47.55679     0.22207     0.95110     0.02471     2.86397    0.59827
15. 2   14.51409     0.89073    35.86979    0.97691    47.45513     0.22160     0.95358     0.02483     2.92119    0.49771
16. 2   17.04467     0.90012    35.87644    0.97361    47.15015     0.21878     0.95314     0.02509     3.07431    0.64665
17. 2   19.17976     0.91039    35.88195    0.97096    46.87909     0.21640     0.95281     0.02562     3.40827    0.59981
18. 2   21.41645     0.94720    35.89177    0.96592    46.47240     0.21207     0.95060     0.02639     4.16716    0.63897
19. 2   27.74295     0.95543    35.90468    0.95532    45.72698     0.20624     0.95197     0.02641     3.84950    0.98256
20. 2   35.15996     0.96959    35.91318    0.95492    45.45578     0.20232     0.94816     0.02492     4.84597    0.74233
21. 2   45.80756     0.98417    35.93155    0.94592    44.47309     0.19346     0.94764     0.02739     4.84698    1.03090
22. 2   62.49223     0.77383    35.94427    0.93843    43.72753     0.18755     0.94961     0.02776     4.29040    0.93139
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                              TABLE OF RESULTS FOR  3  POSITION

          CALCULATED WAVENUMBER= 38.46079  RECIP. CM.  WAVELENGTH=0.16337  CM.  INITIAL FREQUENCY =  202.20  HZ.

ID .K  INDEP. VAR.  DEP. COEF.  WAVE NO.    REL. FQ.  INTERP. TENS. GEN. AMPL.    Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 3    0.0         0.49277    38.46079    1.00000    50.20000     0.28805     0.94719     0.02321    -0.00017   -0.00008
 2. 3    0.21376     0.64231    38.47197    0.99854    49.82724     0.28949     0.94685     0.02321    -0.23381    0.36871
 3. 3    0.99223     0.89075    38.47591    0.99407    49.38671     0.29019     0.94998     0.02336     1.45287    0.65799
 4. 3    1.91753     0.91330    38.49253    0.99011    49.01355     0.29071     0.94864     0.02373     1.27739    0.31476
 5. 3    2.98282     0.91743    38.49723    0.99463    48.87840     0.29073     0.94810     0.02389     1.14785   -0.31299
 6. 3    4.04911     0.92398    38.49723    0.98863    48.77673     0.29073     0.95007     0.02400     1.82946    0.37889
 7. 3    5.11340     0.92322    38.50035    0.98764    48.77673     0.29069     0.94794     0.02398     1.27127   -0.55007
 8. 3    6.17869     0.93794    38.50502    0.98615    48.57341     0.29056     0.94871     0.02435     2.02334   -0.41765
 9. 3    7.24399     0.94326    38.50458    0.98596    48.50564     0.29049     0.94897     0.02450     2.26820   -0.34575
10. 3    8.30928     0.93269    38.50813    0.98516    48.37009     0.29042     0.95056     0.02422     2.19903    0.43359
11. 3    9.37457     0.94958    38.51277    0.98368    48.09899     0.29014     0.95269     0.02466     2.63591    0.50300
12. 3   10.43986     0.95950    38.51585    0.98269    48.03121     0.28990     0.95149     0.02489     2.75503    0.48720
13. 3   12.14455     0.95279    38.51693    0.98170    48.03121     0.28963     0.94975     0.02499     2.83891   -0.01289
14. 3   13.44990     0.99570    38.52811    0.97873    47.62457     0.28859     0.95139     0.02557     3.20406    0.60444
15. 3   14.51409     1.01474    38.53267    0.97729    47.48902     0.28795     0.95088     0.02608     3.59577    0.62171
16. 3   17.04467     1.02793    38.54174    0.97428    47.18403     0.28645     0.95055     0.02666     3.90558    0.78891
17. 3   19.17976     1.04442    38.55267    0.97725    46.94682     0.28795     0.96186     0.02710     3.75863    1.99579
18. 3   21.41645     1.07944    38.56110    0.96789    46.54017     0.28225     0.94959     0.02797     4.34940    1.36166
19. 3   27.74295     1.11248    38.58257    0.96044    45.82054     0.27932     0.94800     0.02936     4.48877    1.89323
20. 3   35.15996     1.15034    38.59300    0.95657    45.48567     0.27932     0.94745     0.02981     4.46920    2.77719
21. 3   45.80756     1.15597    38.62103    0.94738    44.57471     0.26511     0.94495     0.02993     4.63309    2.14748
22. 3   62.49223     1.15119    38.64279    0.93717    43.82919     0.25718     0.94344     0.02979     4.77174    2.17820
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                        ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE IONIC SURFACTANTS - LOCK IN AMPLIFIER (FEB 1968)

EXPERIMENTS PERFORMED AT THE   .01M SODIUM SULFATE (FRESH 4X H2O)    /FRESHLY DISTILLED HEPTANE                 INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS C16SO3 - SODIUM HEXADECYL SULPONATE (1X FROM DIST. ABS. ETHANOL)

                                        SYSTEM PARAMETERS

               LOWER PHASE DENSITY  0.9980 G/ML         UPPER PHASE DENSITY  0.6780 G/ML
                     VISCOSITY  0.00896 POISES                     VISCOSITY  0.00386 POISES

                                INITIAL VALUES ASSUMED IN CALCULATION

               REAL ELASTICITY (EP)   0.0                IMAGINARY ELASTICITY (EPP)   0.0
               WAVENUMBER  31.00000 RECIPROCAL  CM       DAMPING COEFFICIENT   0.70000 CM
               REFERENCE METER SCALE    1.00 MV.         INTERFACIAL TENSION 50.2000 DYNES/CM
               REFERENCE INPUT VTG.  0.100 VT.

                                        PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.07895 CM. BASED ON RESGN= 4.27240 RESFN= 8.37950 DISTGN= 3.03296 DISTFN=-0.04599

                                CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY     DMP. COEF.      WAVE NO.       WAVELENGTH       NO. WAVES    PHS.COR.WANO  GN. PR. SCL.FCTR.
    1         157.00     0.71807932    32.44662402     0.19364685     15.89982602    32.44662402     1.19189045
    2         197.20     0.87372702    37.81924010     0.16613713     18.53297020    37.81924010     0.97761390
    3         255.30     1.09140099    44.98078844     0.13968586     22.04194529    44.98078844     1.55681509
                                        INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =  70.80000  MG.  MOLECULAR WT.= 328.00000 MAKE-UP VOLUME=0.0500 L.
THE AREA IS KEPT CCNST. AT 240.00000 SQ. CM


                                        INTERFACIAL TENSICN DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=     34.30MG.  WEIGHT OF WEIGHT=    171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.89194 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                                      INPUT DATA

ID .K      INDEP. VAR.     FREQUENCY      INPUT VOLT.     OUTPUT VOLT.     METER SCALE     SPTN. VAR.


 1. 1      0.0             157.00000      0.15600         0.09990          0.20000         38.00000
 1. 2      0.0             197.20000      0.15700         0.06020          0.50000         38.00000
 1. 3      0.0             255.30000      0.38500         0.09590          0.10000         38.00000
 2. 1      0.00500         156.90000      0.15600         0.09500          0.20000         38.00000
 2. 2      0.00500         197.10000      0.15700         0.06000          0.50000         38.00000
 2. 3      0.00500         255.30000      0.38600         0.09300          0.10000         38.00000
 3. 1      0.02500         156.70000      0.15600         0.09260          0.20000         38.10000
 3. 2      0.02500         197.00000      0.15700         0.05960          0.50000         38.10000
 3. 3      0.02500         255.00000      0.38700         0.09150          0.10000         38.10000
 4. 1      0.05000         156.70000      0.15600         0.09250          0.20000         38.20000
 4. 2      0.05000         196.90000      0.15600         0.05980          0.50000         38.20000
 4. 3      0.05000         254.80000      0.38400         0.10000          0.10000         38.20000
 5. 1      0.07500         156.60000      0.15600         0.09200          0.20000         38.30000
 5. 2      0.07500         196.90000      0.15700         0.05870          0.50000         38.30000
 5. 3      0.07500         254.70000      0.38700         0.09850          0.10000         38.30000
 6. 1      0.12500         156.40000      0.15600         0.09400          0.20000         38.30000
 6. 2      0.12500         196.60000      0.15700         0.05680          0.50000         38.30000
 6. 3      0.12500         254.40000      0.38700         0.08200          0.10000         38.30000
 7. 1      0.22500         156.30000      0.15500         0.08700          0.20000         38.50000
 7. 2      0.22500         196.50000      0.15600         0.14200          0.20000         38.50000
 7. 3      0.22500         254.20000      0.38300         0.09000          0.10000         38.50000
 8. 1      0.42500         156.10000      0.15500         0.08400          0.20000         38.90000
 8. 2      0.42500         196.20000      0.15600         0.14100          0.20000         38.90000
 8. 3      0.42500         253.70000      0.38200         0.09100          0.10000         38.90000
 9. 1      0.72500         155.70000      0.15500         0.08200          0.20000         39.70000
 9. 2      0.72500         195.90000      0.15600         0.13700          0.20000         39.70000
 9. 3      0.72500         253.40000      0.38200         0.08600          0.10000         39.70000
10. 1      1.12500         155.40000      0.15500         0.07600          0.20000         40.70000
10. 2      1.12500         195.70000      0.15500         0.13300          0.20000         40.70000
10. 3      1.12500         252.70000      0.38200         0.08400          0.10000         40.70000
11. 1      1.62500         155.00000      0.15500         0.06900          0.20000         41.40000
11. 2      1.62500         195.00000      0.15500         0.12200          0.20000         41.40000
11. 3      1.62500         251.90000      0.38100         0.07700          0.10000         41.40000
12. 1      2.62500         153.60000      0.15500         0.05700          0.20000         43.90000
12. 2      2.62500         193.60000      0.15500         0.10000          0.20000         43.90000
12. 3      2.62500         249.70000      0.38200         0.07300          0.10000         43.90000
13. 1      3.62500         152.30000      0.15500         0.04800          0.20000         45.90000
13. 2      3.62500         192.00000      0.15500         0.08700          0.20000         45.90000
13. 3      3.62500         248.10000      0.38100         0.06800          0.10000         45.90000
14. 1      4.62500         150.80000      0.15500         0.08800          0.10000         48.60000
14. 2      4.62500         190.30000      0.15500         0.07800          0.20000         48.60000
14. 3      4.62500         245.30000      0.38000         0.06300          0.10000         48.60000
15. 1      5.62500         149.00000      0.15500         0.08300          0.10000         51.20000
15. 2      5.62500         188.30000      0.15500         0.07300          0.20000         51.20000
15. 3      5.62500         242.90000      0.38100         0.06200          0.10000         51.20000
16. 1      7.12500         147.80000      0.15500         0.07600          0.10000         57.30000
16. 2      7.12500         185.60000      0.15500         0.06800          0.20000         57.30000
16. 3      7.12500         239.10000      0.38100         0.07300          0.10000         57.30000
17. 1      8.62500         145.40000      0.15500         0.06900          0.10000         59.70000
17. 2      8.62500         183.90000      0.15500         0.12700          0.10000         59.70000
17. 3      8.62500         236.50000      0.38000         0.07700          0.10000         59.70000
18. 1     10.62500         142.50000      0.37800         0.14400          0.10000         64.10000
18. 2     10.62500         180.60000      0.15500         0.11400          0.10000         64.10000
18. 3     10.62500         232.30000      0.38100         0.09100          0.10000         64.10000
19. 1     12.62500         139.60000      0.36900         0.13800          0.10000         68.70000
19. 2     12.62500         177.70000      0.15500         0.10600          0.10000         68.70000



19. 3     12.62500         228.20000      0.38100         0.10800          0.10000         68.70000
20. 1     17.62500         135.30000      0.36800         0.10800          0.10000         75.20000
20. 2     17.62500         172.80000      0.15400         0.08000          0.10000         75.20000
20. 3     17.62500         222.20000      0.38000         0.07500          0.20000         75.20000
```

```
                              TABLE OF RESULTS FOR  1  POSITION

        CALCULATED WAVENUMBER= 32.44662  RECIP. CM.  WAVELENGTH=0.19365  CM.  INITIAL FREQUENCY =  197.00  HZ.

ID .#  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

  1. 1   0.0         0.71888    32.44662     1.00000   50.20000      0.09809     0.95109     0.02813    -0.00016    -0.00008
  2. 1   0.00090     0.73321    32.44451     0.99936   50.20000      0.09768     0.95006     0.02260    -0.44008    -1.77919
  3. 1   0.00450     0.73911    32.44088     0.99809   50.16611      0.09696     0.94903     0.02279    -2.39926    -4.32731
  4. 1   0.00899     0.71940    32.44032     0.99809   50.13223      0.09696     0.94929     0.02279    -1.00373    -3.44621
  5. 1   0.01349     0.74002    32.43682     0.99745   50.09834      0.09660     0.94890     0.02281    -1.73002    -4.19807
  6. 1   0.02248     0.73062    32.43401     0.99618   50.09834      0.09589     0.94688     0.02253   -10.41673     1.29363
  7. 1   0.04047     0.75246    32.43191     0.99556   50.03056      0.09513     0.94710     0.02320    -0.08292   -21.47693
  8. 1   0.07645     0.76149    32.42771     0.99427   49.89501      0.09483     0.94762     0.02348     7.48096   -11.47090
  9. 1   0.13041     0.76449    32.41930     0.99172   49.62392      0.09363     0.94866     0.02358     4.48163    -4.14017
 10. 1   0.20236     0.78881    32.41299     0.98981   49.28504      0.09239     0.95206     0.02423     3.89735    -0.66370
 11. 1   0.29230     0.81207    32.40489     0.98726   49.04783      0.09103     0.95249     0.02308     4.42108     0.28448
 12. 1   0.47218     0.83727    32.37318     0.97824   48.20069      0.08843     0.95429     0.02648     4.22334     1.55144
 13. 1   0.65206     0.84750    32.34783     0.97004   47.52291      0.08236     0.95410     0.02775     4.24233     1.91219
 14. 1   0.83194     0.90795    32.31631     0.96051   46.60795      0.07790     0.95658     0.02810     3.91894     1.86007
 15. 1   1.01181     0.90884    32.27647     0.94904   45.72688      0.07308     0.95920     0.02806     3.97707     1.78741
 16. 1   1.28163     0.92071    32.21121     0.94140   43.65976      0.07003     0.96669     0.02499     2.97693     2.52270
 17. 1   1.55145     0.92150    32.20280     0.92611   42.84666      0.06494     0.97761     0.02874     2.97734     2.23922
 18. 1   1.91120     0.94429    32.14129     0.90764   41.35542      0.05868     0.97840     0.02944     2.91494     2.20408
 19. 1   2.27096     0.92995    32.08049     0.88917   39.79661      0.05450     0.98134     0.02885     2.77508     2.17785
 20. 1   3.17035     0.97466    31.99031     0.86178   37.59394      0.04950     0.98412     0.03047     2.69334     2.13788

                              TABLE OF RESULTS FOR  2  POSITION

        CALCULATED WAVENUMBER= 37.81924  RECIP. CM.  WAVELENGTH=0.16614  CM.  INITIAL FREQUENCY =  197.20  HZ.

ID .#  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

  1. 2   0.0         0.87373    37.81924     1.00000   50.20000      0.32195     0.94756     0.02310    -0.00017    -0.00005
  2. 2   0.00090     0.87434    37.81714     0.99949   50.20000      0.32149     0.94675     0.02312    -0.70570    -0.21933
  3. 2   0.00450     0.87605    37.81504     0.99899   50.16611      0.32103     0.94659     0.02317    -0.85562    -0.37160
  4. 2   0.00899     0.87242    37.81293     0.99848   50.13223      0.32056     0.94663     0.02307    -1.05979    -0.08090
  5. 2   0.01349     0.88052    37.81293     0.99848   50.09834      0.32056     0.94707     0.02329    -0.27329    -0.55574
  6. 2   0.02248     0.88979    37.80663     0.99696   50.09834      0.31916     0.94465     0.02354    -4.55673    -2.79332
  7. 2   0.04047     0.88724    37.80423     0.99645   50.03056      0.31870     0.94513     0.02347    -3.11100    -2.05288
  8. 2   0.07645     0.88808    37.79822     0.99493   49.89501      0.31728     0.94528     0.02350    -2.68988    -2.09521
  9. 2   0.13041     0.89594    37.79192     0.99341   49.62392      0.31585     0.94801     0.02371     0.49258    -0.79447
 10. 2   0.20236     0.90251    37.78771     0.99239   49.28504      0.31488     0.95290     0.02388     2.34550     0.43586
 11. 2   0.29230     0.92700    37.77300     0.98864   49.04783      0.31147     0.95178     0.02434     2.71592     0.50080
 12. 2   0.47218     0.98415    37.74357     0.98174   48.20069      0.30442     0.95689     0.02607     3.50810     1.53157
 13. 2   0.65236     1.02031    37.70994     0.97383   47.52291      0.29604     0.95712     0.02706     3.49697     1.66074
 14. 2   0.83194     1.04547    37.67421     0.96501   46.60795      0.28679     0.96143     0.02775     3.36391     1.87548
 15. 2   1.01181     1.05398    37.63217     0.95487   45.72688      0.27551     0.96769     0.02801     3.29255     2.07455
 16. 2   1.28163     1.05783    37.57542     0.94118   43.65976      0.25972     0.98400     0.02819     3.01704     2.31947
 17. 2   1.55145     1.06704    37.53989     0.93256   42.84666      0.24950     0.98721     0.02842     2.98152     2.33104
 18. 2   1.91120     1.07469    37.47032     0.91582   41.35542      0.22927     0.99191     0.02868     2.90895     2.52324
 19. 2   2.27096     1.07168    37.40937     0.90112   39.79661      0.21125     1.00281     0.02865     2.83440     2.55786
 20. 2   3.17035     1.11055    37.30637     0.87627   37.59394      0.18087     1.01217     0.02977     2.74745     2.51338

                              TABLE OF RESULTS FOR  3  POSITION

        CALCULATED WAVENUMBER= 44.98079  RECIP. CM.  WAVELENGTH=0.13969  CM.  INITIAL FREQUENCY =  255.30  HZ.

ID .#  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.    Y1          Y2        REAL ELS.  IMAG. ELAS.

  1. 3   0.0         1.09140    44.98079     1.00000   50.20000      0.04608     0.94395     0.02426    -0.00017    -0.00005
  2. 3   0.00090     1.10222    44.98079     1.00000   50.20000      0.04608     0.94393     0.02450     0.21729    -0.93762
  3. 3   0.00450     1.11153    44.97832     0.99882   50.16611      0.04653     0.94293     0.02471    -0.88812    -2.02365
  4. 3   0.00899     1.08228    44.97665     0.99804   50.13223      0.04684     0.94179     0.02406    -2.71960     0.84580
  5. 3   0.01349     1.09079    44.97582     0.99765   50.09834      0.04700     0.94174     0.02425    -2.50453    -0.06602
  6. 3   0.02248     1.13356    44.97329     0.99647   50.09834      0.04746     0.93968     0.02565    14.21644   -15.22990
  7. 3   0.04047     1.12210    44.97159     0.99569   50.03056      0.04778     0.93958     0.02495   -15.78804    -6.59080
  8. 3   0.07645     1.12310    44.96728     0.99373   49.89501      0.04859     0.93870     0.07498   -26.22492     8.96926
  9. 3   0.13041     1.14474    44.96466     0.99256   49.62392      0.04908     0.94176     0.02546     1.62300    -5.60202
 10. 3   0.20236     1.16013    44.95843     0.98982   49.28504      0.05027     0.94340     0.02580     3.08679    -2.41238
 11. 3   0.29230     1.19655    44.95112     0.98668   49.04783      0.05168     0.94243     0.02662     5.76792    -1.78966
 12. 2   0.47218     1.24053    44.92999     0.97807   48.20065      0.05595     0.94364     0.02761     5.91723     0.23069
 13. 3   0.65206     1.28256    44.91385     0.97180   47.52291      0.05948     0.94591     0.02856     4.69732     1.19493
 14. 3   0.83194     1.34368    44.88313     0.96083   46.60795      0.06669     0.94475     0.02994     4.77941     1.80310
 15. 3   1.01181     1.38429    44.85501     0.95143   45.72688      0.07418     0.94598     0.03086     4.46963     2.00770
 16. 3   1.28163     1.39109    44.80676     0.93655   43.65976      0.08918     0.96312     0.03105     3.35230     2.26890
 17. 3   1.55145     1.41721    44.77112     0.92636   42.84666      0.10222     0.96247     0.03165     3.34905     2.24773
 18. 3   1.91120     1.44010    44.70906     0.90991   41.35542      0.12928     0.96808     0.03221     3.21161     2.29708
 19. 3   2.27096     1.46294    44.64311     0.89385   39.79661      0.16441     0.97309     0.03277     3.06514     2.35812
 20. 3   3.17035     1.47347    44.53705     0.87035   37.59394      0.23678     0.98365     0.03308     2.89172     2.40948
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THE DATA USED FOR EVALUATING THE POLYNOMIALS IN SUBROUTINES AMPLTD AND PHSCOR FOLLOW--

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                    ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE IONIC SURFACTANTS - LOCK IN AMPLIFIER (FEB 1969)

EXPERIMENTS PERFORMED AT THE   .01M SODIUM SULFATE (FRESH 4X H2O)    /FRESHLY DISTILLED HEPTANE                 INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS C18SO3 - SODIUM OCTADECYL SULFONATE (1X FROM ABS. DIST. ETHANOL)

                                          SYSTEM PARAMETERS

               LOWER PHASE DENSITY  0.9980 G/ML         UPPER PHASE DENSITY  0.6780 G/ML
                       VISCOSITY  0.00896 POISES                         VISCOSITY  0.00386 POISES

                                   INITIAL VALUES ASSUMED IN CALCULATION

               REAL ELASTICITY (EP)   0.0              IMAGINARY ELASTICITY (EPP)   0.0
               WAVENUMBER  31.00000 RECIPROCAL  CM     DAMPING COEFFICIENT   0.70000 CM
               REFERENCE METER SCALE    1.00 MV.       INTERFACIAL TENSION 50.2000 DYNES/CM
               REFERENCE INPUT VTG.  0.100 VT.

                                          PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.12384 CM. BASED ON RESGN= 4.21320 RESPN= 8.37820 DISTGN= 3.07808 DISTPN=-0.04576

                                   CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY      CMP. COEF.     WAVE NO.       WAVELENGTH       NO. WAVES    PHS.COR.WAVE GN. PR. SCL.FCTR.
    1          151.30     0.69559917    31.64965747     0.19852294     15.73542485     31.64965747      1.25134928
    2          191.00     0.85002487    37.01618099     0.16974141     18.40353119     37.01618899      0.84019287
    3          246.30     1.05915808    43.90988326     0.14309261     21.83090500     43.90988326      1.14091284
                                          INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =  60.10000  MG.  MOLECULAR WT.= 356.00000 MAKE-UP VOLUME=0.0500 L.
THE AREA IS KEPT CONST. AT 740.00000 SQ. CM


                                          INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=     34.30MG. WEIGHT OF WEIGHT=     171.40 MG.  DENSITY OF WT=21.43300
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.09585 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                        INPUT DATA

 ID .K     INDEP. VAR.     FREQUENCY     INPUT VOLT.    OUTPUT VOLT.    METER SCALE    SETN. VAR.

  1. 1     0.0             151.30000     0.35800        0.08100         0.50000        37.80000
  1. 2     0.0             191.00000     0.16200        0.13900         0.20000        37.80000
  1. 3     0.0             246.30000     0.40000        0.10700         0.10000        37.80000
  2. 1     0.0             151.50000     0.39700        0.08120         0.50000        37.80000
  2. 2     0.0             191.00000     0.16200        0.13700         0.20000        37.80000
  2. 3     0.0             246.20000     0.39900        0.10400         0.10000        37.80000
  3. 1     0.00500         151.30000     0.39700        0.08300         0.50000        37.80000
  3. 2     0.00500         190.80000     0.16100        0.13700         0.20000        37.80000
  3. 3     0.00500         246.30000     0.35800        0.10400         0.10000        37.80000
  4. 1     0.02500         151.10000     0.39200        0.08300         0.50000        38.00000
  4. 2     0.02500         190.50000     0.16000        0.13400         0.20000        38.00000
  4. 3     0.02500         246.10000     0.39700        0.10600         0.10000        38.00000
  5. 1     0.05000         151.10000     0.39200        0.08200         0.50000        38.10000
  5. 2     0.05000         190.50000     0.16100        0.13400         0.20000        38.10000
  5. 3     0.05000         245.80000     0.39700        0.10200         0.10000        38.10000
  6. 1     0.07500         151.00000     0.39100        0.08000         0.50000        38.20000
  6. 2     0.07500         190.40000     0.16000        0.13100         0.20000        38.20000
  6. 3     0.07500         245.60000     0.39300        0.09500         0.10000        38.20000
  7. 1     0.10000         150.50000     0.35100        0.07700         0.50000        38.30000
  7. 2     0.10000         190.20000     0.16000        0.17900         0.20000        38.30000
  7. 3     0.10000         245.60000     0.39200        0.08700         0.10000        38.30000
  8. 1     0.15000         150.90000     0.39000        0.07800         0.50000        38.40000
  8. 2     0.15000         190.20000     0.16000        0.12900         0.20000        38.40000
  8. 3     0.15000         245.60000     0.35200        0.08500         0.10000        38.40000
  9. 1     0.30000         150.70000     0.39000        0.07400         0.50000        38.80000
  9. 2     0.30000         190.10000     0.16000        0.12700         0.20000        38.80000
  9. 3     0.30000         245.30000     0.35200        0.07000         0.10000        38.80000
 10. 1     0.60000         150.30000     0.39000        0.07300         0.50000        39.30000
 10. 2     0.60000         189.80000     0.15900        0.12400         0.20000        39.30000
 10. 3     0.60000         244.40000     0.39200        0.06900         0.10000        39.30000
 11. 1     1.00000         150.20000     0.39000        0.07000         0.50000        40.20000
 11. 2     1.00000         189.20000     0.16000        0.11900         0.20000        40.20000
 11. 3     1.00000         244.20000     0.39300        0.06600         0.10000        40.20000
 12. 1     1.50000         149.70000     0.39000        0.06600         0.50000        40.80000
 12. 2     1.50000         188.90000     0.15900        0.11300         0.20000        40.80000
 12. 3     1.50000         243.50000     0.39000        0.07200         0.10000        40.80000
 13. 1     2.00000         149.50000     0.38700        0.06300         0.50000        42.00000
 13. 2     2.00000         188.80000     0.15700        0.10800         0.20000        42.00000
 13. 3     2.00000         242.90000     0.39000        0.07300         0.10000        42.00000
 14. 1     3.00000         148.40000     0.38900        0.05500         0.50000        44.00000
 14. 2     3.00000         187.40000     0.15800        0.09500         0.20000        44.00000
 14. 3     3.00000         241.30000     0.39000        0.06900         0.10000        44.00000
 15. 1     4.00000         147.50000     0.38900        0.04900         0.50000        45.90000
 15. 2     4.00000         186.40000     0.15800        0.08400         0.20000        45.90000
 15. 3     4.00000         239.90000     0.39000        0.06600         0.10000        45.90000
 16. 1     5.00000         146.40000     0.38900        0.04200         0.50000        47.60000
 16. 2     5.00000         185.30000     0.15800        0.13700         0.10000        47.60000
 16. 3     5.00000         238.50000     0.39000        0.09500         0.05000        47.60000
 17. 1     6.00000         145.20000     0.38900        0.09000         0.20000        49.90000
 17. 2     6.00000         183.90000     0.15700        0.12600         0.10000        49.90000
 17. 3     6.00000         236.30000     0.39000        0.10200         0.05000        49.90000
 18. 1     7.00000         144.20000     0.38800        0.09100         0.20000        51.60000
 18. 2     7.00000         182.60000     0.15600        0.12300         0.10000        51.60000
 18. 3     7.00000         234.50000     0.38900        0.12600         0.05000        51.60000
 19. 1     8.00000         143.20000     0.38500        0.08700         0.20000        53.50000
 19. 2     8.00000         181.30000     0.15600        0.11900         0.10000        53.50000


 19. 3     8.00000         232.90000     0.38500        0.14100         0.05000        53.50000
 20. 1     9.50000         141.10000     0.37100        0.07100         0.20000        56.80000
 20. 2     9.50000         179.20000     0.15600        0.10600         0.10000        56.80000
 20. 3     9.50000         229.90000     0.38900        0.12800         0.05000        56.80000
 21. 1    11.00000         139.70000     0.37100        0.06600         0.20000        59.30000
 21. 2    11.00000         177.60000     0.15600        0.10000         0.10000        59.30000
 21. 3    11.00000         228.10000     0.38800        0.07700         0.10000        59.30000
 22. 1    13.00000         137.10000     0.37200        0.11400         0.10000        63.60000
 22. 2    13.00000         174.80000     0.15800        0.08900         0.10000        63.60000
 22. 3    13.00000         224.20000     0.38800        0.09900         0.10000        63.60000
 23. 1    15.00000         135.40000     0.37100        0.10400         0.10000        68.00000
 23. 2    15.00000         172.60000     0.15600        0.07800         0.10000        68.00000
 23. 3    15.00000         221.70000     0.38700        0.13000         0.10000        68.00000
 24. 1    18.00000         132.10000     0.37000        0.08300         0.10000        74.00000
 24. 2    18.00000         168.70000     0.15700        0.06100         0.10000        74.00000
 24. 3    18.00000         217.40000     0.38600        0.12300         0.10000        74.00000
```

TABLE OF RESULTS FOR 1 POSITION

CALCULATED WAVENUMBER= 31.64966 RECIP. CM. WAVELENGTH=0.19852 CM. INITIAL FREQUENCY = 181.30 HZ.

ID .K	INDEP. VAR.	DMP. COEF.	WAVE NO.	REL. FQ.	INTERP. TENS.	GEN. AMPL.	Y1	Y2	REAL ELS.	IMAG. ELAS.
1. 1	0.0	0.69560	31.64966	1.00000	50.20000	0.07961	0.99170	0.02193	-0.00014	-0.00005
2. 1	0.0	0.71025	31.63380	1.00132	50.20000	0.08000	0.99184	0.02507	2.16992	-0.14646
3. 1	0.00070	0.72089	31.64966	1.00000	50.20000	0.07961	0.98170	0.02272	1.24174	-1.65767
4. 1	0.00352	0.71450	31.64531	0.99960	50.13232	0.07883	0.99034	0.02258	0.00456	-1.02974
5. 1	0.00703	0.71636	31.64531	0.99160	50.09848	0.07883	0.99168	0.02270	0.91499	-1.67986
6. 1	0.01055	0.72430	31.64544	0.99802	50.06463	0.07885	0.99109	0.02289	1.22729	-2.49240
7. 1	0.01407	0.70082	31.64127	0.99716	50.03079	0.07836	0.99068	0.02219	-0.91599	-0.66909
8. 1	0.02110	0.73042	31.64137	0.99736	49.99695	0.07826	0.99127	0.02306	1.98328	-2.40524
9. 1	0.04221	0.74494	31.63723	0.99603	49.86158	0.07769	0.98170	0.02388	3.34014	-1.81945
10. 1	0.08441	0.74465	31.62894	0.99339	49.69238	0.07638	0.98062	0.02394	3.76084	-3.06174
11. 1	0.14068	0.75692	31.62057	0.99273	49.38780	0.07630	0.98540	0.02391	9.17969	0.34429
12. 1	0.21103	0.76999	31.61631	0.98948	49.18475	0.07494	0.95390	0.02433	3.77314	0.04378
13. 1	0.28137	0.78011	31.61237	0.98810	48.77865	0.07440	0.98965	0.02468	3.23444	1.31292
14. 1	0.42205	0.81269	31.58958	0.98043	48.10182	0.07154	0.96097	0.02573	3.40776	1.59333
15. 1	0.56273	0.83957	31.57093	0.97460	47.45883	0.06932	0.96391	0.02689	3.34742	1.98617
16. 1	0.70342	0.87650	31.54814	0.96741	46.88352	0.06974	0.90333	0.02779	3.49583	1.96660
17. 1	0.84410	0.91287	31.57329	0.95968	46.10517	0.06411	0.96588	0.02497	5.48734	2.12492
18. 1	0.98478	0.89851	31.50811	0.95307	45.52986	0.06206	0.96696	0.02692	3.39421	2.07288
19. 1	1.12547	0.90039	31.48195	0.94646	44.88687	0.06014	0.96877	0.02840	3.73400	2.10479
20. 1	1.33649	0.91371	31.43836	0.93258	43.77010	0.05653	0.96657	0.02970	3.23296	2.12991
21. 1	1.54752	0.94501	31.40934	0.92333	42.92406	0.05644	0.97084	0.03009	3.14717	2.14836
22. 1	1.82889	0.97330	31.35548	0.90615	41.46887	0.05122	0.97285	0.03104	3.05999	2.19725
23. 1	2.11025	0.99146	31.32036	0.89491	39.97984	0.04959	0.98754	0.03166	2.85784	2.28142
24. 1	2.53230	1.01992	31.29169	0.87310	37.94935	0.04768	0.99674	0.01356	2.75634	2.28455

TABLE OF RESULTS FOR 2 POSITION

CALCULATED WAVENUMBER= 37.01619 RECIP. CM. WAVELENGTH=0.16974 CM. INITIAL FREQUENCY = 191.00 HZ.

ID .K	INDEP. VAR.	DMP. COEF.	WAVE NO.	REL. FQ.	INTERP. TENS.	GEN. AMPL.	Y1	Y2	REAL ELS.	IMAG. ELAS.
1. 2	0.0	0.85002	37.01619	1.00000	50.20000	0.29064	0.94803	0.02296	-0.00017	-0.00005
2. 2	0.0	0.89466	37.01619	1.00000	50.20000	0.29064	0.94803	0.02509	0.09222	-0.27662
3. 2	0.00070	0.85147	37.01205	0.99895	50.20000	0.28954	0.94636	0.02301	-1.74796	-0.37099
4. 2	0.00352	0.85474	37.00583	0.99730	50.13232	0.28789	0.94914	0.02310	-4.06617	-0.56909
5. 2	0.00703	0.85673	37.00583	0.99738	50.09848	0.28789	0.94578	0.02315	-2.74611	-0.96197
6. 2	0.01055	0.86137	37.00376	0.99688	50.06463	0.28734	0.94558	0.02328	-3.19985	-1.71492
7. 2	0.01407	0.86506	36.99962	0.99581	50.03079	0.28623	0.94499	0.02339	-4.85119	-2.16744
8. 2	0.02110	0.86506	36.99962	0.99581	49.99695	0.28623	0.94519	0.02338	-4.28881	-2.48521
9. 2	0.04221	0.86944	36.99784	0.99529	49.86158	0.28568	0.94692	0.02350	-0.40271	-1.89171
10. 2	0.08441	0.87321	36.99133	0.99372	49.69238	0.28401	0.94762	0.02361	0.91123	-1.90967
11. 2	0.14068	0.88457	36.97890	0.99058	49.38780	0.28063	0.94840	0.02392	1.59468	-1.26950
12. 2	0.21103	0.89718	36.97268	0.98901	49.18475	0.27894	0.94978	0.02427	2.45698	-0.50979
13. 2	0.28137	0.90496	36.97061	0.98848	48.77865	0.27837	0.95684	0.02453	2.85805	1.42878
14. 2	0.42205	0.94065	36.94361	0.98115	48.10182	0.27031	0.95822	0.02544	3.11566	1.58476
15. 2	0.56273	0.97303	36.92089	0.97592	47.45883	0.26446	0.96248	0.02635	3.19779	1.99386
16. 2	0.70342	1.03033	36.89810	0.97016	46.88352	0.25793	0.96461	0.02792	3.33923	2.12694
17. 2	0.84410	1.04446	36.86910	0.96283	46.10517	0.24950	0.96841	0.02833	3.29529	2.24091
18. 2	0.98478	1.03981	36.84217	0.95602	45.52986	0.24159	0.96895	0.02822	3.19855	2.24110
19. 2	1.12547	1.03963	36.81523	0.94921	44.88687	0.23360	0.97102	0.02824	3.13416	2.27676
20. 2	1.33649	1.05031	36.77173	0.93822	43.77010	0.22099	0.97631	0.02878	3.06419	2.36777
21. 2	1.54752	1.06217	36.73858	0.92984	42.92406	0.21063	0.98051	0.02891	3.00986	2.41244
22. 2	1.82889	1.07593	36.68057	0.91518	41.46887	0.19321	0.98784	0.02933	2.92459	2.45892
23. 2	2.11025	1.09077	36.63500	0.90366	39.97984	0.17964	1.00273	0.02977	2.86057	2.54194
24. 2	2.53230	1.12684	36.55470	0.88325	37.94935	0.15614	1.01589	0.03082	2.78269	2.55168

TABLE OF RESULTS FOR 3 POSITICN

CALCULATED WAVENUMBER= 43.90988 RECIP. CM. WAVELENGTH=0.14309 CM. INITIAL FREQUENCY = 246.30 HZ.

ID .K	INDEP. VAR.	DMP. COEF.	WAVE NO.	REL. FQ.	INTERP. TENS.	GEN. AMPL.	Y1	Y2	REAL ELS.	IMAG. ELAS.
1. 3	0.C	1.03816	43.90988	1.00000	50.20000	0.06894	0.94443	0.02410	-0.00017	-0.00005
2. 3	0.0	1.06779	43.90879	0.99959	50.20000	0.06421	0.94574	0.02432	-0.44035	-0.79292
3. 3	0.00070	1.03175	43.90988	1.00000	50.20000	0.06394	0.94443	0.02350	-0.08726	1.17609
4. 3	0.00352	1.06141	43.90770	0.99919	50.13232	0.06448	0.94431	0.02417	-0.03788	-0.17803
5. 3	0.00703	1.07774	43.90441	0.99797	50.09848	0.06529	0.94286	0.02455	-1.20759	-2.09019
6. 3	0.01055	1.09996	43.90220	0.99716	50.06463	0.06584	0.94211	0.02505	-0.09298	-5.91014
7. 3	0.01407	1.12731	43.90220	0.99716	50.03079	0.06584	0.94274	0.02568	4.40290	-4.12942
8. 3	0.02110	1.10030	43.90220	0.99716	49.99695	0.06584	0.94336	0.01506	1.14871	-3.08826
9. 3	0.04221	1.10653	43.89886	0.99594	49.86158	0.06669	0.94385	0.02637	5.46002	-0.90972
10. 3	0.08441	1.21807	43.88867	0.99229	49.69238	0.06934	0.94078	0.02775	6.95024	1.65903
11. 3	0.14068	1.23594	43.88638	0.99147	49.38780	0.06995	0.94518	0.02816	5.19714	1.20934
12. 3	0.21103	1.21564	43.87824	0.98863	49.18475	0.07218	0.94418	0.02770	5.51020	0.75326
13. 3	0.28137	1.21998	43.87114	0.98620	48.77865	0.07418	0.94781	0.02781	4.38119	1.04152
14. 3	0.42205	1.26211	43.85166	0.97970	48.10182	0.07997	0.94979	0.02878	4.20481	1.58418
15. 3	0.56273	1.29831	43.83397	0.97402	47.45883	0.08566	0.95267	0.02962	3.97098	1.91353
16. 3	0.70342	1.42638	43.81546	0.96833	46.88352	0.09197	0.95434	0.03255	3.98322	2.40051
17. 3	0.84410	1.44090	43.78507	0.95940	46.10517	0.10333	0.95459	0.03291	3.91909	2.39691
18. 3	0.98478	1.40419	43.76001	0.95209	45.52986	0.11409	0.95365	0.03209	3.90036	2.25343
19. 3	1.12547	1.39896	43.73486	0.94519	44.88687	0.12562	0.95498	0.03199	3.78224	2.21603
20. 3	1.33649	1.48404	43.68987	0.93341	43.77010	0.14876	0.95806	0.03397	3.64882	2.38313
21. 3	1.54752	1.45836	43.66043	0.92611	42.92406	0.16540	0.96364	0.03340	3.43293	2.36228
22. 3	1.82889	1.45341	43.59183	0.91027	41.46887	0.20965	0.96807	0.03334	3.25308	2.35314
23. 3	2.11025	1.41408	43.54853	0.90012	39.97984	0.24410	0.98492	0.03247	3.01931	2.50591
24. 3	2.53230	1.31432	43.46606	0.88288	37.94935	0.31670	1.00349	0.03484	2.94031	2.57282

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                       ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE IONIC SURFACTANTS - LOCK IN AMPLIFIER (FEB 1980)
EXPERIMENTS PERFORMED AT THE .01M POTASSIUM BROMIDE (1X) FRESH H2O  /FRESHLY DISTILLED HEPTANE              INTERFACE.
THE SYSTEM UNDER INVESTIGATION IS CTAB - CETYLTRIMETHYL AMMONIUM BROMIDE (2X FROM DIST. ABS. ETHANOL)

                                        SYSTEM PARAMETERS

                LOWER PHASE DENSITY  0.9980 G/ML        UPPER PHASE DENSITY  0.6780 G/ML
                      VISCOSITY  0.00896 POISES                   VISCOSITY  0.00386 POISES

                                INITIAL VALUES ASSUMED IN CALCULATION

                REAL ELASTICITY (EP)   0.0              IMAGINARY ELASTICITY (EPP)   0.0
                WAVENUMBER  31.00000 RECIPROCAL  CM     DAMPING COEFFICIENT   0.70000 CM
                REFERENCE METER SCALE    1.00 MV.       INTERFACIAL TENSION 50.2000 DYNES/CM
                REFERENCE INPUT VTG.  0.100 VT.

                                        PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.10979 CM. BASED ON RESGN= 4.21800 RESFN= 8.36440 DISTGN= 3.07442 DISTFN=-0.03536

                               CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY      DMP. COEF.       WAVE NO.       WAVELENGTH       NO. WAVES    PHS.COR.WAND  GN. PR. SCL.FCTR.
    1          168.40     0.76271437     34.01233367     0.18473240     16.83403964     34.01233367     1.23031801
    2          208.10     0.91515616     39.21108164     0.16023991     19.40706558     39.21108164     1.12995736
    3          251.8C     1.07049211     44.56583279     0.14098648     22.05734149     44.56583279     1.55615156

                                     INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =  68.40000  MG.  MOLECULAR WT.= 349.00000 MAKE-UP VOLUME=0.0500 L.
THE AREA IS KEPT CONST. AT 240.00000 SC. CM


                                     INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=      34.33MG.  WEIGHT OF WEIGHT=     171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.88023 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                             INPUT DATA

ID .K       INDEP. VAR.     FREQUENCY      INPUT VCLT.    OUTPUT VOLT.    METER SCALE    SFTN. VAR.

  1.  1     0.0            168.40000       0.15800        0.14000        0.20000        38.60000
  1.  2     0.0            208.10000       0.15800        0.07470        0.50000        38.60000
  1.  3     0.0            251.80000       0.39000        0.11000        0.10000        38.60000
  2.  1     0.00500        168.30000       0.15900        0.14000        0.20000        38.60000
  2.  2     0.00500        208.00000       0.15900        0.07500        0.50000        38.60000
  2.  3     0.00500        251.50000       0.39000        0.10900        0.10000        38.60000
  3.  1     0.05000        168.00000       0.15700        0.14200        0.20000        38.90000
  3.  2     0.05000        207.10000       0.15800        0.07700        0.50000        38.90000
  3.  3     0.05000        251.20000       0.39000        0.10500        0.10000        38.90000
  4.  1     0.10000        168.20000       0.15700        0.13800        0.20000        38.60000
  4.  2     0.10000        207.90000       0.15700        0.07670        0.50000        38.60000
  4.  3     0.10000        251.30000       0.38900        0.10100        0.10000        38.60000
  5.  1     0.20000        168.00000       0.15800        0.13900        0.20000        38.90000
  5.  2     0.20000        207.90000       0.15800        0.07620        0.50000        38.90000
  5.  3     0.20000        251.00000       0.38900        0.09980        0.10000        38.90000
  6.  1     0.40000        167.80000       0.15800        0.13200        0.20000        39.00000
  6.  2     0.40000        207.80000       0.15800        0.07570        0.50000        39.00000
  6.  3     0.40000        250.50000       0.38900        0.09850        0.10000        39.00000
  7.  1     0.70000        167.40000       0.15800        0.12700        0.20000        39.50000
  7.  2     0.70000        207.20000       0.15800        0.07350        0.50000        39.50000
  7.  3     0.70000        250.30000       0.38900        0.09580        0.10000        39.50000
  8.  1     1.00000        167.30000       0.15700        0.12500        0.20000        40.00000
  8.  2     1.00000        207.00000       0.15800        0.07160        0.50000        40.00000
  8.  3     1.00000        250.00000       0.38900        0.09250        0.10000        40.00000
  9.  1     2.00000        166.50000       0.15700        0.11300        0.20000        41.70000
  9.  2     2.00000        206.10000       0.15800        0.06530        0.50000        41.70000
  9.  3     2.00000        248.60000       0.38900        0.08900        0.10000        41.70000
 10.  1     3.00000        165.40000       0.15700        0.09850        0.20000        43.60000
 10.  2     3.00000        204.90000       0.15750        0.05630        0.50000        43.60000
 10.  3     3.00000        247.10000       0.38800        0.08450        0.10000        43.60000
 11.  1     4.00000        164.20000       0.15700        0.08240        0.20000        46.00000
 11.  2     4.00000        203.50000       0.15700        0.11720        0.20000        46.00000
 11.  3     4.00000        245.30000       0.38800        0.07730        0.10000        46.00000
 12.  1     5.00000        163.00000       0.15700        0.07140        0.20000        48.80000
 12.  2     5.00000        202.20000       0.15700        0.10550        0.20000        48.80000
 12.  3     5.00000        243.60000       0.38800        0.07090        0.10000        48.80000
 13.  1     6.00000        162.30000       0.15700        0.06550        0.20000        50.60000
 13.  2     6.00000        201.30000       0.15700        0.10050        0.20000        50.60000
 13.  3     6.00000        242.30000       0.38800        0.06820        0.10000        50.60000
 14.  1     7.50000        160.20000       0.15650        0.05870        0.20000        53.80000
 14.  2     7.50000        198.90000       0.15700        0.09570        0.20000        53.80000
 14.  3     7.50000        239.20000       0.38600        0.07440        0.10000        53.80000
 15.  1     9.00000        158.40000       0.15600        0.10440        0.10000        56.80000
 15.  2     9.00000        197.10000       0.15650        0.09290        0.20000        56.80000
 15.  3     9.00000        236.60000       0.38400        0.08280        0.10000        56.80000
 16.  1    10.50000        156.50000       0.15600        0.09650        0.10000        60.00000
 16.  2    10.50000        194.90000       0.15700        0.08810        0.20000        60.00000
 16.  3    10.50000        233.90000       0.38600        0.09680        0.10000        60.00000
 17.  1    12.00000        155.00000       0.15600        0.08950        0.10000        62.60000
 17.  2    12.00000        193.30000       0.15650        0.08350        0.20000        62.60000
 17.  3    12.00000        231.60000       0.38600        0.10950        0.10000        62.60000
 18.  1    13.50000        154.40000       0.15550        0.08540        0.10000        63.90000
 18.  2    13.50000        192.40000       0.15600        0.08030        0.20000        63.90000
 18.  3    13.50000        230.60000       0.38700        0.11440        0.10000        63.90000
 19.  1    16.00000        151.90000       0.15550        0.07320        0.10000        67.90000
 19.  2    16.00000        189.50000       0.15700        0.07050        0.20000        67.90000
 19.  3    16.00000        227.00000       0.38400        0.12840        0.10000        67.90000
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                                     TABLE OF RESULTS FOR  1  POSITION

           CALCULATED WAVENUMBER= 34.01233  RECIP. CM.  WAVELENGTH=0.18473  CM.  INITIAL FREQUENCY =  168.40  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.   Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 1   0.0          0.79271    34.01233    1.00000    50.20000    0.13438    0.94996    0.02242    -0.00016    -0.00005
 2. 1   0.00082      0.76392    34.01025    0.99961    50.20000    0.15379    0.94900    0.02245    -0.85933    -0.75056
 3. 1   0.00817      0.73785    34.00401    0.99782    50.09792    0.14585    0.94807    0.02170    -1.09879     1.85776
 4. 1   0.01633      0.76284    34.00817    0.99891    50.20000    0.15320    0.94805    0.02243    -2.07612    -0.17387
 5. 1   0.03266      0.74676    34.00401    0.99762    50.09792    0.14585    0.94807    0.02196    -1.46272     1.33547
 6. 1   0.06533      0.76114    33.99985    0.99644    50.06390    0.14484    0.94881    0.02239    -3.93170     0.97762
 7. 1   0.11433      0.76909    33.99192    0.99406    49.89377    0.14284    0.94821    0.02263    -4.27065     0.94600
 8. 1   0.16332      0.77103    33.98944    0.99347    49.72365    0.14239    0.94848    0.02268    -1.33304    -0.96233
 9. 1   0.32665      0.79469    33.97279    0.98872    49.14522    0.13841    0.95189    0.02339     1.95892    -0.25984
10. 1   0.48997      0.82313    33.96980    0.98219    48.49875    0.13314    0.95390    0.02433     3.00319     0.39018
11. 1   0.65330      0.86980    33.92453    0.97506    47.68214    0.12757    0.95822    0.02564     3.32032     1.40409
12. 1   0.81662      0.90201    33.89996    0.96793    46.72944    0.12219    0.96369    0.02661     3.19088     2.00392
13. 1   0.97994      0.92140    33.88539    0.96378    46.11699    0.11913    0.97134    0.02720     3.13304     2.22408
14. 1   1.22493      0.93117    33.84169    0.95131    45.02819    0.11034    0.97301    0.02792     3.07399     2.23877
15. 1   1.46991      0.94696    33.80423    0.94062    44.00744    0.10326    0.97687    0.02800     3.01800     2.29467
16. 1   1.71490      0.94922    33.78465    0.92933    42.91863    0.09824    0.98091    0.02811     2.93970     2.17179
17. 1   1.95989      0.95551    33.75347    0.92043    42.03398    0.09103    0.98517    0.02833     2.88885     2.37175
18. 1   2.20497      0.96242    33.72098    0.91696    41.59165    0.08903    0.98906    0.02854     2.84944     2.49654
19. 1   2.41318      0.94231    33.66896    0.90202    40.23065    0.08118    0.99427    0.02914     2.81099     2.40717


                                     TABLE OF RESULTS FOR  2  POSITION

           CALCULATED WAVENUMBER= 39.21109  RECIP. CM.  WAVELENGTH=0.16024  CM.  INITIAL FREQUENCY =  208.10  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.   Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 2   0.0          0.91916    39.21108    1.00000    50.20000    0.36020    0.94678    0.02394    -0.00017    -0.00005
 2. 2   0.00082      0.91569    39.20900    0.99952    50.20000    0.35998    0.94602    0.02339    -0.66249    -0.29781
 3. 2   0.00817      0.90458    39.20276    0.99808    50.09792    0.35928    0.94966    0.02307    -0.98975     0.59509
 4. 2   0.01633      0.90421    39.20692    0.99904    50.20000    0.35975    0.94526    0.02306    -1.39814     0.87741
 5. 2   0.03266      0.90833    39.20892    0.99904    50.09792    0.35975    0.94718    0.02317     0.72098     0.44674
 6. 2   0.06533      0.91026    39.20484    0.99856    50.06390    0.35951    0.94707    0.02322     0.15999     0.94419
 7. 2   0.11433      0.91945    39.19235    0.99568    49.89377    0.35806    0.94572    0.02343    -0.90267    -0.37311
 8. 2   0.16332      0.87641    39.18819    0.99471    49.72365    0.35756    0.94743    0.02364     0.70233    -0.22963
 9. 2   0.32665      0.95387    39.16946    0.99039    49.14522    0.35517    0.95162    0.02455     2.44647     0.76748
10. 2   0.48997      0.99737    39.14449    0.98462    48.49875    0.35167    0.95694    0.02548     3.39924     1.33752
11. 2   0.65330      1.05109    39.11535    0.97790    47.68214    0.34718    0.96021    0.02687     3.29760     1.92246
12. 2   0.81662      1.08069    39.08830    0.97155    46.72944    0.34262    0.96931    0.02765     3.21646     2.14268
13. 2   0.97994      1.09329    39.06957    0.96732    46.11699    0.33925    0.97488    0.02798     3.17049     2.47801
14. 2   1.22493      1.09945    39.01982    0.95579    45.02819    0.32950    0.97852    0.02818     3.11961     2.51441
15. 2   1.46991      1.10006    38.98218    0.94714    44.00744    0.32148    0.98601    0.02822     3.05708     2.59865
16. 2   1.71490      1.10749    38.93638    0.93657    42.91863    0.31097    0.99207    0.02844     3.00946     2.67843
17. 2   1.95999      1.11518    38.90358    0.92888    42.03398    0.30287    0.99995    0.02867     2.97736     2.65858
18. 2   2.20487      1.12168    38.88435    0.92458    41.59165    0.29816    1.00164    0.02885     2.96176     2.66172
19. 2   2.41318      1.14903    38.82400    0.91062    40.23065    0.28233    1.00924    0.02957     2.91404     2.65241


                                     TABLE OF RESULTS FOR  3  POSITION

           CALCULATED WAVENUMBER= 44.56583  RECIP. CM.  WAVELENGTH=0.14099  CM.  INITIAL FREQUENCY =  251.80  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.   Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 3   0.0          1.07849    44.56583    1.00000    50.20000    0.05186    0.94414    0.02420    -0.00017    -0.00005
 2. 3   0.00082      1.08483    44.56306    0.99981    50.20000    0.05241    0.94206    0.02434    -2.41380    -0.87912
 3. 3   0.00817      1.10028    44.56026    0.99762    50.09792    0.05298    0.94191    0.02469    -2.56670    -2.89945
 4. 3   0.01633      1.11080    44.56119    0.99801    50.20000    0.05279    0.94068    0.02493    -4.21875    -7.91544
 5. 3   0.03266      1.11809    44.55837    0.99682    50.09792    0.05336    0.94053    0.02509    -5.02523   -11.63355
 6. 3   0.04533      1.12347    44.55743    0.99643    50.06390    0.05355    0.94048    0.02521    -2.33692   -13.95791
 7. 3   0.11433      1.13941    44.55168    0.99404    49.89377    0.05473    0.93954    0.02557    19.21323   -17.94328
 8. 3   0.16332      1.14422    44.54877    0.99285    49.72365    0.05533    0.94068    0.02591     8.85739    -4.83791
 9. 3   0.32665      1.16160    44.54479    0.98729    49.14522    0.05833    0.94201    0.02658     6.54727    -1.91991
10. 3   0.48997      1.21847    44.51514    0.98133    48.49875    0.06189    0.94408    0.02737     5.20124     0.08384
11. 3   0.65330      1.27114    44.49946    0.97419    47.68214    0.06669    0.94796    0.02857     4.39119     1.30092
12. 3   0.81662      1.32291    44.47990    0.96743    46.72944    0.07185    0.95479    0.02974     3.79526     1.98896
13. 3   0.97996      1.35458    44.46435    0.96227    46.11659    0.07627    0.95817    0.03046     3.63154     2.17951
14. 3   1.22493      1.37360    44.42515    0.94996    45.02819    0.08873    0.95893    0.03092     3.55799     2.19536
15. 3   1.46991      1.38131    44.38993    0.93963    44.00744    0.10167    0.96224    0.03112     3.40491     2.29807
16. 3   1.71490      1.39064    44.35119    0.92491    42.91863    0.11800    0.96679    0.03115     3.24891     2.32794
17. 3   1.95989      1.39341    44.31651    0.91978    42.03398    0.13463    0.97011    0.03122     3.15870     2.36843
18. 3   2.20487      1.38897    44.30063    0.91581    41.59165    0.14274    0.97301    0.03139     3.11679     2.40700
19. 3   2.41318      1.41838    44.24169    0.90151    40.23065    0.17693    0.97866    0.03206     3.03551     2.44696
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                         ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE IONIC SURFACTANTS - LOCK IN AMPLIFIER (FEB 1968)

EXPERIMENTS PERFORMED AT THE .01M POTASSIUM BROMIDE (1X) (FRESH H2O) /FRESHLY DISTILLED HEPTANE           INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS CTAB - OCTADECYLTRIMETHYL AMMONIUM BROMIDE (2X FROM DIST. ABS. ETHANOL)

                                         SYSTEM PARAMETERS

                 LOWER PHASE DENSITY  0.9980 G/ML        UPPER PHASE DENSITY  0.6780 G/ML
                          VISCOSITY  0.00896 POISES                 VISCOSITY  0.00386 POISES

                                  INITIAL VALUES ASSUMED IN CALCULATION

                 REAL ELASTICITY (EP)   0.0             IMAGINARY ELASTICITY (EPP)    0.0
                 WAVENUMBER  31.00000 RECIPROCAL  CM    DAMPING COEFFICIENT   0.70000 CM
                 REFERENCE METER SCALE    1.00 MV.      INTERFACIAL TENSION 50.2000 DYNES/CM
                 REFERENCE INPUT VTG.  0.100 VT.

                                         PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 2.98716 CM. BASED ON RESGN= 6.37830 RESFN= 9.36546 DISTGN= 2.95240 DISTFN=-0.03476

                                  CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY     AMP. COEF.      WAVE NO.       WAVELENGTH       NO. WAVES   PHS.COR.WANC  GN. PB. SCL.FCTR.
    1        161.70     0.73653202     33.09636262     0.18984388     15.73401197    33.09636262      1.21435473
    2        202.10     0.85400912     38.52464543     0.16309508     18.31543838    38.52464543      0.84502045
    3        263.20     1.12043193     45.91055597     0.13685490     21.82685780    45.91055597      1.65324846

                                         INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =  84.50000  MG.  MOLECULAR WT.= 377.00000 MAKE-UP VOLUME=0.0500 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                         INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=      0.980 WEIGHT OF PLATE=      34.30MG.  WEIGHT OF WEIGHT=    171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETER OF PLATE= 2.85680 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                             INPUT DATA

IC .K      INDEP. VAR.      FREQUENCY      INPUT VOLT.     OUTPUT VOLT.     METER SCALE     SFTN. VAR.

  1. 1     0.0              161.70000      0.17600         0.13800          0.20000         39.80000
  1. 2     0.0              202.70000      0.17600         0.07060          0.50000         39.80000
  1. 3     0.0              263.20000      0.43800         0.09130          0.10000         39.80000
  2. 1     0.00500          161.50000      0.17600         0.13700          0.20000         39.90000
  2. 2     0.00500          202.60000      0.17700         0.06990          0.50000         39.90000
  2. 3     0.00500          263.10000      0.43400         0.08750          0.10000         39.90000
  3. 1     0.02500          161.40000      0.17600         0.13500          0.20000         40.00000
  3. 2     0.02500          202.40000      0.17700         0.06950          0.50000         40.00000
  3. 3     0.02500          263.10000      0.43300         0.08630          0.10000         40.00000
  4. 1     0.05000          161.20000      0.17600         0.13200          0.20000         40.07000
  4. 2     0.05000          202.40000      0.17600         0.06920          0.50000         40.07000
  4. 3     0.05000          262.90000      0.43300         0.08690          0.10000         40.07000
  5. 1     0.10000          161.30000      0.17600         0.13100          0.20000         40.10000
  5. 2     0.10000          202.40000      0.17600         0.06940          0.50000         40.10000
  5. 3     0.10000          262.70000      0.43500         0.08470          0.10000         40.10000
  6. 1     0.20000          161.20000      0.17800         0.13040          0.20000         40.20000
  6. 2     0.20000          202.10000      0.17800         0.07100          0.50000         40.20000
  6. 3     0.20000          262.60000      0.43900         0.08490          0.10000         40.20000
  7. 1     0.40000          161.10000      0.15900         0.11500          0.20000         40.40000
  7. 2     0.40000          202.00000      0.15900         0.06550          0.50000         40.40000
  7. 3     0.40000          262.50000      0.39200         0.07550          0.10000         40.40000
  8. 1     1.00000          160.50000      0.16000         0.11000          0.20000         41.60000
  8. 2     1.00000          201.40000      0.16000         0.06400          0.50000         41.60000
  8. 3     1.00000          261.30000      0.39200         0.07590          0.10000         41.60000
  9. 1     1.50000          160.00000      0.16000         0.10300          0.20000         42.40000
  9. 2     1.50000          201.00000      0.16000         0.06200          0.50000         42.40000
  9. 3     1.50000          260.80000      0.39200         0.07000          0.10000         42.40000
 10. 1     2.00000          159.60000      0.15900         0.09250          0.20000         43.40000
 10. 2     2.00000          200.30000      0.15900         0.05700          0.50000         43.40000
 10. 3     2.00000          259.90000      0.39100         0.06890          0.10000         43.40000
 11. 1     2.50000          158.50000      0.16000         0.08500          0.20000         44.70000
 11. 2     2.50000          199.60000      0.16000         0.05220          0.50000         44.70000
 11. 3     2.50000          258.80000      0.39100         0.06750          0.10000         44.70000
 12. 1     3.00000          158.10000      0.15900         0.07700          0.20000         46.10000
 12. 2     3.00000          198.80000      0.16000         0.11660          0.20000         46.10000
 12. 3     3.00000          257.40000      0.39100         0.06440          0.10000         46.10000
 13. 1     3.50000          157.40000      0.15900         0.13800          0.10000         47.30000
 13. 2     3.50000          197.80000      0.16000         0.10650          0.20000         47.30000
 13. 3     3.50000          256.40000      0.39100         0.06300          0.10000         47.30000
 14. 1     4.50000          155.70000      0.15900         0.12300          0.10000         50.00000
 14. 2     4.50000          196.00000      0.16000         0.09820          0.20000         50.00000
 14. 3     4.50000          253.20000      0.39100         0.06190          0.10000         50.00000
 15. 1     5.50000          154.10000      0.15900         0.11100          0.10000         52.90000
 15. 2     5.50000          194.00000      0.16000         0.09150          0.20000         52.90000
 15. 3     5.50000          250.50000      0.39100         0.06400          0.10000         52.90000
 16. 1     6.50000          152.50000      0.16000         0.10400          0.10000         55.10000
 16. 2     6.50000          192.20000      0.16000         0.08750          0.20000         55.10000
 16. 3     6.50000          248.10000      0.39100         0.07020          0.10000         55.10000
 17. 1     7.50000          150.80000      0.15900         0.09650          0.10000         58.20000
 17. 2     7.50000          190.30000      0.16000         0.08250          0.20000         58.20000
 17. 3     7.50000          245.30000      0.39000         0.07450          0.10000         58.20000
 18. 1     8.50000          149.10000      0.15800         0.09100          0.10000         61.00000
 18. 2     8.50000          188.30000      0.15900         0.07950          0.20000         61.00000
 18. 3     8.50000          242.60000      0.39000         0.07950          0.10000         61.00000
 19. 1     9.50000          147.40000      0.15900         0.08380          0.10000         64.90000
 19. 2     9.50000          186.10000      0.16000         0.07390          0.20000         64.90000



 19. 3     9.50000          239.70000      0.39000         0.08590          0.10000         64.90000
 20. 1    10.50000          145.80000      0.15900         0.07700          0.10000         67.10000
 20. 2    10.50000          184.40000      0.15900         0.06750          0.20000         67.10000
 20. 3    10.50000          237.10000      0.39000         0.09180          0.10000         67.10000
 21. 1    12.00000          143.50000      0.15800         0.06700          0.10000         71.60000
 21. 2    12.00000          181.60000      0.15900         0.06070          0.20000         71.60000
 21. 3    12.00000          233.50000      0.39000         0.10300          0.10000         71.60000
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```
                              TABLE OF RESULTS FOR  1  POSITION

         CALCULATED WAVENUMBER= 33.09856  RECIP. CM.  WAVELENGTH=0.18983  CM.  INITIAL FREQUENCY =  181.70  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERP. TENS. GEN. AMPL.    V1          V2       REAL ELS.  IMAG. ELAS.

 1. 1   0.0        0.73693    33.09856    1.00000   50.20000    0.11898    0.95061    0.02223   -0.00018   -0.00009
 2. 1   0.00093    0.73693    33.09283    0.99876   50.16570    0.11972    0.94928    0.02228   -1.78063   -0.19151
 3. 1   0.00467    0.74023    33.09006    0.99918   50.13139    0.11930    0.94894    0.02237   -1.76310   -2.81408
 4. 1   0.00934    0.74831    33.08373    0.99891   50.10738    0.11648    0.94761    0.02283   -5.33615   -0.91203
 5. 1   0.01868    0.74908    33.08790    0.99793   50.09709    0.11488    0.94860    0.02284   -2.20199   -2.01048
 6. 1   0.03736    0.75318    33.08373    0.99891   50.06278    0.11446    0.94828    0.02278   -2.79776   -3.09749
 7. 1   0.07471    0.73824    33.08386    0.99829   49.99418    0.11406    0.94897    0.02286   -1.74455   -5.35081
 8. 1   0.18678    0.76867    33.07056    0.99288   49.58293    0.11156    0.99043    0.02316    1.29292   -1.74744
 9. 1   0.28017    0.78174    33.05973    0.98949   49.30809    0.10956    0.95073    0.02365    2.61972   -1.73959
10. 1   0.37356    0.81071    33.03107    0.98701   48.98505    0.10794    0.95336    0.02493    3.83493    0.14696
11. 1   0.46695    0.83248    33.03893    0.98228   48.51910    0.10319    0.95321    0.02523    3.63433    0.77393
12. 1   0.56034    0.85359    33.01837    0.97774   48.03884    0.10212    0.95430    0.02581    3.69060    1.22990
13. 1   0.65374    0.87162    33.00340    0.97361   47.62719    0.09981    0.95744    0.02671    3.75862    1.44959
14. 1   0.84052    0.89902    32.96887    0.96289   46.70098    0.09343    0.95846    0.02727    3.63015    1.59497
15. 1   1.02730    0.91182    32.93191    0.95100   45.70616    0.08804    0.96233    0.02774    3.38759    1.80240
16. 1   1.21408    0.91740    32.89724    0.94310   44.95147    0.08144    0.96190    0.02789    3.29809    1.93960
17. 1   1.40086    0.91974    32.86041    0.93239   43.88805    0.07798    0.96621    0.02799    3.15170    1.97218
18. 1   1.58764    0.91673    32.82330    0.92208   42.92753    0.07334    0.96893    0.02793    3.02049    2.29096
19. 1   1.77443    0.92641    32.78673    0.91136   41.58967    0.06908    0.98072    0.02826    2.89974    2.23900
20. 1   1.96121    0.93640    32.75209    0.90167   40.83498    0.06941    0.98039    0.02859    2.83142    2.22022
21. 1   2.24138    0.95593    32.70226    0.88745   39.29130    0.06071    0.99153    0.02923    2.74922    2.31240
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                              TABLE OF RESULTS FOR  2  POSITION

         CALCULATED WAVENUMBER= 38.92465  RECIP. CM.  WAVELENGTH=0.16310  CM.  INITIAL FREQUENCY =  202.70  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERP. TENS. GEN. AMPL.    V1          V2       REAL ELS.  IMAG. ELAS.

 1. 2   0.0        0.89467    38.92465    1.00000   50.20000    0.34442    0.94715    0.02322   -0.00017   -0.00005
 2. 2   0.00093    0.89494    38.92240    0.99951   50.16570    0.34406    0.94703    0.02335   -0.09993   -0.31489
 3. 2   0.00467    0.90078    38.91815    0.99892   50.13139    0.34334    0.94612    0.02339   -0.86590   -0.69319
 4. 2   0.00934    0.90031    38.91815    0.99892   50.10738    0.34334    0.94658    0.02337   -0.39597   -0.50141
 5. 2   0.01868    0.89936    38.91815    0.99892   50.09709    0.34334    0.94677    0.02339   -0.22492   -0.34769
 6. 2   0.03736    0.89445    38.91169    0.99704   50.06278    0.34229    0.94509    0.02323   -2.26434   -0.09901
 7. 2   0.07471    0.88330    38.90445    0.99455   49.99418    0.34189    0.94961    0.02294   -1.39162    0.76642
 8. 2   0.18678    0.89094    38.49048    0.99359   49.58293    0.33964    0.94877    0.02314    0.89693    0.63074
 9. 2   0.28017    0.90005    38.48781    0.99161   49.30809    0.33809    0.95091    0.02339    1.71190    0.89032
10. 2   0.37356    0.92334    38.47265    0.98816   48.98505    0.33532    0.95203    0.02400    2.26279    0.85615
11. 2   0.46695    0.95201    38.49748    0.98471   48.51910    0.33246    0.95521    0.02475    2.87190    1.33318
12. 2   0.56034    0.95628    38.44019    0.98076   48.03884    0.32907    0.95834    0.02566    3.10176    1.69961
13. 2   0.65374    1.01211    38.41849    0.97583   47.62719    0.32467    0.95854    0.02634    3.24116    1.79379
14. 2   0.84052    1.03056    38.37949    0.96695   46.70098    0.31632    0.96277    0.02685    3.18631    2.02317
15. 2   1.02730    1.04381    38.33616    0.95708   45.70616    0.30646    0.96702    0.02722    3.12014    2.19670
16. 2   1.21408    1.04819    38.29716    0.94820   44.95147    0.29710    0.96805    0.02737    3.07667    2.21070
17. 2   1.40086    1.05606    38.25600    0.93883   43.88805    0.28679    0.97514    0.02761    3.00691    2.37797
18. 2   1.58764    1.05293    38.21267    0.92896   42.92753    0.27551    0.97943    0.02795    2.94946    2.42999
19. 2   1.77443    1.06352    38.16501    0.91811   41.58967    0.26248    0.99116    0.02787    2.90079    2.55590
20. 2   1.96121    1.07955    38.12818    0.90972   40.83498    0.25253    0.99400    0.02829    2.87596    2.54096
21. 2   2.24138    1.09065    38.06751    0.89591   39.29130    0.23545    1.00671    0.02865    2.82351    2.57970
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                              TABLE OF RESULTS FOR  3  POSITION

         CALCULATED WAVENUMBER= 45.91056  RECIP. CM.  WAVELENGTH=0.13686  CM.  INITIAL FREQUENCY =  263.20  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERP. TENS. GEN. AMPL.    V1          V2       REAL ELS.  IMAG. ELAS.

 1. 3   0.0        1.17045    45.91056    1.00000   50.20000    0.03503    0.94355    0.02441   -0.00017   -0.00005
 2. 3   0.00093    1.13269    45.90997    0.99962   50.16570    0.03594    0.94351    0.02467    0.22232   -0.59960
 3. 3   0.00467    1.13694    45.90997    0.99962   50.13139    0.03594    0.94416    0.02416    0.77575   -0.44371
 4. 3   0.00934    1.13637    45.90878    0.99886   50.10738    0.03618    0.94325    0.02475    0.11186   -0.89993
 5. 3   0.01868    1.14064    45.90758    0.99810   50.09709    0.03641    0.94208    0.02502   -0.39416   -2.70121
 6. 3   0.03736    1.15199    45.90657    0.99772   50.06278    0.03652    0.94204    0.02509   -0.39439   -3.00710
 7. 3   0.07471    1.15443    45.90636    0.99734   49.99418    0.03666    0.94266    0.02515    0.44810   -2.35496
 8. 3   0.18678    1.16545    45.89881    0.99278   49.58293    0.03807    0.94228    0.02539    0.89774   -3.17899
 9. 3   0.28017    1.19784    45.89552    0.99088   49.30809    0.03960    0.94410    0.02610    3.27510   -1.30961
10. 3   0.37356    1.21180    45.88940    0.98746   48.98505    0.03979    0.94454    0.02641    3.53569   -0.81816
11. 3   0.46695    1.23030    45.88156    0.98328   48.51910    0.04120    0.94566    0.02681    3.79075   -0.04994
12. 3   0.56034    1.26090    45.87102    0.97796   48.03884    0.04307    0.94546    0.02749    4.30785    0.32187
13. 3   0.65374    1.27897    45.86310    0.97416   47.62719    0.04447    0.94673    0.02789    4.15483    0.79972
14. 3   0.84052    1.32018    45.83557    0.96201   46.70098    0.04941    0.94325    0.02880    5.14056    1.07260
15. 3   1.02730    1.34075    45.80975    0.95175   45.70616    0.05433    0.94493    0.02927    4.60190    1.27218
16. 3   1.21408    1.34010    45.78481    0.94263   44.95147    0.05948    0.94401    0.02927    4.69564    1.16481
17. 3   1.40086    1.35788    45.75336    0.93199   43.88805    0.06669    0.94714    0.02967    4.03593    1.38780
18. 3   1.58764    1.37617    45.72061    0.92173   42.92753    0.07521    0.94917    0.03010    3.75943    1.56577
19. 3   1.77443    1.39714    45.68280    0.91071   41.58967    0.08652    0.95874    0.03058    3.22178    2.02905
20. 3   1.96121    1.41996    45.64457    0.90084   40.83498    0.09998    0.95772    0.03111    3.23964    1.99267
21. 3   2.24138    1.44783    45.59279    0.88716   39.29130    0.12070    0.96877    0.03176    3.00802    2.29489
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                    ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE IONIC SURFACTANTS - LOCK IN AMPLIFIER (FEB 1968)

EXPERIMENTS PERFORMED AT THE .01M POTASSIUM BROMIDE (1X) (FRESH H2O) /FRESHLY DISTILLED HEPTANE              INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS ATAB - ARACHIDYLTRIMETHYL AMMONIUM BROMIDE (2% FROM DIST. ABS. ETHANOL)

                                        SYSTEM PARAMETERS

                 LOWER PHASE DENSITY  0.9980 G/ML         UPPER PHASE DENSITY  0.6780 G/ML
                         VISCOSITY  0.00896 POISES                VISCOSITY  0.00386 POISES

                                 INITIAL VALUES ASSUMED IN CALCULATION

                 REAL ELASTICITY (EP)   0.0              IMAGINARY ELASTICITY (EPP)   0.0
                 WAVENUMBER  31.00000 RECIPROCAL  CM      DAMPING COEFFICIENT   0.70000 CM
                 REFERENCE METER SCALE    1.00 MV.       INTERFACIAL TENSION 50.2000 DYNES/CM
                 REFERENCE INPUT VTG.  0.100 VT.

                                        PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.18395 CM. BASED ON RESON= 4.21470 RESFN= 8.45990 DISTON= 3.07694 DISTFN=-0.10701

                                 CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY    DMP. COEF.     WAVE NO.      WAVELENGTH     NO. WAVES    PMS.COR.WANO  ON. PB. SCL.FCTR.
   1        102.80     0.74084138    33.24776819    0.18898052    16.84800970    33.24776819     1.25193538
   2        201.50     0.89010633    38.37128526    0.16374693    19.44450798    38.37129926     0.92579704
   3        275.00     1.10362949    47.28233422    0.13288642    23.95990289    47.28233422     2.55216171

                                      INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =  30.60000  MG.  MOLECULAR WT.= 391.00000 MAKE-UP VOLUME=0.0900 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                      INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=      0.980 WEIGHT OF PLATE=      34.30MG.  WEIGHT OF WEIGHT=    171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETER OF PLATE= 2.89925 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                   INPUT DATA

ID .K    INDEP. VAR.    FREQUENCY    INPUT VOLT.    OUTPUT VOLT.    METER SCALE    SFTN. VAR.

  1. 1    0.0           162.80000     0.15900        0.11410         0.20000        37.80000
  1. 2    0.0           201.50000     0.16000        0.05920         0.50000        37.80000
  1. 3    0.0           275.00000     0.39100        0.11720         0.05000        37.80000
  2. 1    0.00500       162.60000     0.16000        0.11500         0.20000        37.80000
  2. 2    0.00500       201.40000     0.16000        0.06020         0.50000        37.80000
  2. 3    0.00500       274.80000     0.39100        0.10450         0.05000        37.80000
  3. 1    0.02500       162.40000     0.16000        0.11310         0.20000        38.00000
  3. 2    0.02500       201.20000     0.16000        0.06080         0.50000        38.00000
  3. 3    0.02500       274.60000     0.39200        0.10750         0.05000        38.00000
  4. 1    0.05000       162.20000     0.16000        0.11060         0.20000        38.20000
  4. 2    0.05000       201.10000     0.16000        0.05990         0.50000        38.20000
  4. 3    0.05000       274.20000     0.39200        0.09900         0.05000        38.20000
  5. 1    0.10000       162.40000     0.16000        0.10790         0.20000        38.10000
  5. 2    0.10000       201.20000     0.16000        0.05850         0.50000        38.10000
  5. 3    0.10000       274.40000     0.39100        0.09100         0.05000        38.10000
  6. 1    0.20000       162.30000     0.16000        0.10560         0.20000        38.10000
  6. 2    0.20000       201.15000     0.16000        0.05840         0.50000        38.10000
  6. 3    0.20000       274.30000     0.39200        0.09020         0.05000        38.10000
  7. 1    0.40000       162.00000     0.16000        0.10680         0.20000        38.30000
  7. 2    0.40000       201.10000     0.16000        0.06150         0.50000        38.30000
  7. 3    0.40000       274.00000     0.39100        0.08760         0.05000        38.30000
  8. 1    0.70000       161.90000     0.16000        0.10400         0.20000        38.50000
  8. 2    0.70000       200.90000     0.16000        0.06150         0.50000        38.50000
  8. 3    0.70000       273.80000     0.39000        0.08790         0.05000        38.50000
  9. 1    1.00000       161.90000     0.15900        0.10160         0.20000        38.80000
  9. 2    1.00000       200.80000     0.15900        0.06050         0.50000        38.80000
  9. 3    1.00000       273.70000     0.39000        0.08900         0.05000        38.80000
 10. 1    2.00000       161.70000     0.15900        0.10010         0.20000        39.20000
 10. 2    2.00000       200.50000     0.15900        0.06060         0.50000        39.20000
 10. 3    2.00000       273.30000     0.39000        0.08660         0.05000        39.20000
 11. 1    4.00000       161.20000     0.15900        0.09450         0.20000        40.20000
 11. 2    4.00000       199.90000     0.16000        0.05830         0.50000        40.20000
 11. 3    4.00000       272.40000     0.39000        0.08390         0.05000        40.20000
 12. 1    6.00000       160.60000     0.15900        0.08830         0.20000        41.30000
 12. 2    6.00000       199.40000     0.15900        0.05470         0.50000        41.30000
 12. 3    6.00000       271.50000     0.39000        0.07950         0.05000        41.30000
 13. 1    9.00000       159.50000     0.15800        0.07790         0.20000        43.00000
 13. 2    9.00000       198.20000     0.15800        0.04970         0.50000        43.00000
 13. 3    9.00000       270.10000     0.39000        0.06960         0.05000        43.00000
 14. 1   13.00000       158.40000     0.15800        0.06300         0.20000        46.00000
 14. 2   13.00000       196.60000     0.15800        0.10260         0.20000        46.00000
 14. 3   13.00000       267.50000     0.39000        0.06680         0.05000        46.00000
 15. 1   18.00000       156.40000     0.15800        0.10130         0.10000        50.00000
 15. 2   18.00000       194.40000     0.15800        0.09250         0.20000        50.00000
 15. 3   18.00000       264.20000     0.39000        0.06180         0.05000        50.00000
 16. 1   23.00000       154.00000     0.15800        0.08820         0.10000        53.70000
 16. 2   23.00000       191.90000     0.15800        0.08330         0.20000        53.70000
 16. 3   23.00000       260.10000     0.39000        0.05850         0.05000        53.70000
 17. 1   28.00000       151.80000     0.15700        0.08110         0.10000        57.20000
 17. 2   28.00000       189.50000     0.15700        0.07750         0.20000        57.20000
 17. 3   28.00000       256.50000     0.38900        0.06530         0.05000        57.20000
 18. 1   33.00000       149.80000     0.15700        0.07760         0.10000        61.00000
 18. 2   33.00000       187.20000     0.15800        0.07240         0.20000        61.00000
 18. 3   33.00000       252.70000     0.38800        0.06830         0.05000        61.00000
 19. 1   38.00000       148.60000     0.15600        0.07470         0.10000        63.20000
 19. 2   38.00000       185.70000     0.15650        0.06820         0.20000        63.20000
 19. 3   38.00000       250.70000     0.38600        0.06640         0.05000        63.20000
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                                   TABLE OF RESULTS FOR  1  POSITION

           CALCULATED WAVENUMBER= 33.24777  RECIP. CM.  WAVELENGTH=0.18899  CM.  INITIAL FREQUENCY =  162.80  HZ.

ID .K   INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 1   0.0          0.74084     33.24777    1.00000    50.20000     0.12131     0.95050     0.02229    -0.00016    -0.00009
 2. 1   0.00033      0.73807     33.24370    0.99877    50.20000     0.12043     0.94851     0.02220    -2.10398     0.20491
 3. 1   0.00163      0.74193     33.23963    0.99734    50.13232     0.11958     0.94780     0.02229    -3.33947     0.23806
 4. 1   0.00326      0.74377     33.23557    0.99631    50.06463     0.11870     0.94710     0.02244    -5.31438     0.32891
 5. 1   0.00652      0.75591     33.23563    0.99754    50.09848     0.11950     0.94864     0.02274    -2.17993    -2.49914
 6. 1   0.01304      0.76144     33.23760    0.99693    50.09848     0.11913     0.94765     0.02291    -5.06929    -5.18927
 7. 1   0.02609      0.75447     33.23150    0.99509    50.03079     0.11784     0.94979     0.02270   -11.99720     4.88887
 8. 1   0.04565      0.76167     33.22947    0.99447    49.96311     0.11741     0.94603     0.02292   -17.67917    -0.84097
 9. 1   0.06522      0.78704     33.22947    0.99447    49.86158     0.11741     0.94796     0.02308    -1.99930    -5.57496
10. 1   0.13043      0.76942     33.22541    0.99324    49.72622     0.11656     0.94854     0.02316    -0.37430    -4.41228
11. 1   0.26087      0.78178     33.21524    0.99017    49.38780     0.11446     0.95002     0.02354     2.21677    -3.38202
12. 1   0.39130      0.79420     33.20305    0.98649    49.01554     0.11197     0.95117     0.02398     3.15869    -1.19778
13. 1   0.58696      0.82951     33.18082    0.98219    48.44024     0.10913     0.95532     0.02487     3.34020     0.79033
14. 1   0.84783      0.87492     33.15833    0.97297    47.42499     0.10326     0.96019     0.02638     5.42918     1.65805
15. 1   1.17391      0.92007     33.11768    0.96069    46.07133     0.09589     0.96716     0.02778     3.26311     2.08821
16. 1   1.50000      0.93454     33.06890    0.94595    44.81919     0.08772     0.96817     0.02829     3.19875     2.09945
17. 1   1.82609      0.93447     33.02418    0.93243    43.63473     0.08088     0.97017     0.02830     3.07998     2.17715
18. 1   2.15217      0.92548     32.98353    0.92015    42.34875     0.07521     0.97707     0.02806     2.91186     2.21781
19. 1   2.47826      0.92197     32.95914    0.91275    41.60424     0.07205     0.98086     0.02797     2.88886     2.25987


                                   TABLE OF RESULTS FOR  2  POSITION

           CALCULATED WAVENUMBER= 38.37129  RECIP. CM.  WAVELENGTH=0.16375  CM.  INITIAL FREQUENCY =  201.59  HZ.

ID .K   INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 2   0.0          0.89011     38.37129    1.00000    50.20000     0.34002     0.94724     0.02320    -0.00017    -0.00005
 2. 2   0.00033      0.89449     38.36525    0.99950    50.20000     0.33964     0.94645     0.02305    -0.72455     0.23552
 3. 2   0.00163      0.88067     38.36315    0.99851    50.13232     0.33987     0.94615     0.02295    -0.97876     0.52299
 4. 2   0.00326      0.88500     38.36315    0.99831    50.06463     0.33848     0.94864     0.02307    -0.55549     0.24571
 5. 2   0.00652      0.89278     38.36319    0.99831    50.09848     0.33987     0.94679     0.02327    -0.32677    -0.25361
 6. 2   0.01304      0.89314     38.36417    0.99826    50.09848     0.33860     0.94639     0.02328    -0.70929    -0.37886
 7. 2   0.02609      0.87672     38.36315    0.99801    50.03079     0.33848     0.94728     0.02285    -0.06067     0.76467
 8. 2   0.04565      0.87599     38.35905    0.99702    49.96311     0.33770     0.94698     0.02284    -0.25493     0.78931
 9. 2   0.06522      0.87881     38.35706    0.99653    49.86158     0.33731     0.94811     0.02291     0.45135     0.74464
10. 2   0.13043      0.87718     38.35096    0.99504    49.72622     0.33612     0.94830     0.02287     0.54591     0.84617
11. 2   0.26087      0.89903     38.33876    0.99206    49.38780     0.33370     0.95000     0.02319     1.35304     0.81242
12. 2   0.39130      0.90911     38.32860    0.98958    49.01554     0.33162     0.95319     0.02361     2.20116     1.20990
13. 2   0.58696      0.92830     38.30421    0.98362    48.44024     0.32645     0.95476     0.02424     2.57962     1.31909
14. 2   0.84783      0.94155     38.27169    0.97508    47.42499     0.31916     0.96197     0.02564     3.03937     1.98896
15. 2   1.17391      1.00320     38.22697    0.96476    46.07133     0.30848     0.97159     0.02624     3.03838     2.38741
16. 2   1.50000      1.02261     38.17616    0.95236    44.81919     0.29550     0.97711     0.02679     3.01215     2.45774
17. 2   1.82609      1.02695     38.12737    0.94045    43.63473     0.28233     0.98245     0.02699     2.95397     2.51517
18. 2   2.15217      1.03721     38.08062    0.92903    42.34875     0.26415     0.99150     0.02724     2.92337     2.58337
19. 2   2.47826      1.04260     38.05014    0.92159    41.60424     0.25031     0.99552     0.02740     2.89657     2.59972


                                   TABLE OF RESULTS FOR  3  POSITION

           CALCULATED WAVENUMBER= 47.28233  RECIP. CM.  WAVELENGTH=0.13289  CM.  INITIAL FREQUENCY =  275.00  HZ.

ID .K   INDEP. VAR.  DMP. COEF.  WAVE NO.    REL. FQ.  INTERF. TENS. GEN. AMPL.     Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 3   0.0          1.16363     47.28233    1.00000    50.20000     0.02406     0.94297     0.02461    -0.00017    -0.00006
 2. 3   0.00033      1.20169     47.28195    0.99927    50.20000     0.02421     0.94162     0.02542     3.39266    -3.30091
 3. 3   0.00163      1.19566     47.28154    0.99855    50.13232     0.02437     0.94155     0.02529    -0.31394    -2.91771
 4. 3   0.00326      1.22549     47.28071    0.99709    50.06463     0.02470     0.94012     0.02592     3.70528    -8.22902
 5. 3   0.00652      1.24926     47.28113    0.99782    50.09848     0.02454     0.94083     0.02642     6.05571    -6.00433
 6. 3   0.01304      1.25389     47.28092    0.99745    50.09848     0.02462     0.94016     0.02652     7.75888    -4.13023
 7. 3   0.02609      1.26540     47.28027    0.99636    50.03079     0.02486     0.93941     0.02676     9.51628    -2.44988
 8. 3   0.04565      1.26564     47.27982    0.99564    49.96311     0.02503     0.93934     0.02677     5.74901    -2.45224
 9. 3   0.06522      1.26279     47.27559    0.99527    49.86158     0.02512     0.94058     0.02671     7.03593    -2.94627
10. 3   0.13043      1.27563     47.27864    0.99382    49.72622     0.02546     0.94044     0.02698     7.40832    -1.83234
11. 3   0.26087      1.29527     47.27633    0.99055    49.38780     0.02626     0.94080     0.02740     6.85502    -0.62365
12. 3   0.39130      1.32197     47.27377    0.98727    49.01554     0.02709     0.94184     0.02796     5.96059     0.34837
13. 3   0.58696      1.37900     47.26929    0.98218    48.44024     0.02844     0.94349     0.02917     5.18735     1.42220
14. 3   0.84783      1.41992     47.25940    0.97273    47.42499     0.03109     0.94587     0.03005     4.61427     1.74288
15. 3   1.17391      1.47876     47.24389    0.96073    46.07133     0.03469     0.95067     0.03130     4.04494     2.07159
16. 3   1.50000      1.53711     47.21997    0.94982    44.81919     0.03954     0.94858     0.03255     4.11080     2.20864
17. 3   1.82609      1.53764     47.15476    0.93273    43.63473     0.04432     0.94906     0.03299     3.97930     2.12877
18. 3   2.15217      1.56223     47.16385    0.91891    42.34875     0.05027     0.95099     0.03312     3.77354     2.13810
19. 3   2.47826      1.59160     47.14582    0.91164    41.60474     0.05394     0.95384     0.03376     3.61019     2.19711
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                        ANALYSIS OF EXPERIMENTAL DATA FOR CAPILLARY RIPPLE EXPERIMENTS

CONSTANT AREA INSOLUBLE IONIC SURFACTANTS - LOCK IN AMPLIFIER (FEB 1968)

EXPERIMENTS PERFORMED AT THE .01M SODIUM CHLORIDE (FRESH H2O)       /FRESHLY DISTILLED HEPTANE                INTERFACE.

THE SYSTEM UNDER INVESTIGATION IS DMSBAC - DIMETHYLSTEARYLBENZYL AMMONIUM CHLORIDE (2% FROM DIST. ABS. ETHANOL)

                                        SYSTEM PARAMETERS

                  LOWER PHASE DENSITY  0.9980 G/ML        UPPER PHASE DENSITY  0.6780 G/ML
                        VISCOSITY  0.00896 POISES                    VISCOSITY  0.00386 POISES

                                 INITIAL VALUES ASSUMED IN CALCULATION

                  REAL ELASTICITY (EP)   0.0            IMAGINARY ELASTICITY (EPP)   0.0
                  WAVENUMBER   31.00000 RECIPROCAL  CM   DAMPING COEFFICIENT   0.70000 CM
                  REFERENCE METER SCALE    1.00 MV.      INTERFACIAL TENSION 50.2000 DYNES/CM
                  REFERENCE INPUT VTG.  0.100 VT.

                                        PROBE POSITION DATA

THE CALCULATED PROBE SEPARATION IS 3.12319 CM. BASED ON RESGN= 4.29550 RESFN= 8.46050 DISTGN= 3.01537 DISTFN=-0.10776

                                 CALCULATION OF ZERO ELASTICITY PARAMETERS

POS. NO.  FREQUENCY     DPP. COEF.     WAVE NO.      WAVELENGTH      NO. WAVES   PHS.COR.WAND  GN. PR. SCL.FCTR.
    1        164.30     0.74671009   33.45340501    0.18781885    16.62841548   33.45340501     1.04984452
    2        203.90     0.69922807   38.67770512    0.16244566    19.22521640   38.67770512     0.54167921
    3        277.90     1.17274326   47.57044764    0.13208158    23.64544054   47.57044764     1.85776857

                                        INDEPENDENT VARIABLE DATA

THE INDEPENDENT VARIABLE  IS SURFACE CONCENTRATION IN MOLES/CM SQ. X 10**10
INPUT PARAMETERS ARE WT. OF SURFACTANT =  46.30000  MG.  MOLECULAR WT.= 385.00000 MAKE-UP VOLUME=0.0500 L.
THE AREA IS KEPT CONST. AT 240.00000 SQ. CM


                                        INTERFACIAL TENSION DATA

INTERFACIAL TENSIONS WILL BE CALCULATED USING AN OLEOPHILLIC  WILHELMY PLATE AND THESE PARAMETERS:
ACCEL. OF GRAVITY=     0.980 WEIGHT OF PLATE=     34.30MG.  WEIGHT OF WEIGHT=    171.40 MG.  DENSITY OF WT=21.40000
DENSITY OF PLATE= 2.20000 CALCULATED PERIMETEROF PLATE= 2.88023 CM.  CALCULATED FRACTION IN LOWER PHASE=0.200
WHERE THE CALCULATIONS ASSUME AN INITIAL INTERFACIAL TENSION OF  50.20000 DYNES/CM.
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                                          INPUT DATA

ID .K        INDEP. VAR.      FREQUENCY       INPUT VOLT.     OUTPUT VOLT.     METER SCALE      SFTN. VAR.

 1. 1         0.0             164.30000        0.15800         0.10310          0.20000         38.60000
 1. 2         0.0             203.90000        0.15900         0.09050          0.20000         38.60000
 1. 3         0.0             277.50000        0.39000         0.08300          0.05000         38.60000
 2. 1         0.00500         164.30000        0.15800         0.10470          0.20000         38.70000
 2. 2         0.00500         203.70000        0.15900         0.09610          0.20000         38.70000
 2. 3         0.00500         277.70000        0.38900         0.07990          0.05000         38.70000
 3. 1         0.02500         164.10000        0.15800         0.10340          0.20000         38.80000
 3. 2         0.02500         203.50000        0.15900         0.09580          0.20000         38.80000
 3. 3         0.02500         277.50000        0.38900         0.07620          0.05000         38.80000
 4. 1         0.07500         164.10000        0.15800         0.10320          0.20000         38.80000
 4. 2         0.07500         203.50000        0.15800         0.09710          0.20000         38.80000
 4. 3         0.07500         277.70000        0.38700         0.07330          0.05000         38.80000
 5. 1         0.27500         164.00000        0.15600         0.09730          0.20000         39.00000
 5. 2         0.27500         203.50000        0.15700         0.09230          0.20000         39.00000
 5. 3         0.27500         277.30000        0.38400         0.07150          0.05000         39.00000
 6. 1         0.57500         163.70000        0.15600         0.09870          0.20000         39.60000
 6. 2         0.57500         203.20000        0.15700         0.09740          0.20000         39.60000
 6. 3         0.57500         276.90000        0.38300         0.10100          0.05000         39.60000
 7. 1         0.87500         163.60000        0.15600         0.09780          0.20000         39.90000
 7. 2         0.87500         202.90000        0.15700         0.09890          0.20000         39.90000
 7. 3         0.87500         276.50000        0.38300         0.09720          0.05000         39.90000
 8. 1         1.37500         163.40000        0.15600         0.09700          0.20000         40.20000
 8. 2         1.37500         202.60000        0.15600         0.10320          0.20000         40.20000
 8. 3         1.37500         276.20000        0.38200         0.09940          0.05000         40.20000
 9. 1         2.87500         162.60000        0.15600         0.08950          0.20000         42.00000
 9. 2         2.87500         201.60000        0.15700         0.10180          0.20000         42.00000
 9. 3         2.87500         275.00000        0.38200         0.09480          0.05000         42.00000
10. 1         4.87500         161.10000        0.15500         0.07550          0.20000         44.40000
10. 2         4.87500         200.10000        0.15600         0.09010          0.20000         44.40000
10. 3         4.87500         272.50000        0.38100         0.09270          0.05000         44.40000
11. 1         6.87500         159.80000        0.15500         0.06050          0.20000         47.20000
11. 2         6.87500         198.40000        0.15550         0.07190          0.20000         47.20000
11. 3         6.87500         270.00000        0.38100         0.08660          0.05000         47.20000
12. 1         8.87500         158.00000        0.15500         0.05240          0.20000         50.00000
12. 2         8.87500         196.30000        0.15550         0.06270          0.20000         50.00000
12. 3         8.87500         266.40000        0.38000         0.08450          0.05000         50.00000
13. 1        10.87500         156.00000        0.15500         0.04860          0.20000         53.30000
13. 2        10.87500         194.10000        0.15500         0.12540          0.10000         53.30000
13. 3        10.87500         263.00000        0.38000         0.08920          0.05000         53.30000
14. 1        13.87500         152.90000        0.15500         0.08330          0.10000         60.60000
14. 2        13.87500         190.50000        0.15500         0.11860          0.10000         60.60000
14. 3        13.87500         258.40000        0.38000         0.09790          0.05000         60.60000
15. 1        16.37500         150.50000        0.15500         0.07590          0.10000         65.00000
15. 2        16.37500         187.50000        0.15500         0.11130          0.10000         65.00000
15. 3        16.37500         253.70000        0.38000         0.10630          0.05000         65.00000
16. 1        18.87500         147.50000        0.15500         0.06850          0.10000         69.70000
16. 2        18.87500         184.20000        0.15500         0.09970          0.10000         69.70000
16. 3        18.87500         249.50000        0.38000         0.11240          0.05000         69.70000
17. 1        21.37500         144.60000        0.15500         0.05870          0.10000         74.70000
17. 2        21.37500         180.60000        0.15500         0.08810          0.10000         74.70000
17. 3        21.37500         244.20000        0.37900         0.12520          0.05000         74.70000
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                                          TABLE CF RESULTS FOR  1  POSITION

         CALCULATED WAVENUMBER= 33.49341  RECIP. CM.  WAVELENGTH=0.18759  CM.  INITIAL FREQUENCY =  164.30  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.   REL. FQ.  INTERP. TENS. GEN. AMPL.    Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 1   0.0          0.74671    33.49341    1.00000   50.20000     0.12803    0.95035    0.02232    -0.00016   -0.00005
 2. 1   0.00050      0.74178    33.49361    1.00000   50.16597     0.12803    0.95099    0.02217     0.35967    0.41701
 3. 1   0.00251      0.74349    33.44926    0.99878   50.13195     0.12712    0.94968    0.02223    -0.29468    0.13855
 4. 1   0.00752      0.74411    33.44928    0.99878   50.13193     0.12712    0.94968    0.02225    -0.39190    0.08898
 5. 1   0.02756      0.75773    33.44719    0.99817   50.06390     0.12666    0.94989    0.02265     0.01238   -0.37989
 6. 1   0.05762      0.74971    33.44057    0.99638   49.85975     0.12331    0.95092    0.02242     0.49707    0.04791
 7. 1   0.08769      0.73149    33.43890    0.99574   49.75767     0.12488    0.95188    0.02247     0.89718    0.26831
 8. 1   0.13780      0.75182    33.43476    0.99492   49.65560     0.12376    0.95186    0.02249     0.99211    0.26345
 9. 1   0.28812      0.78834    33.41818    0.98965   49.04315     0.12043    0.95876    0.02299     2.22283    0.47112
10. 1   0.48856      0.80328    33.38710    0.98052   48.22655     0.11404    0.95676    0.02406     2.83127    1.00870
11. 1   0.68899      0.85894    33.36018    0.97281   47.27384     0.10873    0.96268    0.02575     3.17691    1.77861
12. 1   0.88942      0.84370    33.32286    0.96186   46.32114     0.10179    0.96370    0.02692     3.20706    1.86077
13. 1   1.08985      0.88906    33.29191    0.94990   45.19831     0.09447    0.96655    0.02686     3.05829    1.96399
14. 1   1.39050      0.89668    33.21718    0.93081   42.71448     0.08422    0.98808    0.02699     2.86678    2.62944
15. 1   1.64104      0.89833    33.16744    0.91601   41.21738     0.07713    0.99633    0.02708     2.79879    2.44900
16. 1   1.89159      0.89687    33.10578    0.89775   39.61820     0.06932    1.00143    0.02709     2.71910    2.44540
17. 1   2.14213      0.91514    33.04519    0.88010   37.91695     0.06287    1.01114    0.02769     2.65869    2.43809
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                                          TABLE OF RESULTS FOR  2  POSITION

         CALCULATED WAVENUMBER= 38.67771  RECIP. CM.  WAVELENGTH=0.16245  CM.  INITIAL FREQUENCY =  203.90  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.   REL. FQ.  INTERP. TENS. GEN. AMPL.    Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 2   0.0          0.89923    38.67771    1.00000   50.20000     0.34851    0.94707    0.02325    -0.00017   -0.00008
 2. 2   0.00050      0.87940    38.67356    0.99902   50.16597     0.34785    0.94616    0.02274    -0.70070    1.11270
 3. 2   0.00251      0.87978    38.66942    0.99804   50.13195     0.34718    0.94524    0.02275    -1.42112    1.36522
 4. 2   0.00752      0.87345    38.66942    0.99804   50.13193     0.34718    0.94524    0.02259    -1.20593    1.71185
 5. 2   0.02756      0.88765    38.66942    0.99804   50.06390     0.34718    0.94653    0.02295    -0.47920    0.63494
 6. 2   0.05762      0.86948    38.66320    0.99657   49.85975     0.34616    0.94806    0.02249     0.47993    1.39128
 7. 2   0.08769      0.86363    38.65698    0.99510   49.75767     0.34512    0.94766    0.02234     0.34578    1.59876
 8. 2   0.13780      0.84697    38.65077    0.99362   49.65560     0.34406    0.94726    0.02191     0.36870    2.09710
 9. 2   0.28812      0.84996    38.63005    0.98872   49.04315     0.34059    0.95117    0.02200     1.42109    1.87578
10. 2   0.48856      0.88142    38.59896    0.98136   48.22655     0.33451    0.95524    0.02289     2.14706    1.78200
11. 2   0.68899      0.94369    38.56374    0.97303   47.27384     0.32733    0.96063    0.02492     2.78427    1.99452
12. 2   0.88942      0.98002    38.52022    0.96273   46.32114     0.31775    0.96300    0.02544     2.92126    2.02842
13. 2   1.08985      0.96794    38.47463    0.95194   45.19831     0.30697    0.96836    0.02516     2.85967    2.25679
14. 2   1.39050      0.96525    38.40003    0.93428   42.71448     0.28789    0.99278    0.02914     2.88379    2.64914
15. 2   1.64104      0.96610    38.33787    0.91957   41.21738     0.27089    1.00155    0.02520     2.84126    2.66642
16. 2   1.89159      0.97723    38.26945    0.90338   39.61820     0.25132    1.01102    0.02554     2.79469    2.65246
17. 2   2.14213      0.98754    38.19489    0.88573   37.91655     0.22927    1.02148    0.02586     2.73751    2.63439
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                                          TABLE CF RESULTS FOR  3  POSITION

         CALCULATED WAVENUMBER= 47.57045  RECIP. CM.  WAVELENGTH=0.13208  CM.  INITIAL FREQUENCY =  277.50  HZ.

ID .K  INDEP. VAR.  DMP. COEF.  WAVE NO.   REL. FQ.  INTERP. TENS. GEN. AMPL.    Y1          Y2       REAL ELS.  IMAG. ELAS.

 1. 3   0.0          1.17275    47.57045    1.00000   50.20000     0.02232    0.94285    0.02463    -0.00017   -0.00006
 2. 3   0.00050      1.18239    47.57068    1.00072   50.16597     0.02220    0.94484    0.02486     1.79538    0.30131
 3. 3   0.00251      1.19929    47.57045    1.00000   50.13195     0.02232    0.94413    0.02521     1.40475   -0.40714
 4. 3   0.00752      1.20835    47.57068    1.00072   50.13195     0.02220    0.94548    0.02540     2.06577    0.09772
 5. 3   0.02756      1.21729    47.57021    0.99928   50.06390     0.02244    0.94407    0.02559     1.99063   -0.81079
 6. 3   0.05762      1.10946    47.56969    0.99784   49.85975     0.02270    0.94522    0.02332     1.02170    1.97225
 7. 3   0.08769      1.12948    47.56912    0.99640   49.75767     0.02296    0.94447    0.02346     0.75681    1.70325
 8. 3   0.13780      1.12036    47.56866    0.99532   49.65560     0.02317    0.94439    0.02355     0.74864    1.82051
 9. 3   0.28812      1.14759    47.56654    0.99099   49.04315     0.02406    0.94802    0.02413     1.79021    1.61451
10. 3   0.48856      1.18081    47.56069    0.98198   48.22685     0.02617    0.94697    0.02483     1.79593    1.14384
11. 3   0.68899      1.23035    47.55290    0.97297   47.27384     0.02893    0.94887    0.02587     2.52663    1.15102
12. 3   0.88942      1.27688    47.53826    0.96000   46.32114     0.03226    0.94361    0.02686     3.08423   -0.65913
13. 3   1.08985      1.29498    47.52075    0.94775   45.19831     0.03606    0.94357    0.02725     3.29861   -0.45719
14. 3   1.39050      1.31188    47.49133    0.93117   42.71448     0.04172    0.96561    0.02762     2.93545    2.32700
15. 3   1.64104      1.33430    47.45448    0.91423   41.21733     0.04859    0.96686    0.02812     2.88405    2.33830
16. 3   1.89159      1.24403    47.41574    0.89910   39.61820     0.05637    0.97524    0.02877     2.85877    2.43213
17. 3   2.14213      1.29776    47.35903    0.88000   37.91655     0.04995    0.97968    0.02951     2.79894    2.42473
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