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PROPAGATION CHARACTERISTICS OF INTERFACIAL RIPPLES AT THE POLARIZED AQUEOUS SOLUTION-MERCURY INTERFACE

by

Gordon Paul Bierwagen

A Dissertation Submitted to the
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In Charge of Major Work

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Dean of Graduate College

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DEDICATION

To my wife, Diane,
whose help and encouragement
made this work possible

INTRODUCTION

Liquid-liquid interfaces have long interested the chemist, physicist, and engineer. Much of modern surface science (1, 8, 40) has centered about the consideration of the surface of separation between two immiscible liquids and its properties. However, the surface scientist has considered mainly static interfaces, equilibrium or pseudo-equilibrium systems which lend themselves easily to study. The properties of interfaces in motion have been studied mainly by chemical engineers, and then usually from an empirical point of view. Thus a method for studying the dynamic properties of liquid-liquid interfaces which has a firm theoretical foundation would fill a gap in the present knowledge of surface scientists.

The use of interfacial ripples presents itself as just such a method. The basic theory is present in the theoretical studies of capillary ripples (25, 45), and the experimental techniques also have a basis in capillary ripple experimental procedures (45-47).

The development of a method for studying liquid-liquid interfaces obviously necessitates the choice of an interfacial system for experimentation. A liquid-liquid interface which has previously received much attention (1, 7, 8, 10, 11, 15, 20, 23, 26, 27, 30-33, 51-57), and is of interest because of its unique properties is the interface between an aqueous electrolyte solution containing a surfactant and mercury. This system also has a large density difference between the two phases and the properties of the interface can be changed by electrical polarization. Thus the solution-mercury interface is one which would lend itself well to interfacial ripple studies.

Objectives of Research

The objectives of this research are fourfold, namely:

1. To develop the theory of interfacial ripples based on the hydrodynamic methods used for capillary ripples.
2. To develop experimental methods for studying the aqueous solution-mercury interface.
3. To demonstrate the applicability of the theory by comparison to experiment.
4. To study various surfactant-electrolyte systems and interpret their behavior.

THEORY OF INTERFACIAL RIPPLES

Basic Theory

Surface waves have long intrigued both the general public and scientific community. Theoretical studies of these waves have centered mainly about capillary ripples[1], or waves at the air-liquid interface (6, 8, 12, 13, 18, 19, 25, 38-40, 45, 59-61). Kussakov (34) extended Levich's work on capillary ripples to the interfacial case but neglected the case of an interfacial film. Milne-Thompson (49) considered interfacial ripples, briefly, using inviscid flow theory (no energy dissipation).

Our system may be described mathematically as follows:

1. An upper and a lower liquid having finite viscosity and density, and being of infinite depth.
2. The liquids are Newtonian and incompressible.
3. The undisturbed interface between the two liquids is a plane described in a Cartesian coordinate system as the plane $y=0$, with the positive y-direction being upward.
4. The waves are propagated from an infinitely long line source which coincides with the z-axis, and the direction of propagation is in the positive x-direction.

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[1] When the term "capillary ripples" is used, the interface is the air-liquid interface; when "interfacial ripples" is used, a liquid-liquid interface is present.

5. The waves are sinusoidal of angular frequency ω.

According to the theory of fluid mechanics (2, 37), the equations describing viscous fluid motion are the following:

$$\vec{\nabla}\cdot\vec{v} = 0 \text{ (Equation of continuity)}, \tag{1}$$

and

$$\rho\left[\frac{\partial\vec{v}}{\partial t} + (\vec{v}\cdot\vec{\nabla})\vec{v}\right] = -\vec{\nabla}p + \mu\nabla^2\vec{v} - \rho\vec{g} \ , \tag{2}$$

(Navier-Stokes equation)

where

$\vec{v}$ = vector particle velocity = $v_x\vec{i} + v_y\vec{j}$,

$\vec{\nabla}$ = gradient operator = $\vec{i}\frac{\partial}{\partial x} + \vec{j}\frac{\partial}{\partial y} + \vec{k}\frac{\partial}{\partial z}$,

ρ = density of fluid ,

$\vec{g}$ = vector acceleration of gravity ,

p = pressure function ,

μ = viscosity coefficient,

and ∇^2 = Laplacian Operator = $\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$.

We must now use these equations to find a solution appropriate to our system: plane waves generated at the interface between two viscous liquids.

If we have waves of amplitude a and wavelength λ for which to ratio $a/\lambda << 1$, we can linearize the Navier-Stokes equation (25, 38-40, 45) to the following form:

$$\rho\frac{\partial\vec{v}}{\partial t} = -\vec{\nabla}(\Delta p) + \mu\,\nabla^2\vec{v} \ , \tag{3}$$

where $\Delta p = p + \rho g y$.

Following the theoretical treatment of Hansen and Mann (24, 45), we have a stream and potential function describing the flow in each liquid. We can write

$$v_x = -\frac{\partial \Phi}{\partial x} - \frac{\partial \Psi}{\partial y} \tag{5}$$

and

$$v_y = -\frac{\partial \Phi}{\partial y} + \frac{\partial \Psi}{\partial x} , \tag{6}$$

where Ψ = stream function and Φ = potential function. Letting the ripples be propagated in the +x direction, we have for the lower phase

$$\Phi = Ae^{\kappa y} e^{i(\kappa x - \omega t)} \tag{7}$$

and

$$\Psi = Be^{my} e^{i(\kappa x - \omega t)} , \tag{8}$$

where

κ = complex wave number = $k + i\alpha$ (cm^{-1}),

k = wave number = $2\pi/\lambda$ (cm^{-1}),

λ = wavelength of ripples (cm),

α = damping coefficient (cm^{-1}) ,

ω = angular frequency = $2\pi\nu$,

ν = ripple frequency (Hz.),

and

$$m^2 = \kappa^2 - i\rho\omega/\mu .$$

(From now on, unprimed terms refer to the lower phase, primed terms refer to the upper phase.) Also, the pressure for the lower phase can be written as

$$\Delta p = i\rho A\omega e^{\kappa y} e^{i(\kappa x-\omega t)} . \qquad (8)$$

Likewise, for the upper phase we can write

$$\Phi' = A'e^{-\kappa y} e^{i(\kappa x-\omega t)} , \qquad (9)$$

$$\Psi' = B'e^{-m'y} e^{i(\kappa x-\omega t)} , \qquad (10)$$

and

$$\Delta p' = i\rho' A'\omega e^{-\kappa y} e^{i(\kappa x-\omega t)} , \qquad (11)$$

where

$$m'^2 = \kappa^2 - \frac{i\rho'\omega}{\mu'} .$$

Boundary conditions

We must now choose the boundary conditions appropriate for our system. Two boundary conditions are given by the fact that the velocity vectors of the two phases are equal at the interface. Expressing this mathematically, we have

$$(v_x)_{y\to 0^-} = (v_x')_{y\to 0^+} \qquad (12)$$

or

$$\left(\frac{-\partial \Phi}{\partial x} - \frac{\partial \Psi}{\partial y}\right)_{y\to 0^-} = \left(\frac{-\partial \Phi'}{\partial x} - \frac{\partial \Psi'}{\partial y}\right)_{y\to 0^+} \qquad (12a)$$

and

$$(v_y)_{y\to 0^-} = (v_y')_{y\to 0^+} \qquad (13)$$

or

$$\left(\frac{-\partial\Phi}{\partial y} + \frac{\partial\Psi}{\partial x}\right)_{y\to 0^-} = \left(\frac{-\partial\Phi'}{\partial y} + \frac{\partial\Psi'}{\partial x}\right)_{y\to 0^+} \quad . \qquad (13a)$$

The stream and potential functions introduce 4 unknown coefficients A, A', B, and B'; equations 12a and 13a provide two relations between them. Two additional relations are furnished by the surface stress boundary conditions.

For a viscous, incompressible fluid, the stress tensor may be written (2, 37, 40)

$$\sigma_{ij} = -p\delta_{ij} + \mu\left(\frac{\partial v_i}{\partial x_j} + \frac{\partial v_i}{\partial x_i}\right) \qquad (14)$$

where i, j and x_i, x_j take on values of x, y, z and δ_{ij} is the Kroeneker delta, $\delta_{ij} = 0$ if $i \neq j$, $\delta_{ij} = 1$ if $i = j$. This expression furnishes the stresses in the bulk phases. The difference between these stresses at the interface must be balanced by an interfacial stress. Let

$\zeta = \int (v_y)_{y\to 0^+}\, dt$ and $\xi = \int (v_x)_{y\to 0^+}\, dt$ be the normal and tangential displacements of the surface, respectively. Then for the normal stress balance we can write (24)

$$(\sigma_{yy})_{y\to 0^-} - (\sigma_{yy}')_{y\to 0^+} = \sigma_{yy}\ (\text{interface}) \ , \qquad (15)$$

or rewriting we have

$$\left(-\Delta p + 2\mu\frac{\partial v_y}{\partial y}\right)_{y\to 0^-} - \left(\Delta p' + 2\mu'\frac{\partial v_y'}{\partial y}\right)_{y\to 0^+} = \gamma\frac{\partial^2\zeta}{\partial x^2} \ , \qquad (15a)$$

where γ = interfacial tension. For the tangential stress balance we write (24)

$$(\sigma_{xy})_{y\to0^-} - (\sigma_{xy}')_{y\to0^+} = \sigma_{xy} \text{ (interface)} \tag{16}$$

or

$$[2\mu(\frac{\partial v_y}{\partial x} + \frac{\partial v_x}{\partial y})]_{y\to0^-} - [2\mu'(\frac{\partial y'}{\partial x} + \frac{\partial v_x'}{\partial y})]_{y\to0^+} = E\,\frac{\partial^2\xi}{\partial x^2} \tag{16a}$$

where E = interfacial elastic film modulus, which for the general case is a complex number. Equation 15 may be thought of as a generalization of the Young-Laplace equation (1)

$$\Delta p = (\frac{1}{R_1} + \frac{1}{R_2}) \tag{17}$$

where Δp (the difference in pressure across an interface), is replaced by $\Delta(\sigma_{yy})$, and for the small curvatures of the waveform for the interfacial ripples $\frac{\partial^2\xi}{\partial x^2} \simeq (\frac{1}{R_1})$, where for plane waves $R_2 \to \infty$. Equation 16 is just a force balance stating that the stress due to interface stretching must be exactly balanced by stresses due to motion of the adjacent bulk phases. In the simplest case the stress due to interface stretching is an interfacial tension gradient and if the local surface tension is in equilibrium with local surface excess (Γ), with no relaxation processes occurring at the interface, we can write

$$E\,\frac{\partial^2\xi}{\partial x^2} = (\frac{\partial\gamma}{\partial x}) = (\frac{-\partial\gamma}{\partial\ln\Gamma})(\frac{-\partial\ln\Gamma}{\partial x}), \tag{18}$$

with $E = -\frac{\partial\gamma}{\partial\ln\Gamma}$, $\frac{\partial^2\xi}{\partial x^2} = -\frac{\partial\ln\Gamma}{\partial x}$.

Diffusion and surface transfer

If we assume the surfactant providing the local surface excess Γ is soluble, we must consider the diffusional process which will occur due to the displacement of the interface by the waveform. Let Γ_0 = equilibrium surface excess, $\Gamma = \Gamma_0 + \Delta\Gamma$ = local surface excess, C_0 = bulk equilibrium concentration in lower phase, $C = C_0 + \Delta C$ = local concentration, C'_0 = bulk equilibrium concentration in upper phase, and $C' = C'_0 + \Delta C'$. As in Hansen and Mann (25), we have

$$\Delta C = He^{ny}\ e^{i(\kappa x-\omega t)} \qquad (19)$$

where n is the positive root of $n^2 = \kappa^2 - \frac{i\omega}{D}$ with D = diffusion coefficient for lower phase. Similarly, for the upper phase we have

$$\Delta C' = H'e^{-n'y}\ e^{i(\kappa x-\omega t)}, \qquad (20)$$

with n' the positive root of $(n')^2 = \kappa^2 - i\omega/D'$, where D' = diffusion coefficient for the upper phase. Assuming a Henry's law distribution between phases at equilibrium, and also assuming local surface equilibrium between phases, we have

$$C'_0 = KC_0, \text{ and} \qquad (21)$$

$$(\Delta C')_{y\to 0^+} = K(\Delta C)_{y\to 0^-} \qquad (22)$$

which implies

$$H' = KH \qquad (23)$$

where K is the Henry's law distribution coefficient. Further following Hansen and Mann (25), we have

$$\left(\frac{d\Gamma}{dC'}\right)_{C_0'}\left(\frac{\partial \Delta C'}{\partial t}\right)_{y\to 0^+} + \Gamma_0\left(\frac{\partial v_x'}{\partial x}\right)_{y\to 0^+} + D\left(\frac{\partial \Delta C}{\partial y}\right)_{y\to 0^-}$$

$$- D'\left(\frac{\partial \Delta C'}{\partial y}\right)_{y\to 0^+} = 0 \qquad (24)$$

This leads immediately to the following relationship:

$$\Delta\Gamma = -\Gamma_0 \left\{\frac{\kappa/\omega(-m'B'+i\kappa A')e^{i(\kappa x-\omega t)}}{1 + \frac{i}{\omega}(\frac{nD}{K}+n'D')\left(\frac{dC'}{d\Gamma}\right)_{C_0'}}\right\} \qquad (25)$$

Now we can write an expression for E in terms of diffusion surface transfer. From 18 we have $E = \left(\frac{-\partial\gamma}{\partial \ln\Gamma}\right)\left(\frac{\partial \ln\Gamma}{\partial x}\right)$, which, substituting from (25) be comes

$$E = -\left(\frac{\partial\gamma}{\partial \ln\Gamma}\right)\left[1 + \frac{i}{\omega}\left(\frac{nD}{K} + n'D'\right)\left(\frac{dC'}{d\Gamma}\right)_{C_0'}\right]^{-1} \qquad (26)$$

<u>Solution of system of equations using boundary conditions</u>

Equations 12, 13, 15 and 16 offer a system of four linear homogeneous equations in four unknowns, A, A', B, and B', which is apparent if they are written in the following form:

Equation	Boundary Condition	
$-(i\kappa A+mB) = -(i\kappa A'-m'B')$	($v_x=v_x'$ at $y=0$)	(27)
$-A + iB = A' + iB'$	($v_y=v_y'$ at $y=0$)	(28)
$[i\rho\omega A -2\mu(A\kappa^2-im\kappa B)]=[i\omega\rho'A'-2\mu'(A'\kappa^2+i\kappa mB']$ $+\frac{\kappa^3\gamma}{\omega}(iA+B)$	(normal stress)	(29)

$$-\mu[B(\kappa^2+m^2)+2i\kappa^2A]= -\mu'[B'(\kappa^2+m'^2)-2i\kappa^2A]$$

$$+\frac{\kappa^2}{\omega}E(mB+i\kappa A)\,(\text{Tangential Stress}). \quad (30)$$

For a non-trivial solution, according to Cramer's Rule, the determinant of the coefficients of the equations must be zero. Then we have

$$\begin{vmatrix} [i\omega\rho-2\mu\kappa^2-\frac{i\kappa^3\gamma}{\omega}] & [i\omega\rho'+2\kappa^2\mu'] & [2i\kappa\mu m-\frac{\gamma\kappa^3}{\omega}] & [2i\kappa\mu' m'] \\ [-2i\kappa^2\mu-\frac{\kappa^3\gamma u_2}{\omega}] & [-2i\kappa^2\mu] & [-\mu(m^2+\kappa^2)-\frac{i\kappa^2 m u_2}{\omega}] & [\mu'(m'^2+\kappa^2)] \\ [i\kappa] & [-i\kappa] & [m] & [m'] \\ [1] & [1] & [-i] & [i] \end{vmatrix} =0, \quad (31)$$

where $u_2=E/\gamma$.

One can reduce this determinant to a two-by-two determinant.

$$\begin{vmatrix} \{i[\frac{(\rho+\rho')\omega^2}{\gamma\kappa^3}-1]-\frac{2\omega}{\gamma\kappa}(\mu+\mu'\frac{m'}{\kappa})\} & \{[\frac{(\rho+\rho')\omega^2}{\gamma\kappa^3}-1]+\frac{i\omega}{\gamma\kappa}[(\mu+\mu\frac{m'}{\kappa})+(\mu\frac{m}{\kappa}+\mu')]\} \\ [u_2-\frac{2i\omega}{\gamma\kappa}(\mu+\mu'\frac{m'}{\kappa})] & [\frac{\omega}{\gamma\kappa}\{(\frac{\mu m}{\kappa}+\mu')-(\mu+\frac{\mu' m'}{\kappa})] \end{vmatrix} = 0 \quad . \quad (32)$$

This determinant can be expanded in different ways. Let us first use a method analogous to the methods of Hansen and Mann (24), which reduces 32 to

$$\frac{(\rho+\rho')\omega^2}{\gamma\kappa^3} - 1 = -i\left[\frac{u_2(u_3+u_4)-4iu_3u_4}{u_2-i(u_3+u_4)}\right] , \tag{33}$$

in which

$$u_3 = \frac{\omega}{\gamma\kappa}(\mu+\frac{\mu' m'}{\kappa}), \text{ and } u_4 = \frac{\omega}{\gamma\kappa}(\frac{\mu m}{\kappa} + \mu') .$$

Equation 33 is complex, implying two real equations. The right side of equation 33 and α, the imaginary part of κ, disappear for the case of an inviscid fluid, reducing equation 33 to

$$\omega^2 \frac{(\rho+\rho')}{\gamma\kappa^3} = 1, \tag{34}$$

a result given by Milne-Thompson (49).

<u>Limiting behavior of Y1 and Y2</u>

Let us now consider equation 33 in terms of the limiting cases of surface behavior. Consider first a non-elastic film, or $u_2=E/\gamma=0$. This gives

$$\lim_{u_2\to 0}\left\{\frac{(\rho+\rho')\omega^2}{\gamma\kappa^3} -1\right\} = -4i/(\frac{1}{u_3} + \frac{1}{u_4}) \tag{35}$$

In characteristic experiments $\alpha<<k$ which implies $\frac{\alpha}{k}<<1$, or $\kappa^3=(k+i\alpha)^3\approx k^3(1+\frac{3i\alpha}{k})$ and $\frac{\mu' k^2}{\rho'\omega}$ and $\frac{\mu k^2}{\rho\omega}$ are about 10^{-2}.

Let us define two further dimensionless variables, Y1 $= (\rho+\rho')\omega^2/\gamma k^3$ and Y2 $= \alpha/k$. Following the definitions of m', and m we can write,

$$\frac{m'}{\kappa} = e^{-\frac{\pi i}{4}}(\frac{\rho'\omega}{\mu\kappa^2})^{\frac{1}{2}}(1+i\frac{\mu'\kappa^2}{\rho'\omega})^{\frac{1}{2}} \approx e^{-\pi i/4}(\frac{\rho'\omega}{\mu'\kappa^2})^{\frac{1}{2}} \tag{36}$$

and

$$\frac{m}{\kappa} = e^{-\frac{\pi i}{4}}\left(\frac{\rho\omega}{\mu\kappa^2}\right)^{\frac{1}{2}}\left(1+\frac{i\mu\kappa^2}{\rho\omega}\right)^{\frac{1}{2}} \simeq e^{-\frac{\pi i}{4}}\left(\frac{\rho\omega}{\mu\kappa^2}\right)^{\frac{1}{2}} \quad . \qquad (37)$$

Multiplying equation 34 by $(\frac{\kappa}{k})^3$ (approximately $1+3iY2$), and using 36 and 37 we have

$$\lim_{u_2\to 0} Y1-1-3iY2 =$$

$$\left[\frac{-4i\omega^{\frac{3}{2}}\, e^{-\frac{\pi i}{4}}\left(1+e^{\frac{\pi i}{4}}\frac{\mu k}{\sqrt{\mu'\rho'\omega}}\right)\left(1+e^{-\frac{i}{4}}\frac{\mu' k}{\sqrt{\omega\rho\mu}}\right.}{\gamma k^2\left[\frac{1}{\sqrt{\rho\mu}}+\frac{1}{\sqrt{\rho'\mu'}}\right]\left(1+e^{-\frac{\pi i}{4}}\left[\frac{(\mu+\mu')k}{\sqrt{\omega\rho\mu}+\sqrt{\omega\rho'\mu'}}\right]\right)}\right] \qquad (38)$$

Equating the real and imaginary portions of 38, the following equations result, with terms of order $(\frac{\mu k^2}{\rho\omega})$ ignored as small:

$$\operatorname*{Lim}_{u_2\to 0} Y1 = 1 - \frac{(2\omega)^{\frac{3}{2}}}{\gamma k^2\left[\frac{1}{\sqrt{\rho\mu}}+\frac{1}{\sqrt{\rho'\mu'}}\right]} \qquad (39)$$

and

$$\operatorname*{Lim}_{u_2\to 0} Y2 = \frac{(2\omega)^{\frac{3}{2}}}{3\gamma k^2\left[\frac{1}{\sqrt{\rho\mu}}+\frac{1}{\sqrt{\rho'\mu'}}\right]}\left\{1+\left(\frac{2}{\omega}\right)^{\frac{1}{2}} k\left[\frac{\mu}{\sqrt{\rho'\mu'}}+\frac{\mu'}{\sqrt{\rho\mu}}\right.\right.$$

$$\left.\left. - \frac{(\mu+\mu')}{\sqrt{\rho\mu}\ \ \sqrt{\rho'\mu'}}\right]\right\} . \qquad (40)$$

The other limiting case of surface behavior is an infinitely elastic film, which modifies equation 33 to give

$$\lim_{u_2\to\infty}\left[\frac{(\rho+\rho')\omega^2}{\gamma\kappa^3} - 1\right] = i(u_3+u_4). \qquad (41)$$

Using similar approximation procedures, we obtain

$$\lim_{u_2 \to \infty} Y1 = 1 - \frac{\omega^{\frac{3}{2}}}{\gamma k^2 \sqrt{2}} (\sqrt{\rho\mu} + \sqrt{\rho'\mu'}) \qquad (42)$$

and

$$\lim_{u_2 \to \infty} Y2 = \frac{\omega^{\frac{3}{2}}}{3\sqrt{2}\gamma k^2} [\sqrt{\rho\mu} + \sqrt{\rho'\mu'} + k\sqrt{2/\omega}(\mu+\mu')]. \qquad (43)$$

<u>Other solution forms</u>

Let us now reconsider our expansion of the determinant in 29. Expanding this equation in the form of a power series[1] in κ (the complex wave number, $k+i\alpha$) in which the coefficients have a weak dependence on κ, we have

$$\sum_{i=0}^{5} B_i \kappa^i = 0, \qquad (44)$$

in which

$$B_0 = [-i\omega(\rho+\rho')(\mu m+\mu' m')],$$

$$B_1 = [4\mu\mu' m m' - i\omega(\rho+\rho')(\mu+\mu')],$$

$$B_2 = [4(\mu^2 m+\mu'^2 m')+E(\rho+\rho')],$$

$$B_3 = [\frac{i(\gamma+E)}{\omega}(\mu' m'+\mu m) + 4\mu\mu'],$$

$$B_4 = [\frac{i(\gamma+E)}{\omega}(\mu+\mu')],$$

and

$$B_5 = -\frac{\gamma E}{\omega^2} \quad .$$

This can be solved for E to give the following equation:

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[1] J. Mann, unpublished results, Department of Chemistry, University of Hawaii, Honolulu, Hawaii, private communication, 1967.

$$E = -\frac{1}{\kappa^2}\left(\frac{A_4\kappa^4+A_3\kappa^3+A_2\kappa^2+A_1\kappa+A_0}{C_3\kappa^3+C_2\kappa^2+C_1\kappa+C_0}\right) \tag{45}$$

with the coefficients Ai and Ci defined as follows:

$$A_0 = -i\omega(\rho+\rho')(\mu m+\mu' m'),$$

$$A_1 = [4\mu\mu' mm'-i\omega(\mu+\mu')(\rho+\rho')],$$

$$A_2 = 4(\mu^2 m+\mu'^2 m'),$$

$$A_3 = [4\mu\mu'+ \frac{i\gamma}{\omega}(\mu' m'+\mu m)],$$

$$A_4 = \frac{i\gamma}{\omega}(\mu+\mu'),$$

$$C_0 = (\rho+\rho'),$$

$$C_1 = \frac{i}{\omega}(\mu' m'+\mu m),$$

$$C_2 = \frac{i}{\omega}(\mu+\mu'),$$

and

$$C_3 = -\gamma/\omega^2.$$

This formula involves no approximations, and covers the entire range of E.

Let us consider equation 44 for the case E→0, and solve the equation for γ. This leads to the following formula:

$$\gamma(E=0) = \frac{-(B_0+B_1\kappa+B_2\kappa^2)-4\mu\mu'\kappa^3}{D_4\kappa^4+D_3\kappa^3} , \qquad (47)$$

where the Bi are defined as above,

$$D_3=\frac{i}{\omega}(\mu m+\mu' m'), \text{ and } D_4= \frac{i}{\omega}(\mu+\mu') .$$

Theory of Im(E)

In Hansen and Mann (25), a model for surface visco-elastic properties is proposed which suggests, as mentioned above, that the real component of E is the Gibbs' elastic modulus, with a correction for diffusion which adds a small imaginary component. Also, a surface relaxation parameter, k_v, is provided to account for an arbitrary imaginary component of E. The contribution of this term including diffusion may be written as

$$E = (E_{Gibbs} + i\ E_{Imag})/(\text{Diffusion correction})$$

$$\text{where } E_{Imag} = -\omega k_v . \qquad (48)$$

This model indicates there is a phase lag in the response of the surface to the imposed stress of the wave propagation. J. Mann [1] has further proposed that the identification of k_v as

$$k_v = \mu_s, \text{ where } \mu_s = \text{surface shear viscosity}, \qquad (49)$$

holds true when relaxation phenomena (chemical reactions, surface reorientation) are not occurring at the surface,

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[1] J. Mann, op. cit., private communication, 1967.

are occurring with a relaxation time $\tau << 1/\omega$.

If we consider an interface with a surfactant present, we have two contributions to our interfacial shear viscosity, one from the pure interface and one due to our surfactant. For bulk phases, two schemes have been proposed for the viscosity of a mixture (17). They are

$$\frac{1}{\mu_{Total}} = \frac{x_1}{\mu_1} + \frac{x_2}{\mu_2} \quad \text{where } X_i = \text{mole fraction,} \tag{50}$$

and

$$\ln \mu_{Total} = X_1 \ln\mu_1 + X_2 \ln\mu_2 \ . \tag{51}$$

In analogy, we may write for our surface viscosities

$$\frac{1}{\mu_s} = \frac{\theta}{\mu^s_{surfactant}} + \frac{(1-\theta)}{\mu^s_{pure}} \tag{52}$$

where θ = surface coverage = Γ/Γ_{max}, and

$$\ln(\mu_s) = \ln(\mu^s_{surfactant}) + (1-\theta)\ln(\mu^s_{pure}) . \tag{53}$$

The authors of the above reference further suggest that the calculation based on the logarithmic terms has a firmer theoretical foundation, and thus equation 53 was later incorporated in our model to generate E values.

Intermediate surface behavior

We have considered the limiting cases ($u_2 \to 0,\infty$) of surface behavior in some detail, since the formulae readily simplify for these two extremes of surface behavior. Statements concerning the intermediate range of E are more difficult to make due to the complexity of the equations involved. It has been shown for the air-water interface, both theoretically (25) and experimentally (5, 43, 44) that there exist clearly defined maxima in Y2 and Y1 for intermediate values of u_2, i.e. that Y2 and Y1 exhibit maxima for some Γ, such that $0<\Gamma<\Gamma_{max}$. For liquid-liquid systems, these maxima are not so clearly defined, theoretically or experimentally (4). The sharpness, or difference of the maxima from the other values depends on the viscosity and density differences and seems to decrease as these decrease.

Another consideration appears of interest concerning Y1 and Y2 behavior at intermediate $u_2(=\frac{E}{\gamma})$ values. In Hansen and Mann (25), u_2 is written in the polar form for a complex number, $u_2=|u_2|e^{i\Theta_2}$, where $\Theta_2 = \tan^{-1}\frac{Re(u_2)}{Im(u_2)}$ and $|u_2| = \sqrt{Re(u_2)^2 + Im(u_2)^2}$. Predictions for Y1 and Y2 are made for a continuous range of $|u_2|$ values at discreet and widely separated Θ_2 values. Figures 1 and 2 of (24) show that as Θ goes from $0\rightarrow-90°$ (physically a phase lag caused by a large k_v value) the maxima diminish and flatten out. This could be the case for interfacial ripples and not for capillary ripples. It would appear from these plots that the sharpness of the Y1 and Y2 maxima depends on the value of Θ_2 and Θ_2 in turn depends on the relaxation parameter k_v. If $\omega k_v \geq E$, the maxima are not clearly interpretable in relation to other values.

THE MERCURY-SOLUTION INTERFACE

Introduction

The interface between electrolyte solutions and mercury has long been investigated by chemists and physicists (1, 7, 8, 10, 11, 15, 20, 23, 25, 27, 30, 32, 33, 40, 41, 51-57). Excellent reviews are available summarizing these investigations (10, 20). The following simple treatment of the theory of this interface will suffice for a discussion of some of the unique interfacial ripple propagation characteristics to be expected from it.

Basic formulation (Ideally polarizable interface)

For the mercury-electroyte solution interface at constant temperature, we may write the Gibb's adsorption theorem in the following form (10):

$$-d\gamma = QdV + \sum_i \Gamma_i d\mu_i, \tag{54}$$

where Q = surface charge density,

V = polarization potential,

Γ_i = surface excess of i^{th} component,

and μ_i = chemical potential of i^{th} component.

It follows from this equation that

$$Q = -\left(\frac{\partial\gamma}{\partial V}\right)_{P,T,\mu_i} \tag{55}$$

which is the Lippmann equation (41), the basis of the theory of electrocapillarity. Further differentiation with respect to the polarization potential yields

$$C = -\left(\frac{\partial^2\gamma}{\partial V^2}\right)_{T,P,\mu_i} = \left(\frac{\partial Q}{\partial V}\right) \text{where C=differential surface capacitance.} \tag{56}$$

An electrocapillary curve, that is a plot of γ vs. V, has been shown experimentally to have the general shape of a parabola. This is especially true in the absence of organic surfactants or specifically adsorbed ions. The apex of this approximate parabola is called the electrocapillary maximum, and since at this point the slope is zero, the surface charge is zero. This point of zero charge has a potential which is dependent upon the electrolyte and its concentration, and upon any surfactant present and its concentration. It is common practice to refer the polarization potentials (measured with respect to a given reference electrode) to the potential of zero charge.

Consider now the simplest case, where C, the differential capacitance, is a constant. This implies

$$Q(V) = \int_{V_{ecm}}^{V} CdV = C(V-V_{ecm}) \text{ where } V_{ecm} = \text{potential at electrocapillary maximum} \tag{57}$$

and

$$\gamma(V) = \gamma_{ecm} - \int_{V_{ecm}}^{V} QdV, \tag{58}$$

or

$$\gamma(V) = \gamma_{ecm} - \tfrac{1}{2}C(V-V_{ecm})^2. \tag{58a}$$

Now we have a simple model for the surface tension behavior during changes in polarization. This simple model is at best approximate for a system in which no adsorption occurs, but may be suitable for treatment of the zero elasticity limiting behavior of interfacial ripples (where again surfactant is absent).

Adsorption at the aqueous solution-mercury interface has been shown to be potential dependent (10, 11, 20, 23, 26, 27, 30, 32). This implies that the surface coverage and elastic modulus will change with the polarization of the interface.

The adsorption of surfactants at the mercury-solution interface at the point of zero charge (the ECM), is similar to the behavior of these materials at the other interfaces in that as concentration of adsorbate increases, Γ goes from 0 to Γ_{max} and then further addition of adsorbate will not increase Γ. The superposition of electrical effects on the adsorption gives this interface its unique properties. As the electric field at the interface increases to either side of the ECM, this region will fill preferentially with material of high dielectric constant (26, 27). As the dielectric constant of water is greater than that of the organic adsorbates, it will displace these from the interface as the field strength increases. Further field effects may be due to ions and to the polarizabilities of the materials near the interface.

Simplified Frumkin model for interfacial behavior

Various isotherms have been proposed to account for the behavior of organic adsorbates at the mercury-electrolyte solution interface (10). Consider a regular localized monolayer with no specific adsorption sites and nearest neighbors. If the pair interaction energy between surfactant molecules is W, we can write

$$\frac{\Theta}{1-\Theta} = B_0 C e^{-\frac{zW}{RT}\Theta}, \qquad (59)$$

where $\Theta = \frac{\Gamma}{\Gamma_m}$ = surface coverage, or in a different form

$$\frac{\Theta}{1-\Theta} = B_0 C e^{2\beta\Theta}, \qquad (60)$$

where B_0 and β are now constant's characteristic of a given adsorbate, β a measure of interaction among molecules. This form will give the concentration dependence of Θ, and one needs in addition an expression for the potential dependence. We can write (assuming C≡activity)

$$\gamma = - QdV - RT\Gamma d \ln C \qquad (61)$$

which implies

$$\left(\frac{\partial \ln C}{\partial V}\right)_\Gamma = + \frac{1}{RT}\left(\frac{\partial Q}{\partial \Gamma}\right)_V \qquad (62)$$

From the above we have Γ at V=0 as a function of C, Γ(C,0), and we need Q(Γ,V) to establish Γ(C,V). Frumkin (15, 26) assumes the form of Q(C,V) to be

$$Q(\Gamma,V) = Q_w(1-\Theta) + C'(V-V_n)\Theta \ , \qquad (63)$$

where

Q_w = $Q(C=0,V)$,

C' = differential capacitance of double layer for $\Theta=1$ (assumed constant),

and V_n = potential of $Q = 0$ for $\Theta=1$.

Then

$$\left(\frac{\partial Q}{\partial \Gamma}\right)_V = -\frac{Q_w}{\Gamma_m} + \frac{C}{\Gamma_m}(V-V_n) \ , \qquad (64)$$

and

$$C(V) = C(0)e^{\frac{1}{RT}\int_0^V \left(\frac{\partial Q}{\partial \Gamma}\right)_V dV} = C(0)e^{-\frac{1}{\Gamma_m RT}\int_0^V [Q_v - C'(V-V_n)]dV} \ . \qquad (65)$$

This allows one to write

$$\frac{\Theta(C,V)}{[1-\Theta(C,V)]} = B_0C_e^{2\beta\Theta(C,V)} = B_0Ce^{2\beta\Theta}e^{-\Phi/\Gamma_m RT} \qquad (66)$$

where $\Phi = \int_0^V [Q_w - C'(V-V_n)]dV$.

Equation 66 is the Frumkin isotherm (15) including potential dependence, and the equation of state (26) resulting from it is

$$\gamma_0 - \gamma = \int_0^V Q_w dV - \Gamma_m RT[\ln(1-\Theta) + \beta\Theta^2] \ , \qquad (67)$$

where γ_0 = surface tension of pure electrolyte solution. Using our definition of Gibbs elasticity, $E_{Gibbs} = \left(\frac{-\partial\gamma}{\partial \ln\Gamma}\right) = \left(-\Theta\frac{\partial\gamma}{d\Theta}\right)$, we have

$$E_{Gibbs} = \Gamma_m RT\left[\frac{\Theta}{1-\Theta} + 2\beta\Theta^2\right] \ . \qquad (68)$$

Also, from our isotherm, we can now generate an expression for $(\frac{dC'}{d\Gamma})_{C'_0}$ which is necessary in our correction for diffusion.

We know $d\Gamma = \Gamma_m d\Theta$, and thus

$$(\frac{dC'}{d\Gamma})_{C'_0} = \frac{1}{\Gamma_m} \frac{dC'}{d\Theta} \tag{69}$$

From our isotherm,

$$C' = \frac{e^{-2\beta\Theta}}{B_0} (\frac{\Theta}{1-\Theta}) e^{\Phi/\Gamma_m RT}, \tag{70}$$

therefore

$$(\frac{dC'}{d\Gamma})_{C'_0} = \frac{e^{\Phi/\Gamma_m RT}}{\Gamma_m B_0} \frac{d}{d\Theta} (\frac{\Theta e^{-2\beta\Theta}}{1-\Theta}) = \frac{e^{\Phi/\Gamma_m RT}}{\Gamma_m B_0} [\frac{-2\beta\Theta e^{-2\beta\Theta}}{1-\Theta} + \frac{e^{-2\beta\Theta}}{(1-\Theta)^2}] \tag{71}$$

or

$$(\frac{dC'}{d\Gamma})_{C'_0} = (\frac{e^{\Phi/\Gamma_m RT}}{\Gamma_m B_0}) (\frac{e^{-2\beta\Theta}}{(1-\Theta)^2}) (1-2\beta\Theta+2\beta\Theta^2) \tag{71a}$$

Before we go further, let us simplify the term Φ involving the potential dependence to make our calculations more tractable. Let us assume that V_n is approximately zero, and that Q_w can be approximated by $C_w V$, where C_w is the differential capacitance of the interface in the abscence of specific adsorption (assumed constant). This yields

$$\Phi = \int_0^V (C_w - C') \, dV = \frac{1}{2}(C_w - C')V^2 \quad . \tag{72}$$

Let $K = (C_w - C')/2\Gamma_m RT$ and we can write our isotherm as

$$\frac{\Theta}{1-\Theta} = B_0 C \, e^{-KV^2} e^{2\beta\Theta} \quad . \tag{73}$$

With our simplified potential dependence, we have a form which may be used for generating numerically $\Theta(C,V)$ values, knowing β, B_0, C, and k. Then, with this Θ value, we can evaluate E, the complex surface elastic modulus, if we know μ_s. From 48 and 49 we can write

$$E = (E_{Gibbs} - i\omega\mu_s)/[1+ \frac{in'D'}{\omega}(\frac{dC'}{d\Gamma})_{C_0'}], \tag{74}$$

with E_{Gibbs} and $(\frac{dC'}{d\Gamma})$ calculated as indicated above.

The Hg-solution interface with the passage of a current

The discussion of the mercury-solution interface has heretofore been limited to the case where the interface is ideally polarized, i.e. there is zero current passing through the interface, and the interface is at equilibrium. Let us consider the case where a current is passing through our interface, the mechanism by which the current arises not being of concern at this point. The tangential stress, at the interface as shown in equation 18, may be put in the form

$$\sigma_{xy}(\text{interface}) = (\frac{\partial\gamma}{\partial x})_{y=0} . \tag{75}$$

Let us rewrite this as

$$\sigma_{xy}(\text{interface}) = (\frac{\partial\gamma}{\partial V})(\frac{\partial V}{\partial x})_{y=0} , \tag{76}$$

where we can replace $(\frac{\partial\gamma}{\partial V})$ according to 45, by $-Q$, and have

$$\sigma_{xy}(\text{interface}) = -Q(\frac{\partial V}{\partial x}), \tag{77}$$

where term $(\frac{\partial V}{\partial x})$ is the potential gradient along the interface.

The potential can be assumed to take the form

$$V = V_0 + \Delta V \,, \tag{78}$$

where V_0 is the potential imposed externally upon the interface, of the form $V = Uy$ where U = electric field strength and ΔV is that potential due to the wave motion of the interface in the presence of the imposed potential. By analogy to our arguments concerning concentration, we can write, since $\nabla^2 V=0$ (36, 50)

$$\Delta V = V-V_0=Ze^{i(\kappa x-\omega t)}e^{-\kappa y} \tag{79}$$

and

$$\sigma_{xy} = -Q\left(\frac{\partial(\Delta V)}{\partial x}\right)_{y=0} . \tag{80}$$

For an interface through which a current is passing, from the requirement of conservation of charge, we can write (40)

$$\sigma\left(\frac{\partial(\Delta V)}{\partial y}\right)_{y=0} = \frac{\partial}{\partial x}\left(Qv_x\right)_{y=0} + \left(\frac{\Delta V}{R}\right)_{y=0} \tag{81}$$

where $R = rA$, A=area, r=interfacial resistance

and σ = specific conductivity

$= \frac{F^2}{RT}\Sigma z_1{}^2 D_i C_i$ with C_i = concentration of i^{th} species

D_i = diffusion coefficient of i^{th} species

z_i = valence of i^{th} species

F = Faraday constant

R = gas constant

T = temperature (absolute) .

Solving this expression for Z, the unknown constant, we have

$$Z=\frac{\frac{\partial Q}{\partial x}(i\kappa A+mB)+Q(\kappa^2A-im\kappa B)}{(\sigma\kappa+\frac{1}{R})}\quad. \tag{82}$$

Now, if we insert this in Equation 77, we get the expression for the interfacial stress due to electrical effects,

$$\sigma_{xy}(\text{interface})=\frac{A(iQ^2\kappa^3-Q\kappa^2(\frac{\partial Q}{\partial x})_{y=0}+b[(iQm\kappa(\frac{\partial Q}{\partial x})_{y=0}-Q^2m\kappa^2]}{(\sigma\kappa+\frac{1}{R})}. \tag{83}$$

Inserting this in our boundary conditions, and then into the determinant from our system of equations, we obtain the electrical analogue for u_2,

$$u_2(\text{electrical}) = \frac{\omega[iQ^2-\frac{Q}{\kappa}(\frac{\partial Q}{\partial x})_{y=0}]}{\gamma(\sigma\kappa+\frac{1}{R})}\,, \tag{84}$$

or the analogue for E is

$$E(\text{electrical}) = \frac{\omega[iQ^2-\frac{Q}{\kappa}(\frac{\partial Q}{\partial x})_{y=0}]}{(\sigma\kappa+\frac{1}{R})}\quad. \tag{85}$$

If the term $\frac{1}{\kappa}(\frac{\partial Q}{\partial x})_{y=0}$ <<Q, we have

$$E(\text{electrical}) \simeq \frac{i\omega Q^2}{(\sigma\kappa+\frac{1}{R})}\,, \tag{86}$$

or the elastic modulus is a pure imaginary quantity, indicating a phase lag.

If we go back to our expression for surface stress, and include both electrical and adsorbate effects, we have

$$\sigma_{xy} = (\frac{\partial\gamma}{\partial x}) = (\frac{-\partial\gamma}{\partial \ln\Gamma})(\frac{\partial \ln\Gamma}{\partial x}) + (\frac{\partial\gamma}{\partial V})(\frac{\partial V}{\partial x}) \qquad (87)$$

or

$$\sigma_{xy}(\text{interface}) = \sigma_{xy}(\text{surfactant}) + \sigma_{xy}(\text{electrical}). \qquad (87a)$$

Thus the stress effects can be assumed additive, which gives us

$$\sigma_{xy} = E\frac{\partial^2\xi}{\partial x^2} - Q(\frac{\partial(\Delta V)}{\partial x})_{y=0} \quad , \qquad (88)$$

or

$$u_2(\text{total}) = u_2(\text{film}) + u_2(\text{electrical}) \qquad (89)$$

$$= \frac{1}{\gamma}[\frac{-\partial\gamma}{\partial \ln\Gamma} - i\omega\mu_s)/[i+ \frac{in'D'}{\omega}(\frac{dC}{d\Gamma})_C]$$

$$+ \frac{1}{\gamma}[\frac{\omega(iQ^2-\frac{Q}{\kappa}(\frac{\partial Q}{\partial x})_{y=0})}{\gamma(\sigma\kappa+\frac{1}{R})}] \quad .$$

EXPERIMENTAL SECTION

Ripple Instrumentation

The instrumentation used to examine the mercury-solution interface was based upon the instrumentation developed for capillary ripple measurements (45-47), with a frequency source, a modified phonograph speaker for generation of the ripples, and a modified phonograph cartridge for measurement of the ripples. The phonograph speaker was coupled to the interface by an inverted T-bar, with the top of the T parallel to the undisturbed interface, which oscillated perpendicular to the interface when the frequency source was activated. The phonograph cartridge used in measuring the ripples was mounted on a micro-manipulator with three degrees of motion and was coupled to the interface by a receiving probe in the shape of an L, the bottom leg of the L being parallel to the generating bar at the interface. The signal from the receiving probe coupled to the phonograph cartridge was shown to be proportional to the wave amplitude (45), and was thus an accurate measure of relative amplitude changes in the ripples. The horizontal drive of the micro-manipulator was mechanically connected to a Helipot resistor, which was calibrated from a vernier scale on the micro-manipulator in terms of distance, using a Wheatstone bridge circuit, giving an accurate distance measuring device rigidly attached to the receiving probe. The wavelength of the ripples was measured as follows: The signal from the frequency generator was used as the y-input, and the receiving probe signal, after amplification, was used as the x-input to an oscilloscope. The resulting Lissajous pattern gave a measure of the phase relationship between the input signal from the oscillator and the output signal from the cartridge. If the receiving probe was moved horizontally such that the Lissajous figure went through a 360 degree phase change, the distance moved by the probe was one wavelength, which could be measured by the resistance change caused by moving the probe. The frequency was measured accurately by monitoring it with a frequency counter, and the signal from the receiving probe was measured, after filtering and amplifying, using a rms VTVM (vacuum tube voltmeter).

In the capillary ripple instrumentation, a thick rigid wire, machined from two sides at a right angle to form an edge, was used as that part of the T-bar in actual contact with the surface, while a single edge razor was used as the bottom leg of the L-shaped bar used as the receiving probe.

Initial experiments at the interface between mercury and an aqueous solution utilized the same electronic instrumentation as described above. However, it was observed that the receiving probe made with the razor blade welded onto a rigid wire corroded very easily at this interface. Steps were taken to redesign the receiving probe such that useful measurements could be made. Empirically, the probe found to give the best results was a rigid, high-quality stainless steel wire of a diameter slightly greater than that of a paper clip. This wire was bent in the form of a modified L, with the bottom leg being rounded at both the attached and free end, and was coated with paraffin or Teflon resin to further reduce corrosion. The generating probe attached to the speaker was left much as described above, with a paraffin coating used to stop corrosion and maintain a constant contact angle at the interface.

In the initial experiments, there was a problem with noise picked up by the receiving probe, which was improved somewhat by the redesign of the probes as mentioned above (See Figure 1). In later experiments another method of eliminating the noise was utilized. It was found that a special type of amplifier (known as a lock-in-amplifier) which was phase and frequency sensitive in the signal which it amplified was commercially available. A Princeton Applied Research Corporation Model HR-8 precision lock-in-amplifier was purchased and substituted in the circuitry for the signal amplifier used with the receiving probe signal (see Figure 2).

The lock-in-amplifier, hereafter referred to as LIA, is described in its instruction manual as follows:

> "The ... amplifier is essentially a detection system capable of operating with an extremely narrow equivalent bandwidth. Its function is to select a band of frequencies from a signal spectum applied to its input circuit and to convert the information therein to an equivalent bandwidth at dc. The basic element of a lock-in-amplifier is a phase-sensitive detector in which the signal voltage is mixed with a reference voltage, producing sum and difference frequencies."
>
> (See Figure 3)

The sum frequencies are rejected by a filter, the difference components of the signal at the reference frequency are passed, and they have a zero frequency, i.e. they are dc. If the reference frequency used in the LIA is the same as the frequency of oscillation used to excite the generating probe, the LIA can be used to eliminate that noise picked up by the receiving probe not at the frequency of the ripple oscillation. This could be done by changing manually the reference frequency generated internally in the LIA to agree with the external frequency source used up to this time. It was discovered, however, that this reference frequency generated internally could be tapped for external use. This reference frequency was then used as the frequency source for the ripple experiments, after it was first amplified to a level sufficient for excitation of the speaker-generating probe assembly. The internal frequency from the LIA was measured after amplification using a frequency counter, as described previously; it was also used as the x-input to the oscilloscope, with the external signal from the receiving probe through the LIA as the y-input. At a times the signal to the speaker was monitored using an rms voltmeter to determine if the signal was fluctuating and to insure that the speaker was not overloaded.

As previously stated, the initial instrumentation included signal filters. These were tuned filters, tuned to frequencies of 20, 60, and 240 Hz, so as to eliminate noise from line voltage frequency and its multiples, and also noise generated in the instrumental circuitry. It was determined, once the LIA was included in the measuring set-up, that the two lower frequency filters led to a large power loss, gave some distortion of the wave form displayed on the oscilloscope and they were therefore eliminated. The 240 Hz filter was retained for use at the mercury-solution interface, as it appeared that this filter was necessary for stability of the Lissajous figure displayed on the oscilloscope.

The micro-manipulator, used to mount the receiving probe and crystal cartridge in these experiments, was a Brinkman

Instruments model MP-V. This differed from the one used in this laboratory previously in that it had available rotation in the horizontal plane, besides motion in two mutually perpendicular directions in this plane, and that it had a coarse and fine control for vertical motion. A Starrett Co. Flex-O-Post was attached to the arm which was used for motion in the direction of ripple propagation. This is an extension arm which allows flexible motion when unlocked, but becomes rigid when locked, and was attached for easier positioning of the receiving probe at the interface. The crystal cartridge and receiving probe were attached to this Flex-O-Post arm by a Lufkin Co. Universal Friction Joint, again for more freedom of motion in positioning the receiving probe. A Starrett Co. Satin-Chrome Master Vernier Caliper was modified and attached to the micro-manipulator to increase the accuracy of the calibration of the Helipot resistor used with a Wheatstone bridge circuit for measuring distance in the direction of ripple propagation. These modifications of the micro-manipulator were performed by D. Brown and C. Miller of the ISU physics shop.

Polarization Apparatus

The initial experiments at the mercury-electrolyte solution were performed with no provisions for controlling the polarization of the interface. As explained in the theoretical section, the properties of this interface should be strongly dependent on the polarization of the interface. The data obtained at the unpolarized interface substantiated this strongly; they were so non-reproducible as to be essentially meaningless. It was therefore necessary to set up a system in which the interfacial polarization could be controlled and monitored during the course of interfacial ripple measurements. The following design resulted from a combination of theory and empirical observation.

The interface was prepared by placing a shallow Teflon dish (6 in. by 6 in. by 1 in.) inside a larger glass dish (8 in. by 8 in. by 2 in.), filling the glass and Teflon dish with the aqueous solution, and pouring the mercury through the solution to displace it in the Teflon dish. The mercury was poured in last to reduce splattering of the mercury and attendant mercury vapor health hazards. This construction permitted convenient cleaning of the interface by aspiration.

The polarization of the interface was effected by placing six platinized platinum sheet working electrodes as symmetrically as possible about the Teflon dish and connecting these to the cathode of an adjustable e.m.f. source, while the mercury was connected to the anode. The e.m.f. was provided by two or three mercury batteries in series with a conventional voltage divider. The potential was monitored with a saturated calomel electrode (hereafter referred to as SCE) dipping into the aqueous phase connected to a high precision potentiometer whose other connection was to the mercury.

The design of a polarization system for interfacial ripple experiments was complicated by the necessity of a relatively large interface resulting in an appreciable current flow. One problem was to minimize interfacial area as much as possible without introducing problems due to reflections from vessel edges. Another problem was to increase the number of working electrodes as much as possible to decrease the current flow from a given electrode and increase the uniformity of the potential field at the mercury. As the mercury is a conductor, in the absence of a current passing through the interface the potential gradient at the interface must be normal to the mercury from the dielectric liquid (36, 50). To a good approximation, with a small current passing through the interface, having the working electrodes at as great as possible a distance from the interface will even out the electric field at the interface, providing the distribution of working electrodes is relatively symmetric. This was experimentally verified in that the potential measured did not vary more that one millivolt as the calomel electrode varied about the interface.

The best placement of the calomel electrode was another feature of the apparatus that had to be empirically determined. As the interface was so large as to make exclusion of oxygen very difficult, the system was exposed to the atmosphere. Thus, there was a small degree of oxidation of the mercury at the interface. The chloride ions which of necessity leak from the SCE interacted with the oxidized mercury to precipitate Hg_2Cl_2 at the interface if the distance or time was such that Cl^- could diffuse to the interface during the course of an experiment. Thus it was found best to place the calomel as far as possible from the interface. Also, it was found necessary to place the calomel electrode away from the vicinity of any of the working electrodes because the local potential fluctuation about these did not correctly reflect the potential in the liquid at the interface. Then within the time of an experiment, the insertion of the calomel electrode did not interfere with the data taking.

The first two series of experiments were performed with the polarization apparatus described above. In later experiments, due to some apparent anomalies in the data, the apparatus was modified to allow continuous monitoring of the current-voltage relationships in the polarization circuitry. This was done by placing a small (relative to the total circuit) resistor in series with the working electrodes, and using the voltage drop across this resistor as a direct measure of the current. This voltage was fed into the x-input of a Mosely Autograf X-Y Recorder. The y-input was the polarization voltage as measured between the SCE and the mercury. The data were then plotted by the recorder to display accurately the current-voltage relationships during experimentation.

Experimental Materials and their Preparation

The following interfacial systems were studied:

1. Octanoic Acid in 0.1-N $HClO_4$--Mercury
2. Phenol in 0.1-N $HClO_4$--Mercury
3. Sodium Decyl-Sulfonate in 0.050-M Na_2SO_4--Mercury.

In each system, the first mentioned material is the surfactant, and the second the so called "inert electrolyte", which makes the solution conducting, permitting the polarization of the interface.

Extreme precautions had to be taken with the purity of the materials used in experiments at the mercury-solution interface, as this interfacial system has been shown to be very sensitive to impurities (20, 32). The mercury, especially, had to be treated very carefully to insure that its surface was free from contaminants. Triply distilled mercury was obtained from the Ames Laboratory stockroom, rinsed with dilute KOH solution, rinsed with dilute HNO_3, and then washed twice in purified water. The rinsing, in all cases, was done by letting the mercury flow through a fine capillary tip to break up into a stream of small droplets which fell through the washing solution. The washing solutions were contained in 100 ml. burettes attached to a movable rack, especially constructed to carry the weight of large volumes of mercury. During and after purification, the mercury was kept covered with a layer of purified water to prevent oxidation of its surface.

The purified water was obtained by taking tap distilled water, distilling it from alkaline permanganate solution, and then doubly distilling from an all quartz still. Periodic checks of this water by R. L. Bendure[1] showed its surface tension to be in agreement with the best quoted literature values.

The perchloric acid used was Baker Analyzed 70% $HClO_4$, which was diluted with no further purification. Analytical reagent Na_2SO_4 was used directly as received. Initially the reagent was heated at 800°C. for two hours to eliminate organic contaminants, but it was pointed out by Professor

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[1] R. L. Bendure, unpublished results, Department of Chemistry, Iowa State University, Ames, Iowa, private communication. 1967.

Harvey Diehl[1] that this procedure could yield more impurities, especially other oxidation states of sulfur, than it eliminated, and the commercial synthesis of the Na_2SO_4 was not likely to introduce organic impurities.

The octanoic acid was purified by taking the middle fraction, boiling over a 1° range at 238°C., from the distillation of chemically pure octanoic acid through a 30 plate Oldershaw column. Solutions were prepared by diluting a concentrated solution of the acid.

The phenol was analytical grade reagent, containing no preservative, further purified by distillation through a Vigreaux column. The phenol solutions were prepared by diluting a standardized solution, the concentration of which was determined by bromination (30).

The sodium *n*-decyl-sulfonate (NaDS) was obtained from Aldrich Chemical Co., and was further purified by recrystallization from ethanol. Solutions were prepared by weighing for the more concentrated solutions, and by dilution for the lower concentrations.

Experimental Procedure

With the interfacial ripple experimental system, two types of experiments are possible. The first is the variable distance measurement, in which the frequency and other variables of the system are kept constant while the output

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[1] H. Diehl, Department of Chemistry, Iowa State University, Ames, Iowa, private communication. 1967.

voltage of the system is measured as a function of distance. In the second type of experiment a constant number of waves is maintained between the two probes by varying the frequency as other variables of the system are changed.

Variable distance method

This type of experiment is the type of experiment for which the apparatus was initially designed. The frequency and surface parameters are kept constant while the output voltage from the receiving probe and the Lissajous figure displayed on the oscilloscope are monitored as the distance is varied. The distance variation is measured by resistance readings from the Helipot attached to the horizontal drive of the micromanipulator. This technique furnishes output voltage as a function of distance, with the wavelength of the ripples being obtained by distance readings between Lissajous figures having a 360° phase difference. The Lissajous figure which results from two signals of the same frequency and different amplitudes is an ellipse which degenerates to a straight line when the two signals are in phase or 180° out of phase. This straight line was observed to be the most sensitive and most accurate figure for detecting the phase change necessary for measuring wavelengths. The error of the wavelength readings for lower frequencies was between .1 and .5%, while for higher frequencies (lower wavelengths) the error was between .5% and

1.5%. This was due to the fact that the absolute error in the difference reading used to obtain the wavelength remained the same, while the difference decreased.

The plot of output voltage vs. distance is not a simple exponential curve as one would expect for a running wave, but a periodic function of distance due to standing waves set up between the two probes. To calculate the damping coefficient from the output voltage (OV) vs. distance curve, one must use methods which take this fact into consideration. Hansen and Mann (25) have done this, and the formula used to calculate results is a modification of their results by Lucassen and Hansen (43). Due to superposition of reflected waves between the probes, the OV vs. distance data will show maxima and minima. Drawing envelope curves through these maxima and minima, we obtain the variables V(d), and v(d), where V is the envelope curve of the maxima, and v, of the minima. The damping coefficient, α, can then be given as

$$\alpha = \{\ln[1/V(d_i)+1/v(d_i)]-\ln[1/V(d_j)+1/v(d_j)]\}/(d_i-d_j) \quad (90)$$

where i and j indicate two position whose Lissajous figure differ in phase by one cycle, and d is the distance reading at a point. If the distance between probes is large enough, the output may be assumed (to a good approximation) to be a simple exponential function of distance of the form

$$OV = OVOe^{-\alpha x}, \quad (91)$$

where x is the distance between probes, and OVO is the output at the generating probe. The damping coefficient may then be calculated as

$$\alpha = \ln(OV_i/OV_j)/(x_i - x_j) \tag{92}$$

where i and j are two positions differing by an integral number of wavelengths. Within the accuracy of the experimental data, after the number of wavelengths between probes exceeded approximately 10 - 12, the damping coefficients calculated by the two formulae were the same, and so because of the simplicity of the experiments needed to obtain the data for using 92, this calculation was used.

<u>Constant k technique</u>

This was the second type of experimental method used to obtain ripple data, and as its name indicates, it is a method in which the wavenumber, $k = 2\pi/\lambda$, is kept constant during the course of the experiment (5, 24). This was done by setting the probes at a constant separation with a straight line for a Lissajous figure, and keeping this Lissajous figure constant by changing the frequency as the surface parameters were changed. In this type of experiment, the initial frequency was arbitrary. The experiment furnished frequency and output voltage as functions of the changing surface parameters.

The damping coefficient and the wave number at the initial frequency were determined by a variable distance measurement. The wavenumber was then kept constant and the damping coefficient was calculated at all other frequencies by relating it to the initial measurement. When the experiments were in their first stages, the damping coefficient at an arbitrary frequency, ν, was related to the measured value at the initial frequency using the following formula:

$$\alpha(\nu) = \alpha(\nu_0) - (1/L)\ln[OV(\nu)/OV(\nu_0)] \ , \qquad (93)$$

with ν_0 = initial frequency, L = probe separation. This equation assumed that the output of the speaker was frequency independent at constant electrical input. This assumption was true if the frequency range investigated was small, but if the experimental range was large, the calculation procedure had to be modified to account for the frequency dependence of the wave generator. This was done experimentally, and the modified equation

$$\alpha(\nu) = \alpha(\nu_0) - (1/L)\ln[OVO(\nu_0)OV(\nu)/OV(\nu_0)OVO(\nu)], \qquad (94)$$

where $OVO(\nu)$ is the calibrated output of the wave generator at a given frequency, resulted.

The surface parameters, the interfacial tension and the surface elastic modulus, were varied by changing the polarization of the interface for a constant concentration of surfactant, this being done for a chosen range of concentrations. Controlling the polarization of the interface permitted an accurate, variable method of controlling the surface, a method feasible only if one of the two liquids in an interfacial system is a conductor.

Choice of surfactants

The choice of surfactants was based on the availability, ease of purification, and completeness and quality of pertinent reference data. The surfactants also had to be relatively involatile, due to the large amount of surface area exposed during experimentation.

The octanoic acid was chosen due to the availability of data from previous investigations in this laboratory (26, 27, 43). The phenol was chosen to utilize the work of Kelsh (23, 31) while the NaDS was chosen to utilize the work of Smolders (55-57). In the last two cases, full electrocapillary curves were available over a range of concentrations.

The density and viscosity values used in all calculations were literature (29) values for mercury and pure water. The viscosity and density of the aqueous solutions were assumed to be unaffected by the electrolyte and surfactant.

Cleaning of the Interface

Before each experiment, a high negative polarization was imposed upon the interface for about two minutes, and then the interface was aspirated with a fine capillary after ceasing the polarization. As the surface returned to equilibrium at zero applied potential, those impurities present tended to collect in the center of the mercury surface due to the fact that the interfacial tension remained higher there while the interface discharged. The Marangoni effect then swept the surface contaminants toward the center for easy removal by aspiration. Other impurities were field desorbed into the bulk solution, and hopefully did not return to the interface during the course of an experiment.

CALCULATION SECTION

Introduction

As mentioned above, initial experiments at the mercury-solution interface were performed utilizing variable distance measurements. All later experiments, however, were performed using the "constant k" techniques. "Constant k" experiments generated output voltage and frequency values as functions of interfacial polarization, plus initial damping coefficient, frequency, and wavelength values. These sufficed to give experimental values of ω, k and α, while values for μ, μ', ρ, and ρ' were taken from the literature. Reference data yielded γ values. Since our theory contains ten variables, and 2 equations (the real and imaginary parts of equation 32) relating them, the 8 variables mentioned above enable us to solve for the two unknown quantities, the real and imaginary components of the surface elastic modulus. With the assumption $E=0$ the theory enables us to solve for γ.

YCOR

With these considerations, a program YCOR (Figure 4, Appendix B), was written to analyze the experimental data. The first part of the program reads in viscosities, densities wavelength, initial damping coefficient and corresponding output voltage, and probe separation as fixed variables.

It then reads the arrays of frequency, output voltage, and polarization voltage. The output voltages are then modified by subroutine AMPCOR to account for the amplitude-frequency response of the ripple generator. AMPCOR requires the frequency at which the initial damping coefficient is measured, and the polynomial coefficients from the calculated fit to the experimental amplitude-frequency data generated by the program CALB, to be discussed later. The main program, YCOR, then calculates the experimental damping coefficients using equation 94, and calculates experimental Y2 values. Experimental Y1 values are calculated from experimental values of ω and k, and the reference values of γ, ρ, and ρ'. The experimental Y1 and Y2 values for each voltage are placed in arrays to be used as needed. The program then calculates experimental γ assuming E=0, and experimental Re(E) and Im(E) using equations 44 and 45, respectively. These operations are performed using the complex arithmetic procedures available with the FORTRAN IV, G level, computer language available on the IBM 360/65 computer at the ISU computation center. Subroutine MODEL is then called by the main program.

Subroutine MODEL was included in the program to generate values of several variables from the modified Frumkin model of surface behavior discussed in the theoretical section. Taking as input values the surfactant concentration, surface viscosities of the pure interface and of the surfactant, the voltage of the ECM for the given surfactant concentration, β, $1/B_0$, $1/B_0\Gamma_{max}$, $RT\Gamma_{max}$, and K (the electrical desorption exponent), the subroutine draws from the main program the polarization voltages and calculates surface coverage (Θ) values. The values for Θ are generated using a numerical method known as binary chopping (21). If it is known that a function is positive at one end of an interval, negative at the other, and has only one root in the interval, it is possible by successively chopping the interval in half to arrive at the root. This is done by setting our equation for Θ in the form $f(\Theta)=0$, and then choosing $0 \leq \Theta \leq 0.999999$ as the initial interval. We know that $f(0)$ is less than zero and $f(.999999)$ is greater than zero, so our root lies in this interval. We define Θ_{mid} as $\frac{1}{2}$ the interval midpoint, 0.4999995 in this case, and evaluate $f(\Theta_{mid})$. If it is less than zero, this becomes our new lower interval bound and if it is greater than zero, it becomes our new upper interval bound. In either case, Θ_{mid} is recalculated and the procedure is repeated until the difference between the bounds is less than the desired accuracy, in our case 1×10^{-6}.

After Θ has been evaluated, it is used to generate the components of the surface elastic modulus as described in the theoretical section. These elasticity components along with frequency, densities, and viscosities are fed to subroutine POLZRO, a subroutine programmed by J. Mann to evaluate the complex wave number using the above input. POLZRO utilizes the Newton-Raphson method (14) to extract the desired complex root of the equation resulting from the determinant solution to the ripple boundary value problem.

This method was chosen after an attempt to calculate α using a simple iteration method with modeled parameters failed. The equation resulting from our determinant, 44, was rewritten as $\alpha=g(\alpha)$. Then an attempt was made to generate α values by writing

$$\alpha_{n+1} = g(\alpha_n), \qquad (95)$$

where α_0 is chosen as the experimental value, and all other values in $g(\alpha)$ are from model or experiment.

A test of $(\alpha_{n+1}-\alpha_n)^2$ was included to monitor the convergence of the iteration to a final value of α_n. This method, using two different data sets, generated either negative α values, or $g(\alpha)$ became very large and the calculation did not converge in 500 iterations. The negative α values are physically impossible in our steady-state systems, while large α values are probably due to roots from transient, non-sinusoidal waveforms. These results led to the choice of the approximation method programmed by J. Mann in POLZRO.

GVAL

GVAL (see Figure 5, Appendix B) was written to generate interfacial tension values at arbitrary voltages from coefficients of a polynomial fit to electrocapillary curves produced by a program, EC1, written by D. Broadhead[1]. The procedure used was to input interfacial tension-voltage values into EC1, and then take the polynomial fit from this program into GVAL, which will then calculate γ values at any voltage desired. The program was written because some of the reference interfacial tension values were measured at 100 mv. intervals, while during much of the interfacial ripple experimentation, the data were measured at 25 mv. intervals.

CALB

CALB (see Figure 6, Appendix B) was programmed to fit the ripple generator amplitude response at constant electrical input-frequency data, and to generate coefficients from this fit. The main purpose of the program was to catalogue and arrange amplitude-frequency data to be fed into subroutine OPLSPA. This subroutine, available at the ISU computer library, is written to take an array of dependent

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[1] D. Broadhead, unpublished results, Department of Chemistry, Iowa State University, Ames, Iowa, private communication. 1966.

and independent variable data and fit it with a polynomial in the dependent variable of desired degree (up to a maximum of ten) whose fit is optimal in the sense of least squares. It is a rapid and efficient computer method of obtaining fits to data sets of reasonable accuracy.

The frequency range of 150-600 Hz for which reasonable data were obtainable was split up into 3 sections, 150-230, and 230-325, and 325-600. This was done as there is a mechanical resonance in the ripple generator at a frequency near 210 cps, and because fitting the other sections separately gave a more accurate fit.

The amplitude data were calculated from experimental data using NWV, a program written by R. L. Bendure, and described in his thesis (4).

Because calculations tended to multiply errors and because many of the variables depended on calculations of small differences between large numbers, most of the programming was done using double precision accuracy.

One other program was utilized in handling the interfacial ripple data, and this was a program to study error propagation in the calculation of ripple parameters from experimental data. This program takes as input experimental parameters and their absolute errors, and from these calculates the error in the variables computed from these data. This program was written by J. Mann, Jr.

RESULTS

System I: Octanoic Acid in N/10 $HClO_4$

As previously stated, the experimental systems studied were octanoic acid in .1-N $HClO_4$, phenol in 0.1-N $HClO_4$, and sodium decyl-sulfonate in 0.050-M Na_2SO_4. Of these, the first to be studied was the octanoic acid system, for which there is no reference **electrocapillary** data available (at least to this author's knowledge). This implies that only a qualitative type of evaluation of the data from this system was possible, since calculations based on modeled behavior require interfacial tension values. The experimental data permitted one to calculate Y2 and interfacial tension (assuming E=0) as functions of the polarization voltage. The concentrations of surfactant used were $c_o/8$, $c_o/32$, $c_o/64$, (c_o=saturation concentration), and the pure electrolyte. These concentrations were chosen since preliminary order-of-magnitude calculations indicated that they would give a range of surface behavior that would hopefully illustrate all facets of the behavior of the dimensionless variable, Y2, the reduced damping coefficient.

The experimental Y2 data of Figure 7 (24) yielded results in good agreement with the qualitative predictions of behavior based on previous experience at the air-water interface. For the pure electrolyte, the values of Y2 were small and relatively insensitive to the polarization imposed on the interface. Y2, with $c = c_o/64$, was close to that of the pure electrolyte for high polarizations vs. the ECM,[1] and went through a maximum centered at the ECM, the region of highest surface coverage. Again for $c = c_o/32$, Y2 was approximately equal to that of the pure electrolyte at high polarizations. However, it exhibited two maxima, at voltages equally spaced in the positive and negative direction with a (lower) value at the ECM equal to the value at $c_o/64$. The Y2 data for $c_o/8$ gave a broad flat maxima centered about the ECM, tapering off sharply to the pure electrolyte value at high polarizations. It may be noted here that the values of the maxima for $c_o/32$ were close (.0165 vs. 0157) to values generated for the NaDS system when reference data were available. Also the Y2 for $c_o/8$ ($\theta \approx 1$) was very close to the limiting behavior for large E shown for NaDS (.013 for both cases) (see .00025 NaDS).

For the octanoic acid data, the interfacial tension values were calculated using a modification of equation 34

$$\gamma = \gamma_0 (\nu/\nu_o)^2, \qquad (96)$$

where γ_0 is a known or calculated value (again from 34), and

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[1] In the following material, the polarizations will be referred to the electrocapillary maximum (ECM) for the given concentration, i.e., V=0 at ECM. For the phenol in 0.1-M $HClO_4$, this varies from -.475 to -.625 V. vs. S.C.E. as the phenol concentration increases. For NaDS in 0.05-M Na_2SO_4 the ECM varies with the concentration from -.460 to -.600 volts vs. S.C.E. (see Appendix D). The voltages on the figures are as experimentally measured vs. the S.C.E.

ν_0 is the frequency corresponding to this value. This equation also results if the dimensionless variable Y1 is assumed constant, which will be true to the accuracy of the experimental data if E = constant. The interfacial tension values calculated from the ripple data assuming E=0 gave both qualitative and quantitative agreement with reference data for the pure electrolyte (Figure 8). The values from the surfactant solutions (Figure 9), while displaying several features expected of surfactant electrocapillary curves, seemed to be qualitatively incorrect. The curves were not always smooth, and the interfacial tension values at the ECM did not monotonically decrease with increasing concentration as has been observed with all other electrocapillary data. It should be noted that the assumption E=0 is not very well justified for the surfactant data, since the quantity Y1 will not be constant, as seen from equation 30, and will vary with E.

The data for the octanoic acid system was obtained at 50 mv. intervals (except in the region of rapid Y2 change), as compared to the 25 mv. interval used in the other experimental systems, due to the fact that these investigations were of a preliminary, qualitative nature. It was initially felt that this interval was sufficient to give all qualitative features of the system. However, the interval was reduced in later experimentation since the reference interfacial tension data was available in this spacing, and it afforded better resolution of variable changes.

System II: Phenol in N/10 $HClO_4$

Introduction

The phenol in 0.1-N perchloric acid system was chosen because a complete investigation of the electrocapillary properties of this system had been done in this laboratory by D. Kelsh (23, 30).

The concentrations chosen were those used by Kelsh, 0.001-M, 0.005-M, 0.010-M, 0.030-M, 0.060-M, and 0.100-M. Together with the data from the pure electrolyte, these concentrations sufficed to give a rather complete description of the surface properties of phenol as measured at the polarized Hg interface throughout almost its entire range of surface concentration.

The data for the phenol system was obtained before the Lock-In-Amplifier was obtained, and thus the output voltage data was read from a rms VTVM after non-selective amplification of the signal from the crystal cartridge connected to the receiving probe. These data were also obtained with all of the tuned filters (20, 60, and 240 Hz) included in the circuit to eliminate noise, and a resultant signal attenuation. The error levels in the phenol data remained relatively constant throughout the concentration range and may be given to a good order of approximation by the following values: wavelength - 0.1 to 1.0%; output voltage - 10 to 15%; frequency - 0.1 Hz; polarization voltage - 0.01 mv; and reference interfacial tension - 0.2 to 0.3 dyne/cm.

For each concentration of phenol, data were taken over the entire electrocapillary range; i.e., in the interval -1.3 volts to +0.25 volts vs. S.C.E. at 25 mv. intervals.

Parameters for modeled behavior

The parameters that are needed for the modified Frumkin model are easily determined from the discussion given in the theoretical section. The first of these is the Frumkin exponent, β, which describes the lateral interaction in the surface layer. For phenol this parameter has been determined by previous work in this laboratory (27) to be 1.22. The quantity B_o had also been determined in this work, but later work by Kelsh showed the earlier value of 5.5 to be in error. His work showed that at c=0.005-M the value of Θ, the surface coverage, was $\geq \frac{1}{2}$. This simplies that B_o, approximated for $\Theta=0$ (Langmuir behavior), is equal to 1/0.005, or 200. This was the value chosen as the input value for the computer calculation of the modeled values. No literature surface viscosity values could be found for this system. It seems that work measuring surface viscosities at the surfactant solution-mercury interface has never been attempted, the work being limited to the air-water and the organic oil-water interfaces. Therefore it was necessary to make order-of-magnitude arguments to choose values as input parameters for the calculation. From the values mentioned in Davies and Rideal (8), values of 10^{-6} surface poise for the pure interface and 10^{-4} surface poise for the phenol are not unreasonable. Several μ_s values were also used in the calculation to determine the importance of the contribution of this part of the elastic modulus to the behavior of surface. If these values were less than 10^{-3} surface poise, their effects were unimportant. The maximum surface concentration, Γ_{max}, was evaluated from the data of Kelsh to be 4.1×10^{-10} moles/cm^2. This gives a value for the parameter $RT\Gamma_{max}$ of about 10, the value used in the calculations. The value of $1/B_o\Gamma_{max}$ appearing in the diffusion term was roughly used as an adjustable parameter. The value chosen was 10,000, while evaluation of it using the data above gives 12,200, essentially equal values considering the accuracy of the model. The exponent, K, which appears in the electrical term, would be given by $(C_w - C_{org})/2RT\Gamma_m$ if both of the capacitance values were constant through the polarization range. But since they are not, the value of K estimated from Kelsh's capacitance data at various polarizations showed it to be in the range from 10-40, when V is in volts. A value of 15.0 for phenol was then chosen from this range to give 0 values in the experimental range. This value gave the appropriate width to the 0 vs. V curve. The voltage of the electro-capillary maximum for each concentration was determined from the data of Kelsh, and is listed with each concentration in Appendix D.

Behavior of ripple parameters

The frequency vs. polarization curves (hereafter, plot abscissa will be polarization unless otherwise stated) from the phenol data resembled electro-capillary curves. At the lower concentrations and with the pure electrolyte, the curves were parabolic in shape, with some little flattening and lowering in the center. At concentrations of 0.01-M and greater, the curves became noticeably flattened about the center. Only one of these curves (Figure 10) is given in Appendix C, with the data for all the others given in the data listings (see Appendix D).

As would be expected, the electrocapillary curves calculated from the interfacial ripple data assuming E=0 agreed quite well with the reference data at the lower concentrations; as the concentrations increased the agreement became less satisfactory, especially at more negative potentials. A plot (Figure 11) showing both the experimental and reference values for 0.005-M phenol illustrates the type of behavior observed.

The Θ curves (Figure 12) calculated with the parameters given above showed the effect of concentration on the amount of surfactant adsorption. There was a large increase in Θ between 0.001 and 0.005-M about the ECM. With increasing concentration, the Θ peaks became broader and shifted slightly with the ECM values in the direction of negative polarization. It appeared, at least from these calculated curves, that the desorption from the maximum coverage occurred over a narrow voltage range with the coverage being little affected until this rapid desorption set in.

The model-generated values of the complex surface elastic modulus reflected the coverage increases due to concentration, but also began to show the effects of the diffusional interchange between the bulk solution and the interface. As the values for Θ approached one, the term $(1-\Theta)^2$ in the quantity $\frac{dC'}{d\Gamma}$ of the diffusional correction became dominant with respect to other terms in the expression for E. This counteracted the contributions to E from the increasing coverage, especially at higher concentrations, so that the calculated E passed through a maximum (located between .005 and .01-M) with increasing concentration. The experimental curves did not show such readily interpretable behavior, but did indicate a decrease in elasticity components at higher concentrations. It was difficult to interpret the behavior of the experimental curves due to the fact that they were very sensitive to experimental error, a fact which will be discussed in more detail later. Figure 13 illustrates the behavior of the model and experimental values for one phenol concentration, with the data for all concentrations given in Appendix D.

Figures 14-17 give results from experiment and the model with the diffusion correction included for the dimensionless parameter Y1, the Kelvin function, at the lower phenol concentrations (0 through 10^{-2}-M). The experimental curves in these plots showed much the same structure. They decreased from a maximum at the extreme negative polarizations to an almost linear form sloping from negative to positive voltages. The model-generated Y1 curves did not show similar behavior. The pure electrolyte curve was constant, the 10^{-3}M curve had a single shallow maxima, while the .005 and .010-M curves had a pair of maxima about the ECM.

Figures 17-20 give the Y1 curves for the more concentrated phenol solutions. The experimental curves are similar to those of the more dilute solutions. Two model curves, one calculated with and one calculated without the diffusion correction to E, are given for each concentration to illustrate clearly the importance of diffusion to the ripple parameters. The maxima in Y1 displayed at .005 and .010-M are washed out in the more concentrated solutions if the diffusion term is included. If it is not included, these maxima become more important and more acute. In all curves, the model and experiment agree within 2% except at potential extremes.

The Y2 curves from experiment and model (including the diffusion term) for the more dilute (0 to .01-M) phenol solutions are given in Figures 21-24. The experimental curves, except for the pure electrolyte, are approximately linear in form, with a positive slope from negative to positive voltages. The .01-M experimental curve also shows a small minimum just to the negative side of the ECM. The experimental Y2 magnitude increases with the phenol concentration.

The model Y2 curves for these concentrations are constant for 0 and 10^{-3}-M, while the .005 and .010-M solutions show a broad hump with a shallow maxima on either edge about the ECM.

Figures 25-27 show the Y2 curves from experiment and model (again, with and without the diffusion correction) for .030, .060 and .100-M phenol. The experimental curves are almost constant, increasing somewhat from positive to negative voltages. When the diffusion term is included, the model values are likewise, almost constant, with a hump in the center which broadens out and flattens as the concentration increases, showing that diffusion becomes dominant at higher concentrations. If the diffusion correction is not included in the calculation of our model-generated values, the Y2 curves show the paired maxima seen experimentally with octanoic acid. The agreement between experiment and model is quite good for the higher concentrations when the model includes diffusion, and for 0 and 10^{-3}-M. But at .005 and .01-M, the experiment and model differ by as much as 50% about the maxima in the model curves, perhaps indicating that the diffusion effects may become important at lower concentrations than the model suggests.

System III: NaDS in 0.05-M Na_2SO_4

Introduction

The second surfactant system to be studied in detail with the aid of reference interfacial tension data was sodium n-decyl-sulfonate, hereafter referred to as NaDS, in 0.050-M sodium sulfate. This system was chosen because of the availability of the reference data[1] (56-57), and the difference in electrolyte and surfactant from the two previously investigated systems. The electrolyte sodium sulfate was a neutral salt, as opposed to the perchloric acid. The surfactant NaDS was ionic and contained a sulfonate group attached to the hydrocarbon skeleton, in contrast to the non-ionic (in acid media) and oxygen-

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[1] This data of these references was kindly made available in tabulated form in a private communication by C. Smolders. C. A. Smolders, Velp, The Netherlands, 1966.

containing surfactants used in the other systems.

Anomalous behavior

Just due to these differences in chemical structure, the experimental results from the NaDS system were expected to show unique behavior. But preliminary results differed from previous work in a manner which did not seem to stem from the static, molecular properties of the system. The system with zero or low surfactant concentrations exhibited anomalies in experimental values for output voltage and frequency in the region of interfacial polarization bounded on the negative side by -.400 V. and on the positive side by -0.100 V. (both referred, as were all experimental polarizations, to the saturated calomel electrode-SCE). The frequencies increased more slowly with polarization than expected from the reference electrocapillary data, and then exhibited a discontinuous jump to the expected value at the negative end point of the polarization region. The output voltage which reflected the wave amplitude dropped sharply in this region and then increased gradually. This occurred when the polarization was scanned from positive to negative, but not when the scanning direction was reversed. The anomalies decreased as surfactant concentration was increased, disappearing at a NaDS concentration of 0.00005-M.

The possibility of electrochemical effects was considered, and apparatus as described in the experimental section was set up to monitor the current-voltage relationships during the ripple experiments. The current-voltage curves showed that the current went through a distinct maximum in the region of the anomalies in the ripple data, and that this maximum decreased and then disappeared with increasing NaDS concentration. The current maxima appeared only as the polarization was scanned from positive to negative, and was absent when the direction of polarization scan was reversed. The general shape of the current-voltage curves at the higher concentrations was that of a polarogram of a pure electrolyte with no reducible metal ions present. As the surfactant concentration was decreased to the point where the maximum appeared, the curve took on the appearance of a polarogram run in the presence of O_2 without "maximum suppressor" present (Figures 57-59).

Whenever an aqueous solution is exposed to the atmosphere, it rapidly becomes saturated with O_2 from diffusion processes. This dissolved oxygen interferes with many phenomena studied in aqueous solution electrochemistry. In polarography especially (28, 31), it has long been known that solutions must be purged and then continuously flushed with nitrogen to rid the solution of the oxygen in order that it not interfere with the reactions of interest at the dropping mercury electrode. If this is not done, the oxygen maxima appears in the current voltage plot, sometimes masking other reactions of interest.

The amounts of solution and the amount of interfacial area common to polarography are small when compared to the quantities used in the interfacial ripple experiments. It was thus very difficult to exclude oxygen satisfactorily from the system. Solutions were purged before experiments, but became apparently saturated with oxygen very soon after they were poured over the mercury pool forming the lower phase. Continuous flushing of the solution by a stream of nitrogen could not be used because the attendant mechanical disturbance involved interferred with ripple measurements.

According to Kolthoff and Lingane (31), this behavior closely parallels the oxygen maxima in polarography, which occurs in the region of the above observations. The oxygen maxima is caused by the electrochemical reduction of oxygen at the Hg surface, the resulting streaming of the solution, and the sharp current increase due to the reduction process. There are other maxima observed in polarograms, usually independent of the direction of polarization scan. But the acute O_2 maxima does not show like behavior and is dependent on the direction of the potential scan, appearing only as one goes from positive to negative. Kolthoff and Lingane (31) also quote Heyrovsky as observing that during and up to the peak of the maximum, the interfacial tension remains unchanged instead of showing the usual changes due to electrocapillary effects, then changes abruptly when the maximum disappears and follows the usual electrocapillary curve again. They state, in addition, that surfactants in appreciable concentrations will cause maxima to disappear.

This strongly suggested that the oxygen reduction and its resultant effects were closely allied to and perhaps the cause of the unusual ripple data. The effect from the O_2 reduction which caused the discontinuities in the frequency curves appeared to be the constancy and then the sharp jump in the interfacial tension during the reduction process, since from the previous ripple data the frequency was known to reflect interfacial tension changes. But the reason for the drop in output voltage from the receiving probe, indicating a rise in the damping coefficient during the reduction process, did not lend itself to such easy interpretation. Even the fact that the interfacial tension remains relatively unchanged during the reduction process has never been adequately explained, and this appeared to be closely involved with whatever physical processes occurred in the reduction.

Proposed explanation of anomalous behavior

It was at this point that the considerations of electrical effects in the boundary conditions were included in the theory in an attempt to explain this behavior. Maxima had appeared in the model-calculated Y2 curves when the Re(E) was approximately 20, and the Im(E) was about 10 or less. This was true for the model data from both the NaDS and phenol. If only the real component is considered, and the order of magnitude of the interfacial tension is considered to be about 400, this implies u_2 will be about .05 when Y2 shows a maximum. From the theory, we can write the expression for the electrical contribution to u_2 as $(i=\sqrt{-1})$

$$u_2(\text{electrical}) = \frac{\omega}{\gamma}\left[\frac{i\Omega^2 - \frac{\Omega}{\kappa}\left(\frac{\partial\Omega}{\partial x}\right)_{y=0}}{\kappa\sigma - 1/R}\right] \quad . \qquad (83)$$

Inserting numerical values typical of our experimental situation of $\Omega = 9 \times 10^{-6}$ coul/cm^2, $\sigma = 1.12 \times 10^{-9}$ coul^2-sec/g-cm^2, $\kappa = 64$ cm^{-1}, $\frac{1}{R} = 10^{-3}$ ohm^{-1} cm^{-2}, $\omega = 2512$ sec^{-1}, and $\gamma = 415$ dyne/cm, we have u_2(electrical) $= [5.95 \left(\frac{\partial\Omega}{\partial x}\right)_{y=0} + 3 \times 10^{-3} i]$ dyne/cm. The derivative $(\partial\Omega/\partial x)_{y=0}$ thus becomes important in the value of the electrical contribution of u_2. u_2 (real) will be about 0.05 if this term is about 0.0085. $(\partial\Omega/\partial x)_{y=0}$ is the gradient of the surface charge density tangential to the interface in the direction of wave propagation. If we approximate this by $(\Delta\Omega/\Delta x)$ and attempt to obtain by physical arguments the values of numerator and denominator, we may determine the order of magnitude of the term. One approximation for $\Delta\Omega$ may be the difference in Ω for the two interfacial tensions at the polarizations which bound the region of the O_2 reduction. The order of magnitude of this closely approximates the value of Q itself, because the negative boundary of the region is close to the ECM where $Q=0$. Thus ΔQ is approximately 8×10^{-6} coul/cm.^{2} (23, 30). We may approximate Δx to be .05 cm, the distance between wave peak and trough which is $\frac{1}{2}$ the wavelength. These approximations imply that this gradient is about 1.6×10^{-4}, which is too small to explain the phenomena under study. Both terms, real and imaginary, seem to differ from the desired value by about a factor of 10. This may be due to the choice of the electrical boundary condition for passage of current through the interface, or else the value of the charge density gradient may be larger than our order-of-magnitude arguments would lead us to believe. But it appears that the electrical effects cannot be neglected in the consideration of the mercury-solution interface, expecially in the polarization regions where there is an appreciable current passing through the interface.

The theoretical considerations which form the basis of the double layer theory for the mercury-electrolyte interface are based on the assumption of the ideal polarizable electrode (20). This means that the surface and double-layer properties about the interface vary with the potential applied to the interface, but there is no current passing through the interface throughout the potential changes (negligible current density). This assumption has proved especially fruitful in the studies of the mercury-solution interface using the capillary electrometer, which has only the small interfacial area of a mercury drop coming out of a very small capillary, and low current density at the Hg surface. With the ripple experiments, the surface area of Hg was large (200 cm^2), and about the O_2 maximum the current density was not negligible.

Discussion of experimental and model results

The lower NaDS concentrations showed the importance of electrical effects. The frequency curves (Figures 28 and 29) were dependent on the direction of polarization, as were the experimental (Figures 30 and 31) Y1 and Y2 curves. The model-generated curves did not display any behavior unique to the polarization region about the O_2 reduction. This was to be expected, as no special considerations for the O_2 reduction were inserted in the model, which included the ideal polarizable electrode assumption. Outside of the anomalous region the model and experiment showed much better agreement.

For the model itself, a different set of parameters was chosen as input. NaDS begins to show considerable surface activity at a concentration much lower than phenol, and therefore should have greater B_o value. Accordingly, a value of 4000 was chosen for the NaDS. Γ_{max} for NaDS was taken as 5.5×10^{-10} moles/cm^2, i.e., the straight chain alcohol value. These two then gave a diffusion term

$\frac{1}{\Gamma_m B_o}$ of 455, and a $RT\Gamma_{max}$ value of 13.5. The electrical desorption exponent was chosen to have a value of 12.5, a value which gave approximately the correct width to the region of adsorption. The Frumkin exponent β was not available from experimental data, but it would appear that the lateral interactions in the NaDS monolayer would be stronger than in phenol because of the longer chain length of the hydrocarbon skeleton involved, as suggested by E. Lucassen - Reynders (42). Therefore, β value of 1.5 was chosen (c.f. 1.2 for phenol). The surface viscosities were again, as with phenol, not available in the literature, and were rather arbitrarily taken as 5 x 10^{-4} surface poises for the NaDS and 1 x 10^{-5} surface poises for the pure interface. The NaDS value was made larger than the corresponding phenol value to again reflect the larger lateral interaction expected for the sulfonate.

Some experimentation was done before choosing the β value, and this showed that the coverage, elasticity, Y1, and Y2 curves generated from the model were very sensitive to this parameter, especially with respect to their shape. With a small β value, the coverage vs. polarization curve is dominated by the electrical desorption term and is a smooth curve, almost Gaussian in shape. But as β becomes large, the Θ curve begins to be almost like a square wave in shape. The value of Θ is near one in a wide central region (the width of which increases with β) and drops abruptly to zero at the endpoints of this region within a very narrow voltage range (Figure 35). The Θ curves for all concentrations with $\beta=1.5$ are given in Figure 34.

The maxima affected the ripple parameters of the NaDS in 0.05-*M* sodium sulfate system for the pure electrolyte, 10^{-6}, 10^{-5}, and 2.5×10^{-5}-*M* NaDS. The data for these concentrations at voltages outside the reduction process showed reasonable agreement with the model in the regions about the ECM for the Y1 data (Figures 30, 36-38), with agreement becoming less satisfactory at the more extreme polarizations. The Y2 results for model and experiment could not be interpreted so easily, for the effects of the O_2 did not disappear as rapidly as they did with the Y1 values. For the pure electrolyte (Figure 31), where the frequency range was scanned from negative to positive as well as from positive to negative (the procedure used in all of the other experiments in this thesis), the Y2 data agreed well with the model when the maxima effects were not present. This seemed to be true for the other concentrations also (Figures 46-48).

Initial experiments with NaDS were performed with reagent used as received, i.e., not recrystallized from hot ethanol. At high reagent concentrations ripple characteristics were substantially the same for purified and unpurified reagent, but at low concentrations the unpurified reagent was much more effective in reducing the oxygen anomaly. This was interpreted to indicate that the material used as received contained trace amounts of n-decyl alcohol, a compound which is a byproduct in the synthesis of the sulfonate from n-decyl halide and sodium sulfite. The n-decyl alcohol displays more surface activity than the NaDS, and probably damped out the reduction process to a much greater degree than the corresponding amount of the sulfonate. The exact effects of the trace amounts of the alcohol on the ripple parameters could not be assessed with any accuracy due to the interfering oxygen effects when the alcohol was eliminated. The behavior is analogous to the effects of trace amounts of lauryl alcohol in lauryl sulfate, where the effects are prevalent at low but not high concentrations (48).

At the concentration at which the oxygen effects were no longer present, 0.00005-M, the data generated from the model for Y1 and Y2 first began to show structure. Up to this concentration, the calculated Y1 and Y2 curves had been essentially constant. The 0.00005-M Y1 and Y2 model curves had single maxima (Figures 39 and 49) but the higher concentrations of 0.0001, 0.00025, 0.0005, 0.001, 0.0025, and 0.005-M NaDS had the paired sharp maxima and intermediate minima for both Y1 and Y2 (Figures 40-45, 50-55). The width of the minima for both parameters increased with concentration, the magnitude of the Y1 maxima being greatest at 0.0001-M, and the magnitude of the Y2 maxima being greatest at 0.00025-M. The voltages at which these two parameters showed maxima did not quite coincide, the Y1 maxima occurring about 25 mv. farther away from the ECM than the Y2 maxima. When the generated Y1 maxima appeared, Θ was about 0.45, while the generated Y2 maxima appeared when 0 was about 0.6. Both of these coverage values occurred on the 0 curves in the region of maximum rate of change. It may be true that the actual maxima occur at a voltage value within the 25 mv. increment, but a smaller voltage increment was experimentally unfeasible.

The effects of diffusion on the model-generated parameters did not appear to be as appreciable as in the case of phenol, for the maxima were decreased somewhat, but not washed out at higher concentrations.

As with the phenol, the magnitudes (Figures 45-51) of the experimental and model Y1 and Y2 values agreed reasonably well, but the shapes of the experimental and model curves differed. The experimental Y1 curves for 5 x 10^{-5} and 10^{-4}-M NaDS (Figures 39 and 40) were nearly constant except for the voltages greater than -0.05 V vs. S.C.E., where they decreased sharply as the polarization increased. The solutions more concentrated than these (Figures 40-45) had Y1 curves (going from positive to negative polarizations) which decreased gradually to a minimum close to the ECM for the given concentration, and then increased rapidly after the ECM.

The experimental Y2 curves for 0.00005 and 0.0001-M (Figures 49 and 50) had a minimum at the ECM, and then increased to either side. The higher concentrations had Y2 curves (Figures 51-55) that were constant in a wide region about the ECM, and then decreased at far negative polarizations and also decreased somewhat at the more positive potentials, with a sharp increase at the endpoints for some solutions. The experimental data did not show the gradual decrease in magnitude with concentration to the extent that the phenol data did, indicating that experimentally as well as with the model, diffusion was less important with NaDS than with phenol.

The effects of β on Y1 and Y2 can be seen in Figures 42 and 52 where these parameters are calculated with β=1.5 and 4.5. The curves displayed the square-wave-like structure shown by θ in Figure 35. Maxima observed with β=1.5 did not appear when β=4.5.

Model and experimental elasticity values showed very different behavior. From the model, Re(E) increased with concentration up to 0.0005-M, and then began to decrease with concentration due to the effect of the diffusion. At higher concentrations pairs of maxima, one on each side of the ECM for an individual concentration, appeared in the Re(E) curves due to the competing effects of the diffusion correction and the increasing adsorption. Figure 56 illustrates this behavior. Im(E) from the model decreased gradually with concentration, and then increased again, as the diffusion term became important.

Rewriting E in the form (a - ib)/(c + id), which is a simplified form of the theoretical expression used in the model, we can get simple expressions for both components of E. We may write

$$\mathrm{Re}(E) = (ac - bd)/c^2 + d^2) \qquad (97)$$

and

$$\mathrm{Im}(E) = -(cb + ad)/(c^2 + d^2), \qquad (98)$$

where

$b = \omega\mu_s$,

a = Gibbs elasticity,

$c = 1$,

and d = diffusion correction .

In the model, b is much less than a, a and c are of the same order, and both a and c are much less than d when Θ is about 1. Thus

$$\mathrm{Re}(E) \approx ac/d^2 \text{ and } \mathrm{Im}(E) \approx -a/d. \qquad (99)$$

The behavior of the model may be explained by the fact that at lower concentrations the rate of change of a is greater than d, and both terms increase at a given voltage with concentration. But when the coverages become close to one, the term d, the diffusion correction, becomes dominant.

The experimental elasticity curves, perhaps because of the use of the more accurate Lock-In-Amplifier in the measurements with the NaDS, were somewhat more interpretable than the corresponding values for the phenol. Yet the error level in the data propagates to such an extent in the calculation of E that the magnitudes of both real and imaginary components are unreliable, although relative trends may be significant. In the region of the O_2 reduction and the large damping coefficients, the real component became large and then decreased when the reduction process was no longer important. The Re(E) experimental curve grew larger as the concentration increased and showed some fine structure, with a maxima about the ECM for 0.0001-M and 0.00025-M, and paired maxima on either side of the ECM for 0.001 and 0.0025-M NaDS. Figure 56 also illustrates the experimental behavior.

The imaginary component from the experimental data did not lend itself even to the qualitative interpretation given the real component. There was no regularity in its behavior, but it did change rapidly in the oxygen reduction region for the more dilute solutions.

The interfacial tension values calculated from the experimental data assuming E=0 showed agreement with the reference data, except about the current-voltage anomalies. As might be expected, the agreement was not as good in the more concentrated solutions where elasticity effects become more important. A curve illustrating the comparison between experimental and reference data is given in the Appendix for 0.00005-M NaDS (Figure 56).

The error levels for NaDS measurements were much the same as in the phenol experiments, except that the Lock-In-Amplifier permitted greater accuracy in measuring the output voltage. This gave about a 5-10% error in α. The reference interfacial tensions were not as accurate for the NaDS, partially because the curves were fitted. Thus .3-.4 dynes/cm may be a good estimate of the error.

The listed data from YCOR for NaDS is given in Appendix D.

DISCUSSION OF RESULTS

Octanoic Acid

The results from the octanoic acid in .1-N perchloric acid system demonstrated the usefulness of interfacial ripple techniques in the investigation of interfaces previously studied by other methods. In the octanoic acid system, the previous investigations (at least in this laboratory) had been made using differential capacitance measurements. Using the results of this earlier work as a starting point, the ripple results clearly showed that other dynamic properties of the mercury-solution interface could be investigated. The effects of polarization on the parameters of the interface were shown to affect not only the equilibrium properties but also those properties of the interface important during sinusoidal deformation.

The frequency response at constant k was shown to be strongly dependent on polarization of the interface, as well as on the concentration of the surfactant. This response appeared to be quite similar to the response of the interfacial tension to both the polarization and the concentration. Such a result was consistent with the predictions of the theory. Further confirming the predictions of the theory, the values of the interfacial tension calculated from ripple results assuming E constant gave meaningful results when the surface properties were constant. In the region of changing adsorption, and thus changing E, the values became less meaningful and indicated the assumptions in the calculation were no longer meaningful. Elasticity and Y1 values could not be calculated for this system since no reference interfacial tension data were available.

The parameter Y2 was calculated from parameters measured directly in the ripple experiments. The dependence of Y2 on polarization agreed with the early qualitative predictions made from the theory (24) and also with the later quantitative predictions from the model. As the model indicated for NaDS, a reagent of seemingly similar surface properties, the Y2 values at negligible surfactant concentration should be low (about 0.008) and relatively constant. The pure electrolyte curve behaved in this way. At low surfactant concentrations the model predicted (Figure 51) a single maxima centered about the ECM, which agrees with the behavior of Y2 when the octanoic acid concentration was $c_o/64$. The magnitudes of the maxima were the same in the model and experiment. At intermediate concentrations the model predicted a pair of maxima about a minimum at the ECM (Figure 53), which the concentration $c_o/32$ exhibited. Again the quantitative agreement was quite good. The model indicated that further increases in concentration decrease the effect of the surfactant on Y2 (Figure 55) eliminating the pair of maxima and giving the curve a humped structure with the magnitude of Y2 decreasing. These effects predicted by the model seem to stem from the fact that the diffusion correction to the elasticity began to be dominant at higher concentrations, the term $(1-\Theta)^2$ predominating in the term $dc/d\Gamma$ as Θ becomes large. The octanoic acid at a concentration of $c_o/8$ showed such behavior.

Even though the model values discussed in reference to the octanoic acid data were from the NaDS system, the qualitative features should be the same for both. The results from the octanoic acid data indicated several things. The first was that the theory proposed in this laboratory predicted to a satisfactory degree of accuracy both the qualitative and quantitative behavior of interfacial ripple parameters. The second was that the octanoic acid system, even though values were not generated for this system, could be described quite well qualitatively by the Frumkin isotherm. The third result, which should have been more closely considered during the experimentation but was not interpreted correctly until the data were analyzed, was the importance of diffusion to the properties displayed by the ripple parameters. The fourth was that the experimental equipment devised for capillary ripples could be extended for use at the Hg-solution interface.

Phenol

The data from the phenol in N/10 perchloric acid--Hg system, both calculated and experimentally measured, showed this surfactant to have quite different properties from the octanoic acid. This was to be expected on the basis of their structures and their solubilities. For octanoic acid (27), the saturation concentration is 0.0051 M/L, and B_o is 16.3. In this paper the values for the Frumkin isotherm were calculated on the basis of activities, assumed to be equal to c/c_o, c_o=saturation concentration. For the calculations based on the Frumkin isotherm in this thesis the correction for activity was included in the B_o value. This indicated that the B_o value for octanoic acid in the terms of our model was approximately 3200, of the same order of magnitude as that used in the NaDS calculations. Hansen, et al. (27), give a B_o value for phenol of 5.5, a value as mentioned previously that is apparently in error, the value used being 200. But for phenol they give a c_o value of 0.896, two orders of magnitude higher than octanoic acid. This means for an equivalent surface concentration, the amount of phenol in the bulk solution is much greater than the octanoic acid.

The parameters Y1 and Y2 reflect this most directly. The high values of Y1 at the extreme negative polarizations may be partially explained by the fact that at these voltages the hydrogen discharge at the mercury surface may have become appreciable, and the high current may have caused an IR drop which was not included in the potential measured. Higher polarizations and therefore lower interfacial tensions than the true values may thus have been used in calculations. As a result, the frequency data inserted in the Y1 expression may not have been accurately reflected by the reference interfacial tension. All other terms being constant, these effects would give incorrectly high Y1 values in this region. This effect would decrease as the potential applied to the interface became more positive, as the phenol data did. For all concentrations, the phenol data showed no discernible maxima as displayed by the model values. This seems to indicate that the effects of diffusion are even greater than included in our simplified model. The model correctly predicted that the diffusion effect short circuited the maxima at the higher concentrations. At the intermediate concentrations, where the model and experiment differed the most, surface properties are most difficult to predict and the surface properties calculated by the model are the most sensitive to change in the parameters used. In this region of concentration no single term dominates in the equations describing the system, and the results of these equations are dependent on small differences between numbers of the same order of magnitude. Consequently, small changes in input give large changes in the results.

The Y2 data for phenol showed this parameter to be more dependent on the concentration than Y1, but did not show the sharp maxima of the octanoic acid curves or the model curves. The magnitude of the Y2 data considered over the whole polarization range for the individual concentrations rose and fell in agreement with the model in that it increased up to an intermediate concentration (0.01-M) and then decreased. But the shape of model and experimental curves were not the same, especially at the intermediate concentrations, the experimental data being more nearly constant with changing polarization than the model. Again, this may be due to a larger diffusion effect in the experimental data as suggested above. At the low and high concentrations, the model and experimental values were in good agreement. These results indicated that perhaps the modification of the Frumkin isotherm used describes limiting behavior of the surface quite well, but fails in the intermediate range, a fault of many isotherms used in describing surface behavior. Other reasons for disagreement at the intermediate concentrations may include the limited accuracy of the experimental data, incorrect choice of model input parameters, the simplification of the potential dependence in the model, or some other unsuspected factor.

The effect of diffusion, even in the model data, was clearly illustrated when model values of Y1 and Y2 for the higher phenol concentrations were generated without considering this effect (Figures 18-20, 25-27). These results showed that, in this case, the coverage was the only parameter that affected these variables. Just from the model, which admittedly does not fully describe our interfacial system, the importance of diffusion in short-circuiting surfactant effects on the ripple behavior was obvious.

NaDS

The sodium n-decyl-sulfonate in 0.050-M sodium sulfate solution-mercury interfacial system proved to be a very interesting system for study. The unexpected effects of the electrochemical reduction of dissolved oxygen indicated that this dynamic process giving a current flow across the interface had important effects on the ripple parameters. But why did this give such a large and discernible change in the experimental measurements? The theoretical explanation proposed in this thesis takes into account the electrical effects on the boundary conditions used to obtain the equations describing interfacial ripple propagation. Inserting what were thought to be correct numbers into the equations resulting from the inclusion of electrical phenomena gave u_2 values which were one order of magnitude too small to account for the observations. The fault of this may lie with the accuracy of the values used in the calculations, or the failure to consider all physical processes occurring at the interface during the reduction. If the gradient of the surface charge density is one order of magnitude greater than our crude estimate during wave motion at the interface, our interpretation of the situation gives numbers which are of the correct order of magnitude to give a damping coefficient maxima about the voltage range of the reaction.

Another plausible reason for the anomalies in the ripple parameters may be production during the reduction processes of a short-lived intermediate at the interface which is strongly surface active and does not exist at the interface outside of the region of the reduction. When the oxygen in solution is reduced at the interface, peroxide ions and radicals are formed (31). These might possibly react with the surfactant, electrolyte, or mercury to give an intermediate which is strongly surface active, even in small concentrations.

Whatever the reason or combination of reasons for the ripple anomalies, there appears to be no question that these are related to the maxima which appear in polarography due to

O_2 reduction. Both of these phenomena occur when the interface between mercury and an aqueous electrolyte solution is set in motion in the presence of an imposed potential. An explanation proposed by Heyrovsky (28) to interpret polarographic maxima suggests that there are varying current densities across the interface giving rise to surface tension gradients which cause electrocapillary flow of the Hg along the interface. This flow of the mercury causes the solution to be set in motion and fresh solution with the oxygen is brought to the interface, bypassing the normal diffusional processes which take place during reactions at the interface. The result is an intensification of the current and the electrical field inhomogeneities of the interface, furthering the surface flow. The current and surface tension gradients Heyrovsky proposes would also give appreciable gradients in surface charge density as the double layer at the interface is disrupted with the passage of the current. If this is true, our interpretation of the phenomena is correct.

Heyrovsky further states that the reason for surfactants damping out the maxima in polarograms is that any flow at the surface in the presence of a surfactant brings fresh surfactant to the interface, decreasing the interfacial tension and eliminating interfacial tension gradients which give rise to the surface flow. It was observed that increased addition of surfactant eliminates the anomalies caused by the oxygen reduction in the ripple parameters as in polarograms. The reasons may be similar to those proposed by Heyrovsky, or they may be due to the fact that an increased amount of surfactant may increase the interfacial resistance to current flow. This explanation is not as plausible, since polarograms which depend on current flow are run as a matter of course in the presence of large amounts of surfactants.

The results from the NaDS system for those portions of the lower concentration curves which were unaffected by the reduction, and also for the higher concentration curves, exhibited more concentration effects than the corresponding results from phenol. The experimental curves showed effects that seemed due to the adsorption and desorption of this surfactant during a polarization scan. But, as with the phenol, no maxima appeared in the Y1 or Y2 curves as suggested in the model. A fact which may relate to this was the absence of maxima in the model plots for Figures 42 and 52 for 5×10^{-4}-M NaDS when β was large. If the lateral interaction among the surfactant molecules was assumed to be large, the desorption of these molecules from the interface appeared to occur over a very narrow range, such that in the model the 25 mv. interval was not small enough to display the maxima which were known to appear at intermediate surface coverages. This may have been true for the experimental case also; the voltage increment was too large to detect any maxima or the equipment was insufficiently accurate to observe the rapidly occurring maxima.

It must be here noted that the relative magnitude of the maxima in Y1 predicted by the model for phenol and NaDS is only 2% from peak to minimum. The parameter Y2 is a number which varies at most from 7×10^{-3} to 2×10^{-2}, and thus is a small number and easily affected by experimental error. With these considerations in mind, it appears that the values from experiment and model agree quite well and justify both the theory developed to describe interfacial ripples and the model proposed to describe the interfacial behavior of the surfactants.

Experimental Errors and their Propagation

Experimental errors and their propagation in calculations based on experimental quantities are serious problems with interfacial ripple measurements and deserve separate discussion. In order to increase accuracy, the "constant k" type of experiment was introduced to replace the variable distance type of measurement, because this type of measurement kept constant the distance between probes, a quantity difficult to measure accurately. The importance of the accuracy of the probe separation, or more important, the wavelength, is seen in Y1, where $k(=2\pi/\lambda)$ is raised to the third power. Writing the expression for the maximum differential error (4) in Y1 we have

$$dY1/Y1 = 3dk/k + 2d\omega/\omega + d\gamma/\gamma + d(\rho+\rho')/(\rho+\rho'). \quad (100)$$

Taking dk as .1% of k, $d\omega$ as .1 Hz, $d\gamma$ as .2 dynes/cm, and $d[\rho+\rho']$ as 0.001 g/cm^3, we have a value of 0.3% for the error. If dk is changed to .3%, this error becomes about 1%, and if the error in k is 1%, the Y1 error is 3%. The other factor which may affect Y1 accuracy, as already mentioned, is the fact that the frequencies and surface tensions inserted into the formula may not always have been correctly corresponding values. Due to error caused by current flow across the interface, the potential at the interface may have been different than that measured by the calomel electrode. No estimate of this error is available, but if the potential measurements were inaccurate at the extreme ranges of polarization where frequency and interfacial tension are changing rapidly, a small potential discrepancy would give a large error in the frequency or interfacial tension. In the electrocapillary curve, at the far positive or negative potentials, a 25 mv. change may give a 1-2% change in γ, which would propagate to an error in Y1 of the same magnitude.

Writing an error expression for Y2, as with Y1, we have

$$dY2/Y2 = dk/k + d\alpha/\alpha \ . \qquad (101)$$

If we take dk as 0.1% of k and $d\alpha$ as 1% of α, the error in Y2 is 1.1%. But if the error in α is 10% and the error in k is 1%, the error in Y2 may be as high as 11%. Since the error in α may go even higher, a 10-15% accuracy in Y2 is about the level in the experimental quantities.

Extending this type of reasoning to the error in the elasticity coefficients, one observes that the errors propagate very significantly in the calculation of E. A program was written by J. Mann to examine the error level in this and all other ripple parameters. A sample calculation based on 0.060-M phenol using this program with 0.01% error in densities and viscosities, dk as .1% of k, $d\omega$ as .62832, $d\gamma$ as .2, and $d\alpha$ as 15% of α gave a standard deviation in both components of E larger than 100%. Errors of 10% in α with the other levels remaining the same gave standard deviations in the components of E of about 50%. Interpretation of experimental E values is thus very difficult with the present accuracy in the data.

CONCLUSIONS

The experimental and theoretical investigations of the mercury-solution interface described in this work indicate the following things: I. The ripple theory and experiment agree within experimental accuracy, and the ripple technique has proved itself to be an important new method of studying interfaces. II. The technique may be applied to various types of surfactants and base electrolytes. III. Electrical effects must be considered in the boundary conditions of the interfacial ripple equations if the theory is to be applicable to the mercury-solution interface when current flows across the interface. IV. Ripple measurements may be useful in studying the maxima effects in polarography. V. A simplified Frumkin model for interfacial behavior, when used to generate parameters for use in the ripple formulae, accounts for many of the qualitative features of experimental data and shows that diffusion plays a very important role in the propagation of interfacial ripples at the mercury-solution interface.

Studies with octanoic acid and phenol in perchloric acid solution and sodium *n*-decyl-sulfonate in sodium sulfate at various concentrations illustrated that the experiments were sufficiently sensitive and accurate to be useful at all polarizations studied. Variation of polarization at the mercury-solution interface, an option not available at oil-water and air-water interfaces, permitted simple and accurate variation of interfacial properties, especially interfacial tension and surface excess.

Several extensions might be made to the work described in this thesis. An independent electrocapillary investigation of the octanoic acid system would yield reference interfacial tension data permitting this system to be re-examined using the model and the refined experimental techniques used in the NaDS experiments. Other surfactant and base electrolyte systems which show unique behavior as observed by other interfacial measurements could be studied by ripple techniques to extend the knowledge of these systems. Additional studies in systems which show polarographic maxima would give further insight into this long unexplained phenomena. This would mean measurements on essentially inorganic systems and would necessitate refinements of the current-voltage apparatus described in this paper. This type of study might prove applicable to the study of kinetics of reactions at the polarized Hg-solution interface.

The objectives of this work, development of a theory of interfacial ripples based on continuum hydrodynamics, development of experimental methods for their measurement at the polarized mercury-solution interface, demonstration that the theory interprets physical reality correctly by comparison to experiment, and the experimental study of varied surfactant systems with the interpretation of their behavior, have been met. It is hoped that this work is only the starting point for a continued investigation of the dynamic properties of the mercury-solution interface, for this interface has been the testing ground for many of the theories of the electrical double layer and of electrode reaction kinetics. Further interpretation of its properties may give insight that will open new fields of study.

SUMMARY

A theory which was an extension of the theory of capillary ripples at the air-water interface was developed for the interface between two liquids. Further modifications of the theory were introduced to make it applicable to the study of the interface between mercury and an aqueous solution. These were made to include the electrical effects which are so important in determining the properties of this interface. A model which was a modification of the Frumkin isotherm was proposed to predict surfactant behavior through the entire polarization range studied and effects on the propagation characteristics of interfacial ripples.

Modifications of the instrumentation developed for the study of capillary ripples were made to enable the study of the polarized mercury-solution interface. These included the redesigning of the receiving probe, the development of a polarization system which would not interfere with the ripple propagation and still give accurately controllable voltages, the inclusion of a more accurate amplification system to increase the accuracy of the damping coefficient, and the introduction of equipment which would give current-voltage curves for the interface under study.

Experiments were performed on three surfactant systems and the experimental results compared to the predictions of the model. The calculations based on the data and the model were performed by programs written in FORTRAN IV language for use on the I.B.M. 360/65 computer available at the I.S.U. Computation Center. These programs fitted the amplitude-frequency response of the ripple generator, calculated interfacial tension data at any desired polarization increment from the fit of reference data, and performed calculations on the ripple data that gave both experimental and model values for parameters of interest.

The first surfactant system, octanoic acid in .1-N perchloric acid, gave results for the ripple parameters which agreed well with the qualitative predictions made before the start of experimentation. The frequency response at constant k closely paralleled the interfacial tension behavior. The Y2 curves showed maxima at intermediate concentrations, with a gradual decrease at higher concentrations, as projected from ripple behavior at the air-water interface. With the development of the model, the Y2 data (using the NaDS model results as the basis for comparison) were also shown to be in quantitative agreement with predicted behavior.

The second surfactant system, phenol in 0.1-N HCl)$_4$, (using the interfacial tension data of D. Kelsh) yielded results which were not as conclusive as for the octanoic acid system. The model was only able to predict trends in experimental behavior, for the maxima in Y1 and Y2 as predicted by the model did not appear in the experiment. Both model and experiment, however, demonstrated the importance of diffusion to the ripple propagation characteristics for this surfactant, which is quite soluble.

The third surfactant system, sodium n-decyl-sulfonate in 0.05-M sodium sulfate, indicated the importance of electrical effects (especially high current density) on the ripple behavior, particularly in neutral solutions of low surfactant concentration. Data in the polarization region of neutral solutions where oxygen reduction occurs at the mercury surface suggested that this process had an important effect on ripple propagation. The relationship of polarographic maxima, due to this reduction, to the anomalies in the ripple experiments was shown. Order of magnitude estimates of surface electrical parameters placed them at least within a factor of 10 of values necessary to theoretically account for the ripple anomalies. Data from the higher concentrations of NaDS again illustrated that the model could predict trends, but not the fine structure of the experimental curves.

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APPENDIX A

Equipment Diagrams (Figures 1-3)

BLOCK DIAGRAM OF EARLY INSTRUMENTATION

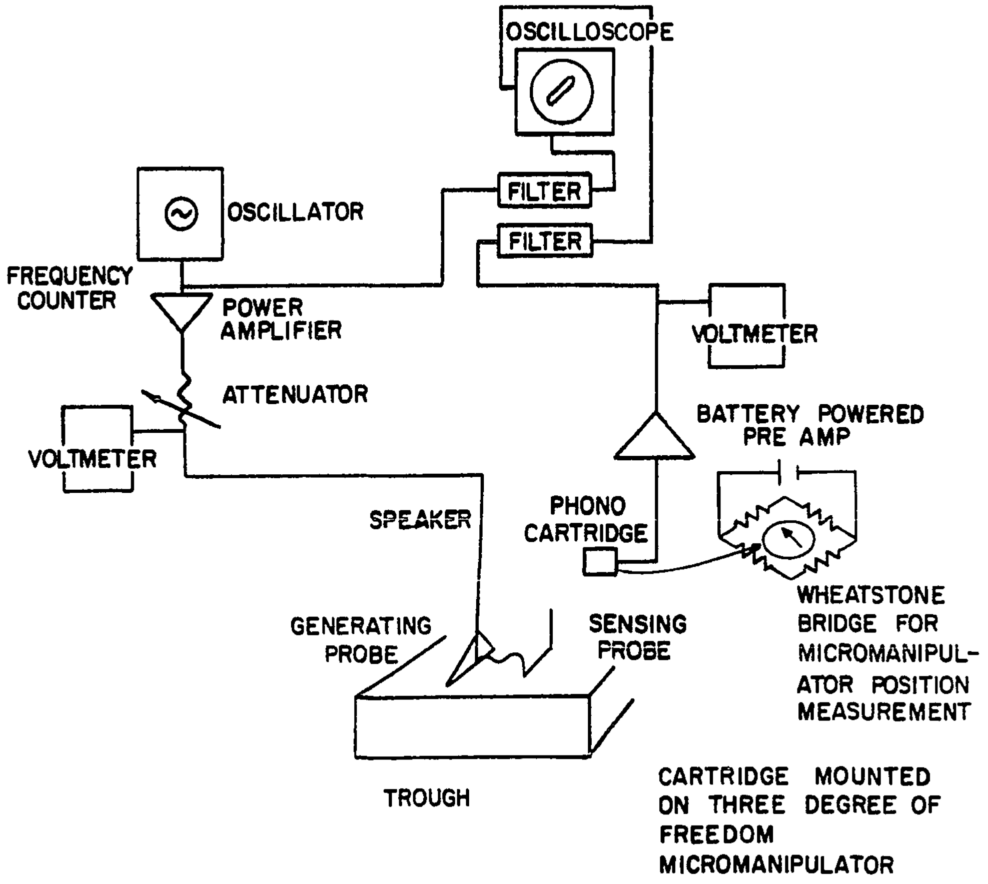


Figure 1. A block diagram of the early interfacial ripple instrumentation

BLOCK DIAGRAM OF FINAL INSTRUMENTATION

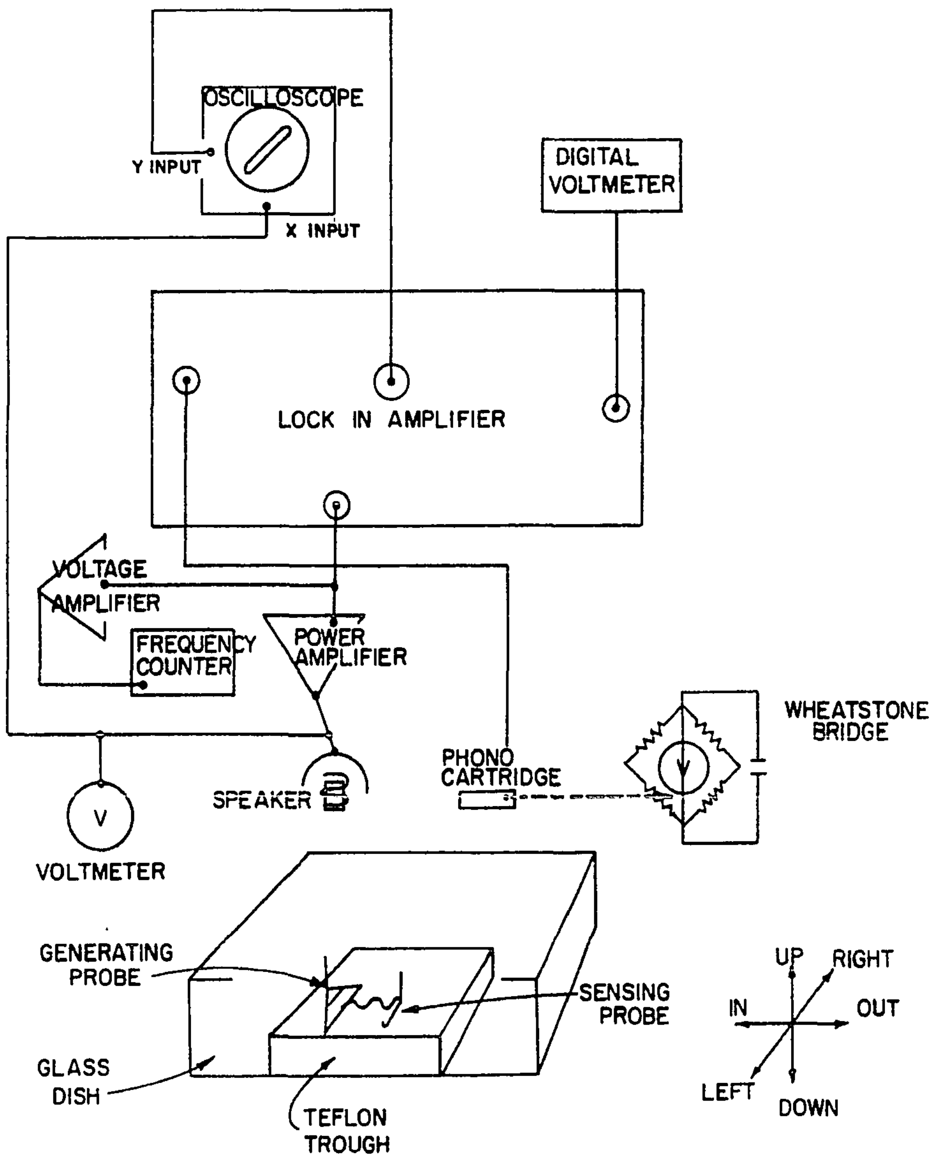


Figure 2. A block diagram of the final interfacial ripple instrumentation

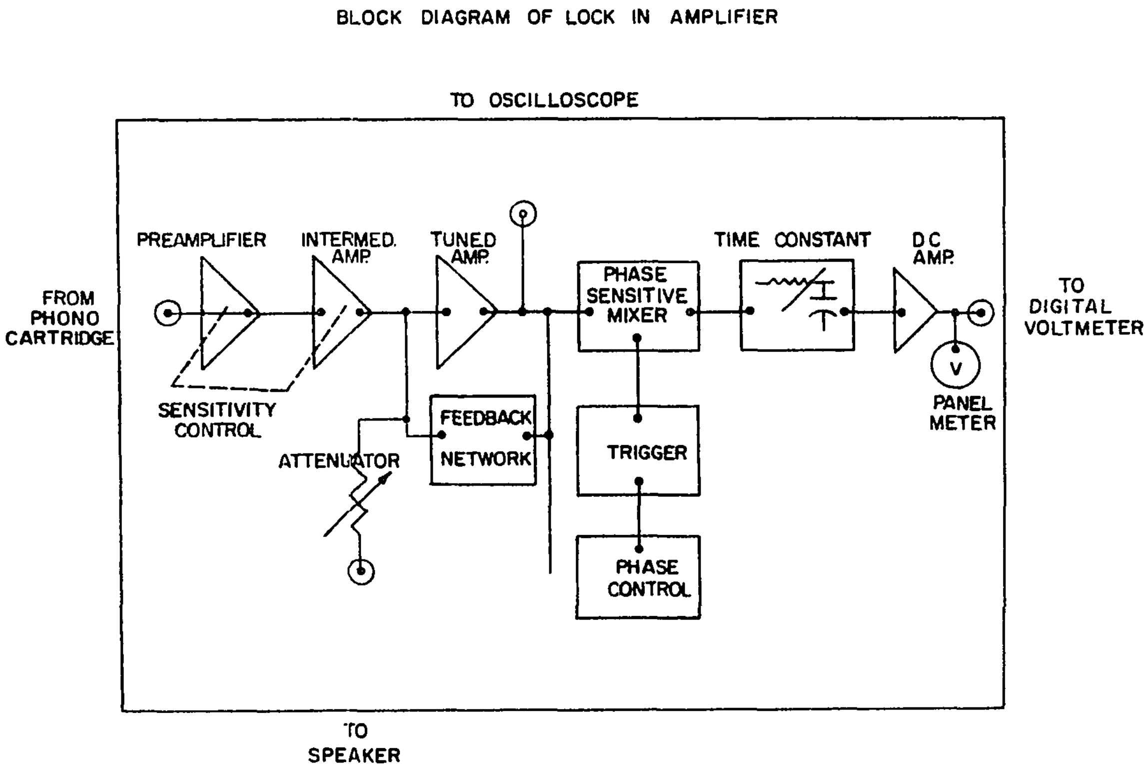


Figure 3. A block diagram of internal circuitry of lock-in-amplifier

APPENDIX B

Listings[1] of Computer Programs (Figures 4-6)

---

[1] The listings were made from an I.B.M. 1401 printout of a I.B.M. 360/65 Fortran IV source deck. Thus the listing contains the symbol @ from the 1401 which on the 360/65 is the symbol'. This symbol is used on the 360/65 to input alphameric data within the program.

```
//BC17YCOR JOB  @A0087,TIME=4,SIZE=128K@,GURDON,MSGLEVEL=1,REGION=96K
//STEPONE EXEC FORTG,PARM.FORT=(MAP,DECK),TIME.GO=4,LINES=5
//FURT.SYSIN  DD  *
C
C ************************************************************************
C
C      FOR DATA TAKEN USING CONSTANT @@K@@ METHOD                          YCOR003
C      INTERFACIAL TENSION CALCULATIONS INCLUDE GRAVITY CORRECTION
C      UNLESS OTHERWISE NOTED, ALL POL. VOLTAGES VS. S.C.E. (IN VOLTS)     YCOR004
C      YCORO A PROGRAM WRITTEN IN FORTRAN IV(G LEVEL) FOR THE ANALYSIS
C      UF INTERFACIAL RIPPLE DATA MEASURED AT THE POLARIZED MERCURY--
C      SOLUTIUN INTERFACE BY G.P.BIERWAGEN . THE REQUIRED INPUT DATA
C      IS THE FOLLOWINGO
C
C      CARDS 1 + 2: TITLE , DATE,AND EXPERIMENTER (COL.1-80)
C      CARD 3: UPPER LIQUID(COL.1-40)  LOWER LIQUID(COL41-80)
C      CARD 4: SURFACTANT AND ITS CONCENTRATION(COL.1-20)  ELCETROLYTE
C      AND ITS CONCENTRATION(COL.21-40)
C      CARD 5: DENSITY OF UPPER LIQUID(COL.11-20)
C             DENSITY OF LOWER LIQUID(COL.31-40)
C             VISCOSITY OF UPPER LIQUID (COL.51-60)
C             VISCOSITY OF LOWER LIQUID(CUL.71-80)
C      CARD 6: INITIAL OUTPUT VOLTAGE (COL.11-20)
C              INITIAL DAMPING COEFFICIENT (COL.31-40)
C              WAVELENGTH FROM CONSTANT K EXPERIMENT (COL.51-60)
C              PROBE SEPARATION (COL.71-80)
C      CARDS 7-(N-8): EXPERIMENTAL DATA
C                      POL.VOLTAGE(COL.1-10)
C                      FREQUENCY(COL.11-20)
C                      OUTPUT VOLTAGE(COL.21-30)
C                      REFERENCE INTERFACIAL TENSION VALUES(COL.31-40)
C      CARD (N-7): BLANK TO INDICATE END OF DATA ARRAYS
C      CARD (N-6): INITIAL FREQUENCY (COL.1-10)
C      CARDS (N-5) TO(N-3): COEFFICIENTS OF AMPLITUDE - FREQUENCY FIT
C      CARD (N-2): FIRST CONTROL CARD FOR SUBROUTINE MODEL
C                  VECM(COL.1-10)
C                  CUNC(COL.11-20)
C                  1/BO (COL.21-30)
C                  MUP(COL.31-40)
C                  MUORG(COL.41-50)
C                  ELECTRICAL DESORPTION EXPONENT(COL.51-60)
C                  FRUMKIN LATERATERAL INTERACTION EXPONENT(COL.61-70)
C      CARD (N-1): SECUND CONTROL CARD FOR MODEL
C                  GMRT(COL.1-10)
C                  DIFFUSIUN TERM(COL.11-20)
C      CARD N: IF SINGLE OR LAST DATA SET LEAVE BLANK
C              IF THIS DATA PRECEDES ANOTHER DATA SET, PUT INTEGER IN
C              COL.1-5
C
C ************************************************************************
C
C
       COMPLEX*16 A0,A1,A2,A3,A4,B0,B1,B2,B3,B4,B5,KAPPA(101),ELAS(70),
      1  DCMPLX,X1,X2,Z1,Z2,N1,N2,M1,M2,IM,RE,CDSQRT,DCONJG,INTEN(70),
      1 CCELAS(70),EEXTRA(70)
       REAL*8 LENGTH,OVO,ALPHO,WL,OMEGA,OV(70),EXTRA(70) ,S
       REAL*8 VOLTS(70),KV(70),Y1EXP(70),Y2(70),GAMMA(70),FREQ(70),
      1       RELAS(70),CELAS(70),ALPHA(70),WNO,D1,D2,V1,V2,INTENS(70)
       REAL*4 ORG(5),ELECTR(5),SOURCE(20),PROGN(20),LIQL(10),LIQH(10)
```

Figure 4. YCOR listing

```
      COMMON KAPPA,VOLTS,Y1EXP,Y2,ALPHA,GAMMA,FREQ,INTENS,RELAS,CELAS,
     1       KV,V1,V2,D1,D2,WNO,ORG,ELECTR,NPTS
      EQUIVALENCE (D1, RHOLIT), (D2,RHOHEV), (V1,VISLIT),(V2,VISHEV)      YCOR028A
C
C     READ IN LABELS, TITLES, AND CONSTANTS FOR THE CALCULATIONS
C
  101 READ(1,1)PROGN,SOURCE,LIQL,LIQH
    1 FORMAT(20A4/20A4/10A4,10A4)
      WRITE(3,2)PROGN,SOURCE,LIQL,LIQH
    2 FORMAT(@1@,T41,20A4/@0@,T31,20A4/@0@,@MEASUREMENTS MADE AT @,10A4,YCOR032
     1       @/@,10A4,@INTERFACE@)
      READ(1,2000)ORG,ELECTR
 2000 FORMAT(2(5A4))
      WRITE(3,200)ORG,ELECTR
  200 FORMAT(@ @,5A4,@  @,5A4)
      READ(1,3)RHOLIT,RHOHEV,VISLIT,VISHEV                                YCOR033
    3 FORMAT(4(10X,F10.0))                                                YCOR034
C     RHOLIT(COL.11-20) , RHOHEV(COL.31-40),VISLIT(COL.51-60)             YCOR035
C     VISHEV(COL.71-80)                                                   YCOR036
      READ(1,3)OVO,ALPHA0,WL ,LENGTH
C     OVO (COL.11-20), ALPHA0(COL.31-40) , WL(COL.51-60)                  YCOR038
      WRITE(3,4)RHOLIT,RHOHEV,VISLIT,VISHEV,OVO,ALPHA0,WL                 YCOR039
C                                                                         YCOR040
    4 FORMAT(/////@0@,@DENSITY OF UPPER PHASE@,F10.5,3X,@DENSITY OF LOWEYCOR041
     1R PHASE@,F10.5,/@0@,@VISCOSITY OF UPPER PHASE@,F12.7,3X,@VISCOSITYYCOR042
     2 OF LOWER PHASE@,F12.7,/@0@,@ORIGINAL OUTPUT VOLTAGE@,F15.8,@ MV.@YCOR043
     3,/@0@,@INITIAL DAMPING COEFFICIENT@,F10.5,@ 1/CM.@,/@0@,@WAVELENGT
     4H@,F8.5,@ CM.@)
      WNO = 6.28318 / WL                                                  YCOR046
      WRITE(3,800)LENGTH
  800 FORMAT(/@ @,@PROBE SEPARATION = @,F10.5,@ CM.@)
      WRITE(3,5)WNO                                                       YCOR047
    5 FORMAT(//@ @,@WAVENUMBER = @,F12.6,@ RECIPROCAL CM.@)               YCOR048
C
C     READ IN THE ARRAYS OF EXPERIMENTAL DATA
C
  111 DO 113 I=1,101
      READ (1,114) VOLTS(I),FREQ(I), OV(I), GAMMA(I)
  114 FORMAT(4F10.0)
      NPTS = I -1
      IF(VOLTS(I) +FREQ(I) +OV(I) +GAMMA(I)) 120,120,113
  113 CONTINUE
  120 WRITE(3,121)
  121 FORMAT(@1@,T60,@INPUT DATA@/@0@,@NO.@,26X,@POL.VOLTAGE@,15X,
     1 @FREQUENCY@,11X,@OUTPUT VOLTAGE(MV.)@,10X,@GAMMA@)
      DO 130 I=1,NPTS
  131 FORMAT(@ @,I3,8X,4F25.6)
  130 WRITE(3,131) I,VOLTS(I),FREQ(I),OV(I),GAMMA(I)
      CALL AMPCOR(NPTS,FREQ,OV)
      DO 40 I= 1,NPTS                                                     YCOR065
C                                                                         YCOR066
      OMEGA=6.2831852D0*FREQ(I)
C
C     CALCULATE ALPHA,Y2,AND Y1 FROM EXPERIMENTAL DATA
C
      S = (D1 + D2) * OMEGA**2 /(WNO**3)                                  YCOR071
  141 Y1EXP(I) = S/GAMMA(I)
      ALPHA(I) = ALPHA0 +  DLOG(OVO/OV(I)) *(1./LENGTH)
      Y2(I)=ALPHA(I) /WNO                                                 YCOR073
```

Figure 4 (Continued)

```
C
C     CALCULATE EXPERIMENTAL GAMMA ASSUMING E=0
C
      KAPPA(I)= DCMPLX(WNU,ALPHA(I))
      IM = (0.D0,1.D0)
      RE = (1.D0,0.D0)
      M2 =CDSQRT(KAPPA(I)**2 -IM*OMEGA*D2/V2)
      M1=CDSQRT(KAPPA(I)**2 - IM*OMEGA*D1/V1)
      A0 = -IM*OMEGA*(D1 + D2)*(V1*M1 +V2*M2)
      A1 = 4.D0*V1*V2*M1*M2 -IM*OMEGA*(V1 + V2)*(D1 + D2)
      A2 = 4.*(M1*V1**2 + M2*V2**2)
      INTEN(I) =(-4.*V1*V2*KAPPA(I)**3 - A2*KAPPA(I)**2 -A1*KAPPA(I)
     1          -A0)/(((IM/OMEGA)*((V1+V2)*KAPPA(I)**4 +(V1*M1+V2*M2)*
     2          KAPPA(I)**3)) +((D2-D1)*980.29)/KAPPA(I)**2
      INTENS(I) = INTEN(I)
      ECXTRA(I) = (INTEN(I) - DCONJG(INTEN(I)))*(0.D0,-.5D0)
      EXTRA(I) = ESXTRA(I)
C
C     CALCULATE COMPLEX E FROM EXPERIMENTAL DATA AND GAMMA DATA
C
      A4 = IM*GAMMA(I)*(V1 + V2)/OMEGA
      A3 = (IM*(V1*M1 + V2*M2)*GAMMA(I))/OMEGA + 4.*V1*V2
      B0 = RE*(D1 + D2)
      B1 = IM*(V1*M1 + V2*M2)/OMEGA
      B2 = IM*(V1 + V2)/OMEGA
      B3 = -RE*GAMMA(I)/OMEGA**2
      ELAS(I)=-((A4*KAPPA(I)**4 + A3*KAPPA(I)**3 + A2*KAPPA(I)**2 +
     1          A1*KAPPA(I) + A0)/(B3*KAPPA(I)**3 + B2*KAPPA(I)**2
     2          + B1*KAPPA(I) + B0))*KAPPA(I)**(-2)
      RELAS(I) = ELAS(I)
      CCELAS(I)= (ELAS(I) -DCONJG(ELAS(I)))*(0.D0,-.5D0)
      CELAS(I) =CCELAS(I)
      KV(I)= CELAS(I)/OMEGA
   40 CONTINUE
      CALL MODEL
      READ(1,61)NEXT                                                    YCOR112
   61 FORMAT(I1)                                                        YCOR113
      IF(NEXT)100,100,101                                               YCOR114
  100 STOP                                                              YCOR115
      END                                                               YCOR116



      SUBROUTINE AMPCOR(NPTS,FREQ,OV)
      REAL*8 FREQ0,Q(11),AMP(101),AMP0,CFREQ(101),OV(101),FREQ(101)
     1 ,XFREQ(50),XOV(50)
      READ(1,1)FREQ0
    1 FORMAT(F10.0)
      WRITE(3,5) FREQ0
    5 FORMAT(/@1@,@INITIAL FREQUENCY = @,F10.5)
      READ(1,2)(Q(I),I=1,11)
    2 FORMAT(4D20.10)
      AMP0=Q(1)
      FREQ0=FREQ0*0.01D0
      DO 3 L=2,11
    3 AMP0=AMP0+Q(L)*FREQ0**(L-1)
      DO 11 J=1,NPTS
      CFREQ(J)=FREQ(J)*0.01D0
      AMP(J)=Q(1)
      DO 4 L=2,11
    4 AMP(J)=AMP(J) +Q(L)*CFREQ(J)**(L-1)
      OV(J) =OV(J)*(AMP0/AMP(J))
   11 CONTINUE
      WRITE (3,6)
    6 FORMAT(//@ @,@POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTIONS@)
      DO 10 K=1,11
      KK=K-1
      WRITE(3,15) Q(K),KK
   15 FORMAT(@ @,20X,D20.10,4X,@FREQUENCY**@,I2)
   10 CONTINUE
      WRITE(3,20)
   20 FORMAT(//@ @,@NO.@,5X,@FREQUENCY@,5X,@CORRECTED OUTPUT VOLTAGE@,
     110X,@NO.@,5X,@FREQUENCY@,5X,@CORRECTED OUTPUT VOLTAGE@)
      N2 = NPTS/2
      DO 25 I=1,N2
      N = I + N2
      XFREQ(I)=FREQ(N)
      XOV(I) = OV(N)
   21 FORMAT(I3,5X,F10.5,9X,F10.5,19X,I3,5X,F10.5,9X,F10.5)
   25 WRITE(3,21)I,FREQ(I),OV(I),N,XFREQ(I),XOV(I)
      RETURN
      END
```

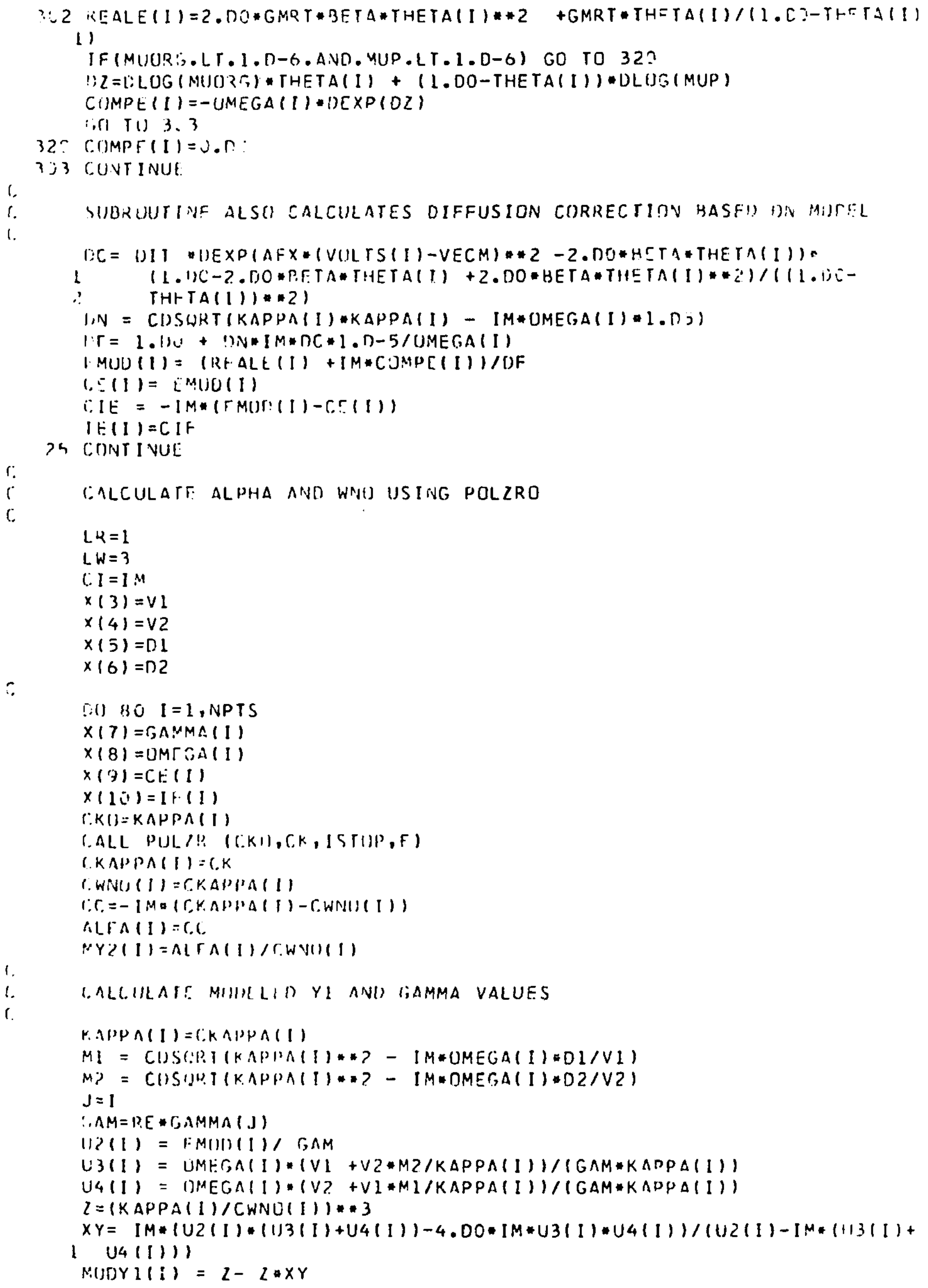
Figure 4 (Continued)

```
      SUBROUTINE MODEL
C
      COMPLEX*16CI,B(10),CC,CK,CK0,F
      COMPLEX*16 EMOD( 70),KAPPA(101),M1,M2,IM,RE,MODY1(70 ),L2(70),
     1     U3(70),U4(70), CST(70),  F1,F2,F3,F4,G3,G4,G5,XY,Z,F0
      COMPLEX*16 KAP,XX,MO,MT,UT,UF ,YY, DN,DF  ,CIE ,CKAPPA(70)
      COMPLEX*16 DCONJG,DCMPLX,CDSQRT
C
      REAL*8 DABS,DEXP,DSQRT ,DLOG
      REAL*8 T,TT,TTT,X(10),Y(10),GMRT,DIT,COVO,COV,DZZ
      REAL*8 CWNO(70),ALFA(70),MY2(70),DC,DZ,BETA,FUNC,DFUNC,CDFUNC,
     1DTHETA,AEX,REALE(70),OMEGA(70),CONC,VECM,BO,MUP,MUORG,
     2 THETA(70),ST(70),MY1(70),COMPE(70),CE(70),IE(70)
      REAL*8 VOLTS(70),KV(70),Y1EXP(70),Y2(70),GAMMA(70),FREQ(70),
     1       RELAS(70),CELAS(70),ALPHA(70),WNO,D1,D2,V1,V2,INTENS(70)
      REAL*8 TMID,TMAX,TMIN,FMAX,FMIN,FMID
C
      REAL*4 ORG(5),ELECTR(5),XL(5),YL1(5),YL2(5),YL3(5),YL4(5),
     1     YL5(5),YL6(5),YL7(5)
      REAL*4 YL8(5),YL9(5),YL10(5),YL11(5),YL12(5),YL13(5),
     1       YL14(5),YL15(5),YL16(5),YL17(5),YL18(5),YL19(5),YL20(5),
     2       YL21(5),YL22(5),YL23(5)
     1 ,YL24(5),YL25(5),YL26(5)
      REAL*4 YL28(5)
       REAL*4 VECML(5),BOL(5),MUPL(5),MUORGL(5),AEXL(5),BETAL(5),
     1       GMRTL(5),DITL(5)
      REAL*4 YLO(5),YLT(5)
C
      COMMON KAPPA,VOLTS,Y1EXP,Y2,ALPHA,GAMMA,FREQ,INTENS,RELAS,CELAS,
     1       KV,V1,V2,D1,D2,WNO,ORG,ELECTR,NPTS
      COMMON/POLZRO/CI,B,X,Y,LR,LW
C
C     USE ALPHAMERIC DATA INITIALIZATION FOR GRAPH LABELS
C
      DATA YLO/@REFE@,@RENC@,@E DA@,@TA  @,@    @/
     1     ,YLT/@EXPT@,@.CAL@,@C. W@,@ITH @,@E=0 @/
      DATA  XL/@POL.@,@VOLT@,@AGE @,@VS. @,@SCE @/,
     1  YL28/@Y2-C@,@ALC.@,@FROM@, @ MOD@,@EL  @/,
     1     YL1/@KFLV@,@IN F@,@UNCT@,@ION @,@    @/,
     1     YL2/@EXPE@,@RIME@,@NTAL@,@ VAL@,@UE  @/,
     1     YL3/@Y1 -@,@ MOD@,@EL +@,@ EXP@,@ER. @/,
     1     YL4/@CALC@,@ULAT@,@ED V@,@ALUE@,@    @/,
     1     YL5/@GAMM@,@A-MO@,@DEL @,@+ EX@,@PER.@/,
     1  YL6/@ELEC@,@TROC@,@AP. @,@DATA@,@    @/,
     1     YL7/@INTE@,@RFAC@,@IAL @,@TENS@,@ION @/,
     1     YL8/@CALC@,@. AS@,@SUMI@,@NG E@,@=0  @/,
     1     YL9/@THEO@,@RY V@,@ALUE@,@FOR @,@E=0 @/,
     1    YL10/@THEO@,@RY V@,@ALUE@,@, E=@,@INF.@/,
     1    YL11/@RIPP@,@LE F@,@REQU@,@ENCY@,@-HZ.@/,
     1    YL12/@FREQ@,@UENC@,@Y AT@,@ CON@,@ST.K@/
     1  ,YL24/@SURF@,@ACE @,@COVE@,@RAGE@,@    @/,
     1  YL25/@THET@,@A VS@,@.POL@,@.VOL@,@TAGE@/,
     1  YL26/@FROM@,@ IDE@,@ALIZ@,@ED M@,@ODEL@/
      DATA YL23/@KV(K@,@=CON@,@ST)V@,@S. V@,@OLTS@/,
     1    YL13/@VS. @,@POLA@,@RIZA@,@TION@,@    @/,
     1    YL14/@Y2=A@,@LPHA@,@/WAV@,@E NO@,@.   @/,
     1    YL15/@Y2 V@,@S. P@,@OL. @,@VOLT@,@AGE @/,
     1    YL16/@SURF@,@ACE @;@ELAS@;@TIC @,@MOD.@/,
     1    YL17/@E(K=@,@CONS@,@T) V@,@S.PO@,@L.V.@/,
```

Figure 4 (Continued)

```
     1      YL18/@REAL@,@ COM@,@PONE@,@NT O@,@F E @/,
     1      YL19/@IMAG@,@INAR@,@Y CU@,@MPON@,@ENT @/,
     1      YL20/@RE(E@,@)CAL@,@C.FR@,@OM M@,@ODEL@/,
     1      YL21/@IM(E@,@)CAL@,@C.FR@,@OM M@,@ODEL@/,
     1      YL22/@KV-S@,@URF.@,@RELA@,@X.PA@,@RAM.@/
C
C
      READ(1,1)VECM,CONC,BO,MUP,MUORG,AEX,BETA
    1 FORMAT(7F10.6)
      READ(1,700) GMRT,DIT
  700 FORMAT(F10.5,F10.2)
  100 CONTINUE
      WRITE(3,750)
  750 FORMAT(@1@,20X,@INPUT DATA FOR MODELED BEHAVIOROMODIFIED FRUMKIN
     1ISOTHERM@)
      WRITE(3,751)ORG,VECM,BETA,AEX,GMRT,DIT,MUP,MUORG,BO
  751 FORMAT(///@0@,@SURFACTANT CONCENTRATION= @,5A4,/@0@,@ELECTROCAPILL
     1ARY MAXIMUM IS @,F10.5,@ VOLTS VS. S.C.E.@,/@0@,@FRUMKIN EXPONENT=
     1 @,F10.5/@0@,@ELECTRICAL DESORPTION EXPONENT = @,F10.5,
     1          /@0@,@MAXIMUM SURFACE COVERAGE X R X TEMPERATURE = @,F10.
     35,/@0@,@DIFFUSION TERM= @,F10.2,/@0@,@SURFACE VISCOSITY OF PURE IN
     1TERFACE= @,F8.6,/@0@,@SURFACTANT SURFACE VISCOSITY= @,F8.6,
     5/@0@,@ 1/BO = FRUMKIN CONCENTRATION CONSTANT=@,F10.6)
      IM = (0.D0,1.D0)
      RE= (1.D0,0.D0)
C
      DO 25 I=1,NPTS
      OMEGA(I)=6.2813800D0*FREQ(I)
C
C     APPROXIMATE CALCULATION PROCEDURE FOR THETA BASED ON FRUMKIN
C     ISOTHERM AND MODEL FOR POLARIZATION DEPENDENCE
C
      TMIN=0.0D0
      TMAX=0.99999D0
      T=(CONC/BO)*DEXP(-AEX*(VOLTS(I)-VECM)**2)
      FMAX=TMAX/(1.D0-TMAX) - T*DEXP(2.D0*BETA*TMAX)
      FMIN=TMIN/(1.D0-TMIN) -T*DEXP(2.D0*TMIN*BETA)
      K=0
  800 K=K+1
      TMID=(TMAX+TMIN)/2.D0
      FMID=TMID/(1.D0-TMID) -T*DEXP(2.D0*BETA*TMID)
      IF((TMAX-TMIN).LT.1.D-6) GO TO 301
      IF(FMID.LT.0.0D0) GO TO 806
      IF(FMID.GT.0.0D0) GO TO 805
      IF(FMID.EQ.0.D0) GO TO 301
      IF(K.GT.100) GO TO 900
  805 TMAX=TMID
      FMAX=FMID
      GO TO 800
  806 TMIN=TMID
      FMIN=FMID
      GO TO 800
  900 WRITE(3,901)
  901 FORMAT(@ @,@THETA CALCULATION DID NOT CONVERGE@)
      CONTINUE
  301 THETA(I)= TMID
C
C     CALCULATE  MODELED ELASTICITY VALUES
C
```

Figure 4 (Continued)



```
  302 REALE(I)=2.DO*GMRT*BETA*THETA(I)**2  +GMRT*THETA(I)/(1.DO-THETA(I)
     1)
      IF(MUORG.LT.1.D-6.AND.MUP.LT.1.D-6) GO TO 320
      DZ=DLOG(MUORG)*THETA(I) + (1.DO-THETA(I))*DLOG(MUP)
      COMPE(I)=-OMEGA(I)*DEXP(DZ)
      GO TO 303
  320 COMPE(I)=0.DO
  303 CONTINUE
C
C     SUBROUTINE ALSO CALCULATES DIFFUSION CORRECTION BASED ON MODEL
C
      DC= DIT *DEXP(AFX*(VOLTS(I)-VECM)**2 -2.DO*BETA*THETA(I))*
     1     (1.DO-2.DO*BETA*THETA(I) +2.DO*BETA*THETA(I)**2)/((1.DO-
     2     THETA(I))**2)
      DN = CDSQRT(KAPPA(I)*KAPPA(I) - IM*OMEGA(I)*1.D5)
      DF= 1.DO + DN*IM*DC*1.D-5/OMEGA(I)
      EMOD(I)= (REALE(I) +IM*COMPE(I))/DF
      CE(I)= EMOD(I)
      CIE = -IM*(EMOD(I)-CE(I))
      IE(I)=CIE
   25 CONTINUE
C
C     CALCULATE ALPHA AND WNO USING POLZRO
C
      LR=1
      LW=3
      CI=IM
      X(3)=V1
      X(4)=V2
      X(5)=D1
      X(6)=D2
C
      DO 80 I=1,NPTS
      X(7)=GAMMA(I)
      X(8)=OMEGA(I)
      X(9)=CE(I)
      X(10)=IE(I)
      CKO=KAPPA(I)
      CALL POLZR (CKO,CK,ISTOP,F)
      CKAPPA(I)=CK
      CWNO(I)=CKAPPA(I)
      CC=-IM*(CKAPPA(I)-CWNO(I))
      ALFA(I)=CC
      MY2(I)=ALFA(I)/CWNO(I)
C
C     CALCULATE MODELLED Y1 AND GAMMA VALUES
C
      KAPPA(I)=CKAPPA(I)
      M1 = CDSQRT(KAPPA(I)**2 - IM*OMEGA(I)*D1/V1)
      M2 = CDSQRT(KAPPA(I)**2 - IM*OMEGA(I)*D2/V2)
      J=I
      GAM=RE*GAMMA(J)
      U2(I) = EMOD(I)/ GAM
      U3(I) = OMEGA(I)*(V1 +V2*M2/KAPPA(I))/(GAM*KAPPA(I))
      U4(I) = OMEGA(I)*(V2 +V1*M1/KAPPA(I))/(GAM*KAPPA(I))
      Z=(KAPPA(I)/CWNO(I))**3
      XY= IM*(U2(I)*(U3(I)+U4(I))-4.DO*IM*U3(I)*U4(I))/(U2(I)-IM*(U3(I)+
     1  U4(I)))
      MODY1(I) = Z- Z*XY
```

Figure 4 (Continued)

```
      MY1(I) = MODY1(I)
      F0 = -IM*OMEGA(I)*(D1+D2)*(V1*M1+V2*M2)
      F1 = 4.D0*V1*V2*M1*M2 - IM*OMEGA(I)*(D1+D2)*(V1+V2)
      F2 = 4.D0*(V1*V1*M1 + V2*V2*M2) + EMOD(I)*(D1+D2)
      F3 = 4.D0*RE*V1*V2 + IM*EMOD(I)*(V1*M1 + V2* M2)/OMEGA(I)
      F4 = IM*EMOD(I)*(V1+V2)/OMEGA(I)
      G3 = IM*(V1*M1 +V2*M2)/OMEGA(I)
      G4 = F4
      G5 = -EMOD(I)/(OMEGA(I)*OMEGA(I))
      CST(I) = -(F0 +F1*KAPPA(I) + F2*KAPPA(I)**2 +F3*KAPPA(I)**3
     1 +F4*KAPPA(I)**4)/(G3*KAPPA(I)**3 + G4*KAPPA(I)**4 +G5*KAPPA(I)**5
     2 ) + (D2-D1)*920.89/KAPPA(I)**2
      ST(I) = CST(I)
   80 CONTINUE
C
C     PRINT OUT DATA OF INTEREST
C
      WRITE(3,760)
  760 FORMAT(@1@,@NO.@,5X,@POL.VOLTAGE@,9X,@GAMMA(EXPT.)CALC.F=0@,
     1  10X,@THETA FROM MODEL@,14X,@ALPHA(EXPTL)@,8X,@ALPHA(MODEL)@)
      WRITE(3,761)(I,VOLTS(I),INTENS(I),THETA(I),ALPHA(I),ALFA(I),I=1,
     1 NPTS)
  761 FORMAT(@ @,I3,5X,F10.5,15X,F10.5,18X,F10.6,17X,F10.6,9X,F10.6)
      WRITE(3,762)
  762 FORMAT(@1@,@NO.@,5X,@POL.VOLTAGE@,9X,@RE(F)-EXPT.@,9X,@RE(F)-MODEL
     1@,9X,@IM(F)-EXPT.@,9X,@IM(F)-MODEL@)
      WRITE(3,763)(I,VOLTS(I),RELAS(I),CE(I),CELAS(I),IE(I),I=1,NPTS)
  763 FORMAT(@ @,I3,5X,F10.5,10X,F10.6,10X,F10.6,10X,F10.6,10X,F10.6)
      WRITE(3,764)
  764 FORMAT(@1@,@NO.@,5X,@POL.VOLTAGE@,10X,@Y1-EXPT.@,12X,@Y1-MODEL@,
     112X,@Y2-EXPT.@,12X,@Y2-MODEL@)
      WRITE(3,765)
      WRITE(3,765)(I,VOLTS(I),Y1EXP(I),MY1(I),Y2(I),MY2(I),I=1,NPTS)
  765 FORMAT(@ @,I3,5X,F10.5,10X,F10.6,10X,F10.6,10X,F10.6,10X,F10.6)
      WRITE(3,766)
  766 FORMAT(@1@,@NO.@,5X,@POL.VOLTAGE@,9X,@GAMMA-MODEL@)
      WRITE(3,767)(I,VOLTS(I),ST(I),I=1,NPTS)
  767 FORMAT(@ @,I3,5X,F10.5,9X,F10.5)
C
C     PUT MODEL PARAMETERS IN ALPHAMERIC GRAPH LABEL FORM
C
  850 FORMAT(@VECM VS.SCE=@,F8.5,@1/(B0)  = @,F10.5,@MU(POPE)= @,F10.6)
      WRITE(12,850) VECM,B0,MUP
      BACKSPACE 12
      READ(12,849)VECML,BOL,MUPL
  849 FORMAT(3(5A4))
      BACKSPACE 12
      WRITE(12,851)MUORG,AEX,BETA,GMRT,DIT
  851 FORMAT(@MU(SURF)= @,F10.6,@EXP(ELEC)=@,F10.5,@EXP-FRAK.=@,F10.5,
     1      @RT X GMAX=@,F10.5,@DIT.CONST=@,F10.4)
      BACKSPACE 12
      READ(12,855)MUORGL,AEXL,BETAL,GMRTL,DITL
  855 FORMAT(5(5A4))
      BACKSPACE 12
C
C     GRAPH VARIABLES OF INTEREST
C
      CALL GRAPH( NPTS,VOLTS,FREQ,11, 20,8.,8.,.2,-1.3,0.,0.,XL,YL11,
     1     YL12,YL13)




      CALL LETTER(.5,7.3,.1,ELECTR,0.,20,0,0,0,0,0,0,0,0,0)
      CALL LETTER(.5,7.5,.1,ORG,0,20,0,0,0,0,0,0,0,0,0)
      CALL LETTER(3.,4.0,.1,VECML ,0.,20,0,0,0,0,0,0,0,0,0)
      CALL LETTER(3.,3.8,.1,BOL   ,0.,20,0,0,0,0,0,0,0,0,0)
      CALL LETTER(3.,3.6,.1,MUPL  ,0.,20,0,0,0,0,0,0,0,0,0)
      CALL LETTER(3.,3.4,.1,MUORGL,0.,20,0,0,0,0,0,0,0,0,0)
      CALL LETTER(3.,3.2,.1,AEXL  ,0.,20,0,0,0,0,0,0,0,0,0)
      CALL LETTER(3.,3.0,.1,BETAL ,0.,20,0,0,0,0,0,0,0,0,0)
      CALL LETTER(3.,2.8,.1,GMRTL ,0.,20,0,0,0,0,0,0,0,0,0)
      CALL LETTER(3.,2.6,.1,DITL  ,0.,20,0,0,0,0,0,0,0,0,0)
      CALL GRAPH(-NPTS,VOLTS,THETA,1,11,8.,8.,.2,-1.3,.125,0.,XL,
     1     YL24,YL25,YL26)
      CALL LETTER(.5,7.5,.1,ORG,0,20,0,0,0,0,0,0,0,0,0)
      CALL LETTER(.5,7.3,.1,ELECTR,0.,20,0,0,0,0,0,0,0,0,0)
      CALL GRAPH(-NPTS,VOLTS,RELAS,1,112,8.,8.,.2,-1.3,16.,-64.,XL,YL16
     1     ,YL17,YL18)
      CALL GRAPH(-NPTS,VOLTS,CELAS,2,112,0,0,0,0,0,0,0,0,0,YL19)
      CALL GRAPH(-NPTS,VOLTS,CE    ,3,101,0,0,0,0,0,0,0,0,0,YL20)
      CALL GRAPH(-NPTS,VOLTS,IE    ,4,101,0,0,0,0,0,0,0,0,0,YL21)
      CALL LETTER(.5,7.5,.1,ORG,0,20,0,0,0,0,0,0,0,0,0)
      CALL LETTER(.5,7.3,.1,ELECTR,0.,20,0,0,0,0,0,0,0,0,0)
      CALL GRAPH(-NPTS,VOLTS,Y1EXP,11,112,8.,8.,.2,-1.3,.01,.94,XL,YL1,
     1YL3,YL2)
      CALL GRAPH(-NPTS,VOLTS,MY1,1,101,0.,8.,0,0,0,0,0,0,0,YL4)
      CALL LETTER(.5,7.5,.1,ORG,0,20,0,0,0,0,0,0,0,0,0)
      CALL LETTER(.5,7.3,.1,ELECTR,0.,20,0,0,0,0,0,0,0,0,0)
      CALL GRAPH(-NPTS,VOLTS,Y2,11,112,8.,8.,.2,-1.3,.0025,.003,XL,YL14,
     1   YL15,YL2)
      CALL GRAPH(-NPTS,VOLTS,MY2,3,101,0,0,0,0,0,0,0,0,0,YL28)
      CALL LETTER(.5,7.3,.1,ELECTR,0.,20,0,0,0,0,0,0,0,0,0)
      CALL LETTER(.5,7.5,.1,ORG,0,20,0,0,0,0,0,0,0,0,0)
      CALL GRAPH(-NPTS,VOLTS,GAMMA,11,120,8.,8.,.2,-1.3,10.,350.,XL,YL7,
     1YL6,YL0)
      CALL GRAPH(-NPTS,VOLTS,INTENS,2,120,0,0,0,0,0,0,0,0,0,YLT)
      CALL LETTER(.5,7.5,.1,ORG,0,20,0,0,0,0,0,0,0,0,0)
      CALL LETTER(.5,7.3,.1,ELECTR,0.,20,0,0,0,0,0,0,0,0,0)
C
      RETURN
      END
```

Figure 4 (Continued)

```
      SUBROUTINE POLZR (CKO,CK,ISTOP,F)
      REAL*8 KAPPA,KAPPO,ALPHA,ALPHO,X(10),Y(10),DABS
      COMPLEX*16 DCONJG,DCMPLX,CDSQRT
      COMPLEX*16 CK, CKO, F, FP, B(10),CI, FPP  ,DCK
      COMMON/POLZRO/CI,B,X,Y,LR,LW
      CUTALP = 1./10.**8
      CUTKAP = 1./10.**8
      ISTOP = 0
    1 ISTOP = ISTOP + 1
      CALL FNCALC(CKO,F,FP,FPP)
      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 = ∂,E16.7, 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)
      COMPLEX*16 DCONJG,DCMPLX,CDSQRT
      COMPLEX*16 CI   ,CK,C(5),D(2),F,FP,FPP,CP5,CPP5,DP1,DPP1,DP2,
     1DPP2,CP1,CPP1,E,G ,B(10)
      REAL*8 X(10),Y(10)
      COMMON/POLZRO/CI,B,X,Y,LR,LW
      CALL CCOEF(CK,C,D)
      G=(1.+990.*(X(5)-X(6))/(X(7)*CK **2))
      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)
      REAL*8 X(10),Y(10)
      COMPLEX*16 DCONJG,DCMPLX,CDSQRT
      COMPLEX*16 CI,B(10),CK,CMUCMP,CMUCM
      COMMON/POLZRO/CI,B,X,Y,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)
      REAL*8 X(10),Y(10)
      COMPLEX*16 DCONJG,DCMPLX,CDSQRT
      COMPLEX*16 CI,B(10),D(2),C(5),CK
      COMMON/POLZRO/CI,B,X,Y,LR,LW
      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(3)
      RETURN
      END
```

Figure 4 (Continued)

```
//BC17CALB JOB @A0087,TIME=2,SIZE=128K@,GORDON,MSGLEVEL=1
//STEPONE  EXEC FORTG
//FORT.SYSIN  DD  *
C      PROGRAM FOR FITTING CURVE OF AMPLITUDE(FEQUENCY) DEPENDENCE OF
C      WAVE GENERATING PROBE OF INTERFACIAL RIPPLE APPARATUS
C      DESCRIPTION OF NECESSARY DATA CARDS FOLLOWSC
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                 IWTS:  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 OFREQUENCY COL.1-10,AMPLITUDE COL.51-60
C                            IF PTS. WEIGHTED ,WT. OF PT. IN CCL.71-80
C
C        REPEAT CARDS 2 TO NPTS+2  FOR EACH SECTION OF CURVE (NPARTS)
C
C
      REAL*8 X(75),Y(75),W(75),Q(11),RES(75),ERROR(75),REST
     1       ,STDEV(10),DSQRT,SUM,FMIN  ,Z
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,IWTS
    2 FORMAT(2I2)
      IF(IWTS)15,15,16
   16 READ(1,3)(X(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)(X(J),Y(J),J=1,NPTS)
    4 FORMAT(F10.0,10X,F10.0)
   18 CONTINUE
      DO 500 J=1,NPTS
  500 X(J)=0.01D0*X(J)
C
C
      TUWYLO = 0.0
      WRITE(2,9) I
    9 FORMAT(@POLYNOMIAL COEFFICIENTS OF SECTION @,I2)
C
      DO 25 NDEG=1,10
      CALL OPLSPA(NDEG,NPTS,X,Y,W,Q,TUWYLO)
      TUWYLO=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
```

Figure 5. CALB listing

```
      WRITE(2,8)NDEG
    8 FORMAT(@COEFFICIENTS OF @,I2,@ TH DEGREE FIT@)
C
      WRITE(2,6)(O(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(///@ @,10X, @FREQUENCY X 0.01@, 7X,@EXPERIMENTAL AMPLITUDE@
     1,10X,@CALCULATED AMPLITUDE@,10X,@ERROR@)
C
      DO 11 J=1,NPTS
      RES(J)= O(1)
      DO 1001 L=2,NDEG1
      RES(J)= RES(J) +O(L)*X(J)**(L-1)
 1001 CONTINUE
      ERROR(J)=Y(J)-RES(J)
      WRITE(3,13)X(J),Y(J),RES(J),ERROR(J)
   13 FORMAT(10X,F10.5,22X,F10.5,15X,F10.5,15X,F10.5)
      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
```

Figure 5 (Continued)

```
      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
      Q(N+1)=SUM(2)/SUM(3)                                              OPLSPA33
      IF (N)  3,3,12                                                    OPLSPA34
   12 DO 13   J=1,N                                                     OPLSPA35
   13 Q(J)=Q(J)+Q(N+1)*PN(J)                                            OPLSPA36
      IF (N-NDEG)  2,14,14                                              OPLSPA37
   14 RETURN                                                            OPLSPA38
      END
```

Figure 5 (Continued)

```
/DATA
/STOP
//B017GVAL JOB    @AOC87,TIME=2,SIZE=128K,CARDS=400@,GORDON
//JOBLIB     DD     DSNAME=SYS1.WATBPS,DISP=(OLD,PASS)
//STEP1      EXEC   BPS
//BPS.SYSIN DD      *
/JOB               AOC87-GVAL,TIME=1,LINES=60,PAGES=30
C      PROGRAM FOR EVALUATING POLYNOMIAL FIT TO ELECTROCAPILLARY DATA
C      AT ARBITRARY VOLTAGES, AND PUNCHING CORDS WITH THESE VALUES
C
C      INPUT DATA REQUIREDGPOLYNOMIAL COEFFICIENTS FOR GAMMA(VOLTS) DATA
C      ALSO ONE MUST GIVE REFERENCE ELECTRODE USED IN VOLTAGE
C      MEASUREMENTS AND  ORGANIC SURFACTANT AND ELECTROLYTE USED
C
       DIMENSION TITLE(18),GAMMA(101),VOLT(101) ,A(20)
    30 READ(1,2)VOLTO
     2 FORMAT(F10.0)
       READ(1,3)(A(I),I=1,11)
     3 FORMAT(4F15.8)
       DELTA = 0.025
       U = (VOLTO + 1.300)/DELTA
       NPTS = 1 + U
       VOLT(1) = VOLTO
       READ(1,20)TITLE
    20 FORMAT(18A4)
       WRITE(3,40)TITLE
    40 FORMAT(@1@,18A4)
       WRITE(2,20)TITLE
       WRITE(3,21)
    21 FORMAT(///@ @,@POLARIZATION VOLTAGE@,5X,@INTERFACIAL TENSION@)
       DO 10 K=1,NPTS
       GAMMA(K) = A(1)
       DO 12 I=2,11
       GAMMA(K) = GAMMA(K) +A(I)*VOLT(K)**(I-1)
    12 CONTINUE
       WRITE(3,22)VOLT(K),GAMMA(K)
    22 FORMAT(F20.7,5X,F20.7)
       WRITE(2,23)VOLT(K),GAMMA(K)
    23 FORMAT(F10.5,20X,F10.5)
    10 VOLT(K+1)=VOLT(K)-DELTA
       READ(1,29)NEXT
    29 FORMAT(I5)
       IF(NEXT)31,31,30
    31 STOP
       END
```

Figure 6. GVAL listing

APPENDIX C

Experimental Plots[1] (Figures 7-59)

---

[1] All plots have interfacial polarization as abscissa.

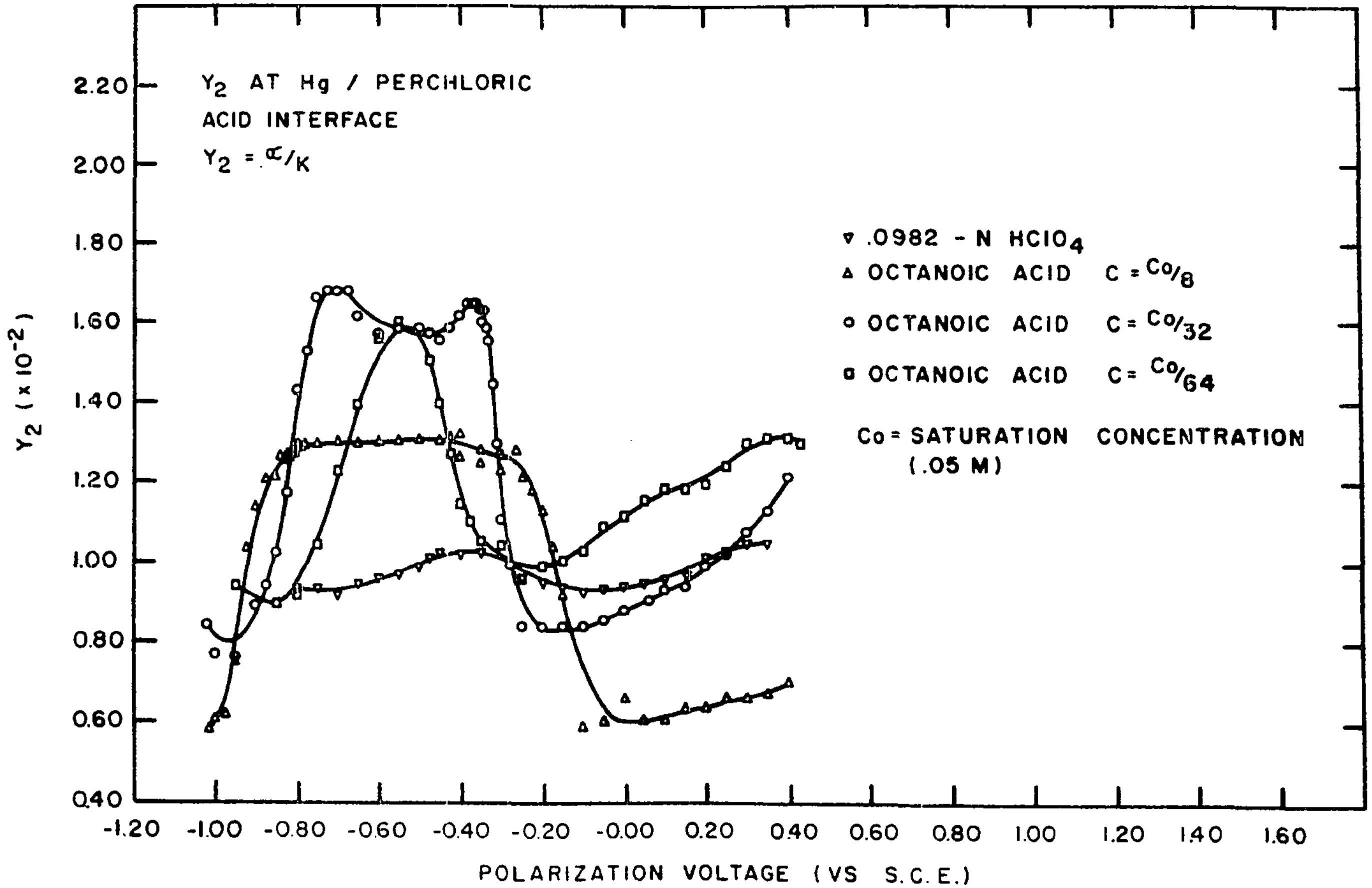


Figure 7. Dependence of reduced damping coefficient $y_2=\alpha/\kappa$ on polarization, system 0.1N aqueous $HClO_4$ plus octanoic acid at indicated concentration-polarized mercury.

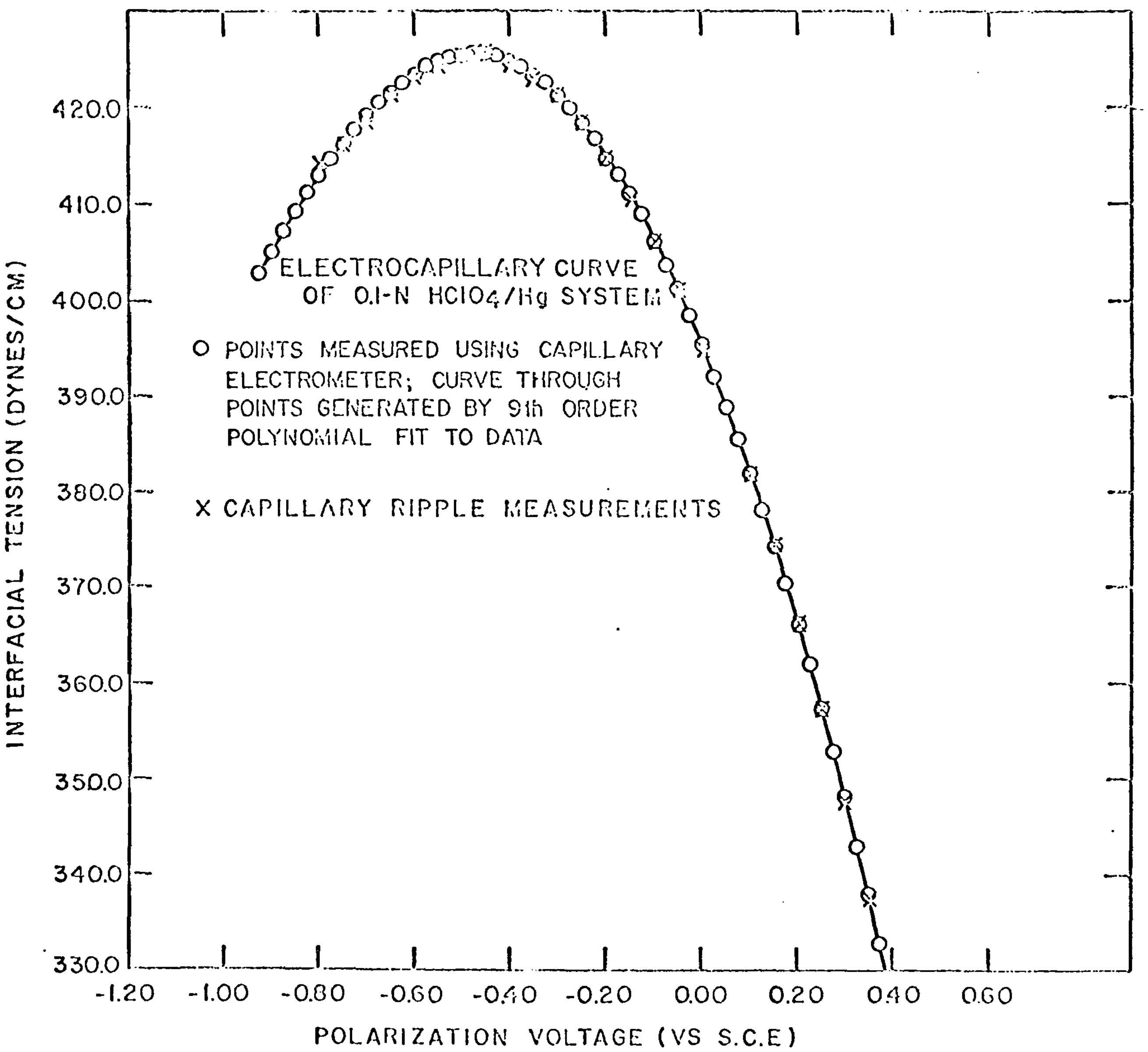


Figure 8. Electrocapillary curve, system 0.1N aqueous $HClO_4$-polarized mercury comparison of capillary ripple and capillary electrometer results

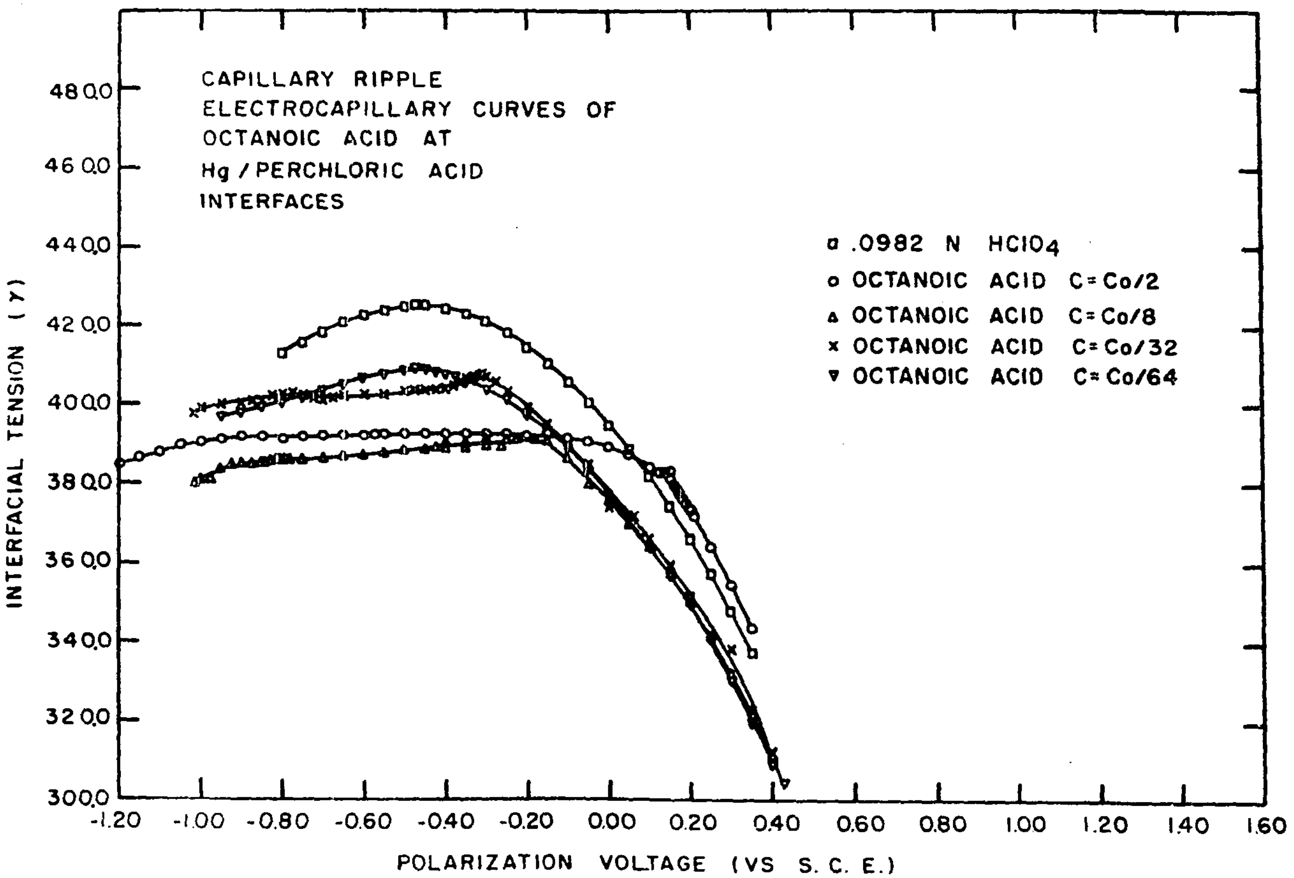


Figure 9. Electrocapillary curves, system 0.1N aqueous $HClO_4$ plus octanoic acid at indicated concentration-polarized mercury. Results were obtained by the capillary ripple method based on Equation 96

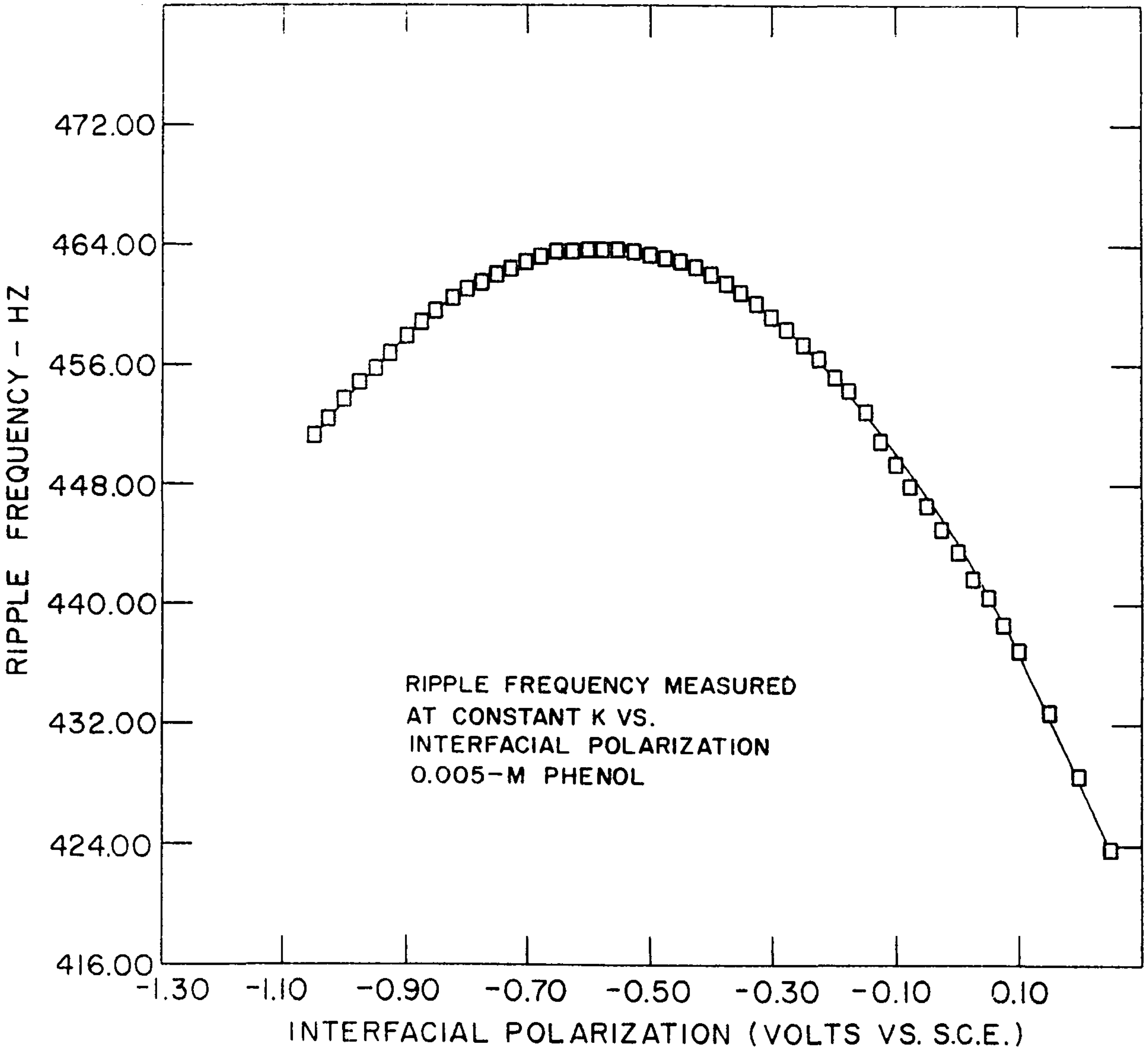


Figure 10. Experimental frequency response to imposed polarization at constant k for the .005-M phenol in N/10 $HClO_4$-mercury interface

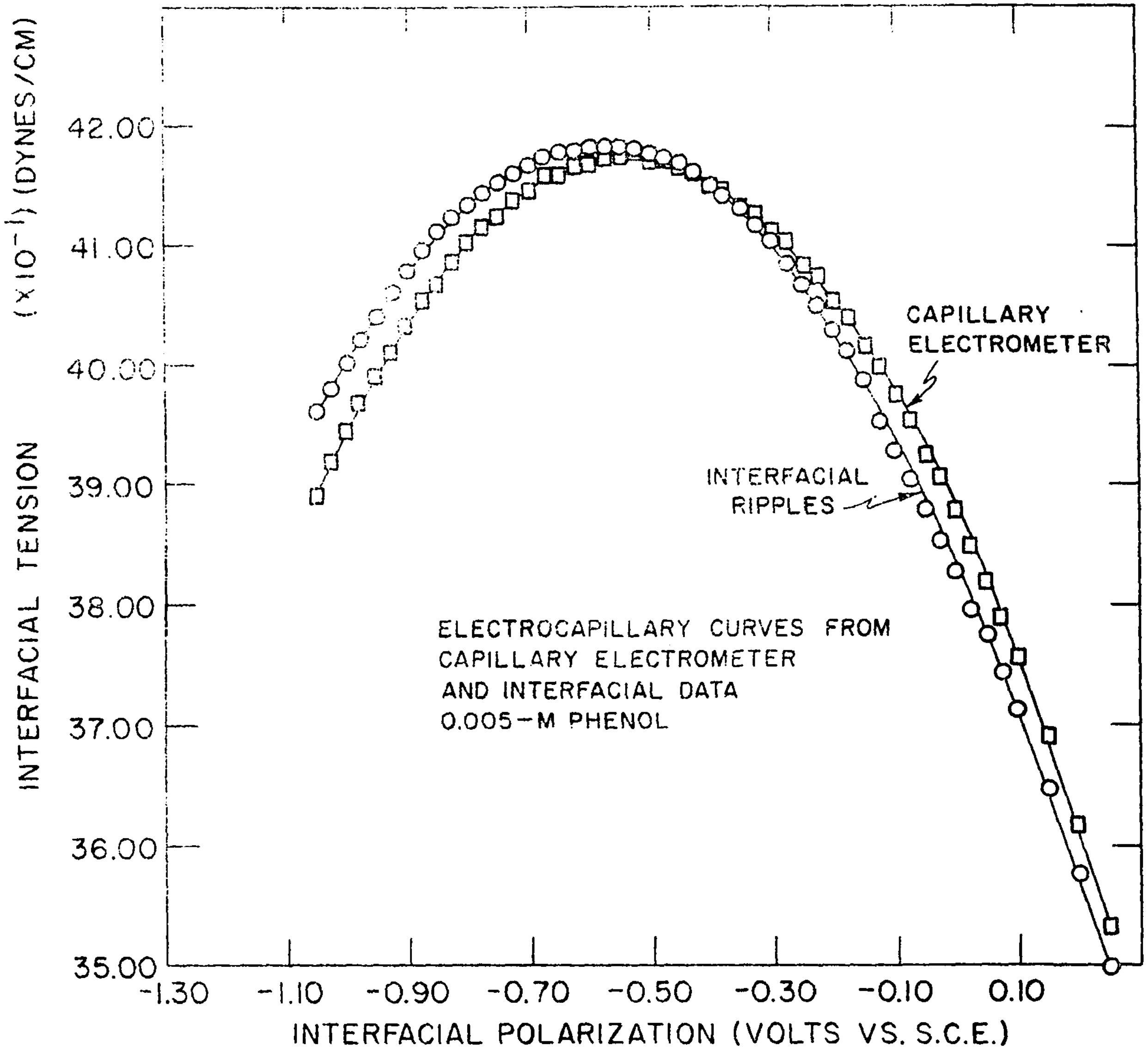


Figure 11. Electrocapillary curves from capillary electrometer and interfacial ripples (calculated assuming E=0) for the .005-M phenol in N/10 $HClO_4$-mercury interface

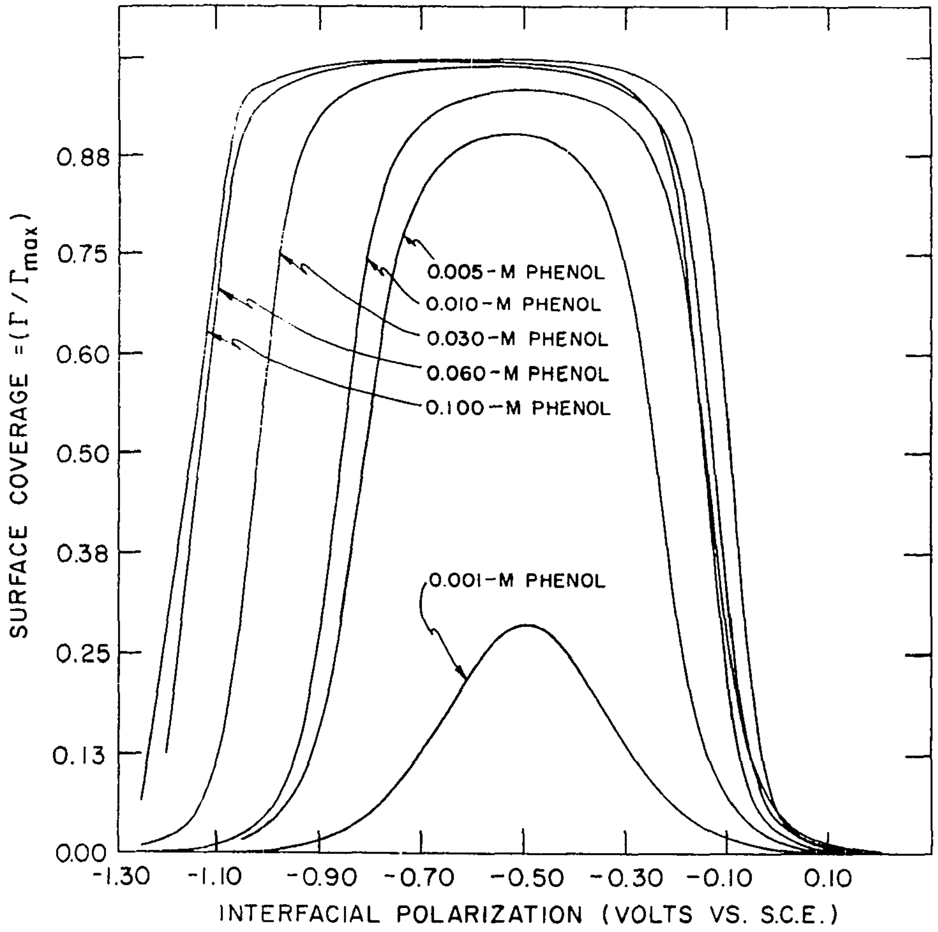


Figure 12. Model-generated Θ curves for the system phenol in N/10 $HClO_4$-mercury

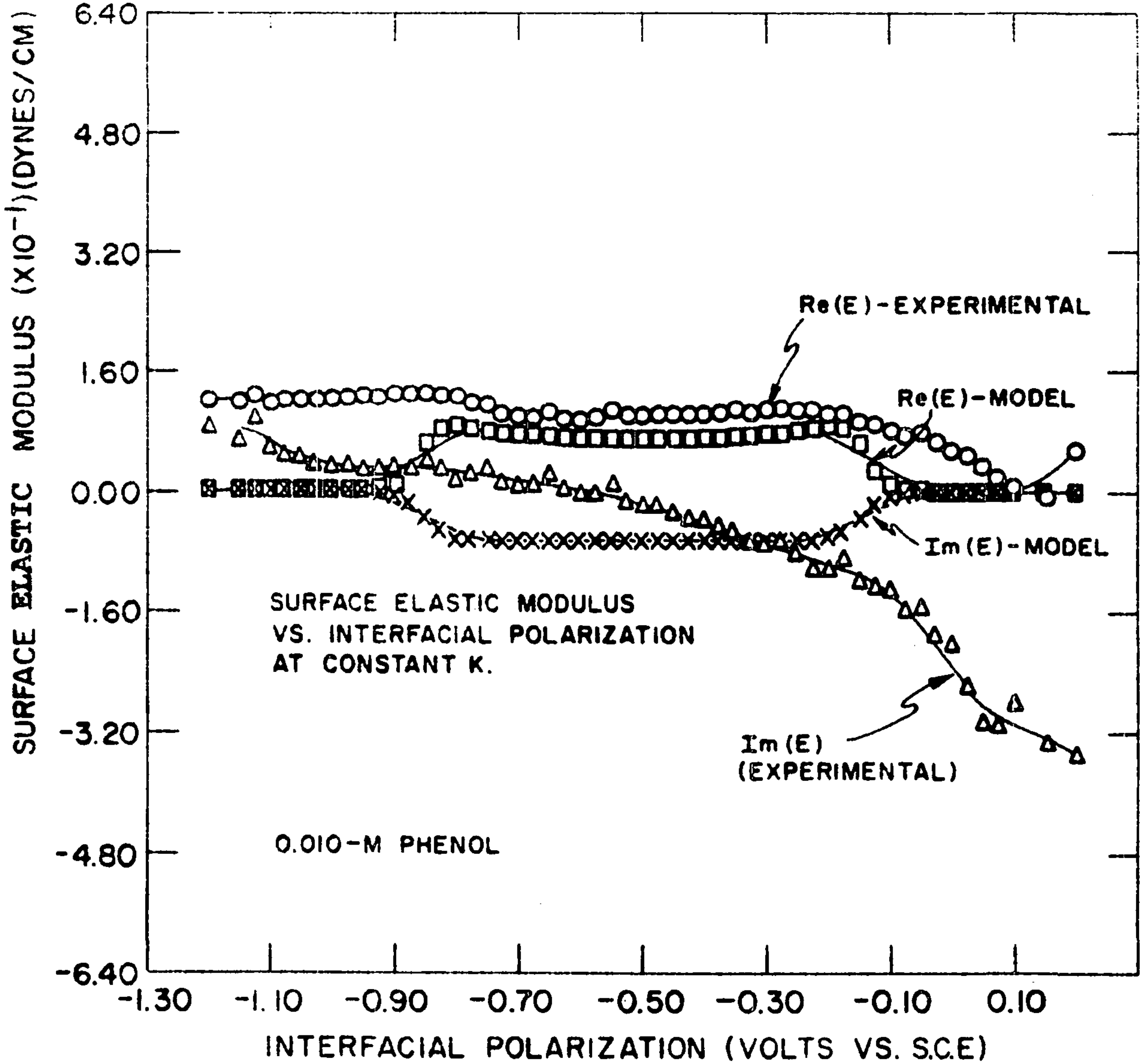


Figure 13. Real and imaginary components of surface elastic modulus (E) for the .010-M phenol in N/10 $HClO_4$-mercury interface

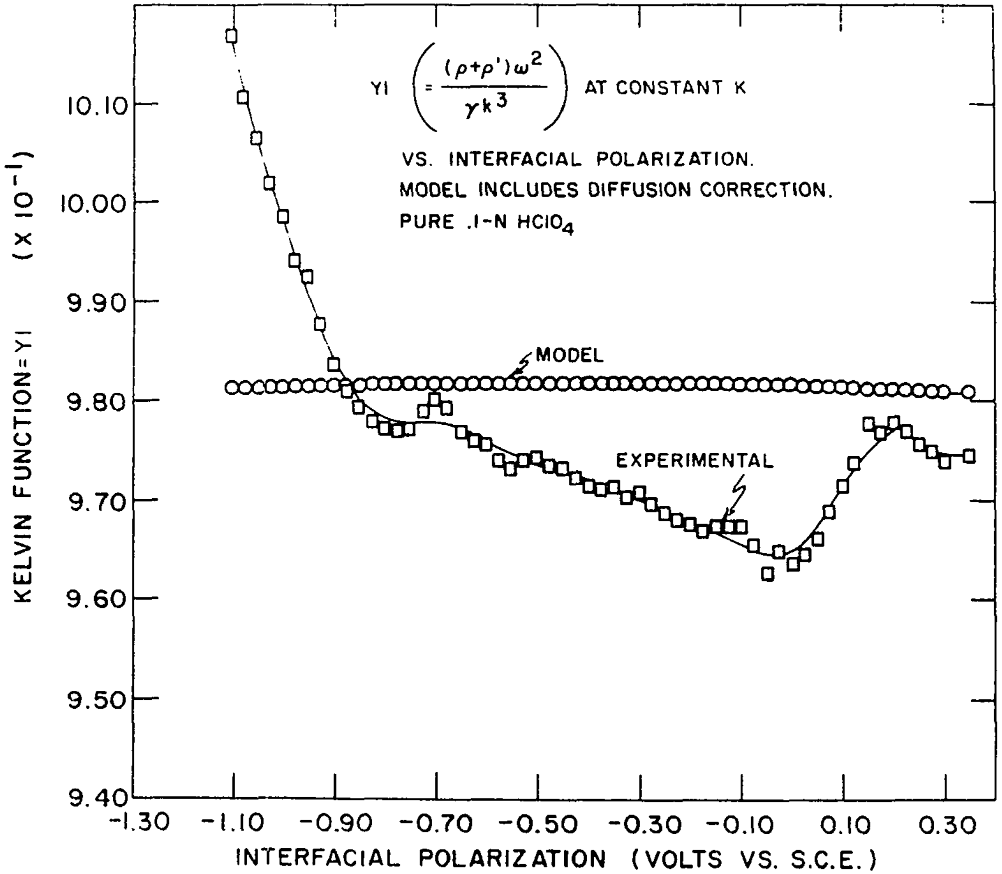


Figure 14. Y1 from experiment and model for the pure N/10 $HClO_4$-mercury interface

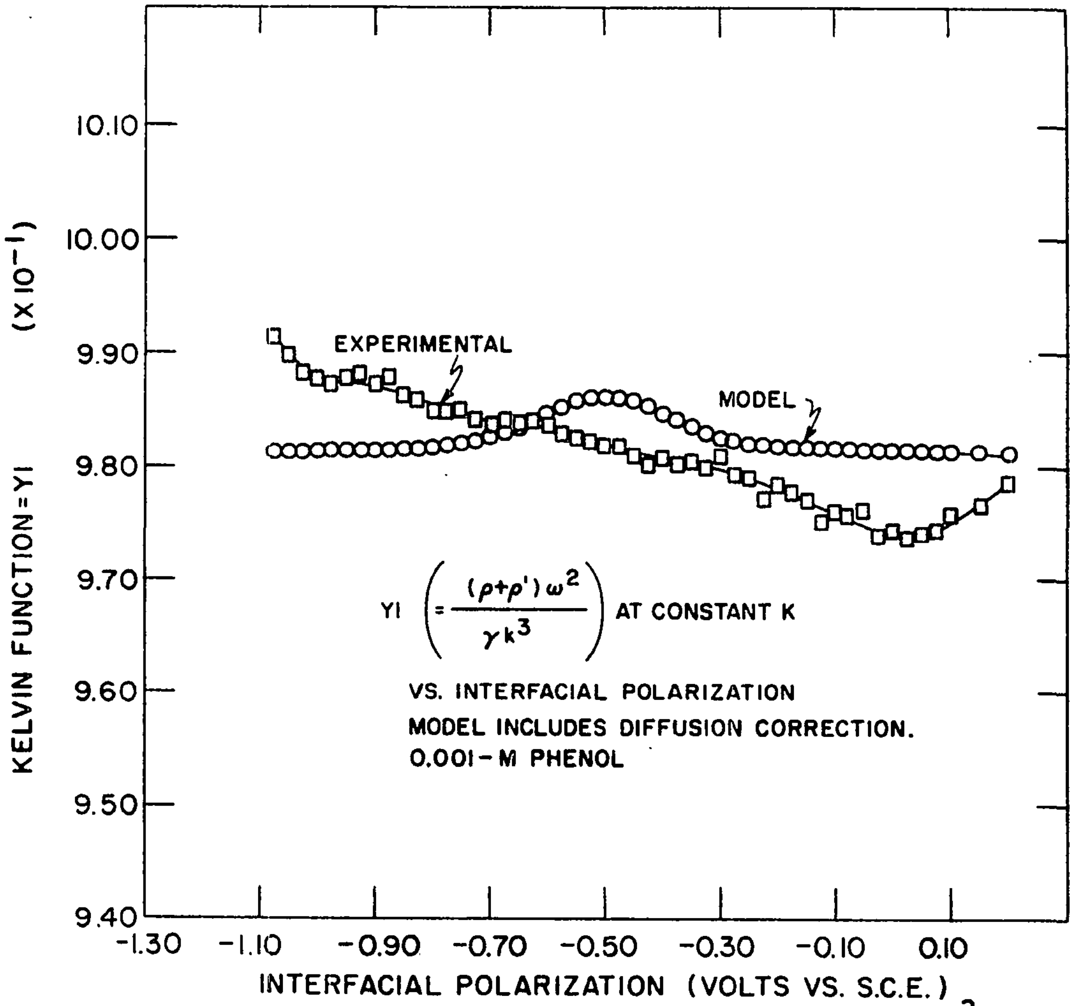


Figure 15: Y1 curves from experiment and model for the 10^{-3}-M phenol in N/10 $HClO_4$-mercury interface

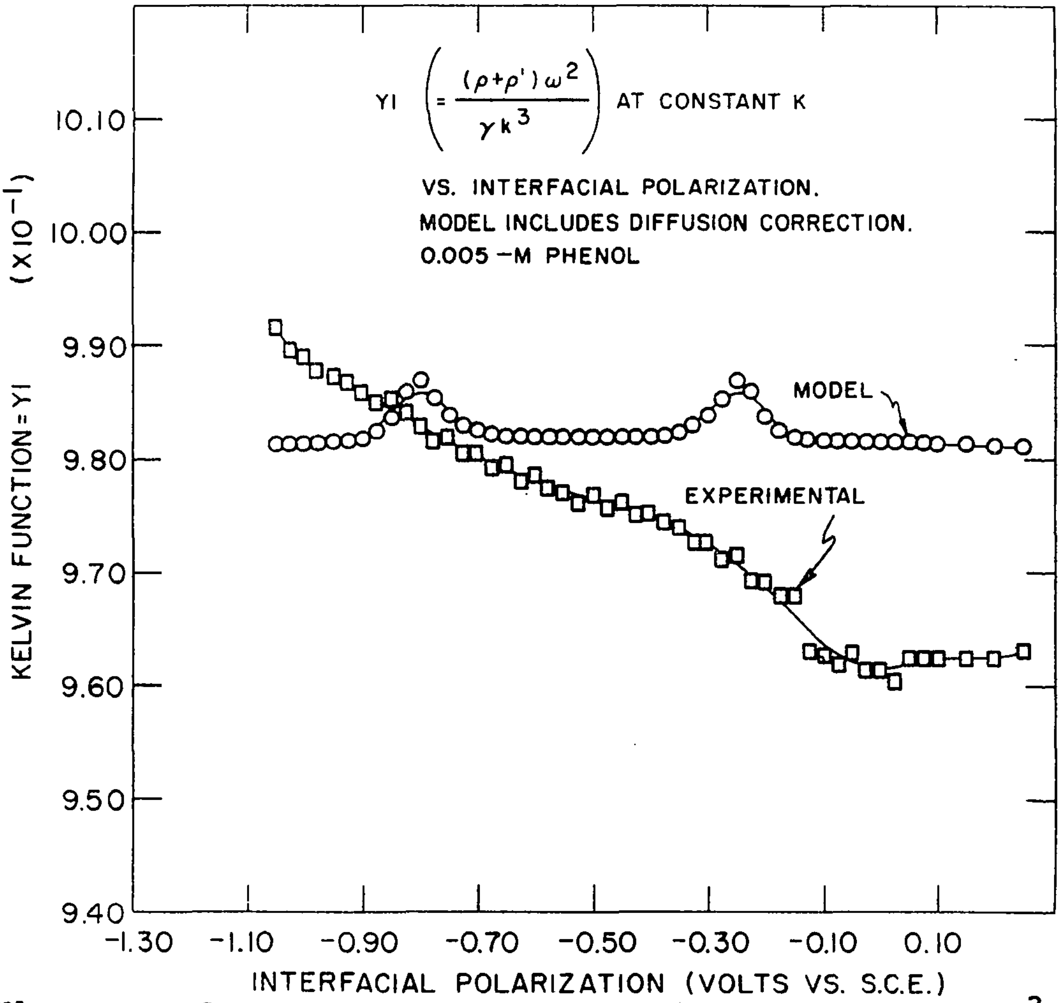


Figure 16. Y1 curves from model and experiment for the 5 x 10^{-3}-M phenol in N/10 $HClO_4$-mercury interface

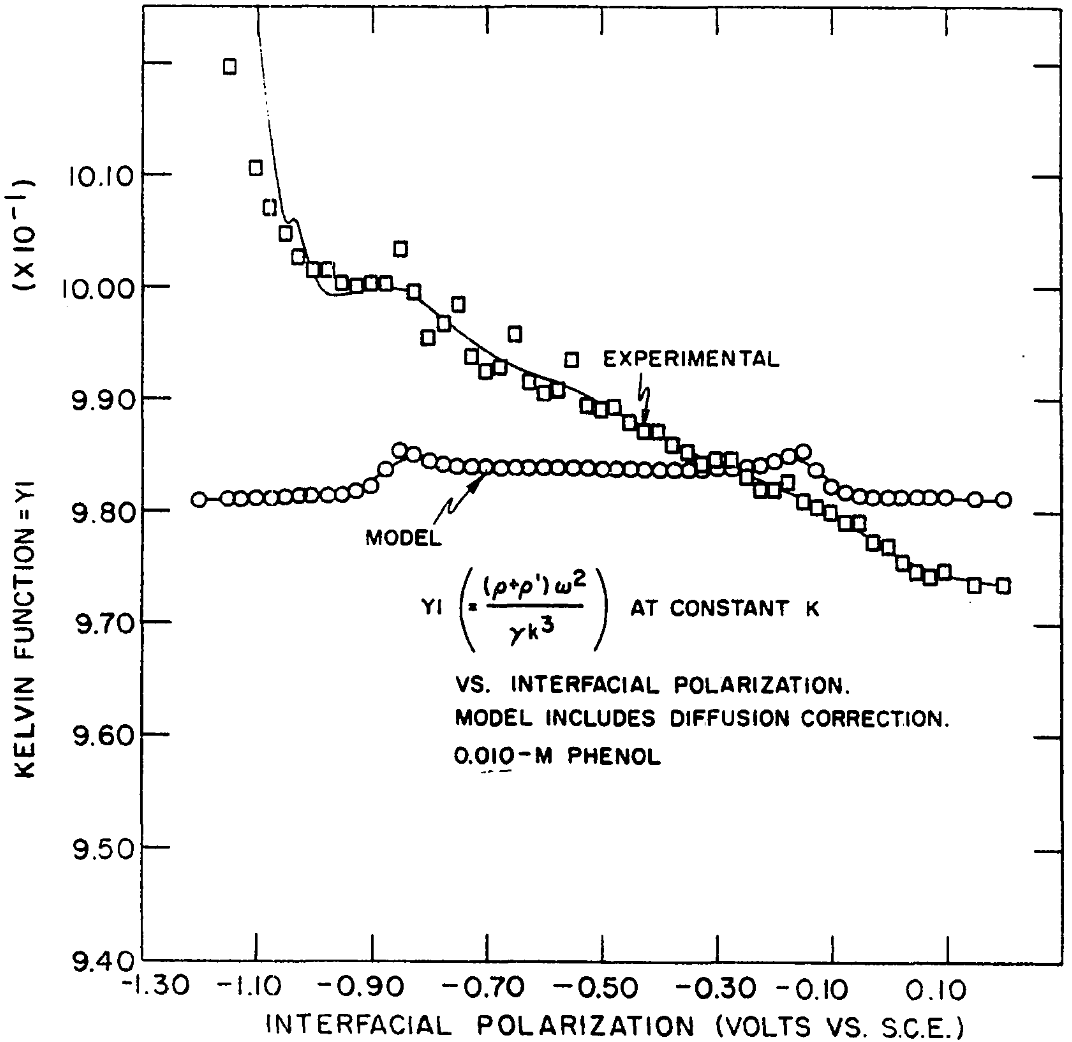


Figure 17. Y1 curves from model and experiment for the 10^{-2}-M phenol in N/10 $HClO_4$-mercury interface

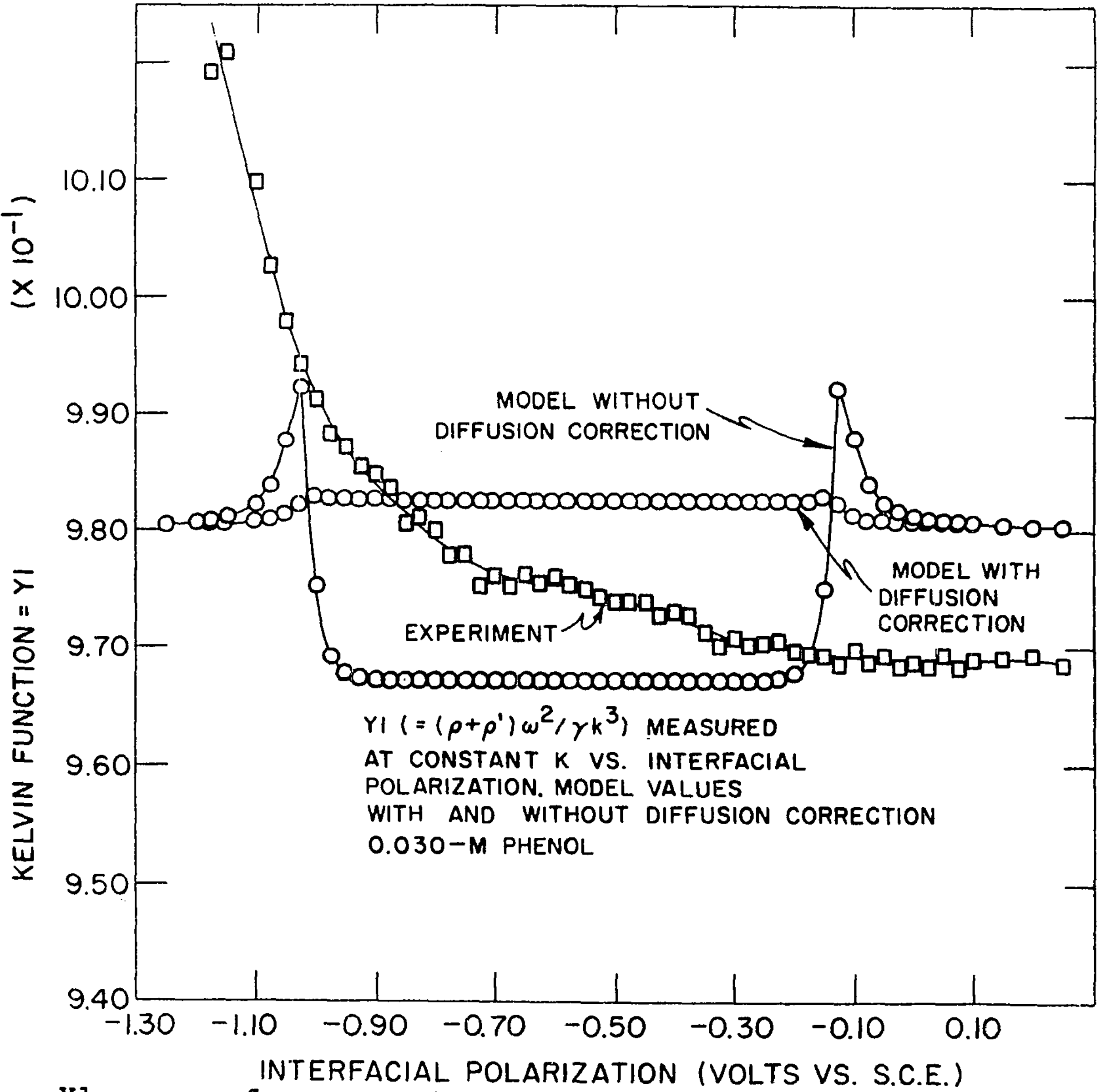


Figure 18. Y1 curves from experiment and model (with and without diffusion correction) for the 0.03-M phenol in N/10 $HClO_4$-mercury interface

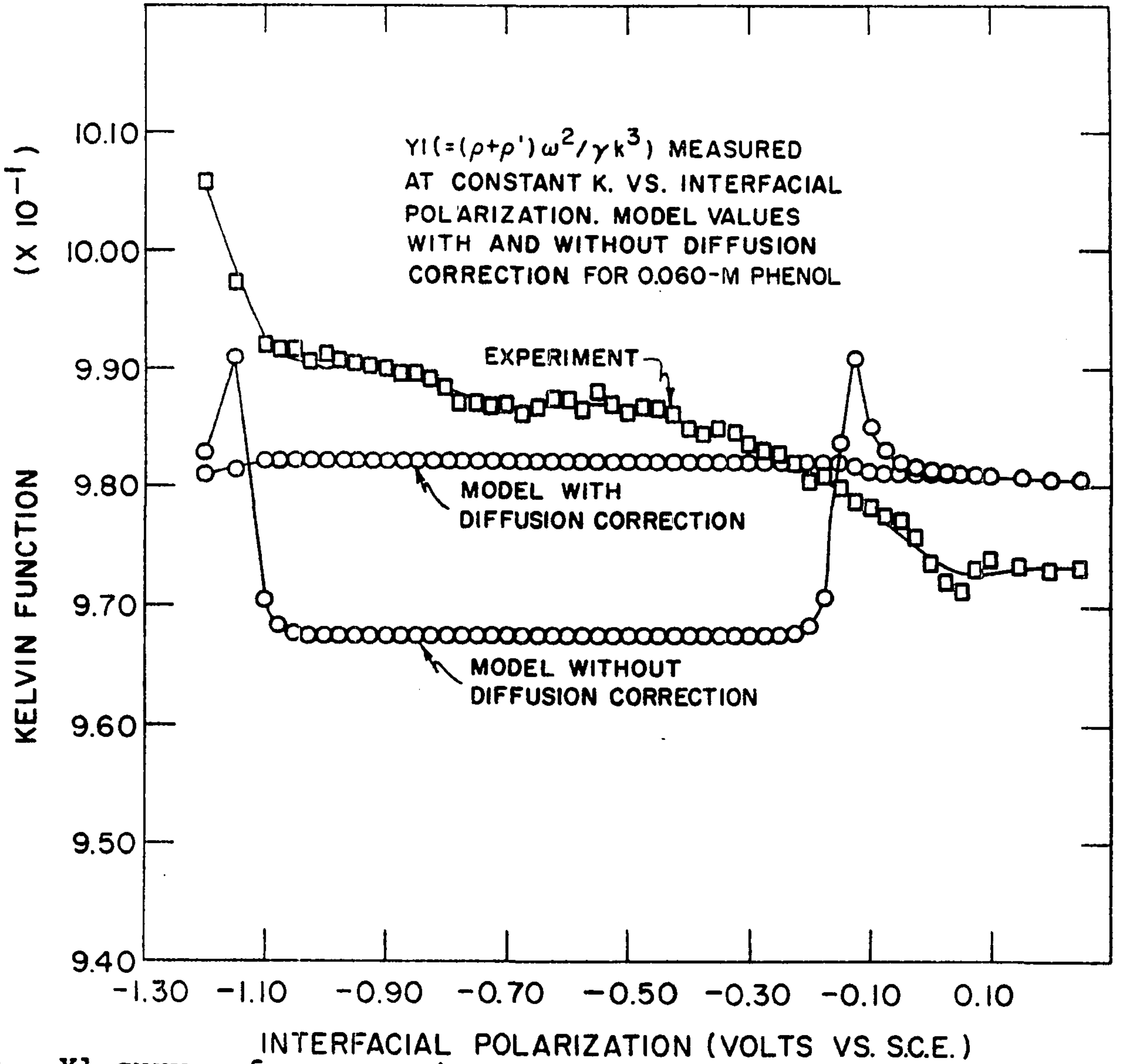


Figure 19. Y1 curves from experiment and model (with and without diffusion correction) for the 0.06-M phenol in N/10 $HClO_4$-mercury interface

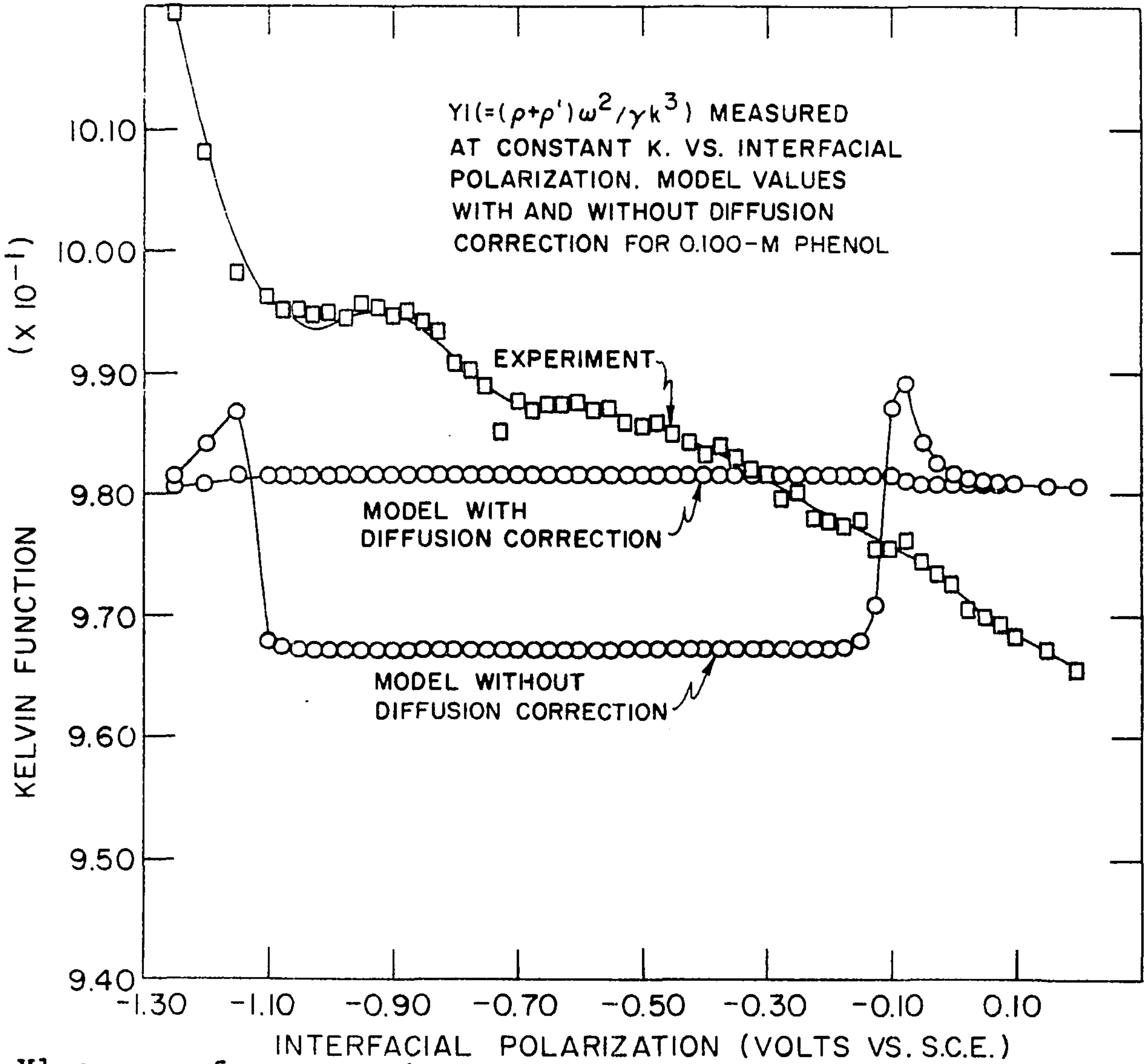


Figure 20. Yl curves from experiment and model (with and without diffusion correction) for the 0.1-M phenol in N/10 $HClO_4$-mercury interface

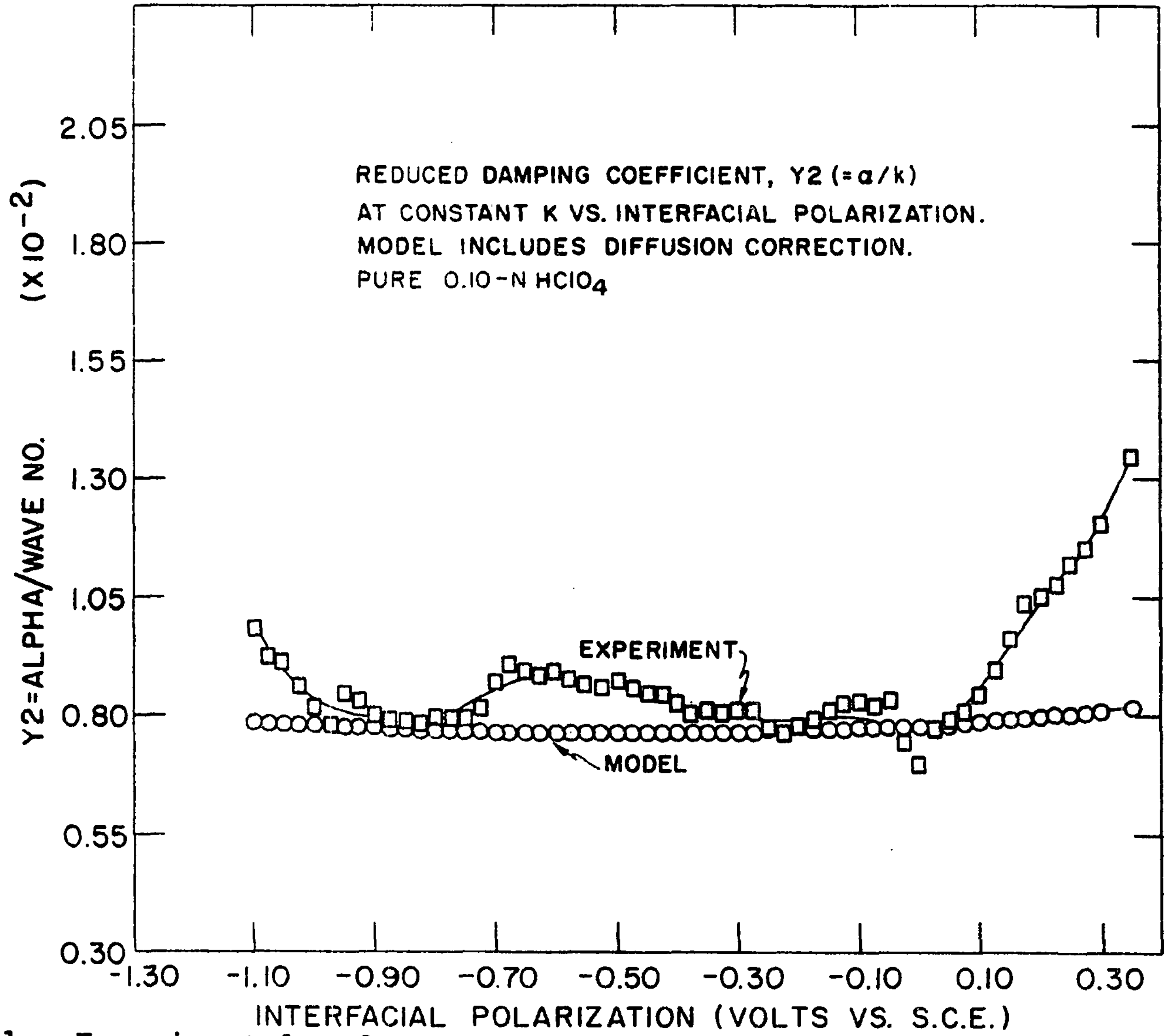


Figure 21. Experimental and model-generated Y2 curves for the pure N/10 $HClO_4$-mercury interface

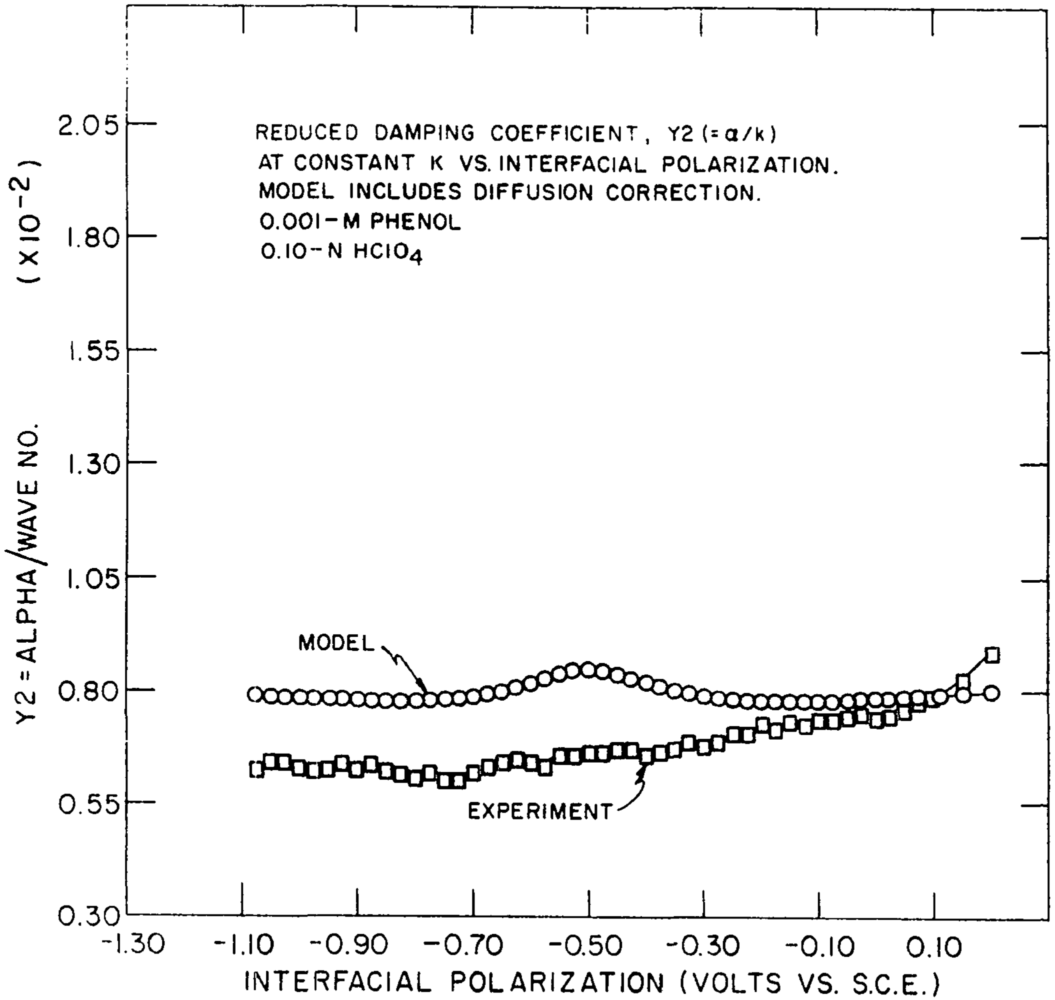


Figure 22. Experimental and model Y2 curves for the 10^{-3}-M phenol in N/10 $HClO_4$-mercury interface

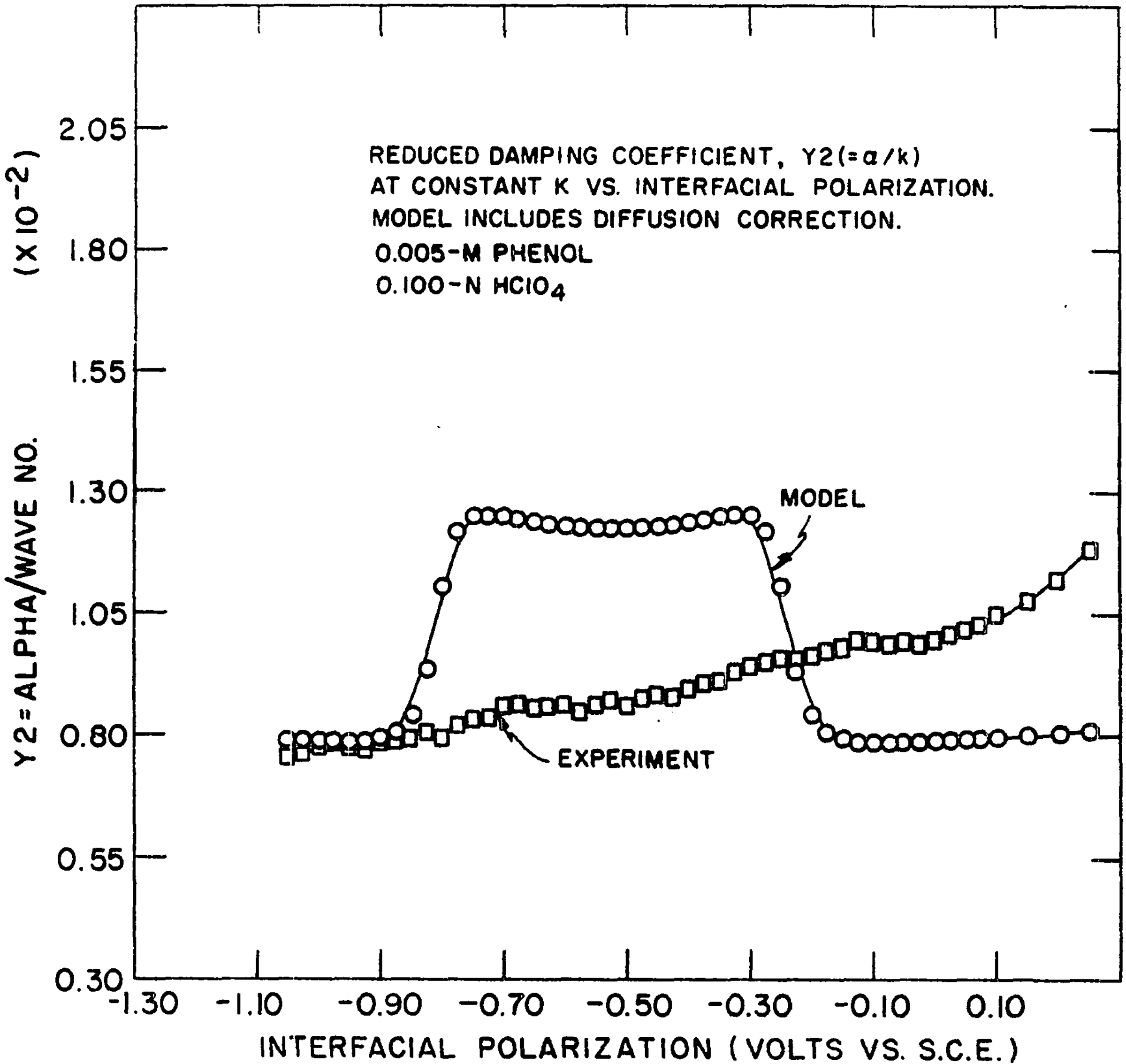


Figure 23. Experimental and model-generated Y2 curves for the 5 x 10^{-3}-M phenol in N/10 $HClO_4$-mercury interface

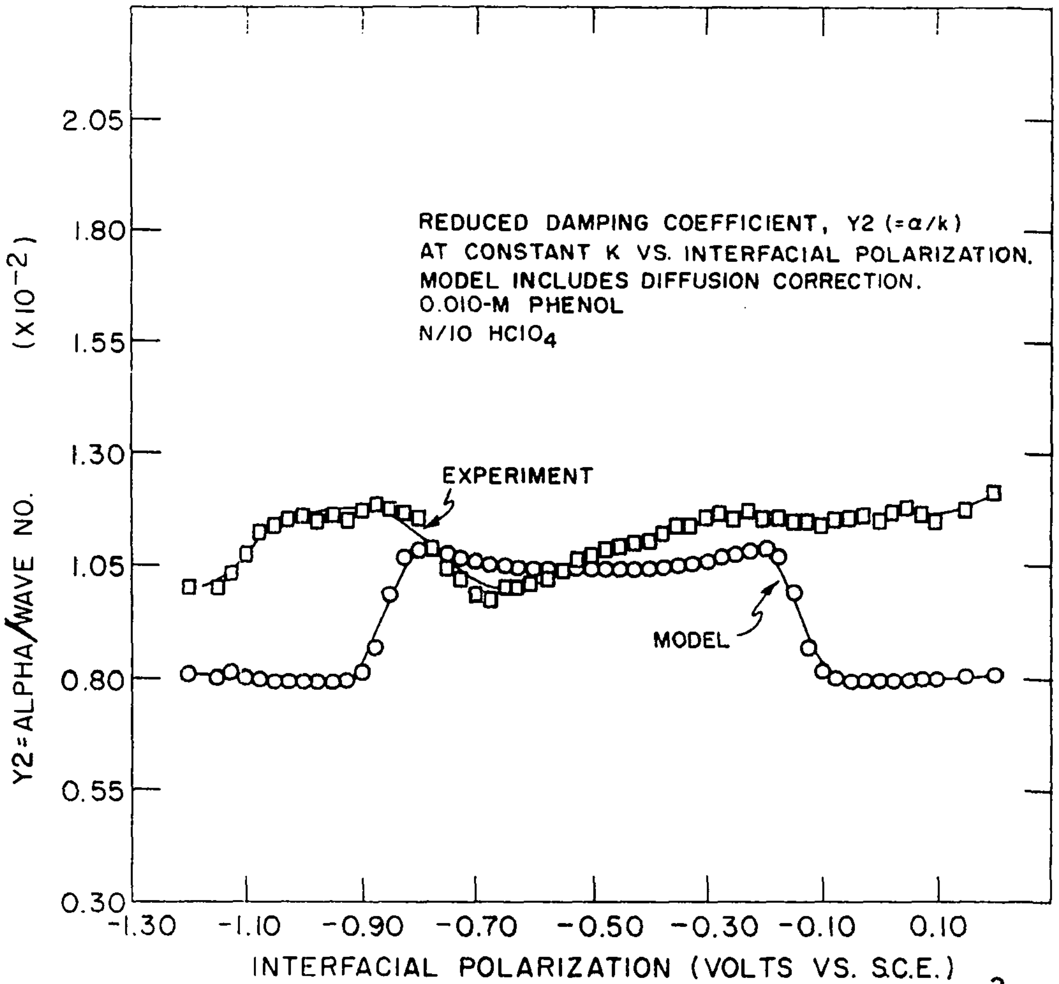


Figure 24. Model-generated and experimental Y2 curves for 10^{-2}-M phenol in N/10 $HClO_4$-mercury interface

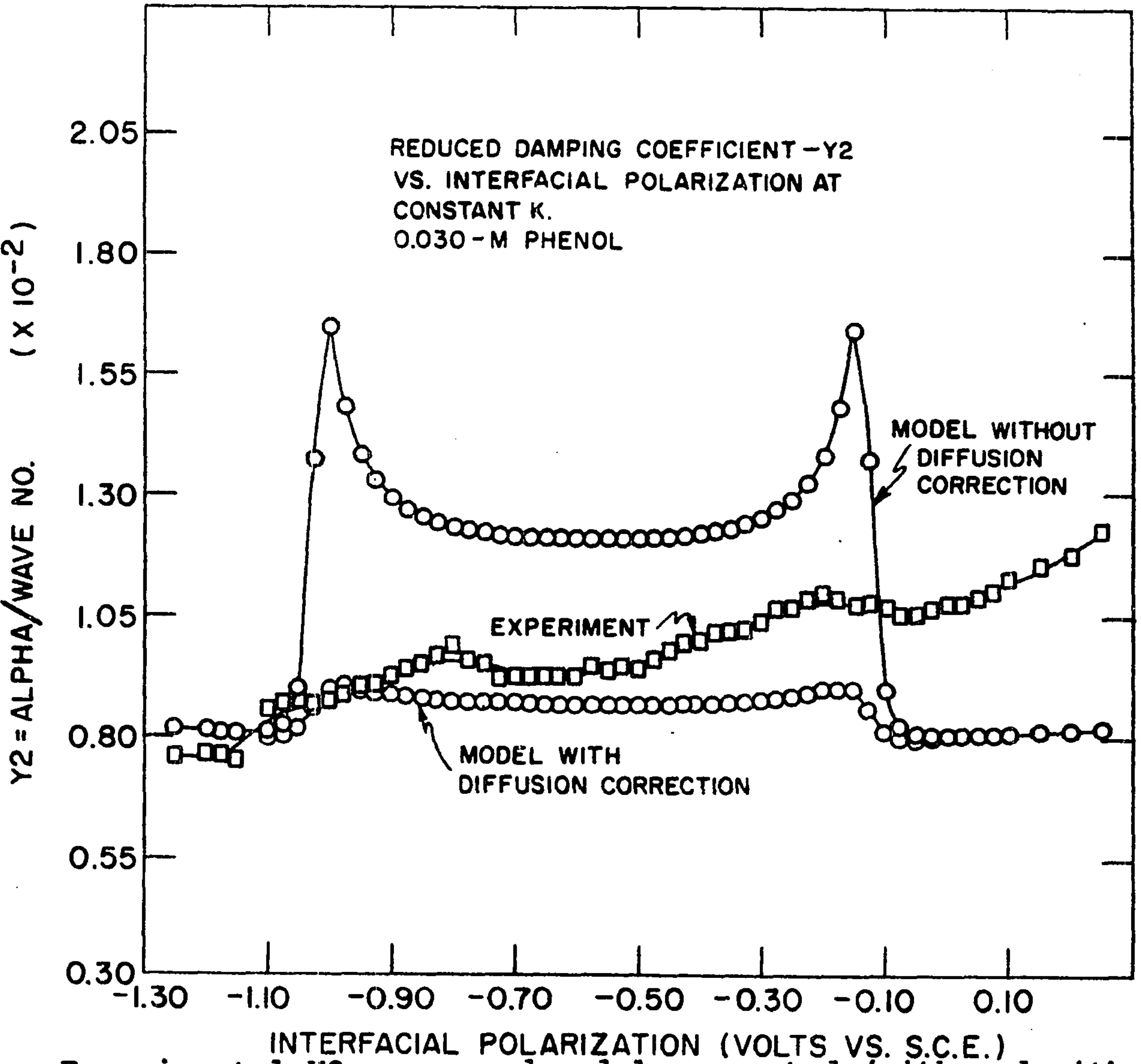


Figure 25. Experimental Y2 curve and model-generated (with and without diffusion correction) Y2 curves for the .03-M phenol in N/10 $HClO_4$-mercury interface

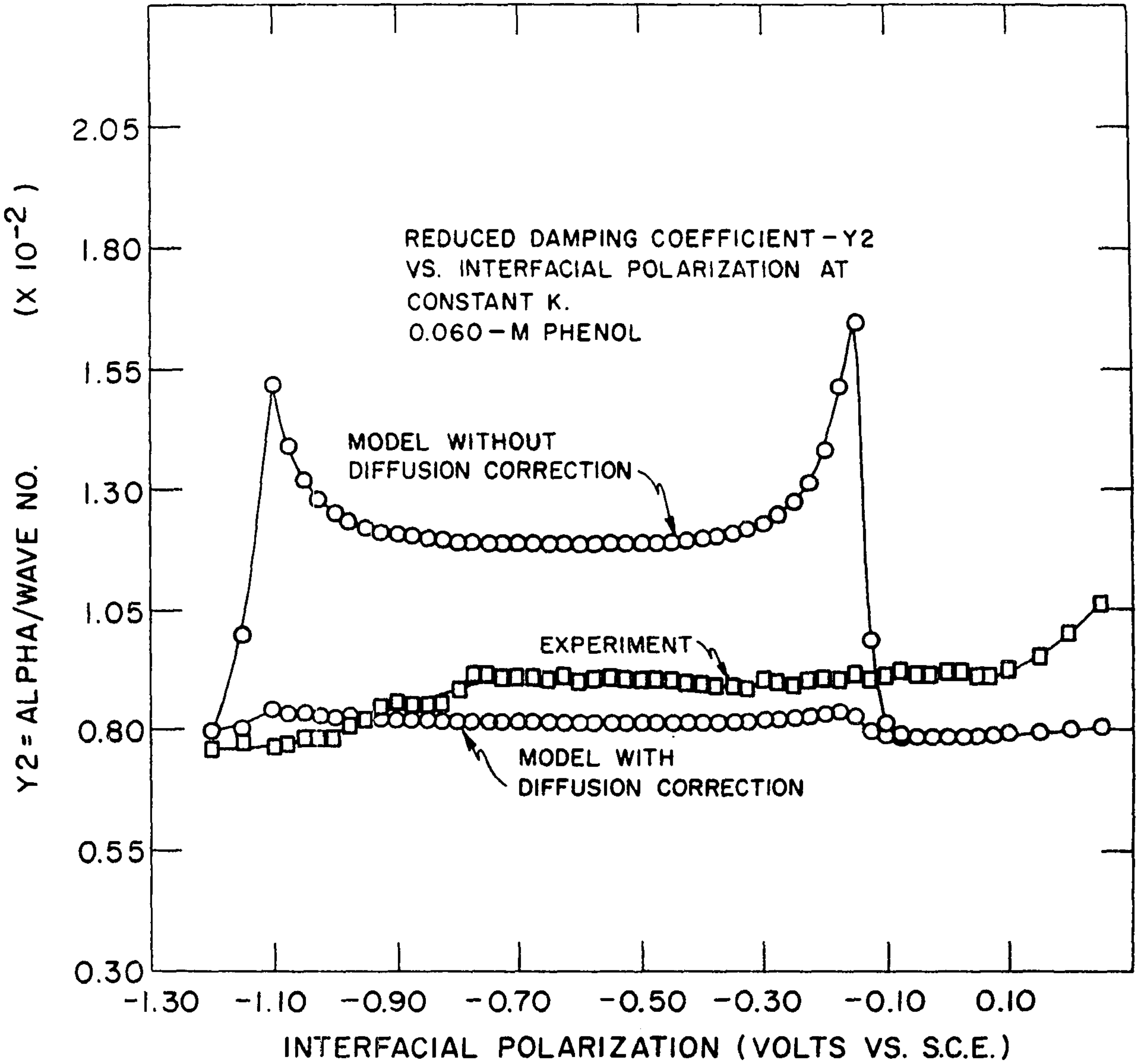


Figure 26. Model-generated (with and without diffusion correction) and experimental Y2 curves for .06-M phenol in N/10 $HClO_4$-mercury interface

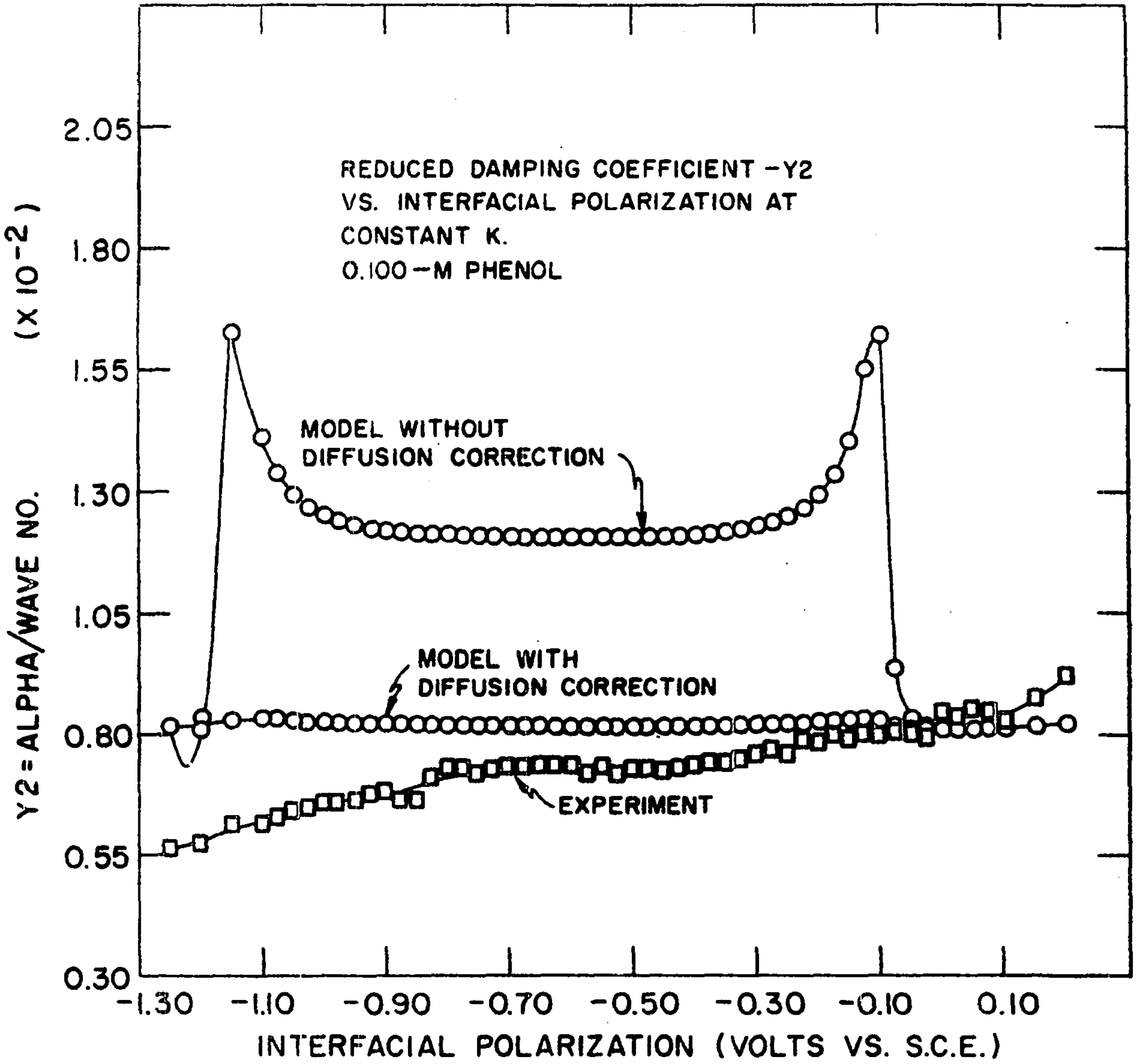


Figure 27. Y2 curves for experiment and model (with and without diffusion correction) for the 10^{-1}-M phenol in N/10 $HClO_4$-mercury interface

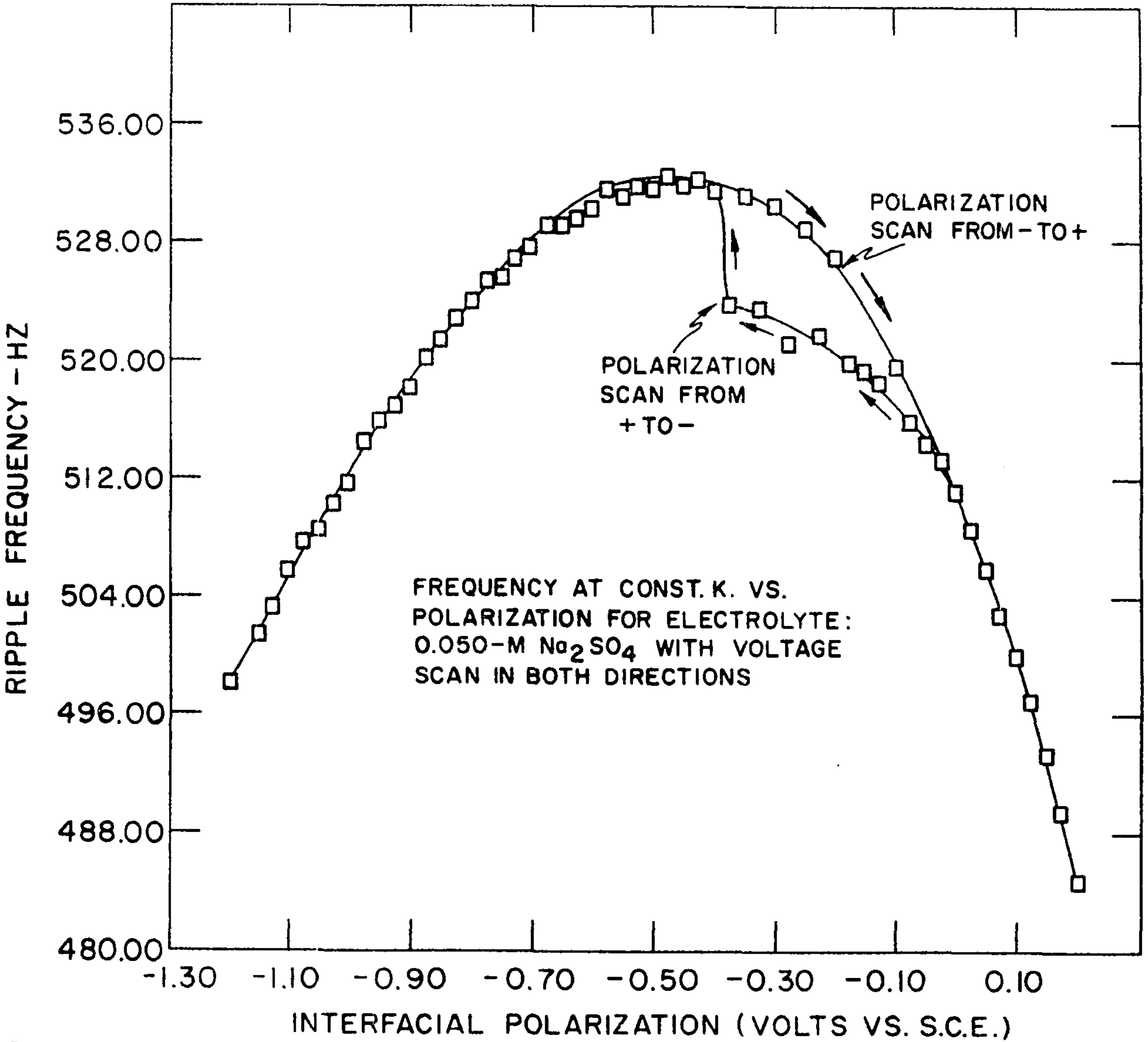


Figure 28. Frequency response at constant k to imposed interfacial polarization for the pure .05-M Na_2SO_4-mercury interface

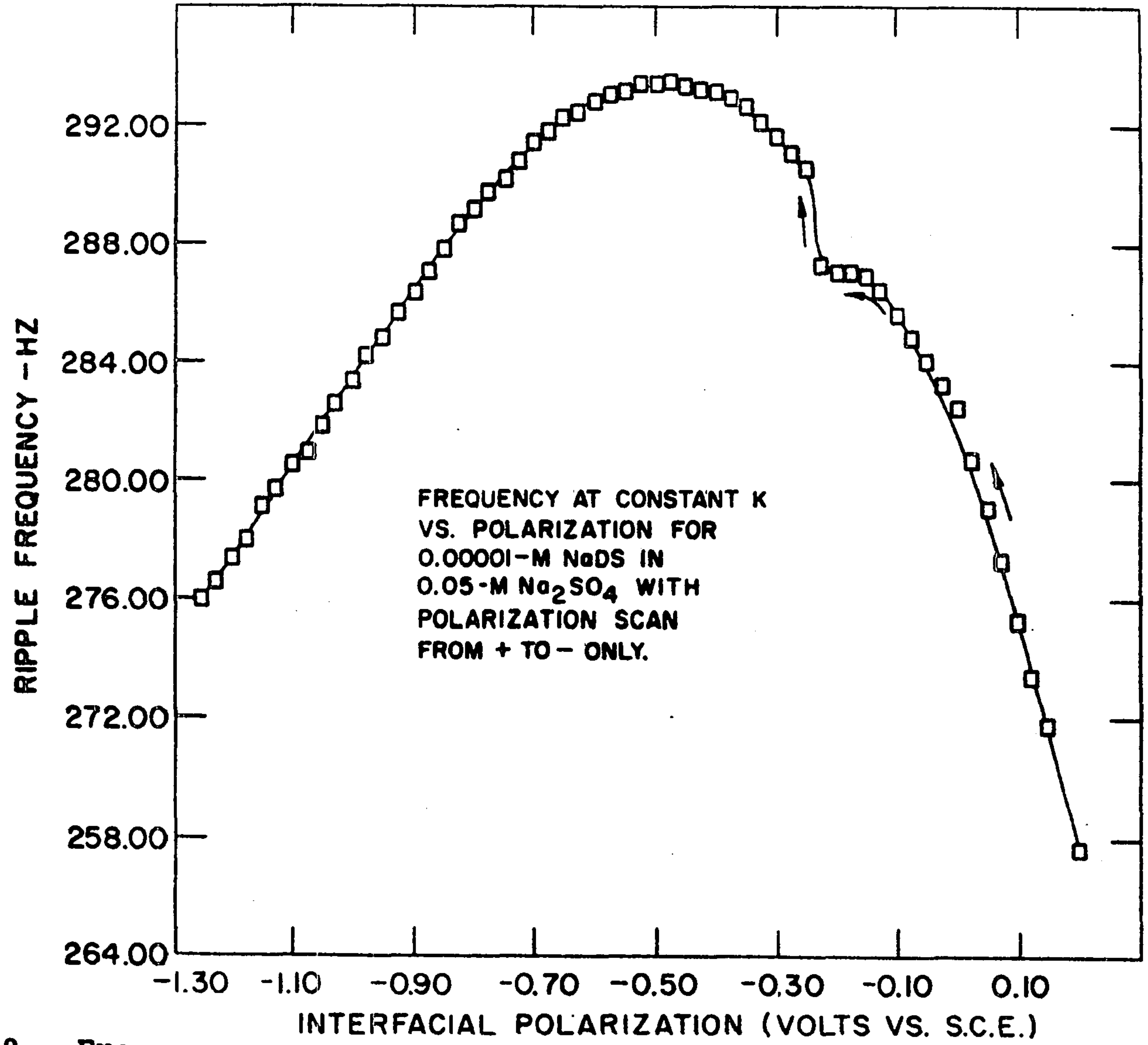


Figure 29. Frequency response at constant k to imposed interfacial polarization for the 10^{-5}-M NaDS in .05-M Na_2SO_4-mercury interface

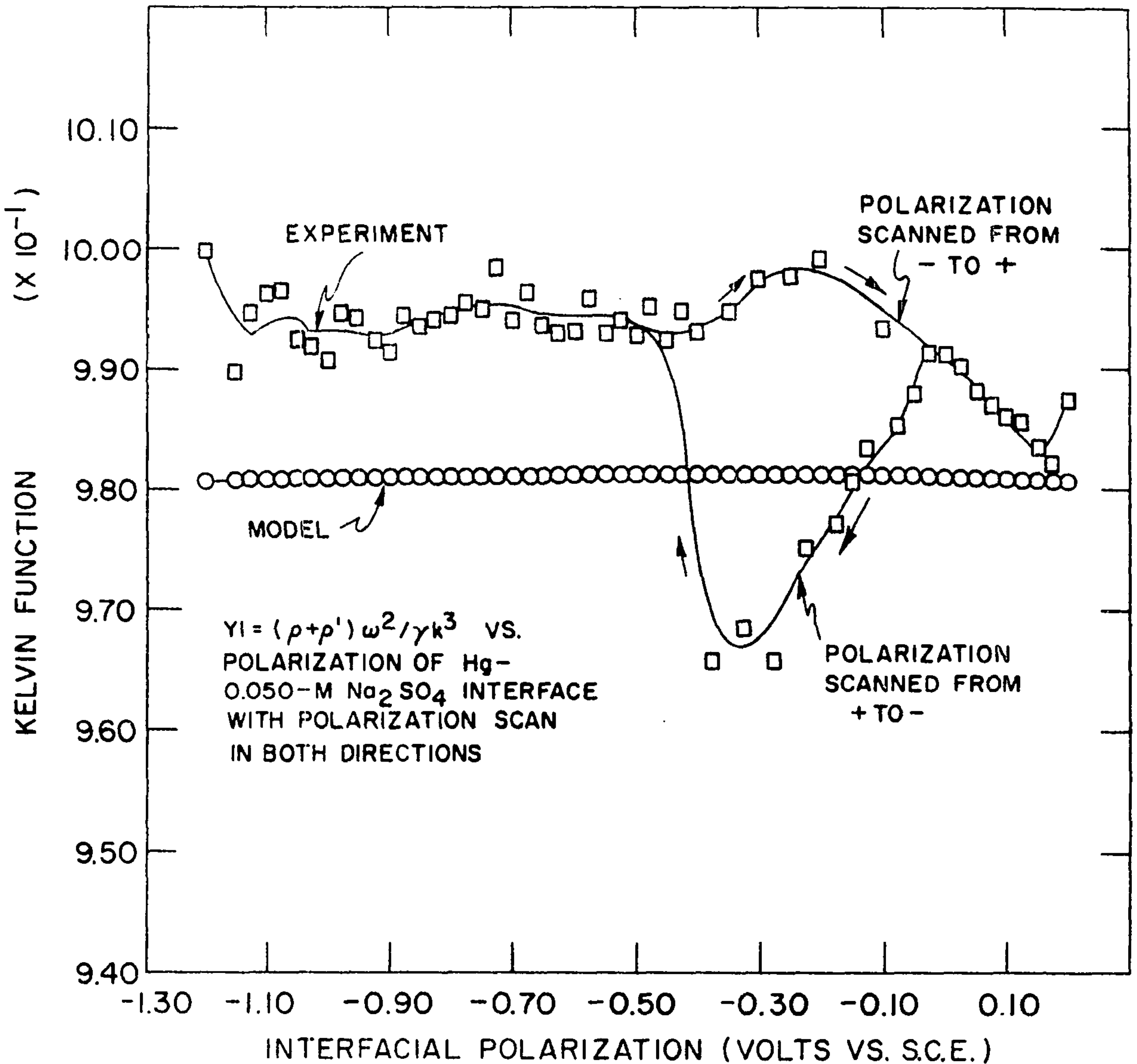


Figure 30. Y1 from experiment and model for the pure .05-M Na_2SO_4-mercury interface

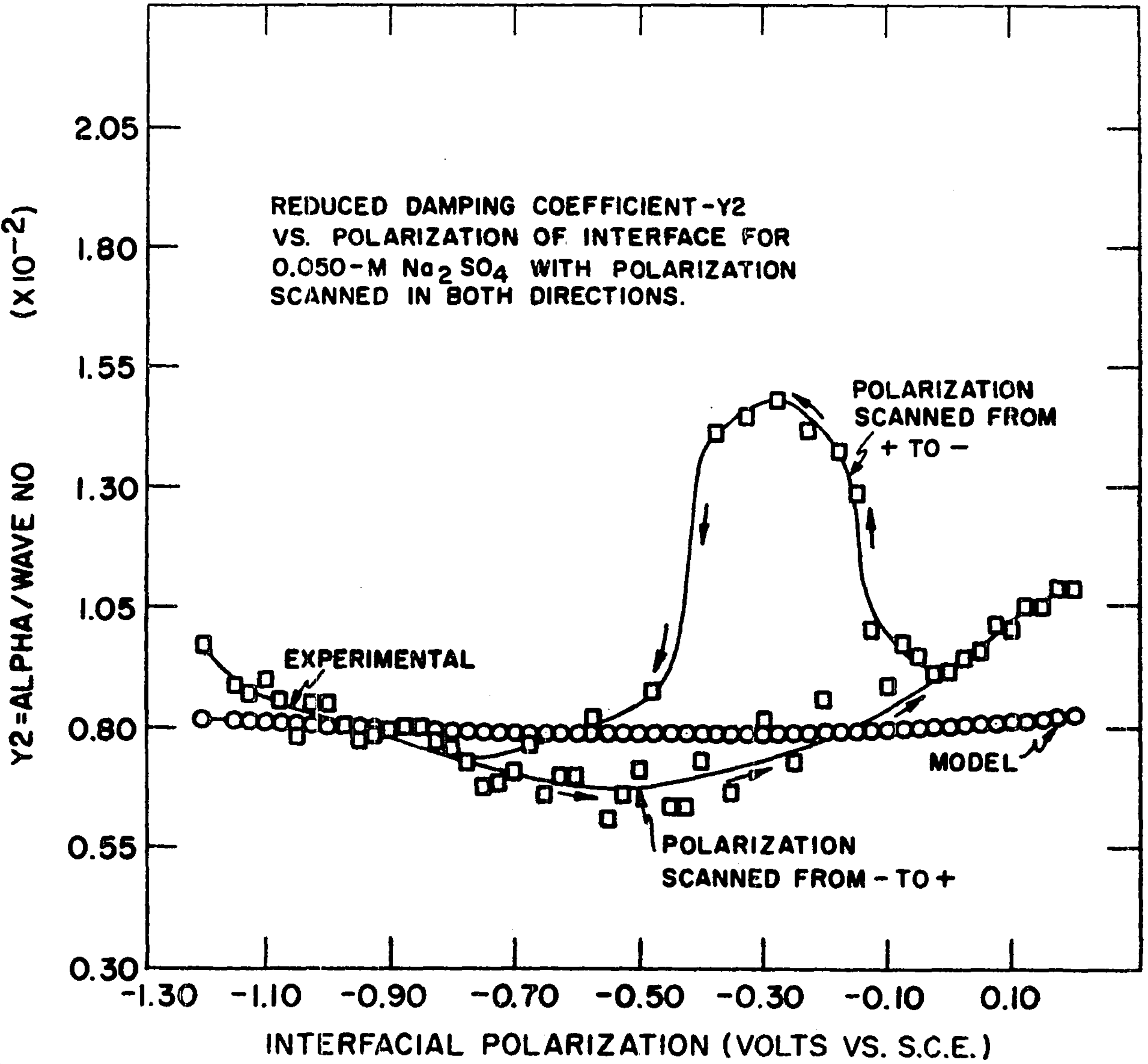


Figure 31. Y2 curves from experiment and model for the pure .05-M Na_2SO_4-mercury interface

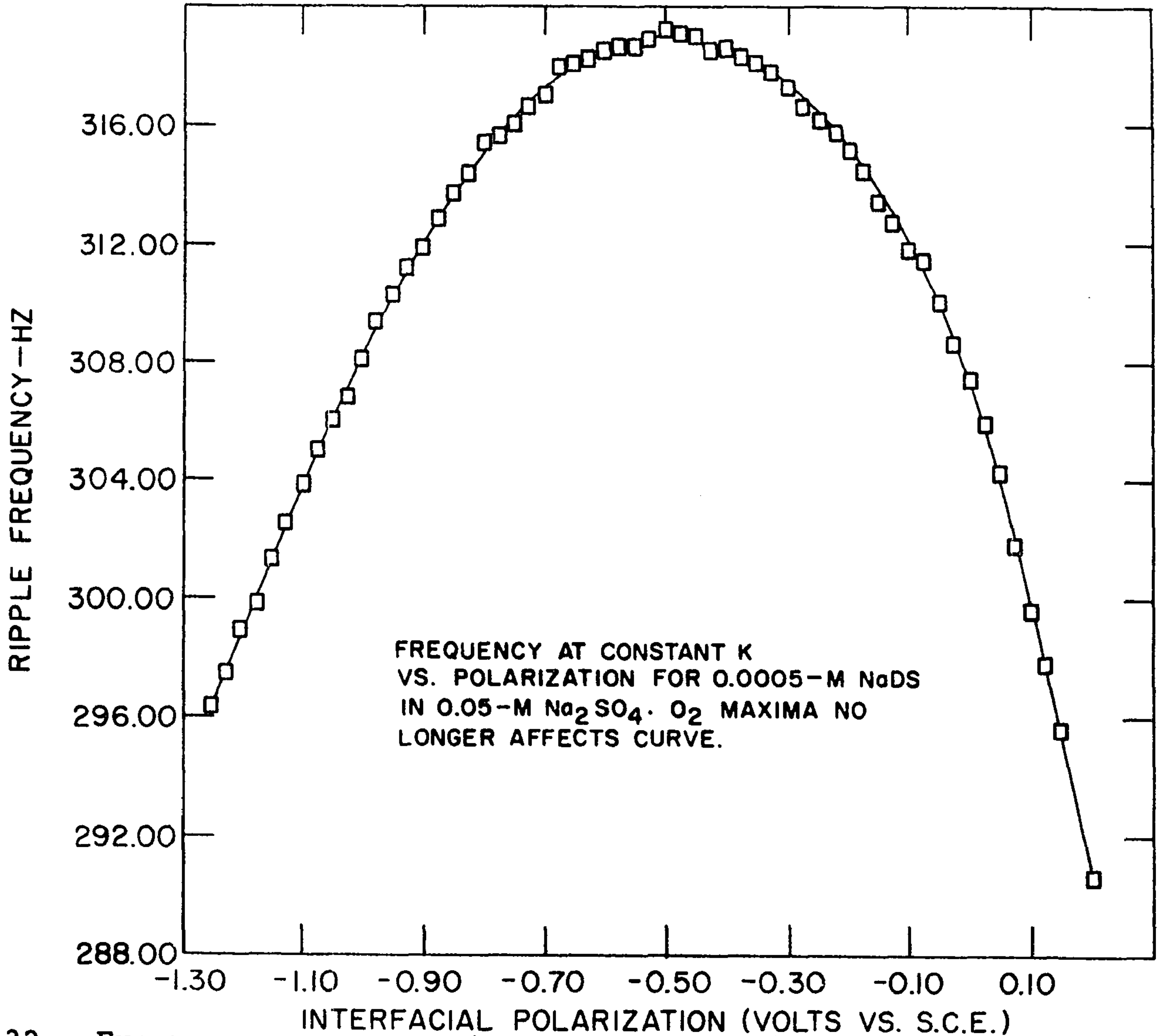


Figure 32. Frequency response at constant k to imposed interfacial polarization for the 10^{-5}-M NaDS in .05-M Na_2SO_4-mercury interface

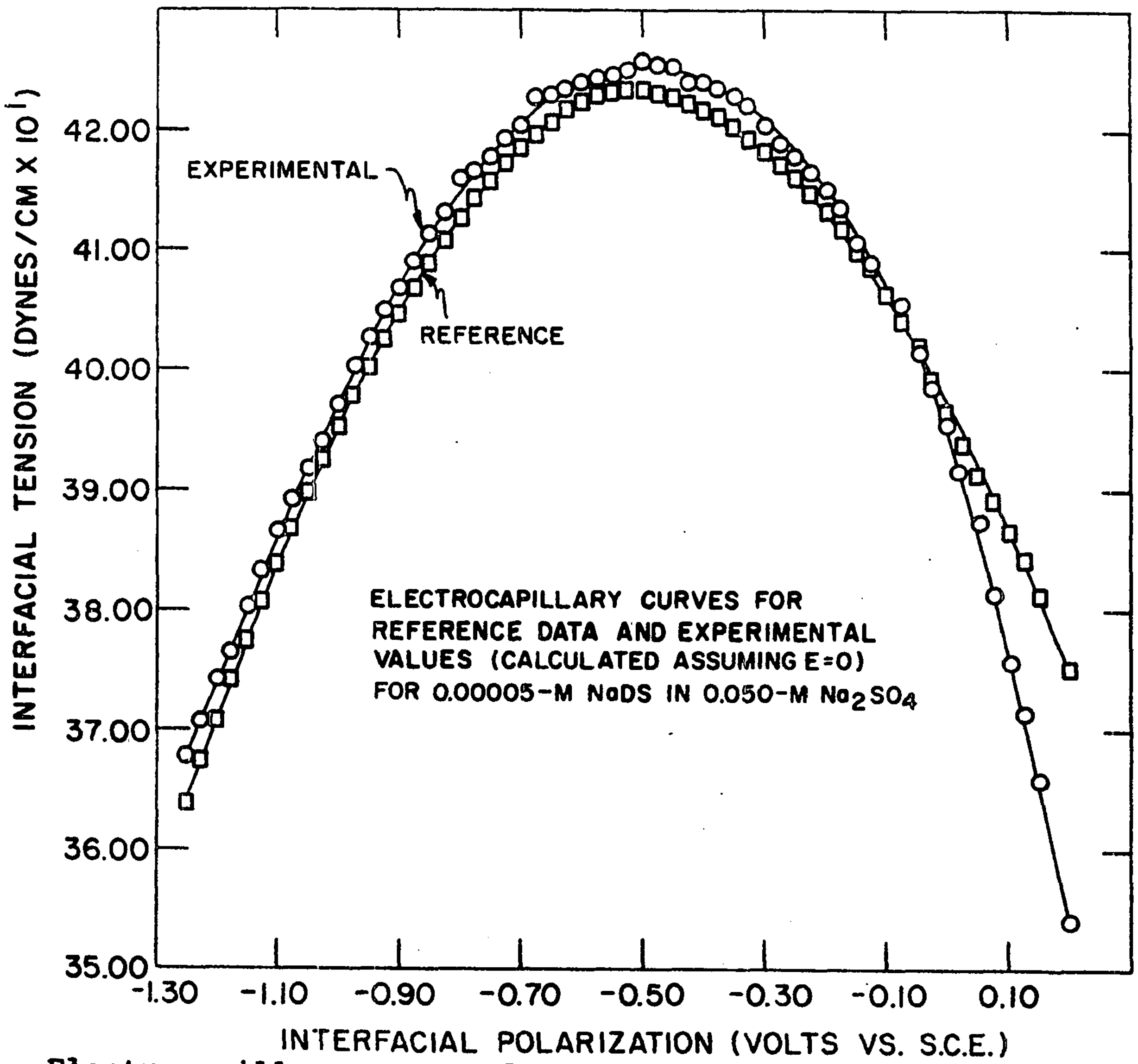


Figure 33. Electrocapillary curves from reference data and experimental values (calculated assuming E=0) for the 10^{-5}-M NaDS in .05-M Na_2SO_4-mercury interface

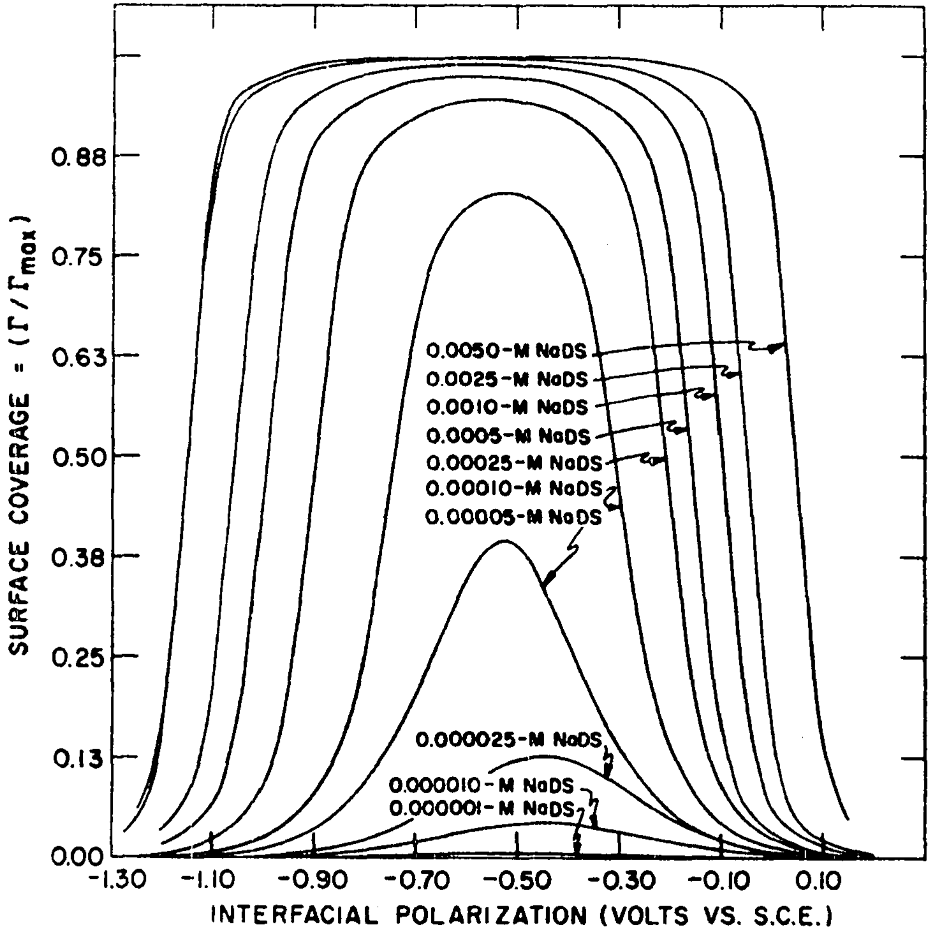


Figure 34 Model generated Θ curves for all NaDS concentrations with β=1.5

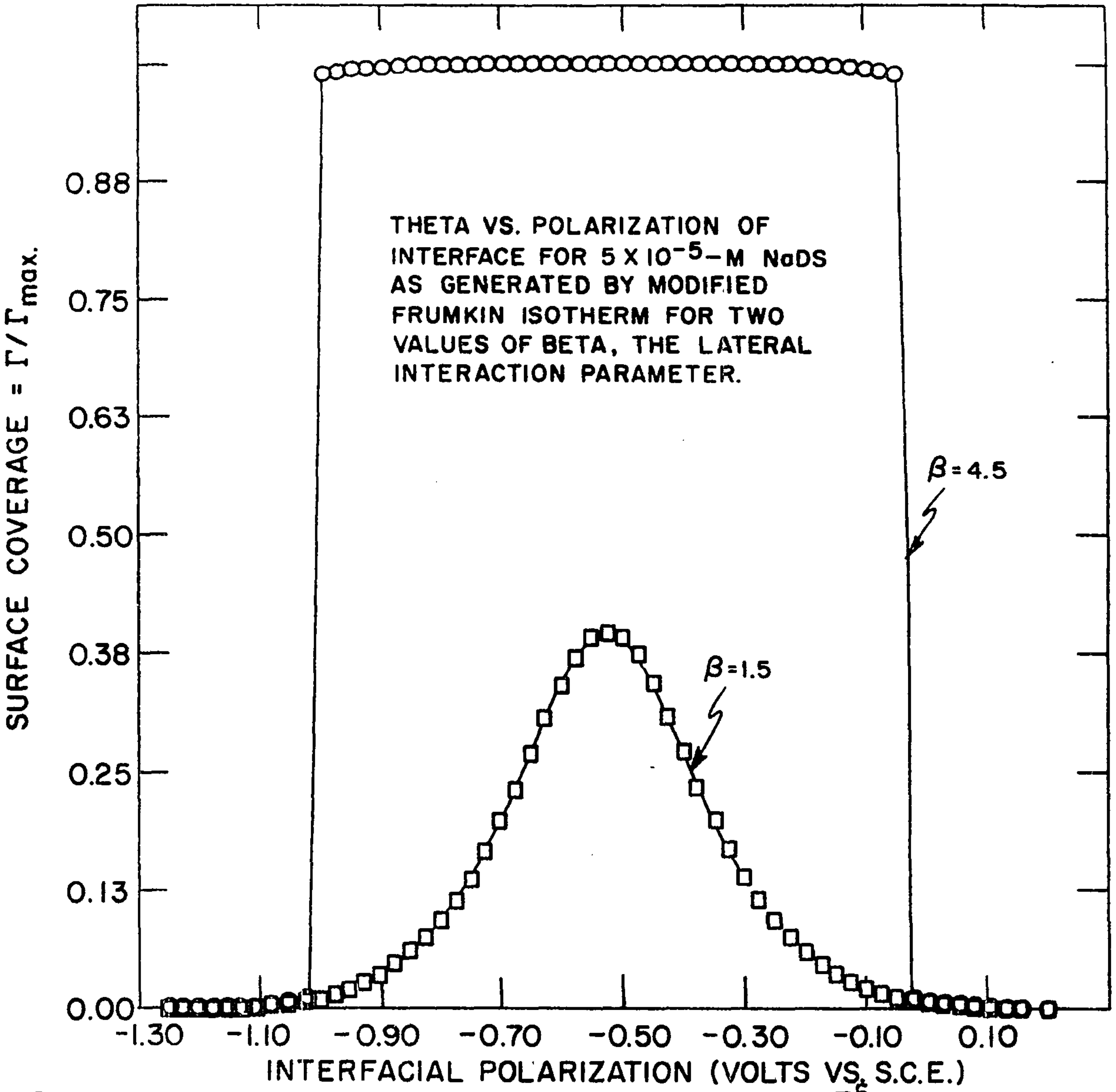


Figure 35. Θ curves for two values of β for the 5×10^{-5}-M NaDS in .05-M Na_2SO_4-mercury interface

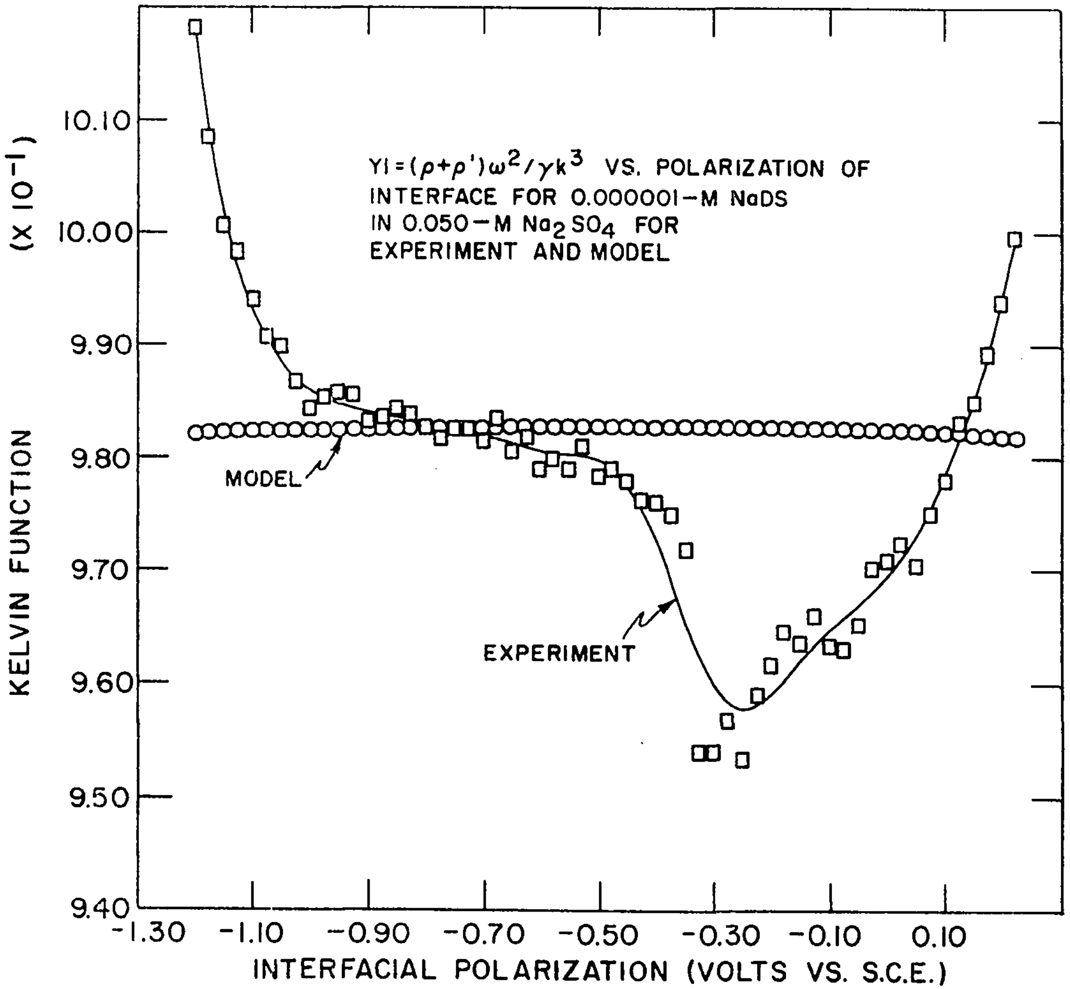


Figure 36. Y1 curves from experiment and model for the 10^{-6}-M NaDS in .05-M Na_2SO_4-mercury interface

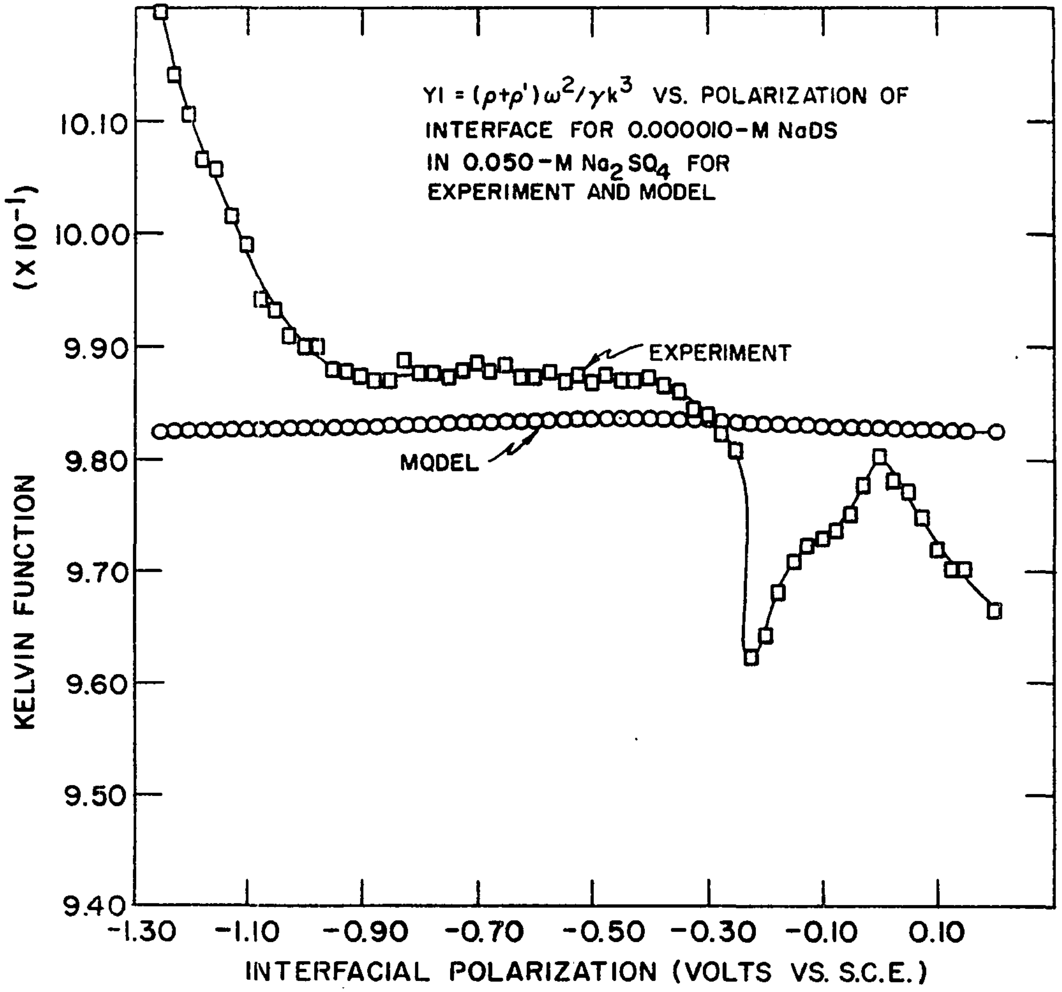


Figure 37. Y1 curves from experiment and model for 10^{-5}-M NaDS in .05-M Na_2SO_4-mercury interface

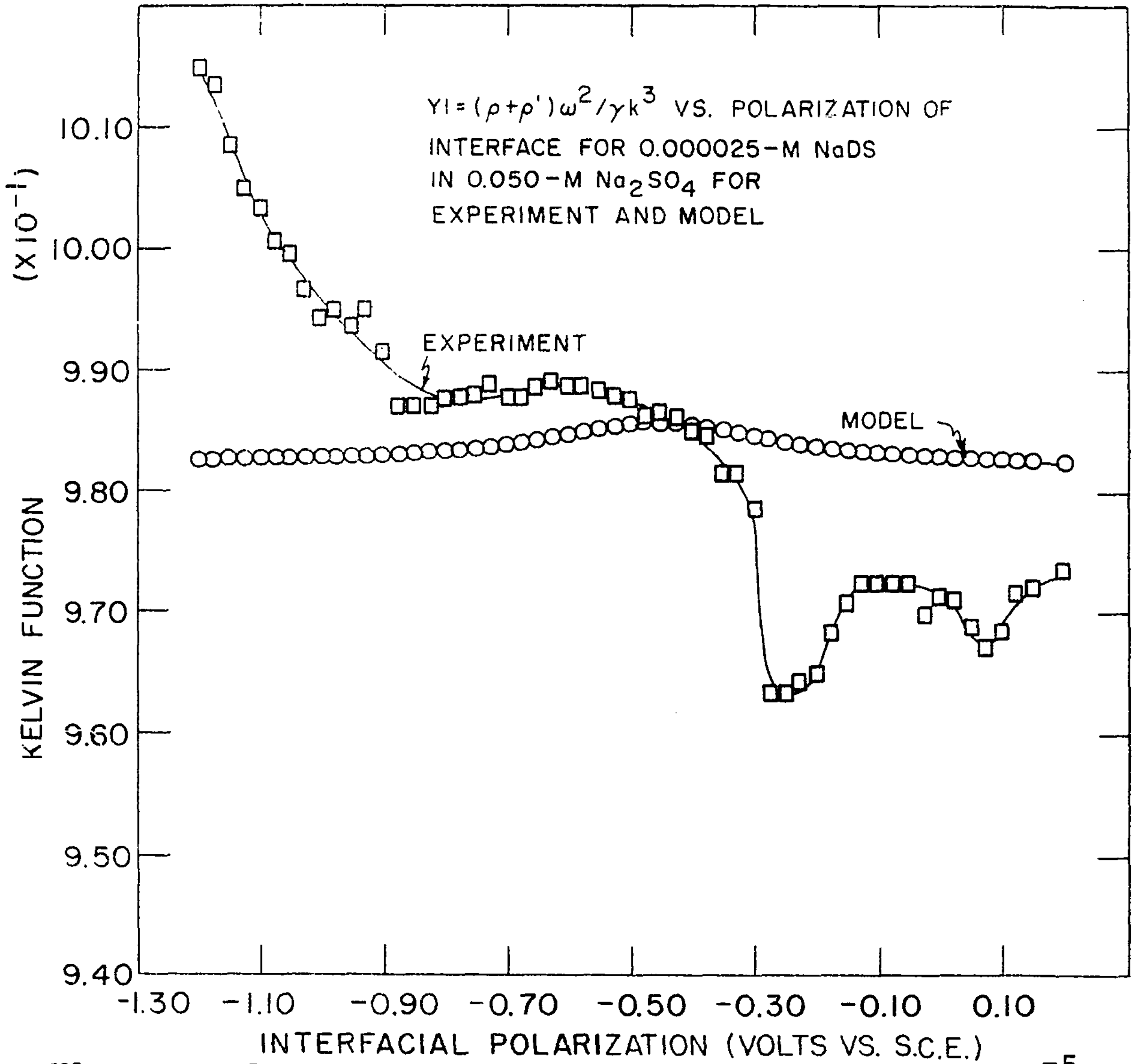


Figure 38. Y1 curves from experiment and model for the 2.5 x 10^{-5}-M NaDS in .05-M Na_2SO_4-mercury interface

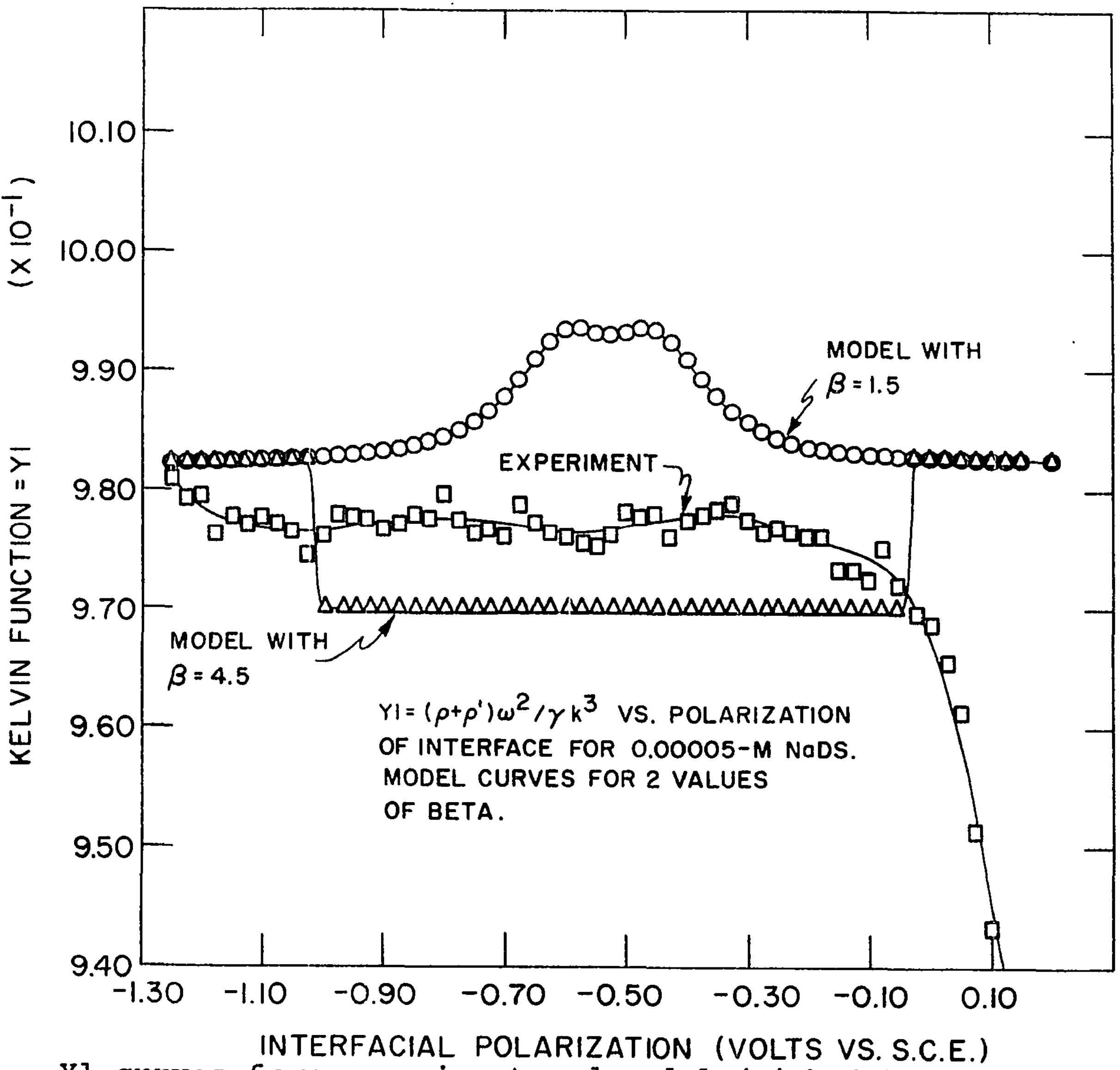


Figure 39. Y1 curves from experiment and model (with β=1.5 and 4.5) for the 5 x 10^{-5}-M NaDS in .05-M Na_2SO_4-mercury interface

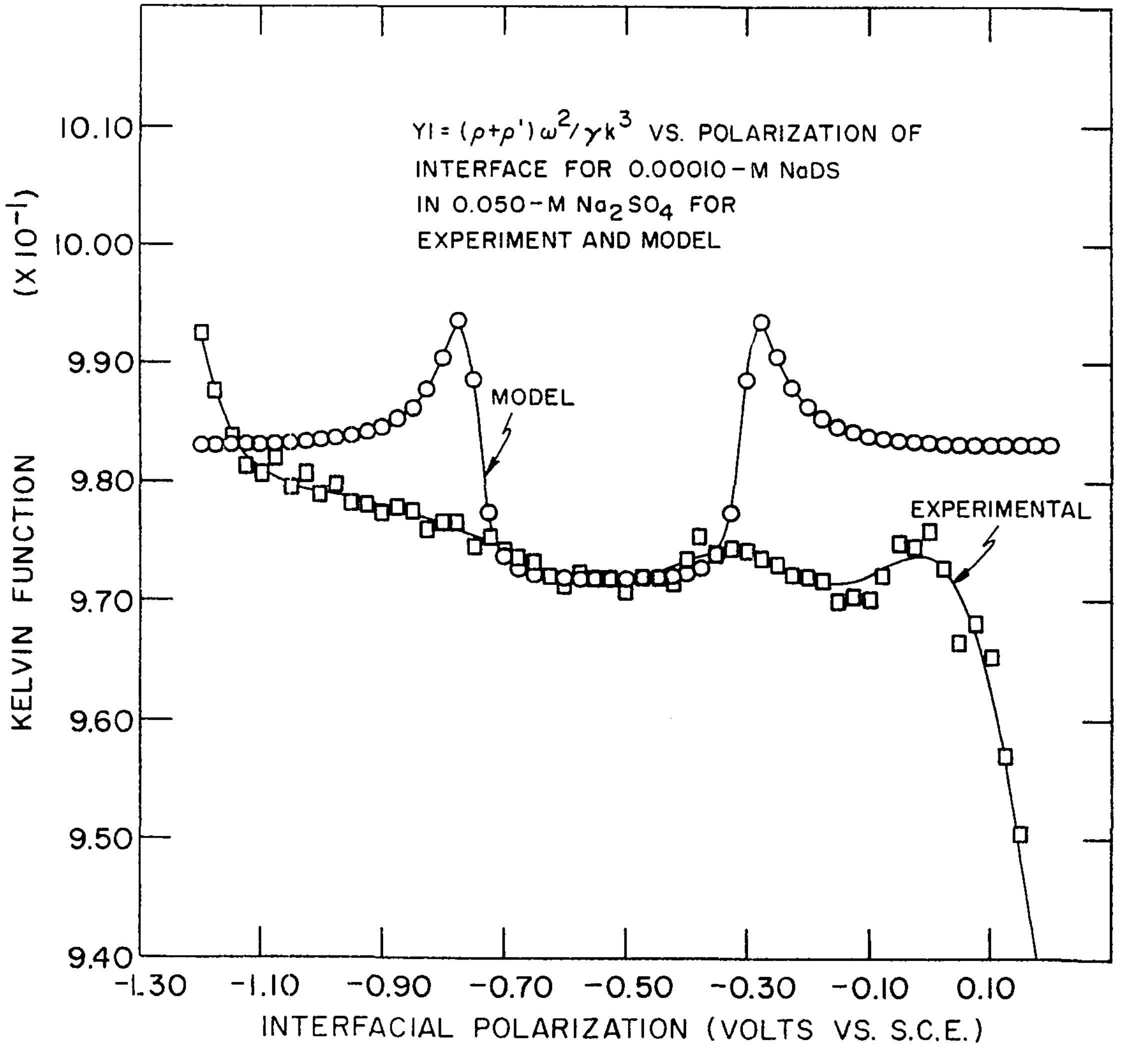


Figure 40. Experimental and model Y1 curves for the 10^{-4}-M NaDS in .05-M Na_2SO_4-mercury interface

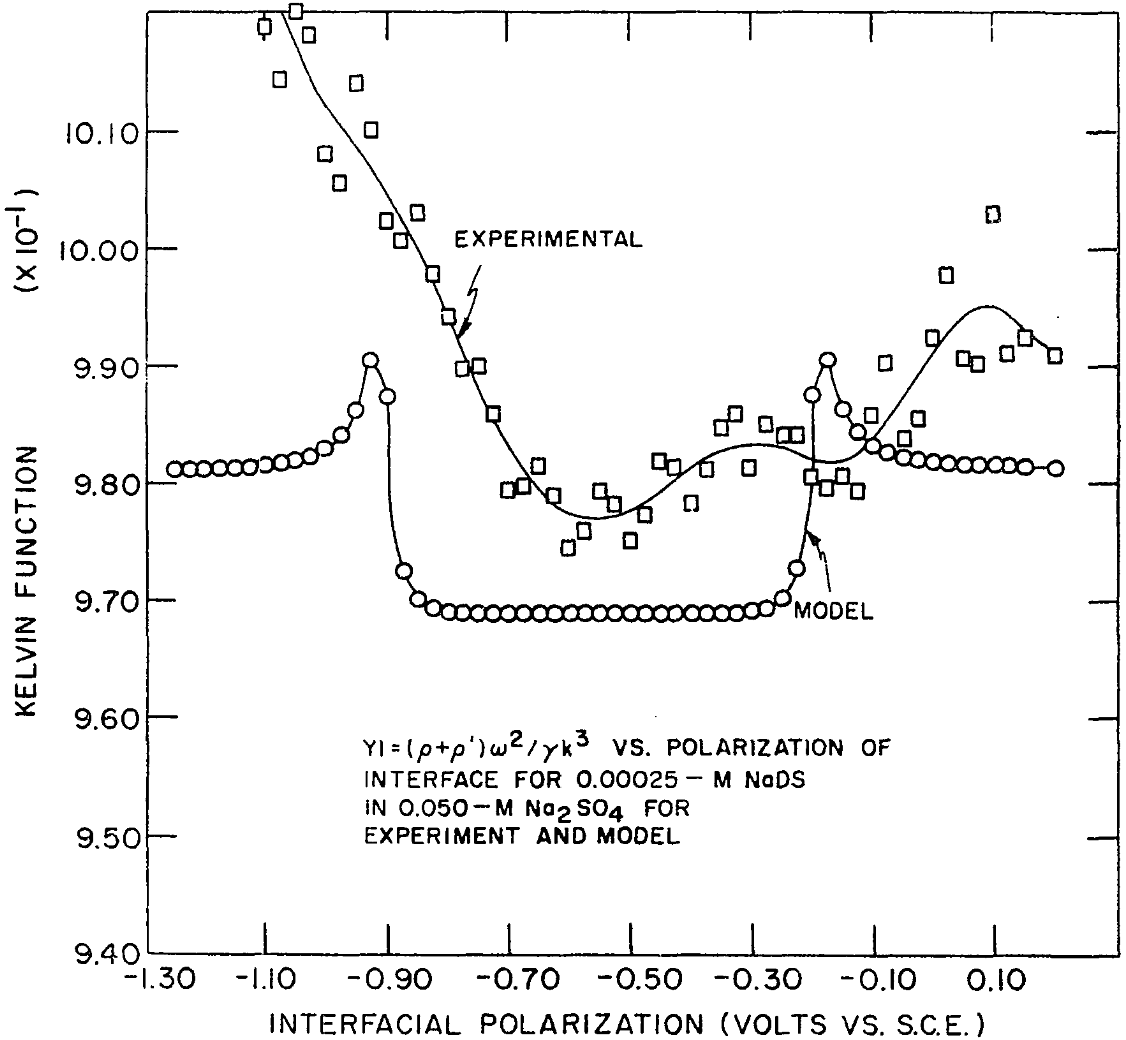


Figure 41. Experimental and model Y1 curves for the 2.5 x 10^{-4}-M NaDS in .05-M Na_2SO_4-mercury interface

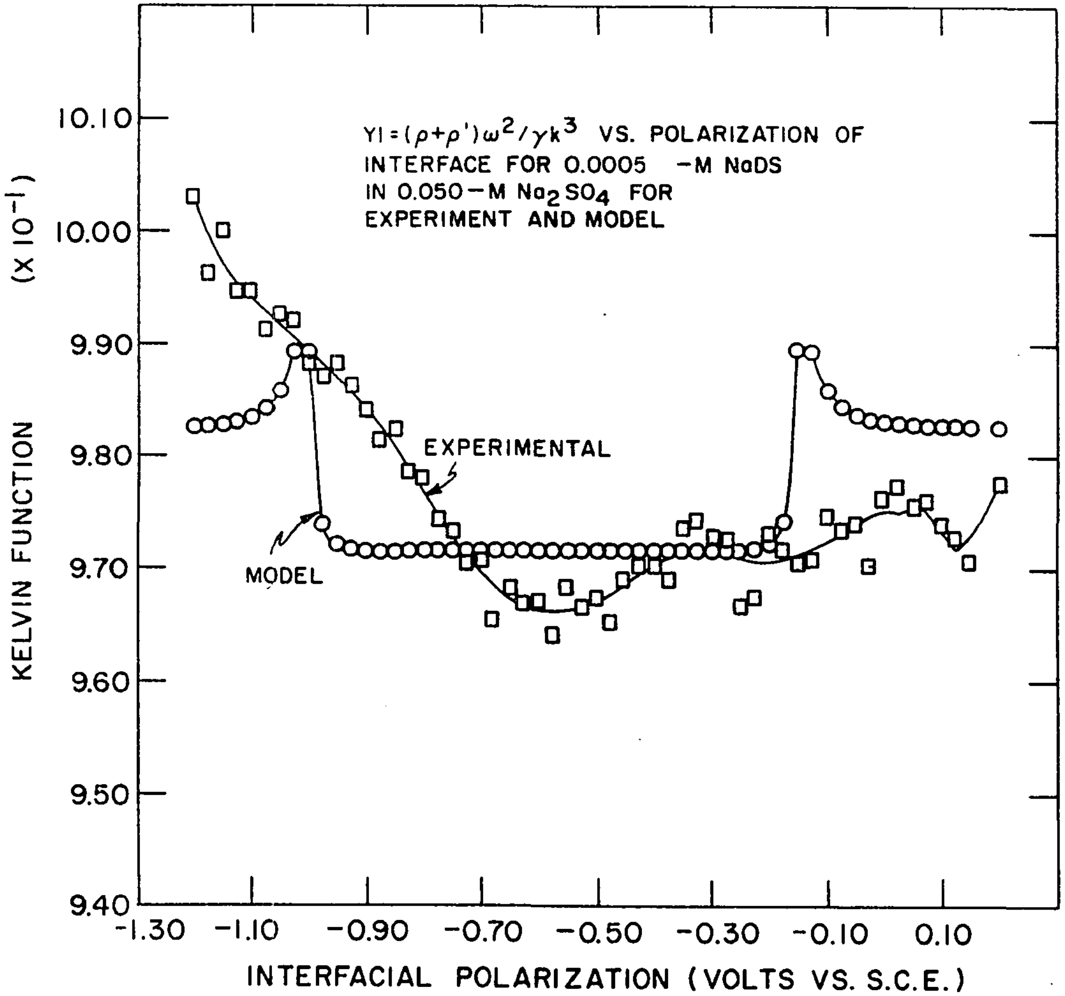


Figure 42. Experimental and model Y1 curves for the 5×10^{-4}-M NaDS in .05-M Na_2SO_4-mercury interface

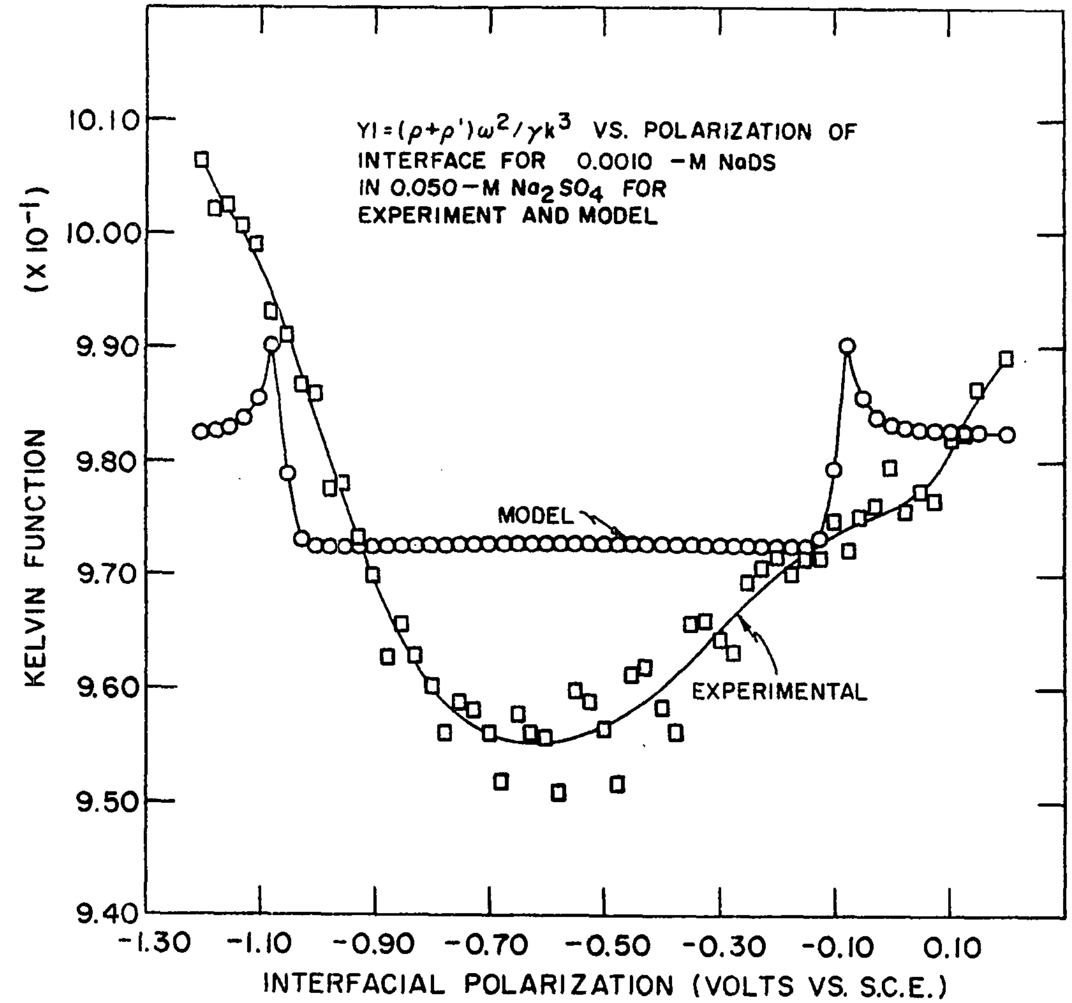


Figure 43. Model and experimental Yl curves for the 10^{-3}-M NaDS in .05-M Na_2SO_4-mercury interface

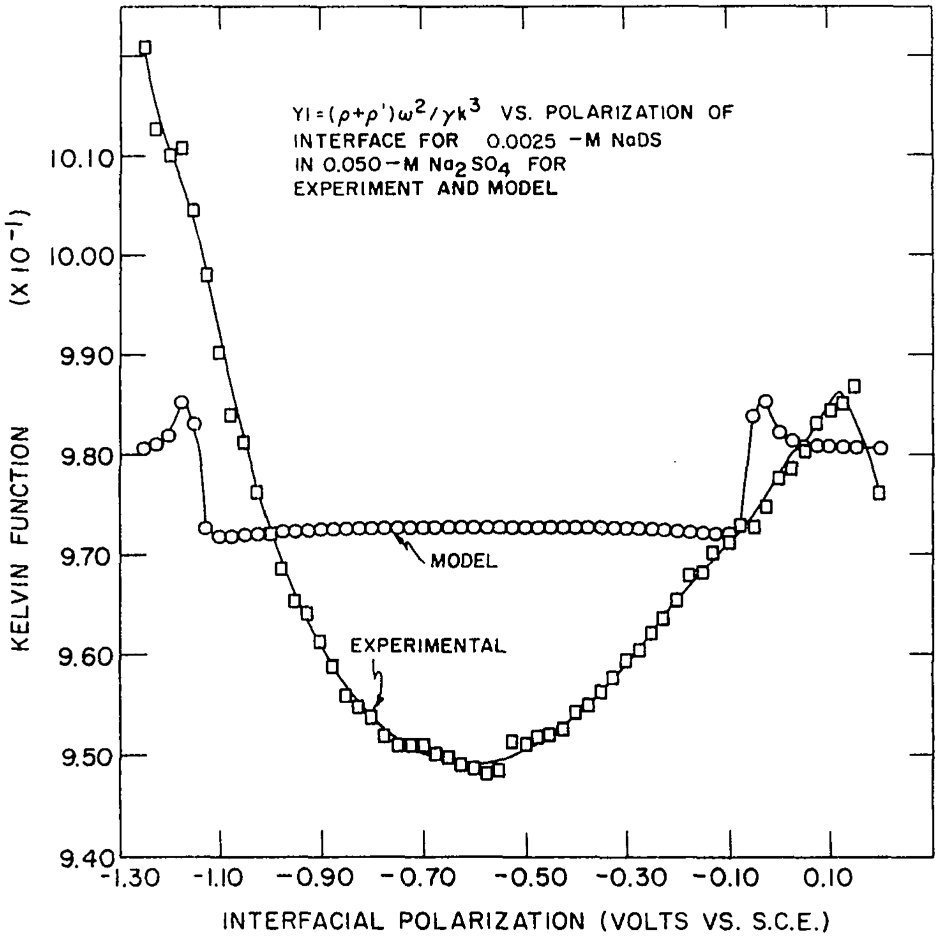


Figure 44. Experimental and model Y1 curves for the .0025-M NaDS in .05-M Na_2SO_4-mercury interface

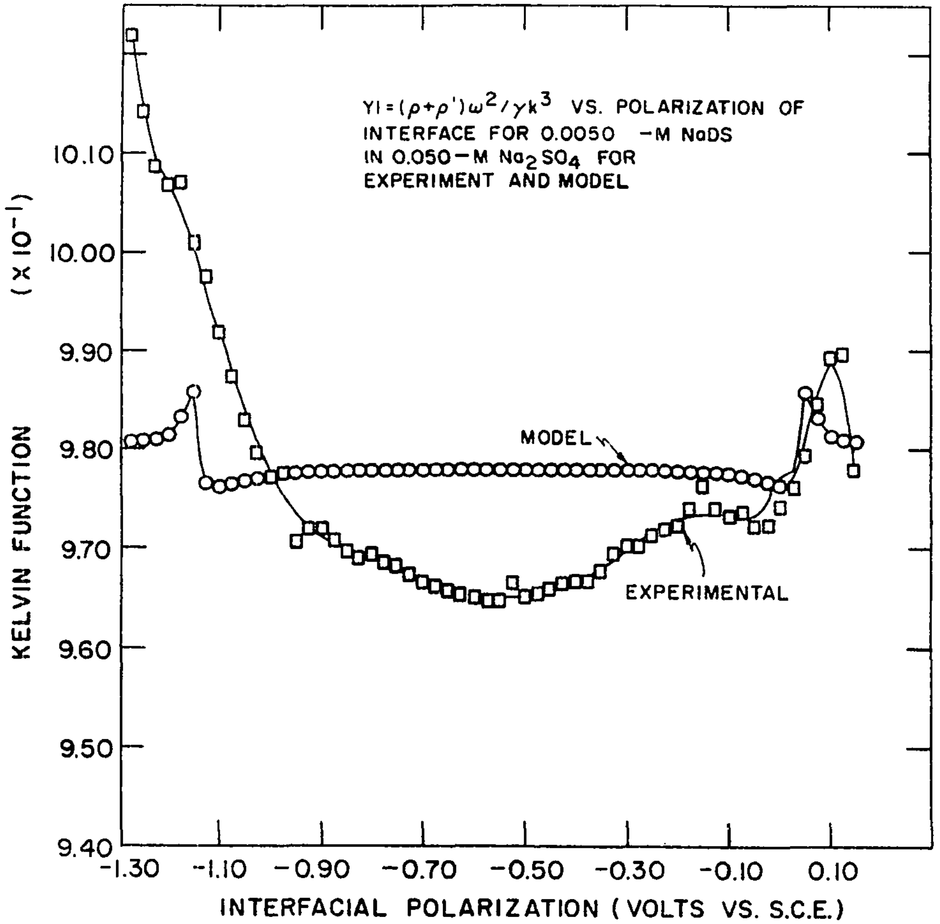


Figure 45. Model and experimental Y1 curves for the .005-M NaDS in .05-M Na_2SO_4-mercury interface

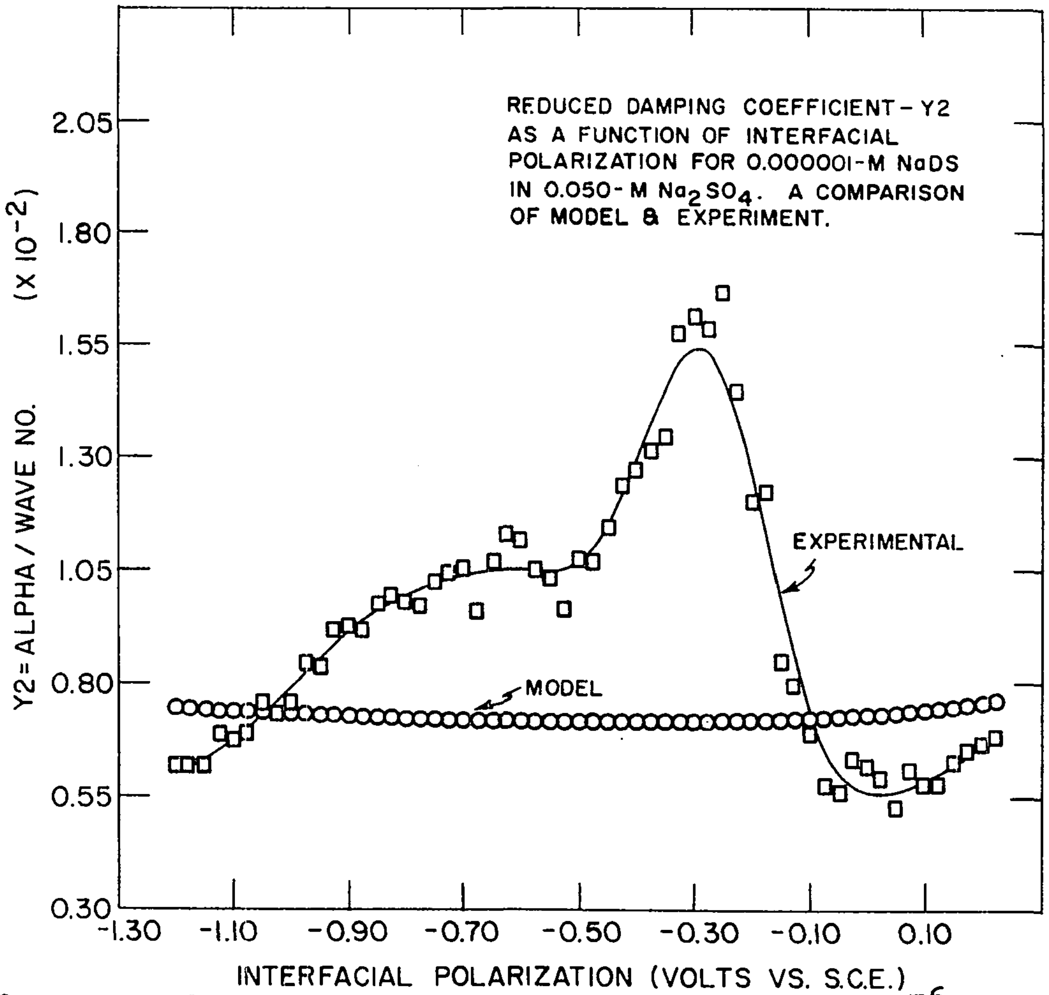


Figure 46. Y2 curves from model and experiment for the 10^{-6}-M NaDS in .05-M Na_2SO_4-mercury interface

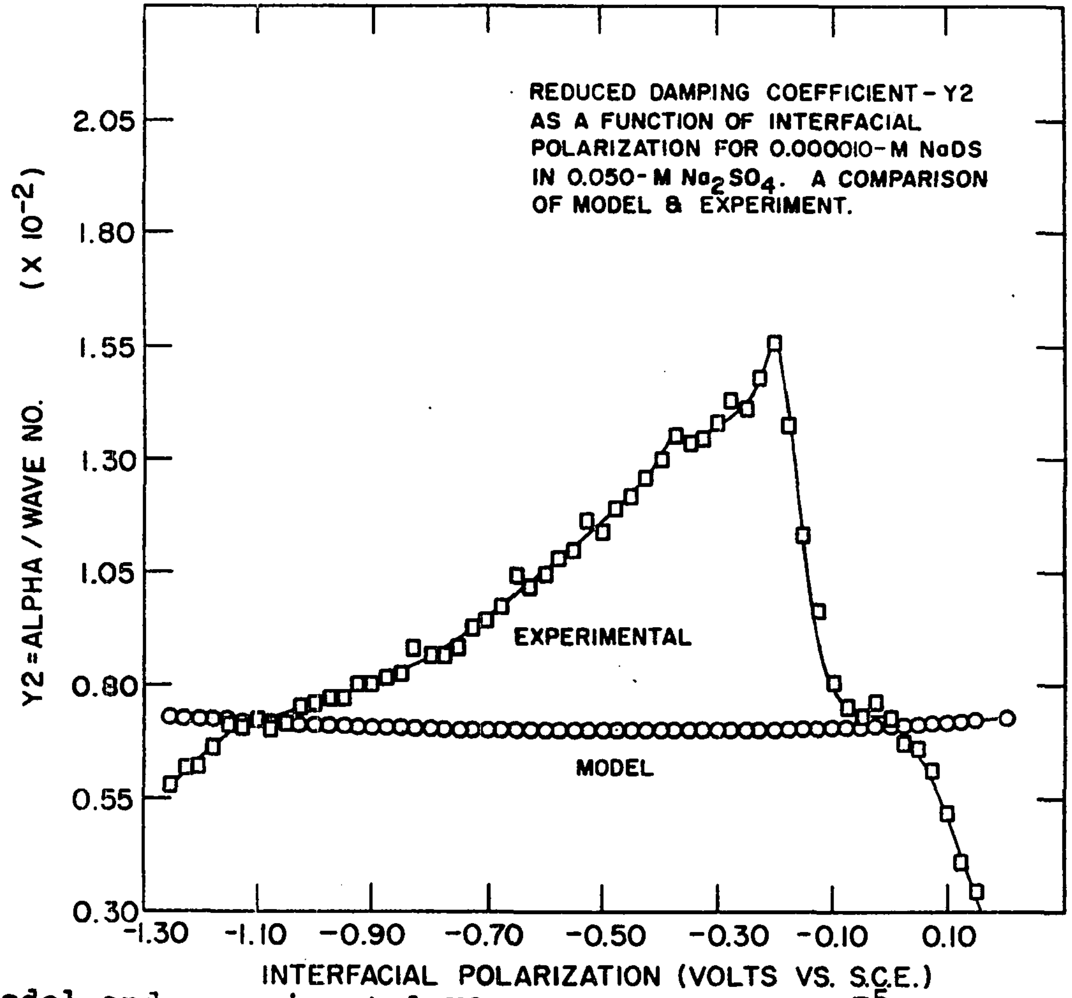


Figure 47. Model and experimental Y2 curves for the 10^{-5}-M NaDS in .05-M Na_2SO_4-mercury interface

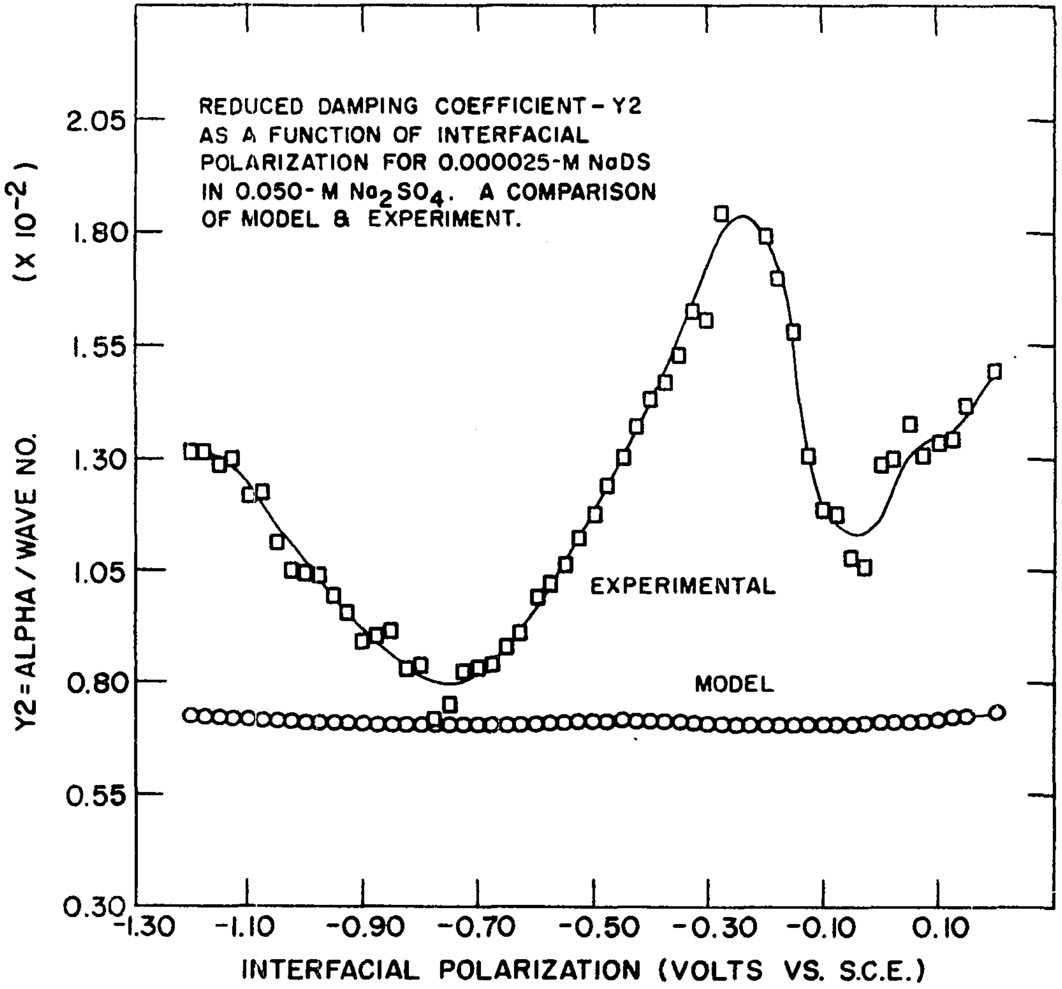


Figure 48. Y2 curves from model and experiment for the 2.5 x 10^{-5}-M NaDS in .05-M Na_2SO_4-mercury interface

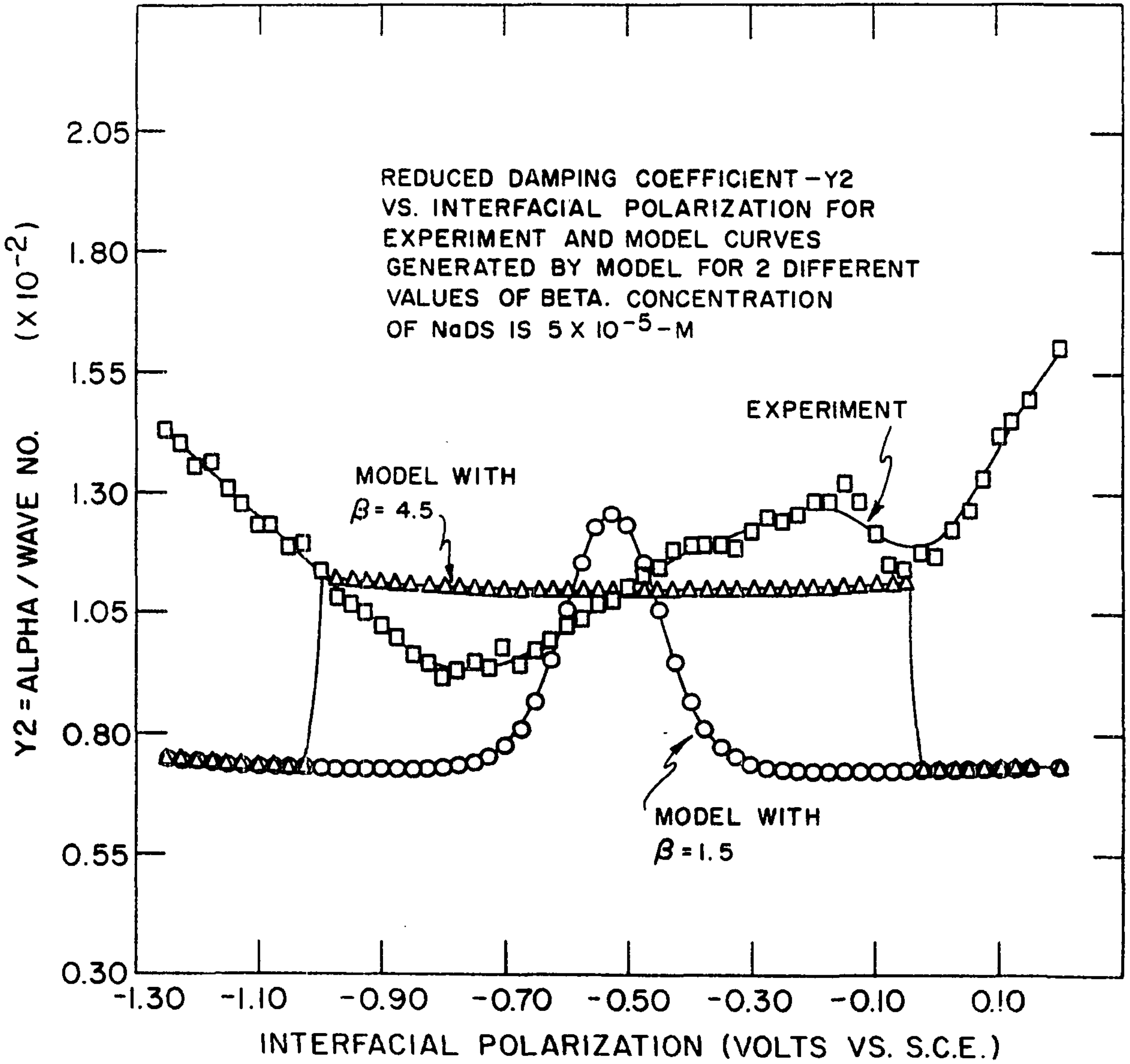


Figure 49. Model Y2 curves for β=1.5 and 4.5 and experimental Y2 curve for the 5 x 10^{-5}-M NaDS in .05-M Na_2SO_4-mercury interface

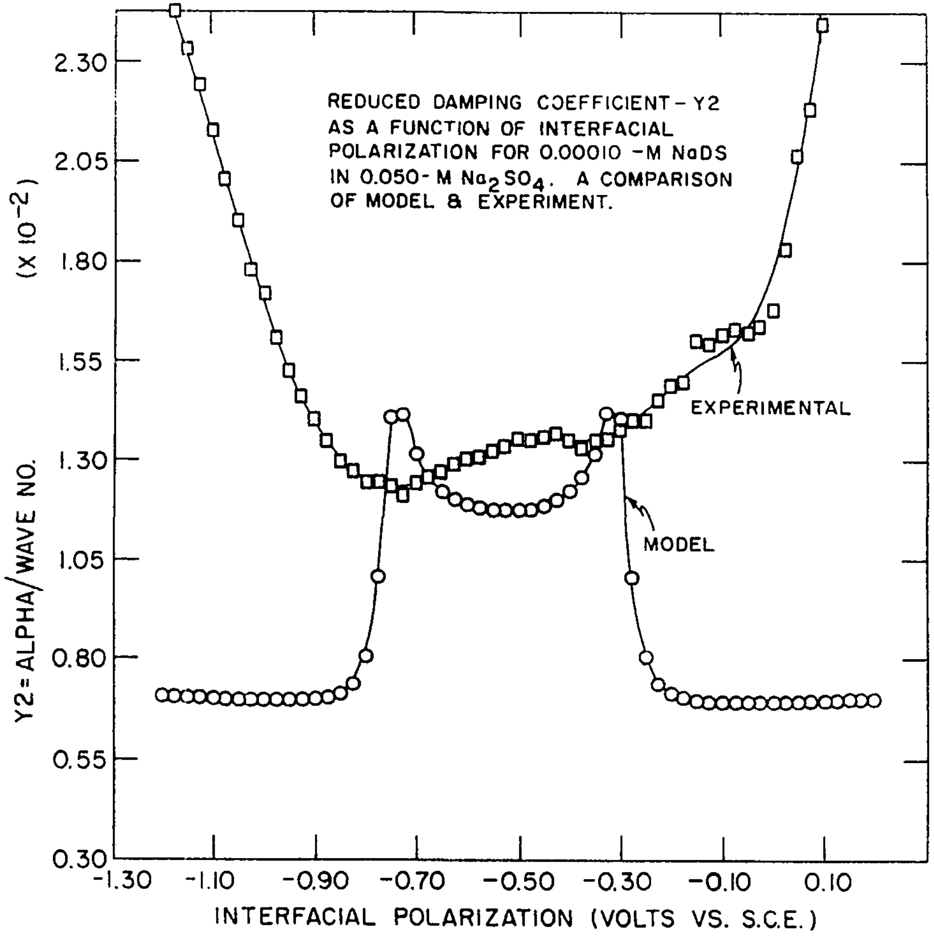


Figure 50. Model and experimental Y2 curves for the 10^{-4}-M NaDS in .05-M Na_2SO_4-mercury interface

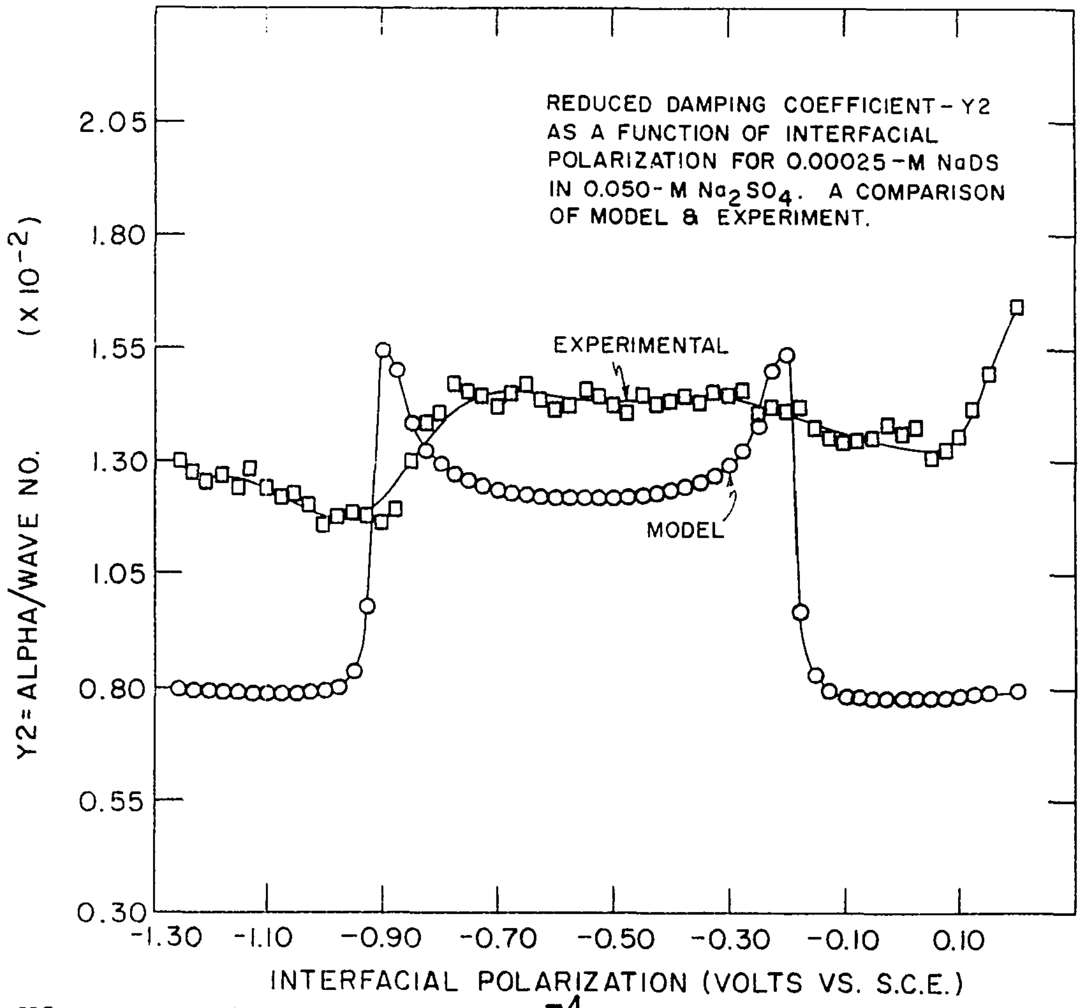


Figure 51. Y2 curves for the 2.5 x 10^{-4}-M NaDS in .05-M Na_2SO_4-mercury interface from model and experiment

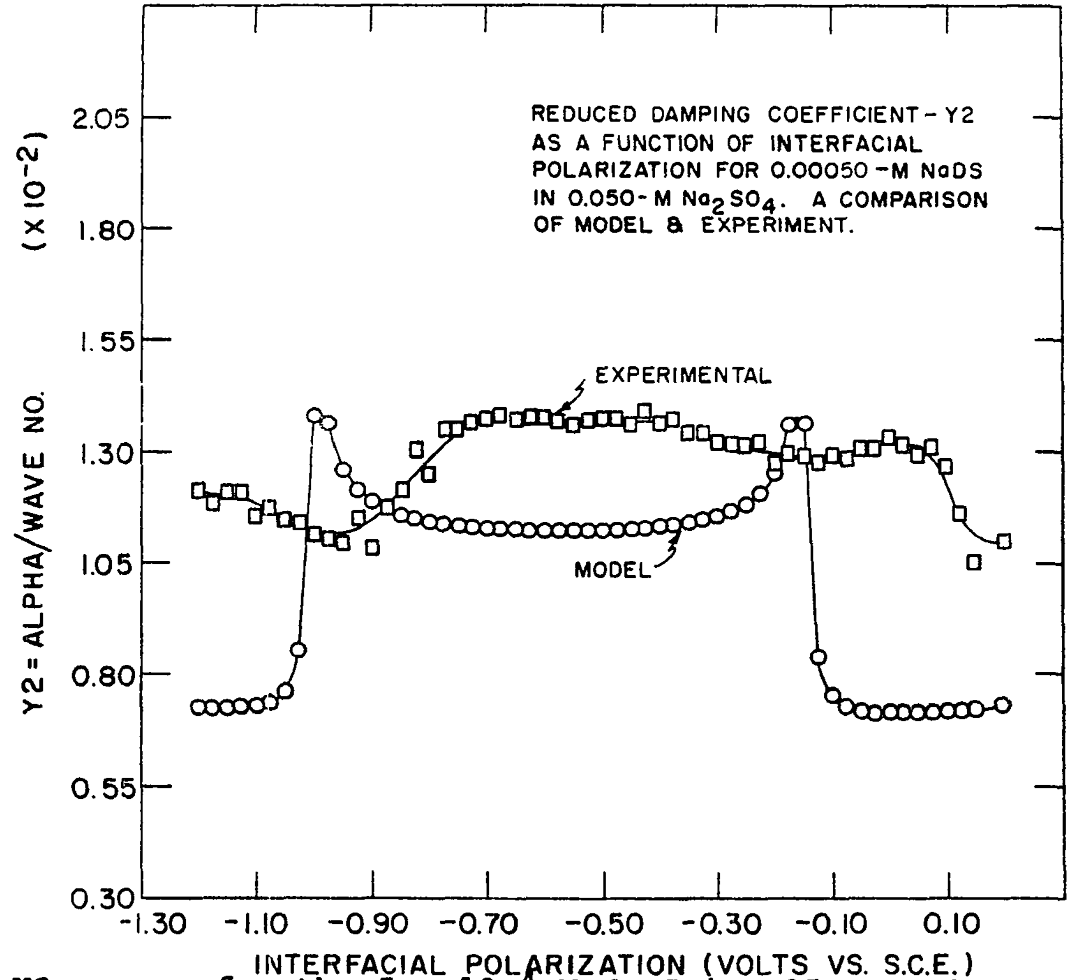


Figure 52. Y2 curves for the 5 x 10^{-4}-M NaDS in .05-M Na_2SO_4-mercury interface from experiment and model

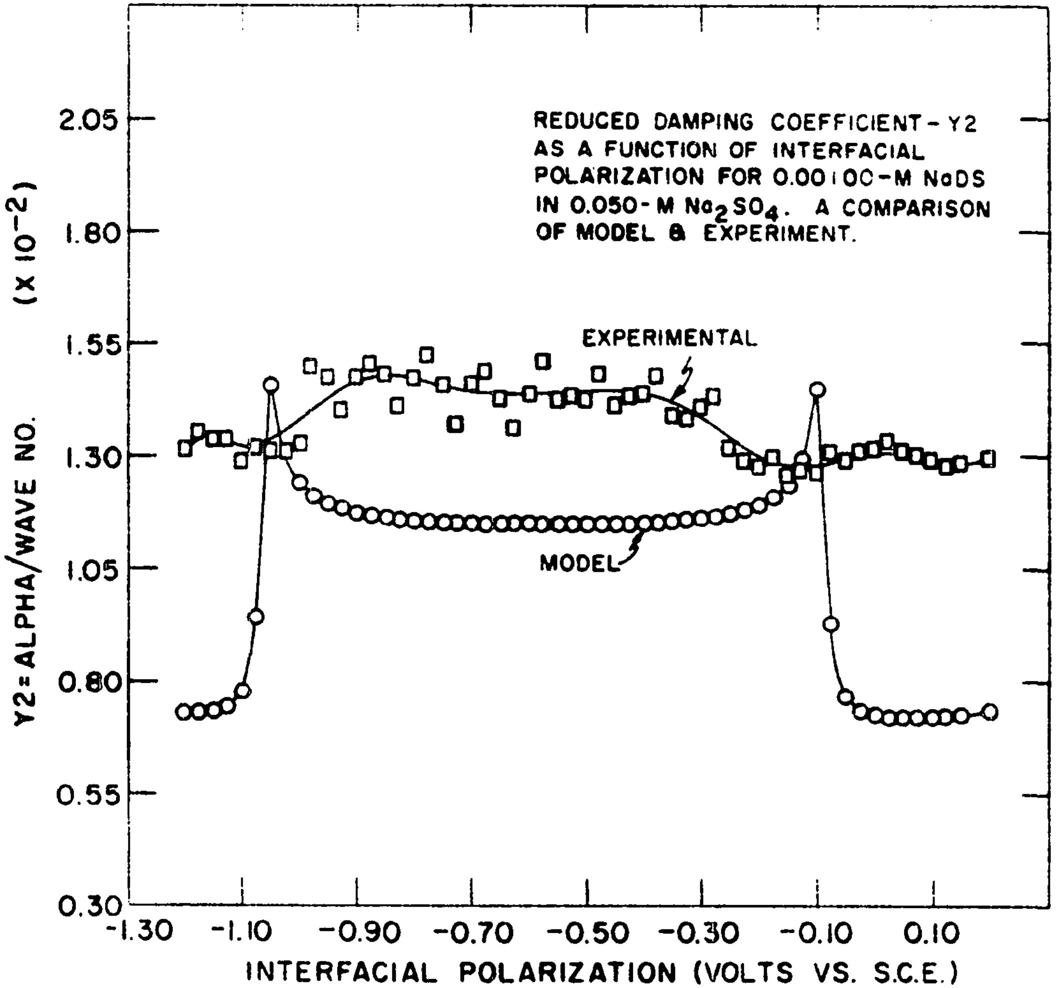
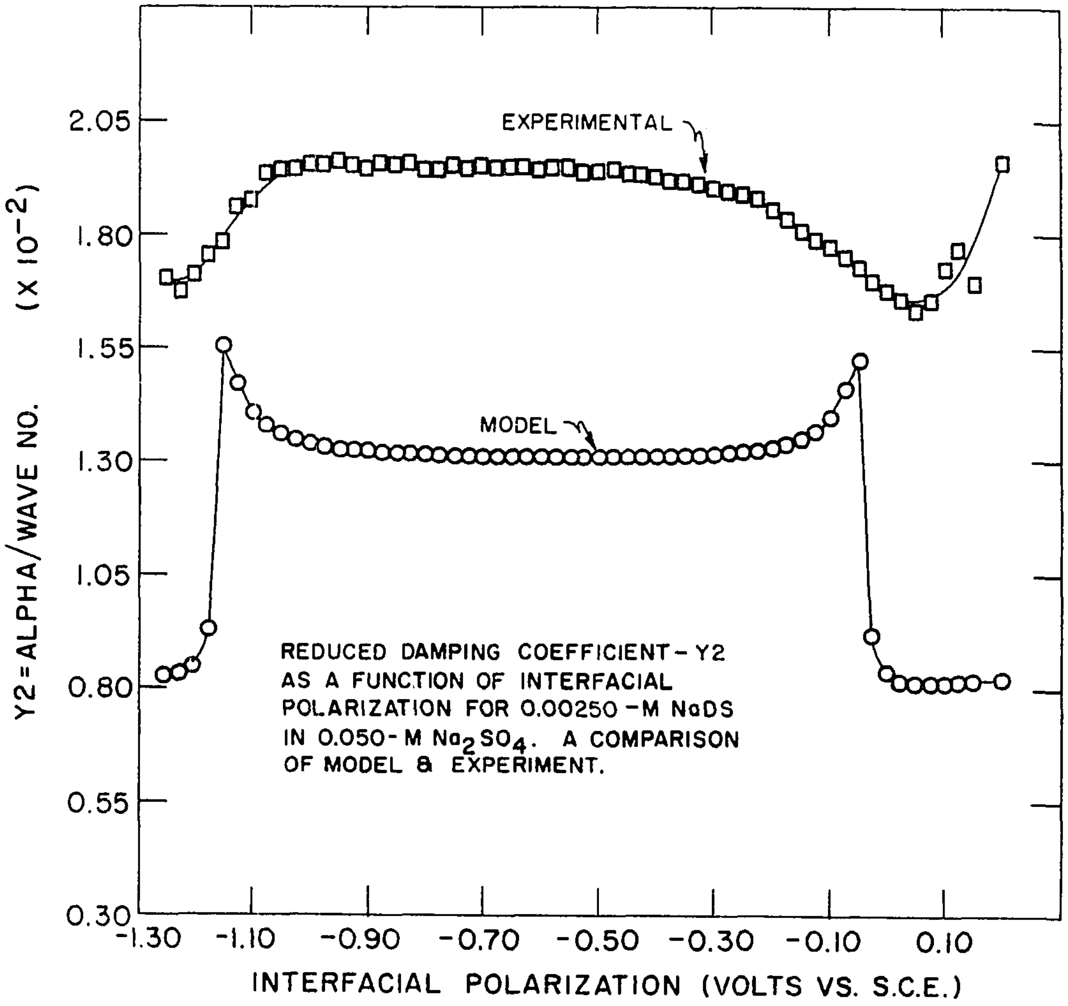


Figure 53. Experimental and model-generated Y2 curves for the 10^{-3}-M NaDS in .05-M Na_2SO_4-mercury interface



REDUCED DAMPING COEFFICIENT - Y2 AS A FUNCTION OF INTERFACIAL POLARIZATION FOR 0.00250 - M NaDS IN 0.050 - M Na_2SO_4. A COMPARISON OF MODEL & EXPERIMENT.

Figure 54. Y2 curves from experiment and model for the 2.5 x 10^{-3}-M NaDS in .05-M Na_2SO_4-mercury interface

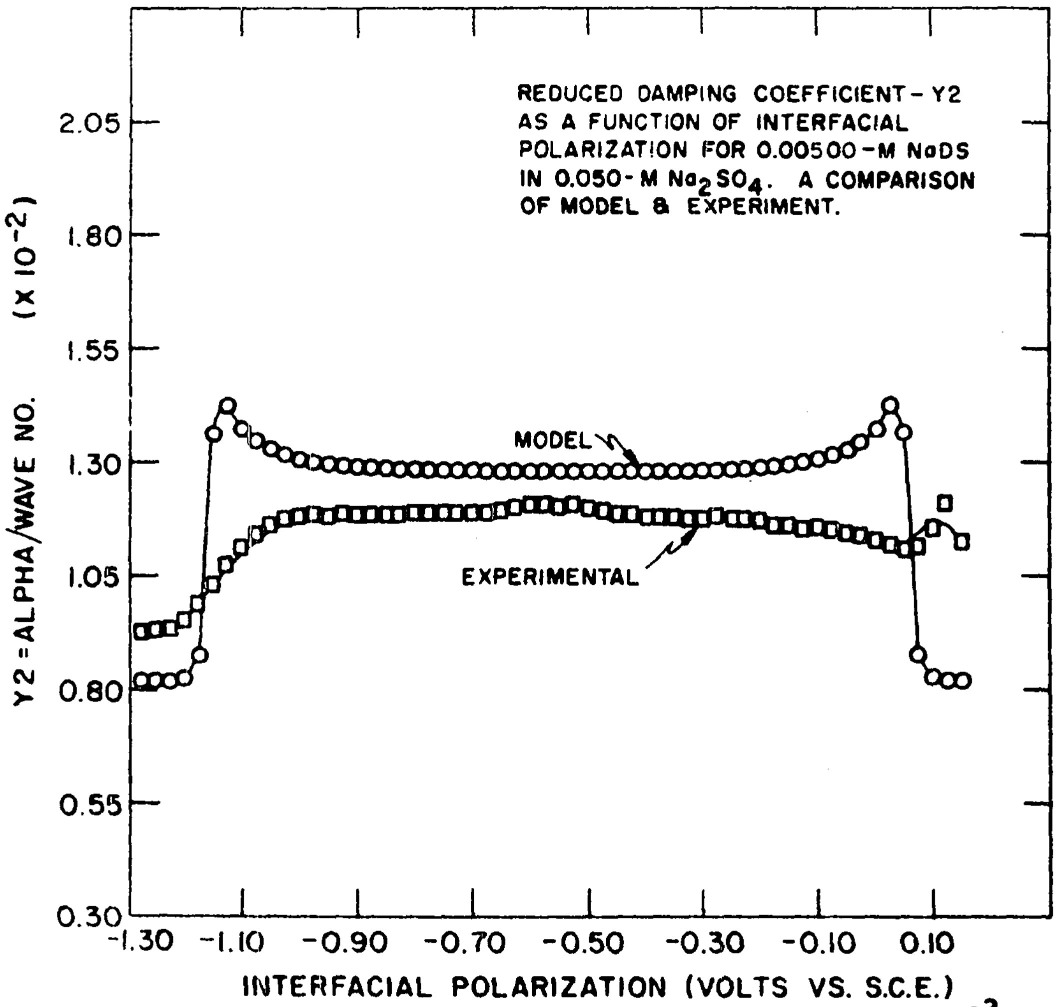


Figure 55. Model and experimental Y2 curves for the 5 x 10^{-3}-M NaDS in .05-M Na_2SO_4-mercury interface

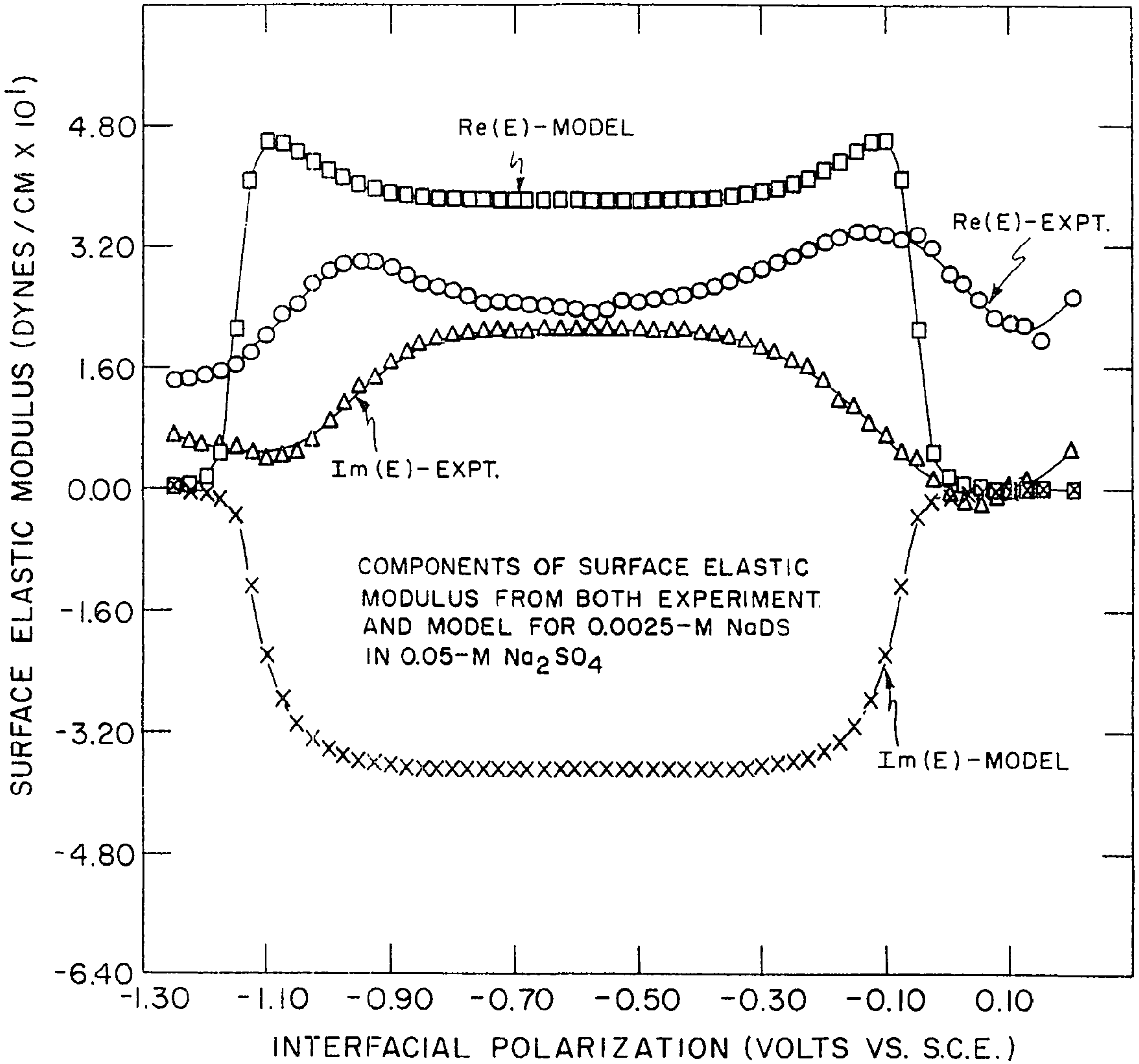


Figure 56. Real and imaginary components of the surface elastic modulus (E) from model and experiment for the 2.5 x 10^{-3}-M NaDS in .05-M Na_2SO_4-mercury interface

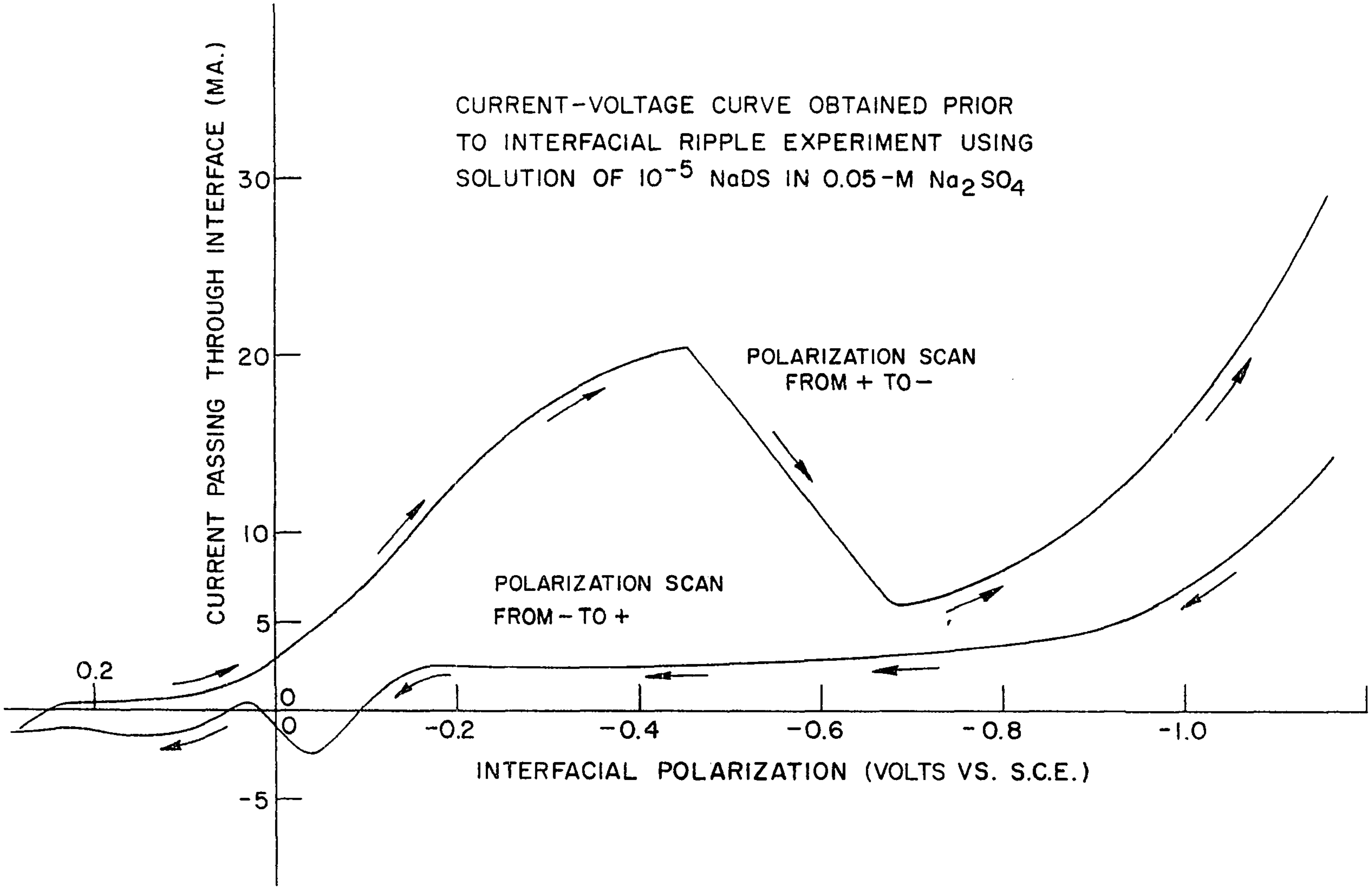


Figure 57. Current-voltage curves showing O_2 maximum in + to - potential scan for the 10^{-5}-M NaDS in .05-M Na_2SO_4-mercury interface. O_2 maximum effects can be seen in ripple data

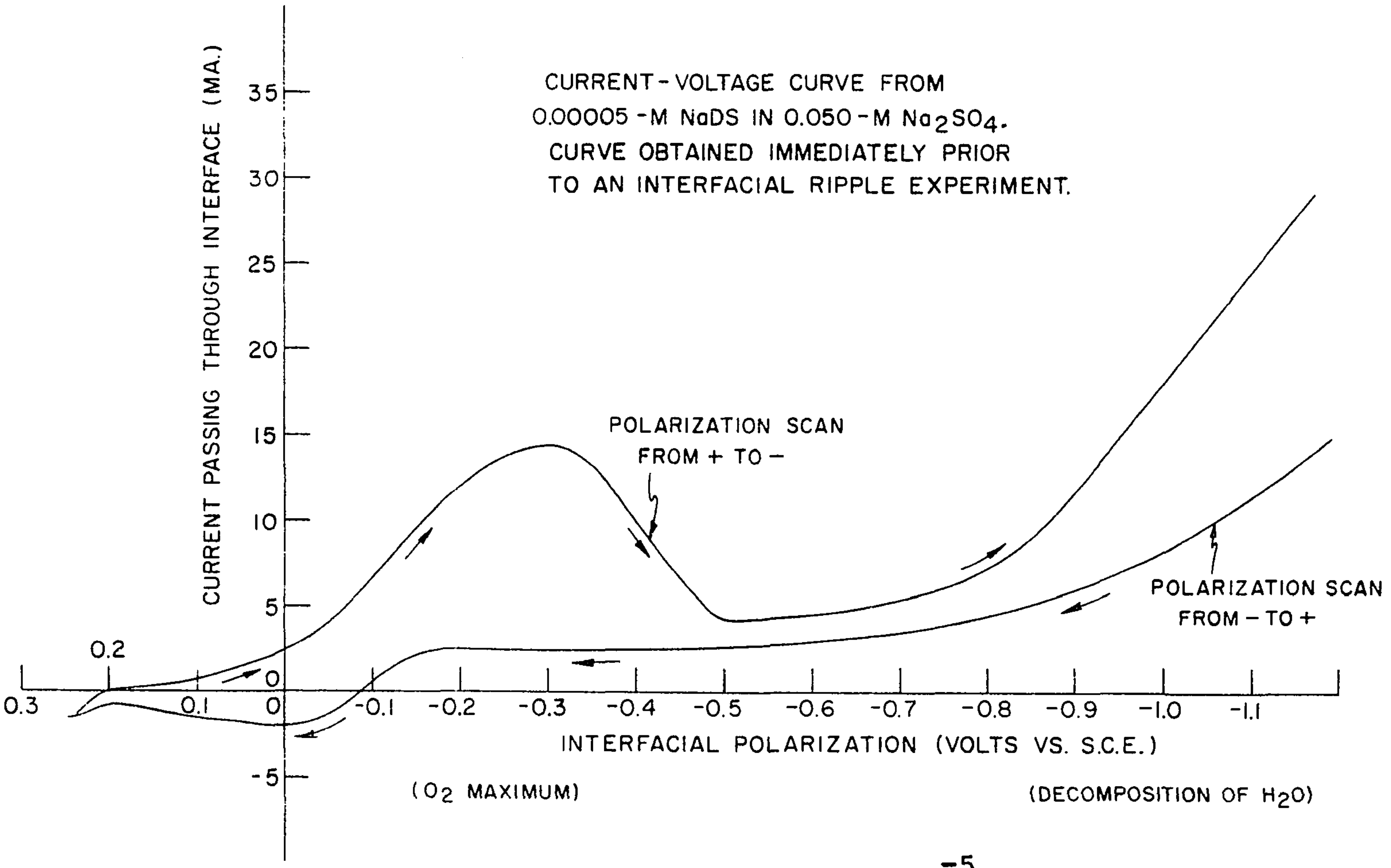


Figure 58. Current-voltage curves for the 5×10^{-5}-M NaDS in .05-M Na_2SO_4-mercury interface. At this NaDS concentration O_2 effects are seen in this plot but not in ripple data

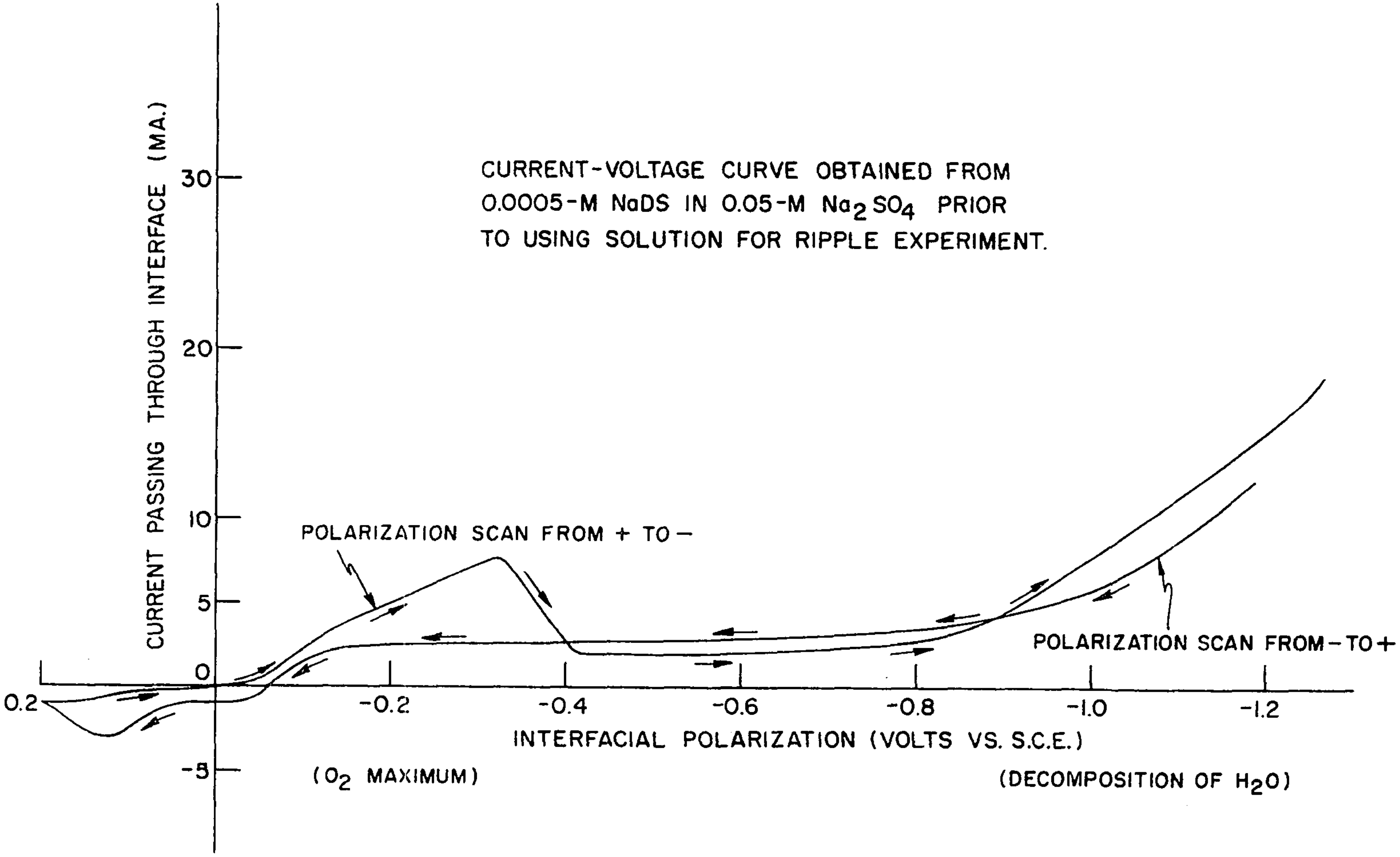


Figure 59. Current-voltage curve for the 5 x 10^{-4}-M NaDS in .05-M Na_2SO_4-mercury interface. O_2 maximum has been almost eliminated by surfactant

APPENDIX D

Listings of Data from YCOR for each Concentration of Phenol and NaDS[1]. Octanoic Acid Data is given in (24)

Each Figure in this appendix is the output from the data set from one concentration and consists of six pages. Page i contains the fixed input data from experiment and the input for the model. Page ii consists of the experimental data arrays. Page iii consists of the data and output for the amplitude correction. Pages iv-vi consist of calculated values from model and experiment. Figures 60-66 are for the phenol in N/10 $HClO_4$ solutions, while Figures 67-77 are for NaDS in .05-M Na_2SO_4, the Figures being in order of increasing concentration.

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[1] Data are given in this appendix for the normal model values mentioned in text, i.e. with the diffusion correction for phenol and with β=1.5 for NaDS.

```
                                        ANALYSIS OF INTERFACIAL RIPPLE DATA : DATA OF G.BIERWAGEN MEASURED AT

                              THE .1N HCLO4/HG INTERFACE(7-11-67)

MEASUREMENTS MADE AT      WATER                                          /    MERCURY                                    INTERFACE
     PURE               0.10-N HCLO4



DENSITY OF UPPER PHASE    0.99700   DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE    0.0089400   VISCOSITY OF LOWER PHASE    0.0152700

ORIGINAL OUTPUT VOLTAGE     27.30000000 MV.

INITIAL DAMPING COEFFICIENT    0.51540 1/CM.

WAVELENGTH 0.09584 CM.

PROBE SEPARATION =     1.15010 CM.

WAVENUMBER =     65.558365 RECIPROCAL CM.



                    INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM


SURFACTANT CONCENTRATION=       PURE

ELECTROCAPILLARY MAXIMUM IS   -0.47500 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=    1.22000

ELECTRICAL DESORPTION EXPONENT =    15.00000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =    10.00000

DIFFUSION TERM=    10000.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000001

SURFACTANT SURFACE VISCOSITY= 0.000100

 1/B0 = FRUMKIN CONCENTRATION CONSTANT=  0.005000
```

Figure 60. YCOR data for pure .1-N $HClO_4$

```
                                          INPUT DATA

NO.          POL.VOLTAGE         FREQUENCY        OUTPUT VOLTAGE(MV.)        GAMMA
  1            0.350000          402.000000           18.900000            337.660000
  2            0.300000          408.000000           20.700000            347.960000
  3            0.275000          411.100000           21.200000            352.890000
  4            0.250000          414.000000           21.600000            357.640000
  5            0.225000          416.900000           22.100000            362.190000
  6            0.200000          419.600000           22.400000            366.560000
  7            0.175000          421.800000          .22.600000            370.730000
  8            0.150000          424.200000           23.800000            374.710000
  9            0.125000          425.500000           25.100000            378.520000
 10            0.100000          427.000000           26.100000            382.160000
 11            0.075000          428.400000           26.800000            385.650000
 12            0.050000          429.600000           27.100000            388.970000
 13            0.025000          431.000000           27.500000            392.160000
 14            0.0               432.500000           28.200000            395.210000
 15           -0.025000          434.400000           28.200000            398.120000
 16           -0.050000          435.400000           26.500000            400.900000
 17           -0.075000          437.500000           26.800000            403.560000
 18           -0.100000          439.200000           26.800000            406.080000
 19           -0.125000          440.500000           27.000000            408.480000
 20           -0.150000          441.700000           27.400000            410.740000
 21           -0.175000          442.800000           27.900000            412.870000
 22           -0.200000          444.000000           28.300000            414.850000
 23           -0.225000          445.100000           28.600000            416.680000
 24           -0.250000          446.200000           28.500000            418.360000
 25           -0.275000          447.200000           27.900000            419.870000
 26           -0.300000          448.100000           28.000000            421.220000
 27           -0.325000          448.700000           28.100000            422.390000
 28           -0.350000          449.400000           28.100000            423.380000
 29           -0.375000          449.800000           28.300000            424.190000
 30           -0.400000          450.200000           27.900000            424.810000
 31           -0.425000          450.700000           27.500000            425.340000
 32           -0.450000          451.000000           27.500000            425.480000
 33           -0.475000          451.100000           27.300000            425.540000
 34           -0.500000          451.200000           27.100000            425.420000
 35           -0.525000          451.000000           27.200000            425.120000
 36           -0.550000          450.600000           27.000000            424.660000
 37           -0.575000          450.400000           26.800000            424.040000
 38           -0.600000          450.400000           26.600000            423.270000
 39           -0.625000          450.000000           26.600000            422.370000
 40           -0.650000          449.600000           26.300000            421.340000
 41           -0.675000          449.600000           26.100000            420.200000
 42           -0.700000          449.100000           26.800000            418.950000
 43           -0.725000          448.100000           27.800000            417.610000
 44           -0.750000          446.900000           28.100000            416.180000
 45           -0.775000          446.100000           28.100000            414.650000
 46           -0.800000          445.300000           28.000000            413.020000
 47           -0.825000          444.500000           28.000000            411.280000
 48           -0.850000          443.800000           27.900000            409.400000
 49           -0.875000          443.100000           27.700000            407.340000
 50           -0.900000          442.400000           27.500000            405.050000
 51           -0.925000          441.900000           26.900000            402.480000
 52           -0.950000          441.500000           26.600000            399.900000
 53           -0.975000          440.600000           27.800000            397.500000
 54           -1.000000          440.100000           27.000000            394.900000
 55           -1.025000          439.400000           26.000000            392.400000
 56           -1.050000          438.900000           25.000000            389.700000
 57           -1.075000          438.300000           24.800000            387.000000
 58           -1.100000          437.800000           23.700000            383.800000
```

Figure 60 (Continued)

```
INITIAL FREQUENCY =   433.60000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                          -0.1208608915D 04     FREQUENCY** 0
                           0.2823330235D 04     FREQUENCY** 1
                          -0.2931293885D 04     FREQUENCY** 2
                           0.1783278968D 04     FREQUENCY** 3
                          -0.7046183117D 03     FREQUENCY** 4
                           0.1890887852D 03     FREQUENCY** 5
                          -0.3492397260D 02     FREQUENCY** 6
                           0.4385962415D 01     FREQUENCY** 7
                          -0.3586019692D 00     FREQUENCY** 8
                           0.1724337906D-01     FREQUENCY** 9
                          -0.3704209668D-03     FREQUENCY**10

NO.     FREQUENCY     CORRECTED OUTPUT  VOLTAGE        NO.     FREQUENCY     CORRECTED OUTPUT  VOLTAGE
 1      402.00000          17.87283                     30      450.20000          26.52177
 2      408.00000          19.97724                     31      450.70000          26.07985
 3      411.10000          20.66085                     32      451.00000          26.04238
 4      414.00000          21.22593                     33      451.10000          25.84051
 5      416.90000          21.87403                     34      451.20000          25.63879
 6      419.60000          22.29324                     35      451.00000          25.75828
 7      421.80000          22.57135                     36      450.60000          25.61785
 8      424.20000          23.83497                     37      450.40000          25.45218
 9      425.50000          25.16148                     38      450.40000          25.26223
10      427.00000          26.18151                     39      450.00000          25.30960
11      428.40000          26.88837                     40      449.60000          25.07040
12      429.60000          27.18378                     41      449.60000          24.87975
13      431.00000          27.56687                     42      449.10000          25.60506
14      432.50000          29.23562                     43      448.10000          26.67777
15      434.40000          28.17002                     44      446.90000          27.10217
16      435.40000          26.43116                     45      446.10000          27.18951
17      437.50000          26.62426                     46      445.30000          27.17673
18      439.20000          26.51926                     47      444.50000          27.25757
19      440.50000          26.62504                     48      443.80000          27.22805
20      441.70000          26.92470                     49      443.10000          27.09768
21      442.80000          27.32052                     50      442.40000          26.96381
22      444.00000          27.59902                     51      441.90000          26.41711
23      445.10000          27.78004                     52      441.50000          26.15445
24      446.20000          27.56565                     53      440.60000          27.40623
25      447.20000          26.87599                     54      440.10000          26.65440
26      448.10000          26.86970                     55      439.40000          25.71459
27      448.70000          26.89503                     56      438.90000          24.75653
28      449.40000          26.81071                     57      438.30000          24.59358
29      449.80000          26.95209                     58      437.80000          23.52929
```

Figure 60 (Continued)

```
NO.   POL.VOLTAGE      GAMMA(EXPT.)CALC.E=0     THETA FROM MODEL      ALPHA(EXPTL)    ALPHA(MODEL)
  1     0.35000             338.23579               0.000000            0.883729        0.534904
  2     0.30000             348.32604               0.000000            0.786934        0.529979
  3     0.27500             353.58462               0.000000            0.757680        0.527990
  4     0.25000             358.53754               0.000000            0.734219        0.526014
  5     0.22500             363.52595               0.000000            0.709067        0.524314
  6     0.20000             368.19746               0.000000            0.691561        0.522631
  7     0.17500             372.02472               0.000000            0.680791        0.520642
  8     0.15000             376.23793               0.000000            0.633413        0.519143
  9     0.12500             378.53732               0.000000            0.596326        0.516671
 10     0.10000             381.19010               0.000000            0.551773        0.514622
 11     0.07500             383.67059               0.000000            0.528610        0.512653
 12     0.05000             385.79966               0.000000            0.519109        0.510676
 13     0.02500             388.29129               0.000000            0.506942        0.509059
 14     0.0                 390.97967               0.000000            0.455839        0.507791
 15    -0.02500             394.37247               0.000000            0.488123        0.506899
 16    -0.05000             396.15127               0.000000            0.543522        0.505327
 17    -0.07500             399.93824               0.000000            0.537193        0.504984
 18    -0.10000             403.01422               0.000000            0.540622        0.504378
 19    -0.12500             405.37653               0.000000            0.537167        0.503494
 20    -0.15000             407.56548               0.000000            0.527436        0.502647
 21    -0.17500             409.57838               0.000000            0.514747        0.501828
 22    -0.20000             411.77821               0.000000            0.505928        0.501249
 23    -0.22500             413.79912               0.000000            0.500244        0.500710
 24    -0.25000             415.82109               0.000000            0.506980        0.500307
 25    -0.27500             417.65810               0.000000            0.529011        0.499959
 26    -0.30000             419.32144               0.000000            0.529214        0.499656
 27    -0.32500             420.43251               0.000000            0.528395        0.499222
 28    -0.35000             421.72933               0.000000            0.531125        0.499041
 29    -0.37500             422.47343               0.000000            0.526552        0.498729
 30    -0.40000             423.21157               0.000000            0.540546        0.498580
 31    -0.42500             424.13592               0.000000            0.555156        0.498605
 32    -0.45000             424.69383               0.000000            0.556406        0.498772
 33    -0.47500             424.87740               0.000000            0.563173        0.498817
 34    -0.50000             425.06094               0.000000            0.569987        0.499015
 35    -0.52500             424.69009               0.000000            0.565944        0.499081
 36    -0.55000             423.94376               0.000000            0.570697        0.499093
 37    -0.57500             423.56951               0.000000            0.576339        0.499434
 38    -0.60000             423.56683               0.000000            0.582852        0.500098
 39    -0.62500             422.82407               0.000000            0.581223        0.500491
 40    -0.65000             422.07785               0.000000            0.589480        0.500999
 41    -0.67500             422.07502               0.000000            0.596117        0.501992
 42    -0.70000             421.15783               0.000000            0.571131        0.502601
 43    -0.72500             419.31924               0.000000            0.535447        0.502808
 44    -0.75000             417.10686               0.000000            0.521724        0.502901
 45    -0.77500             415.63297               0.000000            0.518976        0.503475
 46    -0.80000             414.16063               0.000000            0.519335        0.504143
 47    -0.82500             412.69199               0.000000            0.516752        0.504916
 48    -0.85000             411.40785               0.000000            0.517695        0.505921
 49    -0.87500             410.12475               0.000000            0.521868        0.507099
 50    -0.90000             408.84360               0.000000            0.526174        0.508500
 51    -0.92500             407.92463               0.000000            0.543984        0.510377
 52    -0.95000             407.19199               0.000000            0.552673        0.512386
 53    -0.97500             405.56674               0.000000            0.512023        0.513743
 54    -1.00000             404.64962               0.000000            0.536202        0.515713
 55    -1.02500             403.36735               0.000000            0.567420        0.517407
 56    -1.05000             402.44773               0.000000            0.600434        0.519521
 57    -1.07500             401.35876               0.000000            0.606174        0.521559
 58    -1.10000             400.43762               0.000000            0.644442        0.524227
```

Figure 60 (Continued)

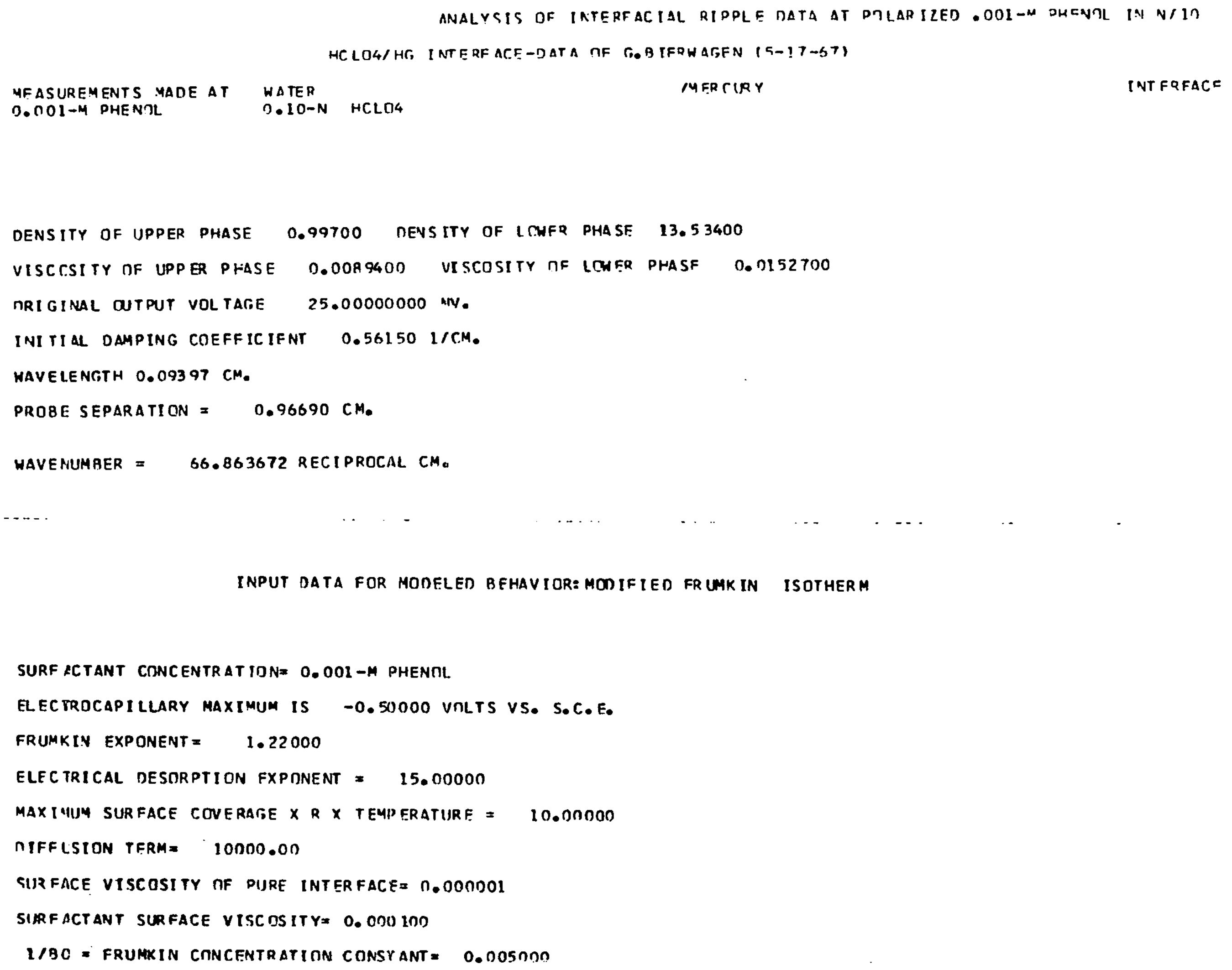
```
NO.   POL.VOLTAGE     RE(F)-EXPT.     RE(F)-MODEL     IM(F)-EXPT.     IM(F)-MODEL
  1     0.35000        23.165119      -0.000000      -22.531262      -0.000000
  2     0.30000         5.048722      -0.000000      -30.144179      -0.000000
  3     0.27500         1.426855      -0.000001      -23.743827      -0.000001
  4     0.25000        -0.321438      -0.000001      -19.887515      -0.000001
  5     0.22500        -0.229550      -0.000002      -14.864550      -0.000002
  6     0.20000         0.213479      -0.000003      -12.335432      -0.000003
  7     0.17500        -2.146380      -0.000005      -13.080085      -0.000005
  8     0.15000        -3.116758      -0.000009       -8.247150      -0.000009
  9     0.12500       -12.669284      -0.000014       -3.583487      -0.000014
 10     0.10000       -16.182064      -0.000021        3.647891      -0.000022
 11     0.07500       -17.006088      -0.000033       10.961972      -0.000033
 12     0.05000       -15.860978      -0.000048       18.626775      -0.000050
 13     0.02500       -13.243611      -0.000070       21.859358      -0.000074
 14     0.0            -8.999484      -0.000099       20.988715      -0.000107
 15    -0.02500       -12.531623      -0.000136       20.406977      -0.000152
 16    -0.05000       -13.361566      -0.000182       23.594734      -0.000211
 17    -0.07500       -18.334444      -0.000236       22.009903      -0.000287
 18    -0.10000       -20.453934      -0.000296       17.922844      -0.000382
 19    -0.12500       -20.155797      -0.000358       18.021366      -0.000494
 20    -0.15000       -18.940534      -0.000418       18.207183      -0.000622
 21    -0.17500       -17.363015      -0.000472       18.588613      -0.000763
 22    -0.20000       -16.751834      -0.000516       16.941793      -0.000911
 23    -0.22500       -16.341605      -0.000548       15.655254      -0.001060
 24    -0.25000       -17.170610      -0.000568       13.442418      -0.001203
 25    -0.27500       -19.635901      -0.000578       10.588456      -0.001337
 26    -0.30000       -18.952801      -0.000580        8.322053      -0.001456
 27    -0.32500       -19.082149      -0.000576        8.688303      -0.001559
 28    -0.35000       -18.461138      -0.000568        6.466578      -0.001645
 29    -0.37500       -18.195179      -0.000560        7.135231      -0.001714
 30    -0.40000       -19.441899      -0.000551        5.310865      -0.001767
 31    -0.42500       -19.125626      -0.000545        1.430691      -0.001805
 32    -0.45000       -16.687670      -0.000541       -0.771944      -0.001828
 33    -0.47500       -16.393275      -0.000540       -2.114839      -0.001836
 34    -0.50000       -14.719609      -0.000541       -3.983712      -0.001829
 35    -0.52500       -14.991804      -0.000545       -3.226087      -0.001807
 36    -0.55000       -17.300172      -0.000552       -2.848635      -0.001769
 37    -0.57500       -15.851664      -0.000560       -4.445320      -0.001717
 38    -0.60000       -10.570624      -0.000569       -6.592606      -0.001650
 39    -0.62500        -9.539407      -0.000577       -6.407929      -0.001564
 40    -0.65000        -7.766695      -0.000582       -7.319203      -0.001462
 41    -0.67500        -1.828086      -0.000582       -6.670792      -0.001346
 42    -0.70000        -1.178340      -0.000572       -4.354167      -0.001214
 43    -0.72500        -3.422871      -0.000552       -2.097092      -0.001069
 44    -0.75000        -6.375496      -0.000520       -0.719614      -0.000919
 45    -0.77500        -6.099626      -0.000476       -0.512611      -0.000771
 46    -0.80000        -5.487799      -0.000422       -0.622908      -0.000629
 47    -0.82500        -4.445983      -0.000362       -0.562050      -0.000500
 48    -0.85000        -2.416816      -0.000300       -0.727112      -0.000387
 49    -0.87500        -0.098457      -0.000240       -0.751385      -0.000293
 50    -0.90000         2.381916      -0.000186       -0.319352      -0.000216
 51    -0.92500         5.538292      -0.000140        0.528957      -0.000156
 52    -0.95000         7.739606      -0.000102        1.996085      -0.000111
 53    -0.97500         7.817916      -0.000072        3.205280      -0.000077
 54    -1.00000         9.183667      -0.000050        3.981787      -0.000052
 55    -1.02500        10.062889      -0.000034        4.446671      -0.000035
 56    -1.05000        10.935494      -0.000022        5.219139      -0.000023
 57    -1.07500        11.313937      -0.000014        5.944631      -0.000015
 58    -1.10000        11.900443      -0.000009        6.714980      -0.000009
```

Figure 60 (Continued)

```
NO.    POL.VOLTAGE      Y1-EXPT.       Y1-MODEL       Y2-EXPT.       Y2-MODEL

  1      0.35000        0.974414       0.980755       0.013480       0.008155
  2      0.30000        0.974007       0.980893       0.012004       0.008082
  3      0.27500        0.975049       0.980956       0.011557       0.008049
  4      0.25000        0.975721       0.981016       0.011199       0.008019
  5      0.22500        0.977008       0.981071       0.010801       0.007989
  6      0.20000        0.977905       0.981124       0.010549       0.007961
  7      0.17500        0.977071       0.981177       0.010384       0.007934
  8      0.15000        0.977725       0.981224       0.009662       0.007909
  9      0.12500        0.973826       0.981276       0.008944       0.007882
 10      0.10000        0.971363       0.981323       0.008417       0.007859
 11      0.07500        0.968894       0.981367       0.008063       0.007835
 12      0.05000        0.966014       0.981410       0.007918       0.007813
 13      0.02500        0.964411       0.981449       0.007733       0.007792
 14      0.0            0.963641       0.981485       0.006953       0.007774
 15     -0.02500        0.965020       0.981515       0.007446       0.007758
 16     -0.05000        0.962746       0.981550       0.008291       0.007740
 17     -0.07500        0.965648       0.981575       0.008194       0.007728
 18     -0.10000        0.967128       0.981600       0.008247       0.007715
 19     -0.12500        0.967146       0.981626       0.008194       0.007701
 20     -0.15000        0.967072       0.981650       0.008045       0.007689
 21     -0.17500        0.966880       0.981673       0.007852       0.007677
 22     -0.20000        0.967488       0.981693       0.007717       0.007666
 23     -0.22500        0.968018       0.981712       0.007631       0.007657
 24     -0.25000        0.968902       0.981728       0.007733       0.007649
 25     -0.27500        0.969750       0.981742       0.008069       0.007641
 26     -0.30000        0.970536       0.981755       0.008072       0.007635
 27     -0.32500        0.970442       0.981768       0.008060       0.007628
 28     -0.35000        0.971196       0.981777       0.008102       0.007624
 29     -0.37500        0.971067       0.981785       0.008032       0.007619
 30     -0.40000        0.971375       0.981791       0.008245       0.007616
 31     -0.42500        0.972321       0.981795       0.008468       0.007614
 32     -0.45000        0.973296       0.981795       0.008487       0.007614
 33     -0.47500        0.973590       0.981795       0.008590       0.007614
 34     -0.50000        0.974297       0.981793       0.008594       0.007615
 35     -0.52500        0.974120       0.981790       0.008633       0.007617
 36     -0.55000        0.973446       0.981786       0.008705       0.007619
 37     -0.57500        0.974004       0.981779       0.008791       0.007622
 38     -0.60000        0.975776       0.981768       0.008891       0.007628
 39     -0.62500        0.976119       0.981758       0.008866       0.007633
 40     -0.65000        0.976767       0.981747       0.008992       0.007639
 41     -0.67500        0.979417       0.981730       0.009093       0.007647
 42     -0.70000        0.980155       0.981716       0.008712       0.007654
 43     -0.72500        0.978926       0.981704       0.008167       0.007660
 44     -0.75000        0.977036       0.981692       0.007958       0.007667
 45     -0.77500        0.977133       0.981676       0.007915       0.007675
 46     -0.80000        0.977474       0.981658       0.007922       0.007684
 47     -0.82500        0.978085       0.981638       0.007882       0.007694
 48     -0.85000        0.979485       0.981616       0.007897       0.007706
 49     -0.87500        0.981335       0.981591       0.007960       0.007719
 50     -0.90000        0.983769       0.981562       0.008026       0.007734
 51     -0.92500        0.987813       0.981527       0.008298       0.007751
 52     -0.95000        0.992387       0.981491       0.008430       0.007770
 53     -0.97500        0.994312       0.981462       0.007810       0.007785
 54     -1.00000        0.998588       0.981426       0.008179       0.007804
 55     -1.02500        1.001756       0.981392       0.008655       0.007821
 56     -1.05000        1.006402       0.981354       0.009159       0.007841
 57     -1.07500        1.010655       0.981316       0.009246       0.007862
 58     -1.10000        1.016758       0.981269       0.009833       0.007884
```

Figure 60 (Continued)



```
                                    ANALYSIS OF INTERFACIAL RIPPLE DATA AT POLARIZED .001-M PHENOL IN N/10
                         HCLO4/HG INTERFACE-DATA OF G.BIERWAGEN (5-17-67)
MEASUREMENTS MADE AT    WATER                                 /MERCURY                           INTERFACE
0.001-M PHENOL          0.10-N  HCLO4



DENSITY OF UPPER PHASE    0.99700    DENSITY OF LOWER PHASE   13.53400

VISCOSITY OF UPPER PHASE    0.0089400    VISCOSITY OF LOWER PHASE    0.0152700

ORIGINAL OUTPUT VOLTAGE    25.00000000 MV.

INITIAL DAMPING COEFFICIENT    0.56150 1/CM.

WAVELENGTH 0.09397 CM.

PROBE SEPARATION =    0.96690 CM.

WAVENUMBER =    66.863672 RECIPROCAL CM.



                 INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM



SURFACTANT CONCENTRATION= 0.001-M PHENOL

ELECTROCAPILLARY MAXIMUM IS    -0.50000 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=    1.22000

ELECTRICAL DESORPTION EXPONENT =    15.00000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =    10.00000

DIFFUSION TERM=    10000.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000001

SURFACTANT SURFACE VISCOSITY= 0.000100

 1/BO = FRUMKIN CONCENTRATION CONSYANT=  0.005000
```

Figure 61. YCOR data for 10^{-3}-M phenol in N/10 $HClO_4$

```
                                          INPUT DATA
NO.               POL.VOLTAGE          FREQUENCY         OUTPUT VOLTAGE(MV.)        GAMMA
  1               -1.075000           447.000000          28.700000             386.800000
  2               -1.050000           448.100000          28.600000             389.300000
  3               -1.025000           449.300000          28.700000             392.100000
  4               -1.000000           450.800000          29.100000             394.800000
  5               -0.975000           452.100000          29.400000             397.300000
  6               -0.950000           453.500000          29.600000             399.600000
  7               -0.925000           454.800000          29.600000             401.800000
  8               -0.900000           456.000000          30.000000             404.200000
  9               -0.875000           457.100000          30.000000             405.900000
 10               -0.850000           458.100000          30.400000             408.300000
 11               -0.825000           459.000000          30.700000             410.100000
 12               -0.800000           459.700000          31.000000             411.800000
 13               -0.775000           460.500000          31.000000             413.300000
 14               -0.750000           461.300000          31.500000             414.700000
 15               -0.725000           461.900000          31.600000             416.100000
 16               -0.700000           462.700000          31.400000             417.700000
 17               -0.675000           463.300000          31.200000             418.600000
 18               -0.650000           463.800000          31.100000             419.600000
 19               -0.625000           464.200000          31.100000             420.300000
 20               -0.600000           464.400000          31.200000             420.700000
 21               -0.575000           464.700000          31.400000             421.600000
 22               -0.550000           464.900000          31.000000             422.100000
 23               -0.525000           464.900000          31.000000             422.300000
 24               -0.500000           464.900000          30.900000             422.400000
 25               -0.475000           464.700000          30.900000             422.100000
 26               -0.450000           464.500000          30.700000             422.100000
 27               -0.425000           464.200000          30.700000             421.900000
 28               -0.400000           463.900000          30.700000             421.100000
 29               -0.375000           463.400000          30.500000             420.400000
 30               -0.350000           463.100000          30.300000             419.800000
 31               -0.325000           462.500000          30.000000             418.900000
 32               -0.300000           461.700000          29.900000             417.100000
 33               -0.275000           460.800000          29.600000             416.100000
 34               -0.250000           459.900000          29.200000             414.600000
 35               -0.225000           458.800000          28.900000             413.400000
 36               -0.200000           457.900000          28.500000             411.300000
 37               -0.175000           456.700000          28.400000             409.400000
 38               -0.150000           455.400000          27.900000             407.300000
 39               -0.125000           454.000000          27.800000             405.600000
 40               -0.100000           452.600000          27.400000             402.800000
 41               -0.075000           451.200000          27.200000             400.400000
 42               -0.050000           449.700000          26.900000             397.600000
 43               -0.025000           448.000000          26.600000             395.500000
 44                0.0                446.400000          26.500000             392.500000
 45                0.025000           444.600000          26.300000             389.600000
 46                0.050000           442.800000          26.000000             386.300000
 47                0.075000           440.900000          25.500000             382.900000
 48                0.100000           439.000000          25.100000             379.100000
 49                0.150000           434.800000          24.400000             371.500000
 50                0.200000           430.000000          23.300000             362.600000
```

Figure 61 (Continued)

```
INITIAL FREQUENCY =   447.00000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                             -0.1208608915D 04     FREQUENCY** 0
                              0.2823330235D 04     FREQUENCY** 1
                             -0.2931293985D 04     FREQUENCY** 2
                              0.1793278968D 04     FREQUENCY** 3
                             -0.7046183117D 03     FREQUENCY** 4
                              0.1890887852D 03     FREQUENCY** 5
                             -0.3492397260D 02     FREQUENCY** 6
                              0.4385962415D 01     FREQUENCY** 7
                             -0.3596019692D 00     FREQUENCY** 8
                              0.1724337906D-01     FREQUENCY** 9
                             -0.3704209668D-03     FREQUENCY**10

NO.      FREQUENCY       CORRECTED OUTPUT VOLTAGE          NO.      FREQUENCY       CORRECTED OUTPUT VOLTAGE
  1      447.00000             28.70000                     26      464.50000             27.90554
  2      448.10000             28.46763                     27      464.20000             27.95992
  3      449.30000             28.41590                     28      463.90000             28.01417
  4      450.80000             28.61136                     29      463.40000             27.92122
  5      452.10000             28.72319                     30      463.10000             27.79134
  6      453.50000             28.71281                     31      462.50000             27.62111
  7      454.80000             28.51559                     32      461.70000             27.66757
  8      456.00000             28.71156                     33      460.80000             27.54291
  9      457.10000             28.53420                     34      459.90000             27.32006
 10      458.10000             28.74837                     35      458.80000             27.21776
 11      459.00000             28.87874                     36      457.90000             26.98297
 12      459.70000             29.03916                     37      456.70000             27.07381
 13      460.50000             28.89866                     38      455.40000             26.79033
 14      461.30000             29.22065                     39      454.00000             26.89616
 15      461.90000             29.20415                     40      452.60000             26.70197
 16      462.70000             28.87354                     41      451.20000             26.69179
 17      463.30000             28.58031                     42      449.70000             26.58514
 18      463.80000             28.39747                     43      448.00000             26.48830
 19      464.20000             28.32422                     44      446.40000             26.56462
 20      464.40000             28.37846                     45      444.60000             26.54650
 21      464.70000             28.50468                     46      442.80000             26.40819
 22      464.90000             28.10484                     47      440.90000             26.05274
 23      464.90000             28.10484                     48      439.00000             25.77493
 24      464.90000             28.01418                     49      434.80000             25.26698
 25      464.70000             28.05078                     50      430.00000             24.23905
```

Figure 61 (Continued)

```
NO.   POL.VOLTAGE   GAMMA(EXPT.)(CALC.F=)   THETA FROM MODEL   ALPHA(EXPTL)   ALPHA(MODEL)
 1     -1.07500       393.55419              0.001406            0.418754       0.530719
 2     -1.05000       395.46915              0.002146            0.427161       0.529346
 3     -1.02500       397.56494              0.003217            0.429042       0.527799
 4     -1.00000       400.19439              0.004735            0.421953       0.526684
 5     -0.97500       402.47985              0.006947            0.417918       0.525594
 6     -0.95000       404.94750              0.009726            0.418292       0.524841
 7     -0.92500       407.24431              0.013577            0.425420       0.524144
 8     -0.90000       409.37299              0.018633            0.418337       0.523251
 9     -0.87500       411.32655              0.025150            0.424746       0.523059
10     -0.85000       413.10934              0.033392            0.417012       0.522298
11     -0.82500       414.71666              0.043632            0.412333       0.522259
12     -0.80000       415.96936              0.056120            0.406603       0.522438
13     -0.77500       417.40110              0.071067            0.411619       0.523288
14     -0.75000       418.83847              0.088610            0.400160       0.524685
15     -0.72500       419.91638              0.108764            0.400744       0.526416
16     -0.70000       421.35361              0.131371            0.412519       0.528792
17     -0.67500       422.43267              0.156024            0.423076       0.532423
18     -0.65000       423.33333              0.182000            0.429714       0.536826
19     -0.62500       424.05510              0.208202            0.432385       0.542515
20     -0.60000       424.41696              0.233169            0.430496       0.549316
21     -0.57500       424.96039              0.255180            0.425817       0.556195
22     -0.55000       425.31889              0.272476            0.440426       0.562833
23     -0.52500       425.31889              0.283537            0.440425       0.567642
24     -0.50000       425.31810              0.287344            0.443768       0.569375
25     -0.47500       424.95662              0.283537            0.442418       0.567659
26     -0.45000       424.59368              0.272476            0.447787       0.562424
27     -0.42500       424.05199              0.255180            0.445773       0.555371
28     -0.40000       423.51064              0.233168            0.443768       0.548402
29     -0.37500       422.60754              0.208202            0.447206       0.541616
30     -0.35000       422.06546              0.182000            0.452028       0.535936
31     -0.32500       420.98313              0.156024            0.458382       0.531345
32     -0.30000       419.54472              0.131371            0.456644       0.528375
33     -0.27500       417.92781              0.108764            0.461314       0.525333
34     -0.25000       416.31305              0.088610            0.469717       0.523401
35     -0.22500       414.34534              0.071067            0.473596       0.521522
36     -0.20000       412.73731              0.056120            0.482557       0.521132
37     -0.17500       410.60228              0.043632            0.479081       0.520645
38     -0.15000       408.29166              0.033392            0.489967       0.520567
39     -0.12500       405.81489              0.025150            0.485890       0.520267
40     -0.10000       403.34255              0.018633            0.493384       0.521195
41     -0.07500       400.87973              0.013577            0.493778       0.521884
42     -0.05000       398.24838              0.009726            0.497919       0.522951
43     -0.02500       395.27695              0.006947            0.501693       0.523203
44      0.0           392.49232              0.004735            0.498717       0.524472
45      0.02500       389.37032              0.003217            0.499423       0.525474
46      0.05000       386.25958              0.002146            0.504825       0.526900
47      0.07500       382.98727              0.001406            0.518841       0.528354
48      0.10000       379.72966              0.000905            0.529929       0.530246
49      0.15000       372.57916              0.000354            0.550514       0.533724
50      0.20000       364.48409              0.000128            0.593469       0.538113
```

Figure 61 (Continued)

```
NO.   PCL.VOLTAGE    RE(F)-EXPT.    RE(F)-MODEL    IM(F)-EXPT.    IM(F)-MODEL
  1    -1.07500       5.738930       0.000095       4.363941      -0.000140
  2    -1.05000       5.189606       0.000241       4.029800      -0.000325
  3    -1.02500       4.386021       0.000571       3.790993      -0.000656
  4    -1.00000       4.277182       0.001296       3.976343      -0.001372
  5    -0.97500       3.997338       0.002767       3.971741      -0.002780
  6    -0.95000       4.219043       0.005724       3.932128      -0.005435
  7    -0.92500       4.376484       0.011410       3.848562      -0.010222
  8    -0.90000       4.008180       0.021957       3.951402      -0.018446
  9    -0.87500       4.364289       0.040813       3.851995      -0.031865
 10    -0.85000       3.524823       0.073257       3.920882      -0.052574
 11    -0.82500       3.249155       0.126895       4.018321      -0.082720
 12    -0.80000       2.597701       0.211896       4.157261      -0.123996
 13    -0.77500       2.493790       0.340909       4.017021      -0.177104
 14    -0.75000       2.558716       0.528191       4.332852      -0.241324
 15    -0.72500       2.071551       0.788044       4.344430      -0.314476
 16    -0.70000       1.786377       1.132929       4.013157      -0.393297
 17    -0.67500       2.066235       1.569503       3.673057      -0.474044
 18    -C.65000       1.897339       2.094809       3.464043      -0.553089
 19    -0.62500       1.934251       2.650753       3.375159      -0.627282
 20    -C.60000       1.869527       3.319491       3.437685      -0.693962
 21    -0.57500       1.253666       3.923365       3.614199      -0.750470
 22    -0.55000       0.959388       4.430625       3.124156      -0.794097
 23    -0.52500       0.573876       4.770134       3.152407      -0.821959
 24    -0.50000       0.362787       4.889766       3.046195      -0.831567
 25    -0.47500       0.244879       4.769911       3.112462      -0.822062
 26    -0.45000      -0.538651       4.430192       3.005727      -0.794290
 27    -0.42500      -1.270531       3.922847       3.236989      -0.750687
 28    -0.40000      -0.687180       3.318995       3.206872      -0.694147
 29    -0.37500      -1.156333       2.690038       3.162092      -0.627518
 30    -0.35000      -1.066088       2.094246       2.939058      -0.553239
 31    -0.32500      -1.537167       1.568942       2.758993      -0.474152
 32    -0.30000      -0.691385       1.132339       2.702588      -0.393361
 33    -0.27500      -2.172265       0.787521       2.801236      -0.314485
 34    -C.25000      -2.553459       0.527680       2.503087      -0.241283
 35    -0.22500      -4.684414       0.340459       3.038370      -0.177021
 36    -0.20000      -3.449488       0.211570       2.115501      -0.123901
 37    -0.17500      -4.046980       0.126626       2.535423      -0.082613
 38    -0.15000      -4.859699       0.073064       2.219124      -0.052475
 39    -0.12500      -7.111652       0.040685       3.680981      -0.031785
 40    -0.10000      -6.305143       0.021880       2.736794      -0.018390
 41    -0.07500      -6.494369       0.011367       2.872282      -0.010186
 42    -0.05000      -6.049750       0.005701       2.431088      -0.005413
 43    -0.02500      -8.996802       0.002756       4.055757      -0.002767
 44     0.0          -8.133891       0.001280       3.769006      -0.001365
 45     0.02500      -8.823333       0.000569       4.366201      -0.000652
 46     0.05000      -8.406500       0.000240       3.675257      -0.000303
 47     0.07500      -8.488662       0.000094       2.649339      -0.000138
 48     0.10000      -6.797296       0.000034       1.027840      -0.000062
 49     0.15000      -5.412609       0.000002      -0.587975      -0.000013
 50     C.20000      -2.319503      -0.000001      -3.124839      -0.000003
```

Figure 61 (Continued)

```
NO.    PCL.VOLTAGE      Y1-EXPT.      Y1-MODEL      Y2-EXPT.      Y2-MODEL

 1      -1.07500        0.991319      0.981251      0.006263      0.007893
 2      -1.05000        0.989806      0.981292      0.006389      0.007877
 3      -1.02500        0.988008      0.981318      0.006417      0.007852
 4      -1.00000        0.987814      0.981349      0.006311      0.007843
 5      -0.97500        0.987268      0.981380      0.006250      0.007829
 6      -0.95000        0.987674      0.981407      0.006256      0.007816
 7      -0.92500        0.987906      0.981437      0.006363      0.007805
 8      -0.90000        0.987229      0.981473      0.006257      0.007794
 9      -0.87500        0.987843      0.981507      0.006352      0.007790
10      -0.85000        0.986338      0.981564      0.006237      0.007783
11      -0.82500        0.985871      0.981631      0.006167      0.007783
12      -0.80000        0.984798      0.981725      0.006081      0.007789
13      -0.77500        0.984642      0.981853      0.006156      0.007803
14      -0.75000        0.984731      0.982032      0.005985      0.007824
15      -0.72500        0.983972      0.982277      0.005993      0.007852
16      -0.70000        0.983601      0.982599      0.006170      0.007890
17      -0.67500        0.984034      0.983000      0.006327      0.007944
18      -0.65000        0.983808      0.983498      0.006427      0.008012
19      -0.62500        0.983865      0.984044      0.006467      0.008098
20      -0.60000        0.983777      0.984635      0.006437      0.008201
21      -0.57500        0.982945      0.985208      0.006368      0.008308
22      -0.55000        0.982626      0.985686      0.006587      0.008409
23      -0.52500        0.982161      0.986005      0.006587      0.008484
24      -0.50000        0.981928      0.986117      0.006637      0.008510
25      -0.47500        0.981781      0.986005      0.006617      0.008485
26      -0.45000        0.980936      0.985688      0.006697      0.008408
27      -0.42500        0.980134      0.985212      0.006667      0.008304
28      -0.40000        0.980727      0.984641      0.006637      0.008196
29      -0.37500        0.980243      0.984050      0.006688      0.008094
30      -0.35000        0.980374      0.983494      0.006760      0.008008
31      -0.32500        0.979936      0.983008      0.006855      0.007939
32      -0.30000        0.980763      0.982598      0.006829      0.007891
33      -0.27500        0.979291      0.982284      0.006899      0.007849
34      -0.25000        0.978999      0.982040      0.007025      0.007820
35      -0.22500        0.977149      0.981866      0.007083      0.007796
36      -0.20000        0.978289      0.981730      0.007217      0.007787
37      -0.17500        0.977685      0.981636      0.007165      0.007781
38      -0.15000        0.977139      0.981568      0.007328      0.007781
39      -0.12500        0.975210      0.981524      0.007267      0.007781
40      -0.10000        0.975942      0.981476      0.007379      0.007793
41      -0.07500        0.975728      0.981440      0.007385      0.007804
42      -0.05000        0.976077      0.981404      0.007447      0.007818
43      -0.02500        0.973855      0.981381      0.007503      0.007828
44       0.0            0.974301      0.981345      0.007459      0.007846
45       0.02500        0.973654      0.981312      0.007469      0.007862
46       0.05000        0.974036      0.981273      0.007550      0.007882
47       0.07500        0.974270      0.981232      0.007760      0.007903
48       0.10000        0.975573      0.981185      0.007926      0.007927
49       0.15000        0.976573      0.981092      0.008233      0.007976
50       0.20000        0.978574      0.980978      0.008876      0.008035
```

Figure 61 (Continued)

```
                        ANALYSIS OF INTERFACIAL RIPPLE DATA AT POLARIZED 0.005-M PHENOL IN N/10
                  HCLO4/HG INTERFACE--DATA OF G.BIERWAGEN (5/17/67)
MEASUREMENTS MADE AT   WATER                          /MERCURY                          INTERFACE
C.005-M PHENOL        0.100-N HCLC4



DENSITY OF UPPER PHASE   0.99700   DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE   0.0089400   VISCOSITY OF LOWER PHASE   0.0152700

ORIGINAL OUTPUT VOLTAGE    27.70000000 MV.

INITIAL DAMPING COEFFICIENT   0.50500 1/CM.

WAVELENGTH 0.09359 CM.

PROBE SEPARATION =    1.01200 CM.

WAVENUMBER =    67.132287 RECIPROCAL CM.
---------------------------------------------------------------------------------


                INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM


SURFACTANT CONCENTRATION= 0.005-M PHENOL

ELECTROCAPILLARY MAXIMUM IS   -0.52500 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=    1.22000

ELECTRICAL DESORPTION EXPONENT =   15.00000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =   10.00000

DIFFUSION TERM=   10000.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000001

SURFACTANT SURFACE VISCOSITY= 0.000100

 1/BO = FRUMKIN CONCENTRATION CONSTANT=  0.005000
```

Figure 62. YCOR data for 5 x 10^{-3}-M phenol in N/10 $HClO_4$

```
                                   INPUT DATA

NO.          POL.VOLTAGE        FREQUENCY       OUTPUT VOLTAGE(MV.)        GAMMA
  1          -1.050000          451.100000          27.700000          389.200000
  2          -1.025000          452.300000          27.700000          392.000000
  3          -1.000000          453.600000          27.700000          394.500000
  4          -0.975000          454.700000          27.700000          397.000000
  5          -0.950000          455.800000          28.000000          399.000000
  6          -0.925000          456.900000          28.300000          401.100000
  7          -0.900000          457.900000          28.100000          403.300000
  8          -0.875000          458.900000          28.200000          405.400000
  9          -0.850000          459.800000          28.300000          406.900000
 10          -0.825000          460.500000          28.200000          408.600000
 11          -0.800000          461.100000          28.400000          410.200000
 12          -0.775000          461.600000          28.100000          411.600000
 13          -0.750000          462.100000          28.000000          412.400000
 14          -0.725000          462.500000          27.900000          413.700000
 15          -0.700000          462.900000          27.600000          414.400000
 16          -0.675000          463.300000          27.600000          415.700000
 17          -0.650000          463.500000          27.700000          415.900000
 18          -0.625000          463.500000          27.700000          416.500000
 19          -0.600000          463.700000          27.600000          416.700000
 20          -0.575000          463.700000          27.800000          417.100000
 21          -0.550000          463.700000          27.600000          417.300000
 22          -0.525000          463.600000          27.500000          417.500000
 23          -0.500000          463.400000          27.600000          416.800000
 24          -0.475000          463.200000          27.400000          416.900000
 25          -0.450000          463.000000          27.200000          416.400000
 26          -0.425000          462.600000          27.100000          416.100000
 27          -0.400000          462.000000          26.800000          415.000000
 28          -0.375000          461.500000          26.500000          414.500000
 29          -0.350000          460.800000          26.300000          413.300000
 30          -0.325000          460.100000          25.900000          412.700000
 31          -0.300000          459.300000          25.500000          411.300000
 32          -0.275000          458.300000          25.200000          410.200000
 33          -0.250000          457.300000          25.000000          408.200000
 34          -0.225000          456.300000          24.800000          407.300000
 35          -0.200000          455.100000          24.500000          405.200000
 36          -0.175000          454.100000          24.200000          403.900000
 37          -0.150000          452.700000          24.000000          401.400000
 38          -0.125000          450.700000          23.500000          399.900000
 39          -0.100000          449.200000          23.400000          397.500000
 40          -0.075000          447.800000          23.300000          395.300000
 41          -0.050000          446.400000          23.100000          392.400000
 42          -0.025000          444.900000          23.000000          390.400000
 43           0.0               443.400000          22.800000          387.800000
 44           0.025000          441.600000          22.500000          385.000000
 45           0.050000          440.300000          22.300000          381.900000
 46           0.075000          438.600000          22.000000          379.000000
 47           0.100000          436.700000          21.600000          375.700000
 48           0.150000          432.700000          21.100000          368.900000
 49           0.200000          428.400000          20.400000          361.600000
 50           0.250000          423.600000          19.600000          353.300000
```

Figure 62 (Continued)

```
INITIAL FREQUENCY =  451.10000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                                 -0.1208608915D 04      FREQUENCY** 0
                                  0.2823330235D 04      FREQUENCY** 1
                                 -0.2931293885D 04      FREQUENCY** 2
                                  0.1783278968D 04      FREQUENCY** 3
                                 -0.7046183117D 03      FREQUENCY** 4
                                  0.1890887852D 03      FREQUENCY** 5
                                 -0.3492397260D 02      FREQUENCY** 6
                                  0.4385962415D 01      FREQUENCY** 7
                                 -0.3586019692D 00      FREQUENCY** 8
                                  0.1724337906D-01      FREQUENCY** 9
                                 -0.3704209668D-03      FREQUENCY**10

NO.     FREQUENCY     CORRECTED OUTPUT VOLTAGE        NO.     FREQUENCY     CORRECTED OUTPUT VOLTAGE
 1      451.10000           27.70000                  26      462.60000           25.39778
 2      452.30000           27.53664                  27      462.00000           25.21166
 3      453.60000           27.35384                  28      461.50000           25.00733
 4      454.70000           27.19478                  29      460.90000           24.92613
 5      455.80000           27.32476                  30      460.10000           24.65210
 6      456.90000           27.44772                  31      459.30000           24.38850
 7      457.90000           27.09769                  32      458.30000           24.24453
 8      458.90000           27.03507                  33      457.30000           24.19184
 9      459.80000           26.98537                  34      456.30000           24.13465
10      460.50000           26.77603                  35      455.10000           24.00116
11      461.10000           26.86678                  36      454.10000           23.83483
12      461.60000           26.50072                  37      452.70000           23.81028
13      462.10000           26.32403                  38      450.70000           23.54517
14      462.50000           26.16406                  39      449.20000           23.60874
15      462.90000           25.81722                  40      447.80000           23.65273
16      463.30000           25.75149                  41      446.40000           23.58581
17      463.50000           25.81172                  42      444.90000           23.62003
18      463.50000           25.81172                  43      443.40000           23.54010
19      463.70000           25.68554                  44      441.60000           23.36559
20      463.70000           25.87167                  45      440.30000           23.24524
21      463.70000           25.68554                  46      438.60000           23.03290
22      463.60000           25.60893                  47      436.70000           22.70742
23      463.40000           25.73502                  48      432.70000           22.31446
24      463.20000           25.58122                  49      428.40000           21.62327
25      463.00000           25.42689                  50      423.60000           20.72557
```

Figure 62 (Continued)

```
NO.   POL.VOLTAGE    GAMMA(EXPT.)CALC.F=C    THETA FROM MODEL    ALPHA(EXPTL)    ALPHA(MODEL)
 1     -1.05000          395.95178               0.016393          0.505000       0.532590
 2     -1.02500          398.03497               0.024350          0.510945       0.531119
 3     -1.00000          400.29783               0.035662          0.517426       0.530183
 4     -0.97500          402.21748               0.051581          0.523183       0.529306
 5     -0.95000          404.14489               0.073835          0.518477       0.529445
 6     -0.92500          406.07684               0.104885          0.514041       0.530582
 7     -0.90000          407.83209               0.148386          0.526723       0.533878
 8     -0.87500          409.59430               0.209952          0.529009       0.542645
 9     -0.85000          411.18361               0.297823          0.530829       0.545772
10     -0.82500          412.41983               0.418545          0.538523       0.626806
11     -0.80000          413.48416               0.554336          0.535180       0.739225
12     -0.77500          414.36671               0.664728          0.548736       0.816003
13     -0.75000          415.25245               0.740093          0.555346       0.838991
14     -0.72500          415.96143               0.790744          0.561369       0.840557
15     -0.70000          416.66832               0.825674          0.574556       0.837722
16     -0.67500          417.37969               0.850351          0.577075       0.832786
17     -0.65000          417.73694               0.868024          0.574766       0.829571
18     -0.62500          417.73694               0.880676          0.574765       0.825919
19     -0.60000          418.09165               0.889547          0.579609       0.823880
20     -0.57500          418.09433               0.895418          0.572474       0.821805
21     -0.55000          418.09165               0.898769          0.579609       0.820642
22     -0.52500          417.91224               0.899859          0.592561       0.819878
23     -0.50000          417.55762               0.898769          0.577707       0.820976
24     -0.47500          417.19907               0.895418          0.583630       0.821325
25     -0.45000          416.84061               0.889547          0.589610       0.823240
26     -0.42500          416.12833               0.880676          0.590742       0.825119
27     -0.40000          415.05886               0.868024          0.598010       0.828623
28     -0.37500          414.16785               0.850351          0.606051       0.831851
29     -0.35000          412.92526               0.825674          0.609265       0.836134
30     -0.32500          411.68136               0.790744          0.620188       0.838330
31     -0.30000          410.26272               0.740093          0.630811       0.836330
32     -0.27500          408.49597               0.664728          0.636662       0.813285
33     -0.25000          406.73463               0.554336          0.638811       0.737258
34     -0.22500          404.97703               0.418545          0.641150       0.623578
35     -0.20000          402.87179               0.297823          0.646631       0.562607
36     -0.17500          401.12062               0.209952          0.653502       0.539221
37     -0.15000          398.67915               0.148386          0.654521       0.530470
38     -0.12500          395.20012               0.104885          0.665585       0.525492
39     -0.10000          392.60571               0.073835          0.662920       0.524243
40     -0.07500          390.19171               0.051581          0.661081       0.523988
41     -0.05000          387.78318               0.035662          0.663881       0.524937
42     -0.02500          385.21283               0.024350          0.662448       0.525157
43      0.0              382.64903               0.016393          0.665797       0.526095
44      0.02500          379.58239               0.010969          0.673150       0.526994
45      0.05000          377.37538               0.007089          0.678253       0.528757
46      0.07500          374.49798               0.004547          0.687321       0.529935
47      0.10000          371.29336               0.002864          0.701384       0.531342
48      0.15000          364.59733               0.001079          0.718634       0.534238
49      0.20000          357.46140               0.000377          0.749725       0.537467
50      0.25000          349.57523               0.000123          0.791625       0.541404
```

Figure 62 (Continued)

```
NO.  POL.VOLTAGE   RE(E)-EXPT.   RE(E)-MODEL   IM(E)-EXPT.   IM(E)-MODEL
 1    -1.05000      6.431705      0.003399      2.837632     -0.003386
 2    -1.02500      5.725133      0.007833      2.334171     -0.007560
 3    -1.00000      5.527253      0.017757      2.022062     -0.016573
 4    -0.97500      4.830770      0.039891      1.478674     -0.035640
 5    -0.95000      4.682924      0.089578      1.531280     -0.075534
 6    -0.92500      4.394469      0.202888      1.521968     -0.158115
 7    -0.90000      3.839104      0.467401      0.846883     -0.326731
 8    -0.87500      3.278710      1.099782      0.521656     -0.661974
 9    -0.85000      3.473930      2.606672      0.500312     -1.292208
10    -0.82500      2.695765      5.795417     -0.117085     -2.385885
11    -0.80000      1.479599     10.292280     -0.356693     -4.144285
12    -0.77500      0.332448     13.647693     -1.311943     -6.304324
13    -0.75000      0.651056     15.163605     -1.601069     -8.135720
14    -0.72500     -1.004419     15.624776     -2.347518     -9.406698
15    -0.70000     -0.799440     15.638561     -3.147138    -10.233562
16    -0.67500     -2.873125     15.493216     -3.773415    -10.765183
17    -0.65000     -2.298072     15.308273     -3.522679    -11.107536
18    -0.62500     -4.726109     15.133697     -3.800290    -11.328106
19    -0.60000     -4.022073     14.994739     -4.147189    -11.471410
20    -0.57500     -5.821292     14.892242     -3.643616    -11.558886
21    -0.55000     -6.812967     14.830624     -4.256438    -11.606424
22    -0.52500     -8.850298     14.808558     -4.387940    -11.620564
23    -0.50000     -6.979050     14.826094     -4.049067    -11.603679
24    -0.47500     -9.510808     14.884687     -4.377100    -11.554389
25    -0.45000     -8.764761     14.984156     -5.086636    -11.465307
26    -0.42500    -11.296965     15.120097     -4.827687    -11.320636
27    -0.40000    -11.253106     15.285693     -5.666566    -11.095987
28    -0.37500    -14.267124     15.466423     -6.100601    -10.752824
29    -0.35000    -14.717245     15.608114     -6.376166    -10.221509
30    -0.32500    -21.025345     15.591917     -5.971928     -9.396450
31    -0.30000    -22.100790     15.129577     -7.692628     -8.128184
32    -0.27500    -30.381917     13.616045     -3.872798     -6.301622
33    -0.25000    -27.873540     10.268209     -6.180578     -4.144630
34    -0.22500    -37.463905      5.780062      4.257975     -2.385873
35    -0.20000    -38.921033      2.597430      3.998961     -1.290909
36    -0.17500    -43.716481      1.095111     12.829663     -0.660516
37    -0.15000    -43.393881      0.465028     12.036320     -0.325616
38    -0.12500    -23.146648      0.201590     45.755435     -0.157331
39    -0.10000    -19.293097      0.088950     45.043369     -0.075084
40    -0.07500    -15.741348      0.039594     44.334071     -0.035401
41    -0.05000    -22.136061      0.017618     43.784886     -0.016450
42    -0.02500    -13.663447      0.007770     43.671335     -0.007509
43     0.0        -13.517202      0.003371     43.894781     -0.003357
44     0.02500     -9.653586      0.001429     44.224826     -0.001466
45     0.05000    -21.189478      0.000588     45.623774     -0.000625
46     0.07500    -20.923815      0.000233     47.606099     -0.000260
47     0.10000    -21.764929      0.000088     51.262270     -0.000106
48     0.15000    -21.137479      0.000010     55.531756     -0.000017
49     0.20000    -18.840036      0.000000     66.691937     -0.000003
50     0.25000    -12.697459     -0.000000     94.637124     -0.000001
```

Figure 62 (Continued)

```
NO.   POL.VOLTAGE     Y1-EXPT.      Y1-MODEL      Y2-EXPT.      Y2-MODEL

 1     -1.05000       0.991365      0.981262      0.007522      0.007889
 2     -1.02500       0.989528      0.981301      0.007610      0.007873
 3     -1.00000       0.988917      0.981339      0.007708      0.007861
 4     -0.97500       0.987462      0.981399      0.007793      0.007852
 5     -0.95000       0.987272      0.981455      0.007723      0.007854
 6     -0.92500       0.986849      0.981577      0.007657      0.007873
 7     -0.90000       0.985766      0.981929      0.007846      0.007925
 8     -0.87500       0.984948      0.982386      0.007880      0.008059
 9     -0.85000       0.985170      0.983623      0.007907      0.008406
10     -0.82500       0.984060      0.985829      0.009022      0.009323
11     -0.80000       0.982779      0.986878      0.007972      0.011004
12     -0.77500       0.981561      0.985308      0.008174      0.012146
13     -0.75000       0.981780      0.983747      0.008272      0.012480
14     -0.72500       0.980390      0.982867      0.008362      0.012505
15     -0.70000       0.980428      0.982371      0.008559      0.012451
16     -0.67500       0.979051      0.982113      0.008596      0.012393
17     -0.65000       0.979426      0.981944      0.008562      0.012343
18     -0.62500       0.978015      0.981954      0.008562      0.012294
19     -0.60000       0.978389      0.981792      0.008634      0.012262
20     -0.57500       0.977451      0.981763      0.008528      0.012235
21     -0.55000       0.976982      0.981747      0.008634      0.012219
22     -0.52500       0.976093      0.981747      0.008678      0.012212
23     -0.50000       0.976889      0.981737      0.008606      0.012225
24     -0.47500       0.975812      0.981763      0.008694      0.012234
25     -0.45000       0.976140      0.981791      0.008783      0.012262
26     -0.42500       0.975157      0.981852      0.008800      0.012294
27     -0.40000       0.975207      0.981934      0.008908      0.012346
28     -0.37500       0.974271      0.982097      0.009028      0.012399
29     -0.35000       0.974138      0.982360      0.009076      0.012464
30     -0.32500       0.972592      0.982855      0.009238      0.012506
31     -0.30000       0.972512      0.983737      0.009397      0.012480
32     -0.27500       0.970879      0.985292      0.009484      0.012149
33     -0.25000       0.971383      0.986863      0.009516      0.011017
34     -0.22500       0.969276      0.985836      0.009551      0.009322
35     -0.20000       0.969182      0.983630      0.009632      0.008404
36     -0.17500       0.968033      0.982396      0.009735      0.008055
37     -0.15000       0.968065      0.981837      0.009750      0.007922
38     -0.12500       0.963129      0.981601      0.009915      0.007961
39     -0.10000       0.962506      0.981478      0.009875      0.007843
40     -0.07500       0.961839      0.981412      0.009847      0.007841
41     -0.05000       0.962898      0.981358      0.009889      0.007852
42     -0.02500       0.961338      0.981329      0.009868      0.007859
43      0.0           0.961268      0.981295      0.009918      0.007873
44      0.02500       0.960414      0.981262      0.010027      0.007889
45      0.05000       0.962517      0.981221      0.010103      0.007909
46      0.07500       0.962407      0.981187      0.010238      0.007927
47      0.10000       0.962468      0.981147      0.010448      0.007947
48      0.15000       0.962334      0.981064      0.010705      0.007999
49      0.20000       0.962346      0.980973      0.011168      0.008039
50      0.25000       0.963006      0.980866      0.011792      0.008094
```

Figure 62 (Continued)

```
                                        ANALYSIS OF INTERFACIAL RIPPLE DATA AT POLARIZED .010-M PHENOL IN N/10

                               HCLO4/HG INTERFACE-DATA OF G.BIERWAGEN (5-17-67)

MEASUREMENTS MADE AT   WATER                                        /MERCURY                                    INTERFACE
  0.010-M PHENOL        N/10 HCLO4



DENSITY OF UPPER PHASE   0.99700   DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE   0.0089400   VISCOSITY OF LOWER PHASE   0.0152700

ORIGINAL OUTPUT VOLTAGE    11.00000000 MV.

INITIAL DAMPING COEFFICIENT   1.09903 1/CM.

WAVELENGTH 0.09223 CM.

PROBE SEPARATION =    1.01800 CM.

WAVENUMBER =    68.125114 RECIPROCAL CM.

    ---------  .


                    INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM



SURFACTANT CONCENTRATION=   0.010-M PHENOL

ELECTROCAPILLARY MAXIMUM IS   -0.50000 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=    1.22000

ELECTRICAL DESORPTION EXPONENT =   15.00000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =   10.00000

DIFFUSION TERM=   10000.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000001

SURFACTANT SURFACE VISCOSITY= 0.000100

 1/BO = FRUMKIN CONCENTRATION CONSTANT=  0.005000
```

Figure 63. Data from YCOR for 10^{-2}-M phenol in N/10 $HClO_4$

```
                                   INPUT DATA
NO.          POL.VOLTAGE        FREQUENCY       OUTPUT VOLTAGE(MV.)        GAMMA
  1           -1.125000         461.400000          18.000000           354.800000
  2           -1.200000         459.700000          19.300000           371.300000
  3           -1.150000         460.700000          18.400000           377.700000
  4           -1.100000         462.200000          17.600000           383.600000
  5           -1.075000         463.000000          17.100000           386.300000
  6           -1.050000         464.000000          17.100000           388.800000
  7           -1.025000         465.200000          17.000000           391.600000
  8           -1.000000         466.400000          17.100000           394.100000
  9           -0.975000         467.600000          17.300000           396.200000
 10           -0.950000         468.700000          17.300000           398.500000
 11           -0.925000         469.800000          17.500000           400.500000
 12           -0.900000         470.900000          17.500000           402.200000
 13           -0.875000         471.900000          17.500000           404.000000
 14           -0.850000         472.900000          17.600000           404.400000
 15           -0.825000         473.500000          17.800000           407.000000
 16           -0.800000         473.900000          18.000000           409.400000
 17           -0.775000         474.100000          18.900000           409.200000
 18           -0.750000         474.300000          19.500000           408.900000
 19           -0.725000         474.600000          19.900000           411.300000
 20           -0.700000         474.800000          20.400000           412.200000
 21           -0.675000         475.100000          20.500000           412.600000
 22           -0.650000         475.300000          20.300000           411.700000
 23           -0.625000         475.300000          20.300000           413.500000
 24           -0.600000         475.300000          20.200000           413.800000
 25           -0.575000         475.300000          20.000000           413.800000
 26           -0.550000         475.400000          19.800000           412.800000
 27           -0.525000         475.100000          19.400000           414.000000
 28           -0.500000         474.800000          19.300000           413.600000
 29           -0.475000         474.600000          19.100000           413.200000
 30           -0.450000         474.100000          18.900000           412.800000
 31           -0.425000         473.600000          18.700000           412.300000
 32           -0.400000         473.100000          18.600000           411.500000
 33           -0.375000         472.400000          18.300000           410.700000
 34           -0.350000         471.700000          18.000000           409.800000
 35           -0.325000         470.900000          17.900000           408.800000
 36           -0.300000         470.300000          17.600000           407.700000
 37           -0.275000         469.400000          17.400000           406.100000
 38           -0.250000         468.400000          17.300000           404.900000
 39           -0.225000         467.300000          17.100000           403.500000
 40           -0.200000         466.400000          17.100000           402.000000
 41           -0.175000         465.400000          17.000000           400.000000
 42           -0.150000         464.000000          16.900000           398.300000
 43           -0.125000         462.800000          16.800000           396.400000
 44           -0.100000         461.400000          16.700000           394.200000
 45           -0.075000         459.900000          16.500000           392.100000
 46           -0.050000         458.500000          16.300000           389.700000
 47           -0.025000         456.800000          16.100000           387.400000
 48            0.0              455.100000          16.000000           384.700000
 49            0.025000         453.300000          15.700000           382.200000
 50            0.050000         451.400000          15.500000           379.400000
 51            0.075000         449.500000          15.400000           376.300000
 52            0.100000         447.700000          15.400000           373.200000
 53            0.150000         443.500000          15.000000           366.600000
 54            0.200000         439.100000          14.400000           359.400000
```

Figure 63 (Continued)

```
INITIAL FREQUENCY =  412.70000

POLYNOMIAL COEFFICIENTS  OF AMPLITUCE CORRECTION
                          -0.1208608915D 04    FREQUENCY** 0
                           0.2823330235D 04    FREQUENCY** 1
                          -0.2931293985D 04    FREQUENCY** 2
                           0.1793278968D 04    FREQUENCY** 3
                          -0.7046183117D 03    FREQUENCY** 4
                           0.1890887852D 03    FREQUENCY** 5
                          -0.3492397260D 02    FREQUENCY** 6
                           0.4395962415D 01    FREQUENCY** 7
                          -0.3586019692D 00    FREQUENCY** 8
                           0.1724337906D-01    FREQUENCY** 9
                          -0.3704209668D-03    FREQUENCY**10

NO.    FREQUENCY     CORRECTED OUTPUT VOLTAGE      NO.    FREQUENCY     CORRECTED OUTPUT VOLTAGE
 1     461.40000          16.43049                 28     474.80000          16.09074
 2     459.70000          16.87980                 29     474.60000          15.94694
 3     460.70000          16.86827                 30     474.10000          15.83670
 4     462.20000          15.98532                 31     473.60000          15.72526
 5     463.00000          15.45281                 32     473.10000          15.69701
 6     464.00000          15.35406                 33     472.40000          15.52070
 7     465.20000          15.14548                 34     471.70000          15.34182
 8     466.40000          15.11414                 35     470.90000          15.34237
 9     467.60000          15.16828                 36     470.30000          15.14840
10     468.70000          15.05529                 37     469.40000          15.06976
11     469.80000          15.11461                 38     468.40000          15.08616
12     470.90000          14.99952                 39     467.30000          15.02329
13     471.90000          14.89468                 40     466.40000          15.11414
14     472.90000          14.87421                 41     465.40000          15.12558
15     473.50000          14.97912                 42     464.00000          15.17449
16     473.90000          15.10419                 43     462.80000          15.20101
17     474.10000          15.83670                 44     461.40000          15.24385
18     474.30000          16.31603                 45     459.90000          15.20025
19     474.60000          16.61487                 46     458.50000          15.14183
20     474.80000          17.00783                 47     456.90000          15.10355
21     475.10000          17.05427                 48     455.10000          15.15211
22     475.30000          16.86351                 49     453.30000          15.01076
23     475.30000          16.86351                 50     451.40000          14.96188
24     475.30000          16.78044                 51     449.50000          14.99938
25     475.30000          16.61430                 52     447.70000          15.11882
26     475.40000          16.43627                 53     443.50000          14.96592
27     475.10000          16.13916                 54     439.10000          14.55615
```

Figure 63 (Continued)

```
NO.   POL.VOLTAGE   GAMMA(EXPT.)CALC.E=0   THETA FROM MODEL   ALPHA(EXPTL)   ALPHA(MODEL)
 1     -1.12500        396.26392             0.005753          0.704880       0.559491
 2     -1.20000        393.39459             0.001288          0.678437       0.560335
 3     -1.15000        395.08795             0.003556          0.679050       0.554385
 4     -1.10000        397.61040             0.009153          0.731863       0.549671
 5     -1.07500        398.95505             0.014326          0.765144       0.547688
 6     -1.05000        400.65714             0.022087          0.771441       0.546168
 7     -1.02500        402.70110             0.033594          0.784879       0.544628
 8     -1.00000        404.75654             0.050518          0.786912       0.543567
 9     -0.97500        406.82037             0.075342          0.783400       0.543294
10     -0.95000        408.71084             0.111922          0.790745       0.543666
11     -0.92500        410.61711             0.166641          0.786882       0.546875
12     -0.90000        412.51124             0.250609          0.794390       0.557929
13     -0.87500        414.24143             0.380288          0.801280       0.593230
14     -0.85000        415.97851             0.548109          0.802631       0.677180
15     -0.82500        417.02711             0.686512          0.795727       0.732394
16     -0.80000        417.72898             0.774205          0.787559       0.741353
17     -0.77500        418.10383             0.829644          0.741039       0.740034
18     -0.75000        418.46802             0.866427          0.711748       0.736057
19     -0.72500        419.00055             0.891863          0.693919       0.728061
20     -0.70000        419.36078             0.909991          0.670957       0.722997
21     -0.67500        419.88627             0.923177          0.668278       0.719612
22     -0.65000        420.23080             0.932886          0.679327       0.718732
23     -0.62500        420.23080             0.940054          0.679327       0.714070
24     -0.60000        420.22850             0.945302          0.684178       0.712151
25     -0.57500        420.22377             0.949041          0.693953       0.711081
26     -0.55000        420.39343             0.951543          0.704535       0.711980
27     -0.52500        419.85974             0.952981          0.722454       0.709355
28     -0.50000        419.33398             0.953451          0.725406       0.709395
29     -0.47500        418.98005             0.952981          0.734225       0.709850
30     -0.45000        418.10383             0.951543          0.741038       0.710174
31     -0.42500        417.22842             0.949041          0.747975       0.710953
32     -0.40000        416.35672             0.945302          0.749742       0.712524
33     -0.37500        415.13314             0.940054          0.760838       0.714223
34     -0.35000        413.91109             0.932886          0.772225       0.716552
35     -0.32500        412.52395             0.923177          0.772190       0.719472
36     -0.30000        411.47804             0.909991          0.784688       0.723524
37     -0.27500        409.91936             0.891863          0.789801       0.728713
38     -0.25000        408.19483             0.866427          0.788733       0.733866
39     -0.22500        406.29906             0.829644          0.792835       0.739288
40     -0.20000        404.75654             0.774205          0.786912       0.742456
41     -0.17500        403.04277             0.686512          0.786169       0.732241
42     -0.15000        400.65091             0.548109          0.782998       0.574743
43     -0.12500        398.60567             0.380288          0.781282       0.592116
44     -0.10000        396.22673             0.250609          0.778518       0.556490
45     -0.07500        393.68266             0.166641          0.781331       0.545354
46     -0.05000        391.31500             0.111922          0.785114       0.542237
47     -0.02500        388.45077             0.075342          0.787601       0.541264
48      0.0            385.60012             0.050518          0.784447       0.541655
49      0.02500        382.58661             0.033594          0.793654       0.542121
50      0.05000        379.42203             0.022087          0.796858       0.542963
51      0.07500        376.27365             0.014326          0.794399       0.544204
52      0.10000        373.30593             0.009153          0.786608       0.545599
53      0.15000        366.41272             0.003556          0.796593       0.548290
54      0.20000        359.25178             0.001288          0.823864       0.551551
```

Figure 63 (Continued)

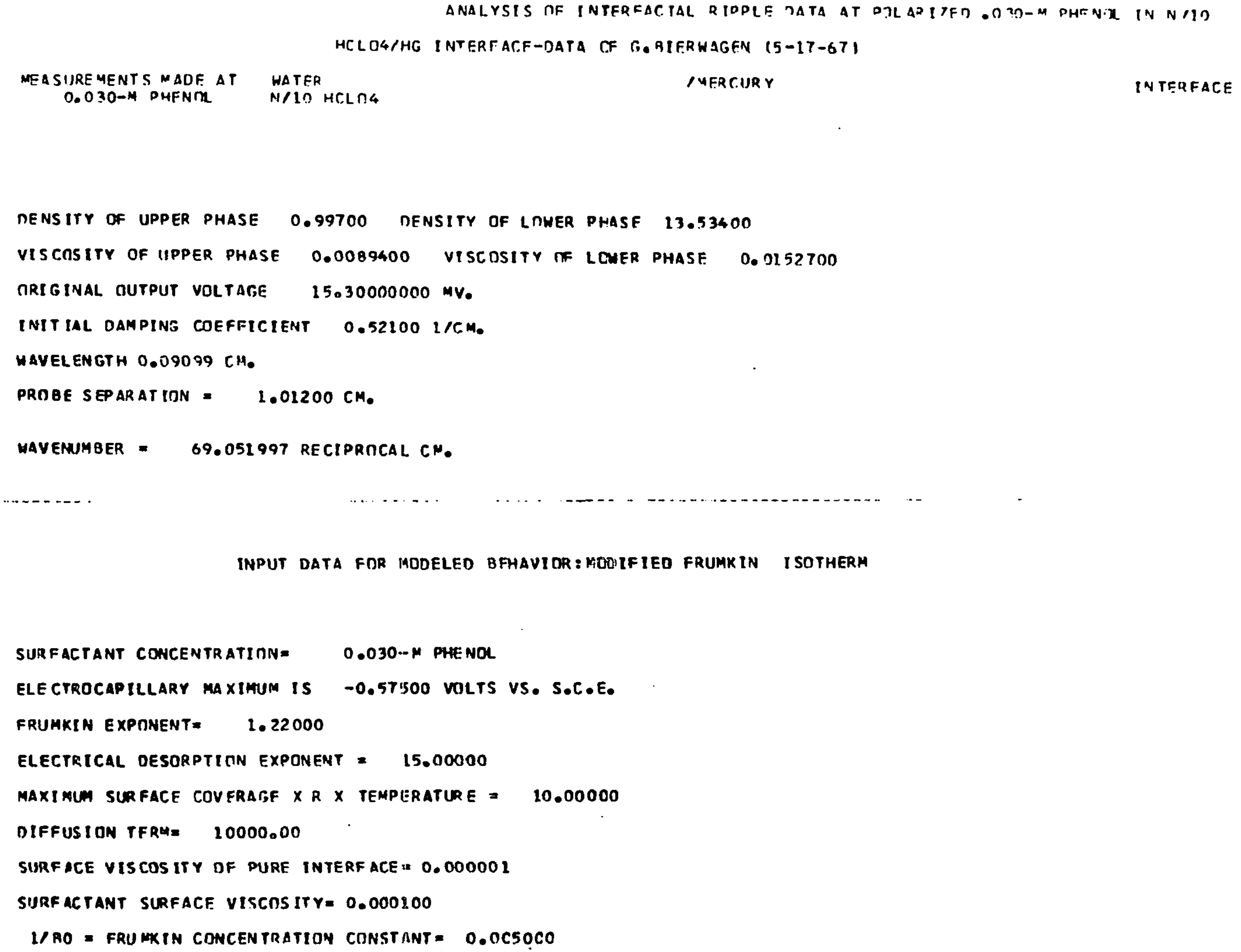
```
NO.   POL.VOLTAGE    RE(E)-EXPT.    RE(E)-MODEL    IM(E)-EXPT.    IM(E)-MODEL
 1     -1.12500      12.779365      0.000195       9.758903      -0.000214
 2     -1.20000      12.303357      0.000008       8.275611      -0.000012
 3     -1.15000      11.993734      0.000071       7.051592      -0.000083
 4     -1.10000      12.048725      0.000511       5.627258      -0.000539
 5     -1.07500      12.233519      0.001299       4.849508      -0.001339
 6     -1.05000      12.261330      0.003228       4.350380      -0.003228
 7     -1.02500      12.397436      0.007917       3.804121      -0.007733
 8     -1.00000      12.438689      0.019384       3.459892      -0.018417
 9     -0.97500      12.447678      0.048064       3.425359      -0.044011
10     -0.95000      12.564339      0.122967       3.071234      -0.106757
11     -0.92500      12.554266      0.332266       2.982506      -0.266020
12     -0.90000      12.740261      0.966142       3.118113      -0.682418
13     -0.87500      12.888886      2.868875       3.036540      -1.719537
14     -0.85000      13.040034      6.364499       4.036136      -3.626252
15     -0.82500      12.874006      8.391232       2.842394      -5.429483
16     -0.80000      12.572368      8.645249       1.177469      -6.330286
17     -0.77500      11.806460      8.376696       1.961681      -6.659506
18     -0.75000      11.506702      8.043044       2.729201      -6.746857
19     -0.72500      10.471370      7.752348       0.998124      -6.742186
20     -0.70000       9.684386      7.518591       0.618670      -6.705161
21     -0.67500       9.722116      7.337407       0.788553      -6.661587
22     -0.65000      10.623035      7.197738       1.981525      -6.619922
23     -0.62500       9.594699      7.090427      -0.028098      -6.583108
24     -0.60000       9.491037      7.010258      -0.494576      -6.553371
25     -0.57500       9.734493      6.952442      -0.632020      -6.530836
26     -0.55000      10.674463      6.914050       0.757578      -6.515685
27     -0.52500      10.129943      6.889275      -1.853083      -6.504434
28     -0.50000      10.120903      6.879716      -2.092312      -6.499421
29     -0.47500      10.416417      6.885668      -2.109428      -6.501212
30     -0.45000      10.313098      6.904644      -3.044177      -6.507313
31     -0.42500      10.287096      6.940074      -3.873721      -6.519897
32     -0.40000      10.275964      6.994126      -4.030127      -6.539240
33     -0.37500      10.402289      7.068934      -5.116354      -6.564534
34     -0.35000      10.669159      7.170687      -6.049151      -6.596978
35     -0.32500      10.346336      7.305290      -7.116684      -6.635040
36     -0.30000      11.001638      7.483435      -7.066267      -6.677126
37     -0.27500      11.219837      7.710685      -6.948490      -6.710606
38     -0.25000      10.799156      7.994465      -8.579071      -6.712663
39     -0.22500      10.658463      8.319438     -10.431886      -6.623507
40     -0.20000      10.114083      9.582393     -10.485851      -6.297357
41     -0.17500      10.196310      8.329819      -9.311057      -5.405821
42     -0.15000       9.172792      6.317664     -12.062129      -3.614023
43     -0.12500       8.722051      2.846388     -12.648688      -1.712603
44     -0.10000       8.067268      0.957339     -13.393707      -0.678180
45     -0.07500       7.363793      0.328916     -15.888304      -0.263879
46     -0.05000       7.644074      0.121655     -15.724052      -0.105762
47     -0.02500       6.455281      0.047515     -19.640808      -0.043546
48      0.0           5.309450      0.019151     -20.600807      -0.018204
49      0.02500       4.623905      0.007817     -26.038259      -0.007636
50      0.05000       3.145769      0.003185     -30.834774      -0.003183
51      0.07500       1.729086      0.001280     -31.178491      -0.001310
52      0.10000       0.375829      0.000503     -29.380130      -0.000530
53      0.15000      -0.766959      0.000070     -33.454000      -0.000082
54      0.20000       5.637487      0.000008     -35.191545      -0.000012
```

Figure 63 (Continued)

```
NO.   POL.VOLTAGE      Y1-EXPT.       Y1-MODEL       Y2-EXPT.       Y2-MODEL

  1     -1.12500       1.058849       0.980787       0.010347       0.008131
  2     -1.20000       1.032660       0.980909       0.009959       0.008063
  3     -1.15000       1.019584       0.981008       0.009968       0.008017
  4     -1.10000       1.010450       0.981093       0.010743       0.007973
  5     -1.07500       1.006864       0.981132       0.011231       0.007954
  6     -1.05000       1.004716       0.981166       0.011324       0.007937
  7     -1.02500       1.002698       0.981206       0.011521       0.007921
  8     -1.00000       1.001484       0.981246       0.011551       0.007909
  9     -0.97500       1.001309       0.981295       0.011499       0.007905
 10     -0.95000       1.000219       0.981388       0.011607       0.007914
 11     -0.92500       0.999901       0.981589       0.011551       0.007962
 12     -0.90000       1.000343       0.982132       0.011661       0.008123
 13     -0.87500       1.000120       0.983579       0.011762       0.008642
 14     -0.85000       1.003370       0.985216       0.011782       0.009860
 15     -0.82500       0.999491       0.984927       0.011680       0.010677
 16     -0.80000       0.995312       0.984365       0.011560       0.010821
 17     -0.77500       0.996639       0.984031       0.010878       0.010795
 18     -0.75000       0.998212       0.983847       0.010448       0.010731
 19     -0.72500       0.993643       0.983782       0.010186       0.010631
 20     -0.70000       0.992309       0.983732       0.009849       0.010561
 21     -0.67500       0.992600       0.983695       0.009810       0.010511
 22     -0.65000       0.995608       0.983650       0.009972       0.010487
 23     -0.62500       0.991274       0.983659       0.009972       0.010434
 24     -0.60000       0.990555       0.983649       0.010043       0.010409
 25     -0.57500       0.990555       0.983639       0.010186       0.010393
 26     -0.55000       0.993373       0.983617       0.010342       0.010396
 27     -0.52500       0.989244       0.983633       0.010605       0.010372
 28     -0.50000       0.988950       0.983628       0.010648       0.010374
 29     -0.47500       0.989074       0.983624       0.010778       0.010380
 30     -0.45000       0.987947       0.983625       0.010878       0.010389
 31     -0.42500       0.987060       0.983627       0.010979       0.010403
 32     -0.40000       0.986892       0.983628       0.011005       0.010427
 33     -0.37500       0.985890       0.983634       0.011168       0.010455
 34     -0.35000       0.985129       0.983644       0.011335       0.010492
 35     -0.32500       0.984192       0.983662       0.011335       0.010538
 36     -0.30000       0.984335       0.983689       0.011518       0.010597
 37     -0.27500       0.984434       0.983732       0.011593       0.010673
 38     -0.25000       0.983149       0.983820       0.011578       0.010753
 39     -0.22500       0.981932       0.983979       0.011638       0.010837
 40     -0.20000       0.981803       0.984288       0.011551       0.010885
 41     -0.17500       0.982486       0.984859       0.011540       0.010735
 42     -0.15000       0.980752       0.985196       0.011494       0.009899
 43     -0.12500       0.980362       0.983543       0.011468       0.008683
 44     -0.10000       0.979878       0.982082       0.011428       0.008158
 45     -0.07500       0.978731       0.981530       0.011469       0.007996
 46     -0.05000       0.978773       0.981323       0.011525       0.007949
 47     -0.02500       0.977296       0.981233       0.011561       0.007939
 48      0.0           0.976843       0.981177       0.011515       0.007946
 49      0.02500       0.975471       0.981140       0.011650       0.007954
 50      0.05000       0.974449       0.981104       0.011697       0.007971
 51      0.07500       0.974224       0.981065       0.011661       0.007987
 52      0.10000       0.974465       0.981076       0.011547       0.008009
 53      0.15000       0.973483       0.980946       0.011693       0.008059
 54      0.20000       0.973380       0.980855       0.012093       0.008098
```

Figure 63 (Continued)



```
                                        ANALYSIS OF INTERFACIAL RIPPLE DATA AT POLARIZED .030-M PHENOL IN N/10
                                HCLO4/HG INTERFACE-DATA OF G.BIERWAGEN (5-17-67)
MEASUREMENTS MADE AT   WATER                                      /MERCURY                                  INTERFACE
   0.030-M PHENOL      N/10 HCLO4



DENSITY OF UPPER PHASE   0.99700   DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE   0.0089400   VISCOSITY OF LOWER PHASE   0.0152700

ORIGINAL OUTPUT VOLTAGE    15.30000000 MV.

INITIAL DAMPING COEFFICIENT   0.52100 1/CM.

WAVELENGTH 0.09099 CM.

PROBE SEPARATION =    1.01200 CM.

WAVENUMBER =    69.051997 RECIPROCAL CM.



                  INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM



SURFACTANT CONCENTRATION=     0.030--M PHENOL

ELECTROCAPILLARY MAXIMUM IS   -0.57500 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=    1.22000

ELECTRICAL DESORPTION EXPONENT =   15.00000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =   10.00000

DIFFUSION TERM=   10000.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000001

SURFACTANT SURFACE VISCOSITY= 0.000100

 1/BO = FRUMKIN CONCENTRATION CONSTANT=  0.0C5000
```

Figure 64. YCOR data listing for .03-M phenol in N/10 $HClO_4$

```
                                      INPUT DATA

NO.              POL.VOLTAGE          FREQUENCY        OUTPUT VOLTAGE(MV.)       GAMMA
 1                -1.250000           468.400000          15.300000            364.600000
 2                -1.200000           469.300000          15.300000            370.900000
 3                -1.175000           469.900000          15.400000            377.200000
 4                -1.150000           470.200000          15.500000            377.200000
 5                -1.100000           470.900000          14.500000            382.500000
 6                -1.075000           471.000000          14.400000            385.400000
 7                -1.050000           471.300000          14.400000            387.700000
 8                -1.025000           471.800000          14.500000            390.000000
 9                -1.000000           472.300000          14.500000            392.000000
10                -0.975000           472.800000          14.400000            394.000000
11                -0.950000           473.500000          14.300000            395.600000
12                -0.925000           474.000000          14.300000            397.100000
13                -0.900000           474.700000          14.200000            398.600000
14                -0.875000           475.200000          14.100000            399.900000
15                -0.850000           475.200000          14.000000            401.100000
16                -0.825000           475.900000          13.900000            402.100000
17                -0.800000           476.000000          13.700000            402.700000
18                -0.775000           476.200000          14.000000            403.900000
19                -0.750000           476.200000          14.100000            403.900000
20                -0.725000           476.200000          14.400000            405.000000
21                -0.700000           476.500000          14.400000            405.100000
22                -0.675000           476.600000          14.400000            405.700000
23                -0.650000           476.900000          14.400000            405.800000
24                -0.625000           477.000000          14.400000            406.200000
25                -0.600000           477.000000          14.400000            406.000000
26                -0.575000           477.000000          14.200000            406.300000
27                -0.550000           476.800000          14.300000            406.100000
28                -0.525000           476.600000          14.200000            406.100000
29                -0.500000           476.300000          14.200000            405.700000
30                -0.475000           476.100000          14.000000            405.400000
31                -0.450000           475.800000          13.800000            404.900000
32                -0.425000           475.300000          13.600000            404.500000
33                -0.400000           474.800000          13.500000            403.500000
34                -0.375000           474.400000          13.300000            402.900000
35                -0.350000           473.500000          13.200000            402.000000
36                -0.325000           472.800000          13.100000            401.300000
37                -0.300000           472.200000          12.900000            400.000000
38                -0.275000           471.400000          12.600000            398.900000
39                -0.250000           470.600000          12.500000            397.500000
40                -0.225000           469.900000          12.300000            396.300000
41                -0.200000           468.800000          12.100000            394.700000
42                -0.175000           467.700000          12.100000            393.000000
43                -0.150000           466.600000          12.100000            391.200000
44                -0.125000           465.600000          12.000000            389.800000
45                -0.100000           464.400000          12.000000            387.300000
46                -0.075000           463.200000          12.000000            385.700000
47                -0.050000           461.800000          11.900000            383.200000
48                -0.025000           460.400000          11.700000            381.200000
49                 0.0                458.900000          11.500000            378.600000
50                 0.025000           457.300000          11.400000            376.100000
51                 0.050000           455.800000          11.200000            373.300000
52                 0.075000           454.000000          11.000000            370.700000
53                 0.100000           452.100000          10.700000            367.400000
54                 0.150000           448.400000          10.300000            361.300000
55                 0.200000           444.300000          10.000000            354.700000
56                 0.250000           439.500000           9.500000            347.300000
```

Figure 64 (Continued)

```
INITIAL FREQUENCY =  468.40000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                              -0.1209608915D 04     FREQUENCY** 0
                               0.2823330235D 04     FREQUENCY** 1
                              -0.2931293885D 04     FREQUENCY** 2
                               0.1793278968D 04     FREQUENCY** 3
                              -0.7046183117D 03     FREQUENCY** 4
                               0.1890887852D 03     FREQUENCY** 5
                              -0.3492397260D 02     FREQUENCY** 6
                               0.4385962415D 01     FREQUENCY** 7
                              -0.3586019692D 00     FREQUENCY** 8
                               0.1724337906D-01     FREQUENCY** 9
                              -0.3704209668D-03     FREQUENCY**10

NO.     FREQUENCY     CORRECTED OUTPUT VOLTAGE          NO.     FREQUENCY     CORRECTED OUTPUT VOLTAGE
 1      468.40000           15.30000                    29      476.30000           13.42946
 2      469.30000           15.20600                    30      476.10000           13.25958
 3      469.80000           15.25271                    31      475.90000           13.09865
 4      470.20000           15.30928                    32      475.30000           12.95563
 5      470.90000           14.25197                    33      474.80000           12.90684
 6      471.00000           14.14379                    34      474.40000           12.75227
 7      471.30000           14.11413                    35      473.50000           12.73819
 8      471.80000           14.16232                    36      472.80000           12.70482
 9      472.30000           14.11247                    37      472.20000           12.56410
10      472.80000           13.96560                    38      471.40000           12.34121
11      473.50000           13.79971                    39      470.60000           12.31191
12      474.00000           13.75047                    40      469.90000           12.17394
13      474.70000           13.58586                    41      468.80000           12.06699
14      475.20000           13.44164                    42      467.70000           12.15765
15      475.20000           13.34631                    43      466.60000           12.24797
16      475.90000           13.18400                    44      465.60000           12.22756
17      476.00000           12.98488                    45      464.40000           12.32398
18      476.20000           13.24995                    46      463.20000           12.41957
19      476.20000           13.34459                    47      461.80000           12.42543
20      476.20000           13.62852                    48      460.40000           12.32260
21      476.50000           13.59880                    49      458.90000           12.22168
22      476.60000           13.58889                    50      457.30000           12.22893
23      476.90000           13.55918                    51      455.80000           12.11633
24      477.00000           13.54929                    52      454.00000           12.01638
25      477.00000           13.54929                    53      452.10000           11.80333
26      477.00000           13.36110                    54      448.40000           11.56092
27      476.80000           13.47486                    55      444.30000           11.40930
28      476.60000           13.40016                    56      439.50000           11.00106
```

Figure 64 (Continued)

```
NO.   POL.VOLTAGE     GAMMA(EXPT.)CALC.F=?     THETA FROM MODEL     ALPHA(EXPTL)     ALPHA(MODEL)
 1     -1.25000          392.22536                0.006519            0.521000        0.577194
 2     -1.20000          393.71528                0.017554            0.527083        0.570935
 3     -1.17500          394.54599                0.028212            0.524059        0.544462
 4     -1.15000          395.21151                0.044867            0.520400        0.564961
 5     -1.10000          396.35426                0.112150            0.591116        0.550828
 6     -1.07500          396.51813                0.179380            0.598645        0.560087
 7     -1.05000          397.01699                0.294328            0.600720        0.566791
 8     -1.02500          397.85148                0.483515            0.597351        0.596735
 9     -1.00000          398.68447                0.674290            0.600836        0.626335
10     -0.97500          399.51586                0.788441            0.611174        0.626908
11     -0.95000          400.68206                0.853967            0.622982        0.621743
12     -0.92500          401.51799                0.894413            0.626513        0.516535
13     -0.90000          402.68678                0.920977            0.638414        0.612452
14     -0.87500          403.52183                0.938932            0.648960        0.509182
15     -0.85000          403.51896                0.951633            0.655993        0.606065
16     -0.82500          404.69029                0.960781            0.668084        0.604427
17     -0.80000          404.85198                0.967487            0.683127        0.602901
18     -0.77500          405.19708                0.972471            0.663153        0.601010
19     -0.75000          405.20001                0.976208            0.656120        0.600484
20     -0.72500          405.20840                0.979022            0.635316        0.598793
21     -0.70000          405.71258                0.981134            0.637474        0.598713
22     -0.67500          405.88071                0.982699            0.638194        0.597900
23     -0.65000          406.38529                0.983824            0.640356        0.597957
24     -0.62500          406.55356                0.984581            0.641078        0.597495
25     -0.60000          406.55356                0.985018            0.641078        0.597666
26     -0.57500          406.54793                0.985161            0.654898        0.597295
27     -0.55000          406.21430                0.985018            0.646521        0.597325
28     -0.52500          405.87513                0.984581            0.652014        0.597163
29     -0.50000          405.37089                0.983824            0.649855        0.597401
30     -0.47500          405.02911                0.982699            0.662435        0.597689
31     -0.45000          404.51939                0.981134            0.674501        0.598160
32     -0.42500          403.67438                0.979022            0.685350        0.598366
33     -0.40000          402.83335                0.976208            0.689078        0.599374
34     -0.37500          402.15713                0.972471            0.700984        0.600155
35     -0.35000          400.64925                0.967487            0.702075        0.600894
36     -0.32500          399.47763                0.960781            0.704868        0.601850
37     -0.30000          398.47071                0.951633            0.715673        0.503954
38     -0.27500          397.12853                0.938932            0.733361        0.606020
39     -0.25000          395.79584                0.920877            0.735709        0.609047
40     -0.22500          394.62717                0.894413            0.746845        0.612731
41     -0.20000          392.79839                0.853967            0.755565        0.617323
42     -0.17500          390.98178                0.788441            0.748169        0.522101
43     -0.15000          389.16929                0.674290            0.740862        0.620582
44     -0.12500          387.52127                0.483515            0.742503        0.590045
45     -0.10000          385.55285                0.294328            0.734741        0.559985
46     -0.07500          383.58933                0.179380            0.727106        0.551711
47     -0.05000          381.30104                0.112150            0.726640        0.550678
48     -0.02500          379.01569                0.070916            0.734851        0.550681
49      0.0              376.57503                0.044867            0.742978        0.551670
50      0.02500          373.98462                0.028212            0.742392        0.552606
51      0.05000          371.55983                0.017554            0.751533        0.554039
52      0.07500          368.66178                0.010778            0.759717        0.554973
53      0.10000          365.61080                0.006518            0.777394        0.556501
54      0.15000          359.71226                0.002266            0.797900        0.559491
55      0.20000          353.23691                0.000734            0.810944        0.562628
56      0.25000          345.72075                0.000221            0.846950        0.566054
```

Figure 64 (Continued)

```
NO.   POL.VOLTAGE    RE(E)-EXPT.    RE(E)-MODEL    IM(E)-EXPT.    IM(E)-MODEL
 1     -1.25000       12.133663      0.000085       9.453861      -0.000092
 2     -1.20000       11.839774      0.000667       8.706285      -0.000685
 3     -1.17500       11.168166      0.001822       7.499635      -0.001841
 4     -1.15000       11.272533      0.004994       7.689626      -0.004968
 5     -1.10000       10.879719      0.041674       5.102666      -0.039816
 6     -1.07500       10.126583      0.137508       4.781041      -0.126371
 7     -1.05000        9.360856      0.529215       3.693566      -0.453700
 8     -1.02500        8.430485      1.900313       2.664024      -1.514607
 9     -1.00000        7.529285      3.002329       1.639927      -2.529206
10     -0.97500        6.445854      2.572356       0.307393      -2.679110
11     -0.95000        6.118339      2.766710      -0.459686      -2.589159
12     -0.92500        5.200076      2.593519      -1.384581      -2.478974
13     -0.90000        4.922935      2.466865      -2.216027      -2.388236
14     -0.87500        4.318510      2.375134      -3.302097      -2.318350
15     -0.85000        1.477054      2.307499      -5.754107      -2.264760
16     -0.82500        2.441948      2.259364      -6.075965      -2.225977
17     -0.80000        1.696113      2.222603      -7.924843      -2.195723
18     -0.77500       -2.600720      2.195299      -8.574674      -2.173038
19     -0.75000       -2.826515      2.174331      -7.982835      -2.155422
20     -0.72500       -9.445385      2.158505      -7.038692      -2.142052
21     -0.70000       -6.909775      2.147212      -7.176097      -2.132557
22     -0.67500       -9.624015      2.138563      -7.416343      -2.125224
23     -0.65000       -7.026045      2.132771      -7.530905      -2.120362
24     -0.62500       -8.458944      2.128703      -7.756156      -2.116916
25     -0.60000       -7.205146      2.126234      -7.639733      -2.114806
26     -0.57500       -9.025502      2.125385      -9.463850      -2.114075
27     -0.55000      -10.067951      2.125789      -8.458980      -2.114365
28     -0.52500      -12.703725      2.127811      -9.146758      -2.116034
29     -0.50000      -13.562173      2.131430      -8.724106      -2.119035
30     -0.47500      -14.067333      2.137442     -10.610069      -2.124115
31     -0.45000      -14.172992      2.145636     -12.586305      -2.131001
32     -0.42500      -19.282940      2.156467     -14.562821      -2.140043
33     -0.40000      -17.326775      2.171136     -15.303654      -2.152280
34     -0.37500      -18.203775      2.191153     -17.959370      -2.168970
35     -0.35000      -28.057711      2.216769     -17.433727      -2.190020
36     -0.32500      -37.776420      2.252008     -14.747745      -2.218824
37     -0.30000      -32.788661      2.300222     -20.944581      -2.257734
38     -0.27500      -41.059247      2.365648     -27.367615      -2.309289
39     -0.25000      -39.318243      2.456232     -28.510125      -2.378239
40     -0.22500      -38.888223      2.582341     -34.535634      -2.468723
41     -0.20000      -48.939140      2.753059     -39.438275      -2.577152
42     -0.17500      -53.658212      2.956516     -31.621787      -2.666187
43     -0.15000      -52.514230      2.984720     -25.327055      -2.516698
44     -0.12500      -62.906952      1.888398     -19.524764      -1.507081
45     -0.10000      -41.820286      0.525426     -23.808748      -0.450911
46     -0.07500      -50.618180      0.136378     -13.406624      -0.125411
47     -0.05000      -44.734886      0.041272     -16.257631      -0.039447
48     -0.02500      -55.603617      0.013872     -12.852937      -0.013572
49      0.0          -53.738044      0.004934     -19.826833      -0.004908
50      0.02500      -56.570820      0.001799     -15.744097      -0.001816
51      0.05000      -46.000261      0.000657     -27.074457      -0.000675
52      0.07500      -61.287523      0.000237     -25.396590      -0.000249
53      0.10000      -53.342050      0.000083     -42.578664      -0.000091
54      0.15000      -41.669441      0.000009     -56.948830      -0.000012
55      0.20000      -33.341836      0.000001     -62.229376      -0.000001
56      0.25000      -11.897597     -0.000000     -97.078522      -0.000000
```

Figure 64 (Continued)

NO.	POL.VOLTAGE	Y1-EXPT.	Y1-MODEL	Y2-EXPT.	Y2-MODEL
1	-1.25000	1.049440	0.980735	0.007545	0.008159
2	-1.20000	1.034596	0.980836	0.007633	0.008105
3	-1.17500	1.019485	0.980938	0.007599	0.008053
4	-1.15000	1.021222	0.980938	0.007536	0.008056
5	-1.10000	1.010072	0.981053	0.008550	0.008027
6	-1.07500	1.002898	0.981183	0.008659	0.008036
7	-1.05000	0.998218	0.981551	0.008700	0.008146
8	-1.02500	0.994438	0.982613	0.008651	0.008590
9	-1.00000	0.991463	0.983201	0.008701	0.009027
10	-0.97500	0.988519	0.983129	0.008851	0.009044
11	-0.95000	0.987439	0.983015	0.009022	0.008972
12	-0.92500	0.985787	0.982933	0.009073	0.008902
13	-0.90000	0.984981	0.982878	0.009245	0.008845
14	-0.87500	0.983849	0.982841	0.009398	0.008802
15	-0.85000	0.980904	0.982820	0.009500	0.008765
16	-0.82500	0.981350	0.982802	0.009675	0.008740
17	-0.80000	0.980299	0.982789	0.009893	0.008721
18	-0.77500	0.978208	0.982788	0.009604	0.008700
19	-0.75000	0.978208	0.982776	0.009502	0.008692
20	-0.72500	0.975552	0.982782	0.009201	0.008676
21	-0.70000	0.976540	0.982775	0.009232	0.008672
22	-0.67500	0.975505	0.982777	0.009242	0.008663
23	-0.65000	0.976493	0.982773	0.009274	0.008661
24	-0.62500	0.975940	0.982775	0.009284	0.008656
25	-0.60000	0.976421	0.982771	0.009284	0.008657
26	-0.57500	0.975700	0.982774	0.009484	0.008654
27	-0.55000	0.975362	0.982773	0.009363	0.008655
28	-0.52500	0.974544	0.982776	0.009442	0.008655
29	-0.50000	0.974277	0.982775	0.009411	0.008659
30	-0.47500	0.974180	0.982776	0.009593	0.008664
31	-0.45000	0.974154	0.982776	0.009768	0.008671
32	-0.42500	0.973069	0.982780	0.009925	0.008577
33	-0.40000	0.973429	0.982779	0.009979	0.008690
34	-0.37500	0.973237	0.982785	0.010152	0.008702
35	-0.35000	0.971718	0.982794	0.010167	0.008718
36	-0.32500	0.970537	0.982809	0.010205	0.008735
37	-0.30000	0.971222	0.982823	0.010364	0.008763
38	-0.27500	0.970603	0.982850	0.010620	0.008795
39	-0.25000	0.970718	0.982887	0.010654	0.008839
40	-0.22500	0.970763	0.982945	0.010816	0.008892
41	-0.20000	0.970140	0.983029	0.010942	0.008961
42	-0.17500	0.969770	0.983144	0.010835	0.009032
43	-0.15000	0.969655	0.983221	0.010729	0.009110
44	-0.12500	0.968971	0.982645	0.010753	0.008567
45	-0.10000	0.970205	0.981590	0.010640	0.008124
46	-0.07500	0.969201	0.981240	0.010530	0.008006
47	-0.05000	0.969636	0.981126	0.010523	0.007989
48	-0.02500	0.968823	0.981079	0.010642	0.007991
49	0.0	0.969130	0.981039	0.010760	0.008005
50	0.02500	0.968781	0.981007	0.010751	0.008019
51	0.05000	0.969655	0.980970	0.010884	0.008037
52	0.07500	0.968759	0.980939	0.011002	0.008053
53	0.10000	0.969296	0.980897	0.011258	0.008075
54	0.15000	0.969594	0.980820	0.011555	0.008115
55	0.20000	0.969657	0.980735	0.011744	0.008160
56	0.25000	0.969035	0.980638	0.012265	0.008211

Figure 64 (Continued)

```
                                   ANALYSIS OF INTERFACIAL RIPPLE DATA AT POLARIZED .060-M PHENOL IN N/10
                          HCLO4/HG INTERFACE-DATA OF G.BIERWAGEN (5-17-67)
MEASUREMENTS MADE AT    WATER                                        /MERCURY                                  INTERFACE
    0.060-M PHENOL      N/10 HCLO4



DENSITY OF UPPER PHASE   0.99700   DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE   0.0089400   VISCOSITY OF LOWER PHASE   0.0152700

ORIGINAL OUTPUT VOLTAGE    32.20000000 MV.

INITIAL DAMPING COEFFICIENT   0.83002 1/CM.

WAVELENGTH 0.09180 CM.

PROBE SEPARATION =    1.01000 CM.

WAVENUMBER =    68.444219 RECIPROCAL CM.
------ -- --  -   ---         - ------------------------------------                           ------


                     INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM


SURFACTANT CONCENTRATION=     0.060-M PHENOL

ELECTROCAPILLARY MAXIMUM IS   -0.63750 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=     1.22000

ELECTRICAL DESORPTION EXPONENT =   15.00000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =   10.00000

DIFFUSION TERM=   10000.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000001

SURFACTANT SURFACE VISCOSITY= 0.000100

 1/BC = FRUMKIN CONCENTRATION CONSTANT=  0.005000
```

Figure 65. YCOR data listing for .06-M phenol in N/10 $HClO_4$

```
                                            INPUT DATA

NO.                     POL.VOLTAGE          FREQUENCY          OUTPUT VOLTAGE(MV.)          GAMMA
  1                     -1.200000            456.300000          47.000000               370.400000
  2                     -1.150000            457.900000          47.000000               376.200000
  3                     -1.100000            459.800000          47.800000               381.300000
  4                     -1.075000            461.000000          48.000000               383.400000
  5                     -1.050000            462.300000          48.000000               385.600000
  6                     -1.025000            463.200000          48.200000               387.500000
  7                     -1.000000            464.300000          48.500000               389.100000
  8                     -0.975000            465.100000          48.000000               390.600000
  9                     -0.950000            465.900000          47.800000               392.100000
 10                     -0.925000            466.500000          47.100000               393.200000
 11                     -0.900000            467.100000          47.000000               394.400000
 12                     -0.875000            467.600000          47.200000               395.300000
 13                     -0.850000            468.100000          47.500000               396.200000
 14                     -0.825000            468.400000          47.500000               396.800000
 15                     -0.800000            468.500000          46.500000               397.300000
 16                     -0.775000            468.600000          45.500000               398.000000
 17                     -0.750000            468.800000          45.600000               398.400000
 18                     -0.725000            469.000000          45.900000               398.800000
 19                     -0.700000            469.200000          46.000000               399.100000
 20                     -0.675000            469.300000          46.000000               399.500000
 21                     -0.650000            469.500000          46.200000               399.800000
 22                     -0.625000            469.700000          46.200000               399.800000
 23                     -0.600000            469.700000          46.500000               399.700000
 24                     -0.575000            469.700000          46.400000               400.100000
 25                     -0.550000            469.700000          46.200000               399.600000
 26                     -0.525000            469.500000          46.100000               399.600000
 27                     -0.500000            469.200000          46.100000               399.400000
 28                     -0.475000            469.100000          46.100000               399.100000
 29                     -0.450000            468.800000          46.000000               398.600000
 30                     -0.425000            468.400000          46.100000               398.100000
 31                     -0.400000            467.900000          46.000000               397.800000
 32                     -0.375000            467.500000          46.000000               397.200000
 33                     -0.350000            467.000000          45.900000               396.200000
 34                     -0.325000            466.400000          45.800000               395.300000
 35                     -0.300000            465.700000          45.100000               394.600000
 36                     -0.275000            464.900000          45.000000               393.400000
 37                     -0.250000            464.100000          45.000000               392.100000
 38                     -0.225000            463.200000          44.500000               390.900000
 39                     -0.200000            462.100000          44.000000               389.700000
 40                     -0.175000            461.200000          43.800000               388.000000
 41                     -0.150000            460.000000          43.200000               386.400000
 42                     -0.125000            458.700000          43.100000               384.600000
 43                     -0.100000            457.600000          42.700000               382.900000
 44                     -0.075000            456.100000          42.000000               380.700000
 45                     -0.050000            454.800000          41.800000               378.700000
 46                     -0.025000            453.000000          41.500000               376.300000
 47                      0.0                 451.200000          41.000000               374.200000
 48                      0.025000            449.200000          40.600000               371.500000
 49                      0.050000            447.400000          40.400000               368.800000
 50                      0.075000            446.200000          40.200000               366.000000
 51                      0.100000            444.400000          39.600000               362.800000
 52                      0.250000            430.600000          35.000000               340.900000
 53                      0.200000            436.000000          36.900000               349.600000
 54                      0.150000            440.400000          38.500000               356.500000
```

Figure 65 (Continued)

```
INITIAL FREQUENCY =  419.60000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                              -0.1209608915D 04    FREQUENCY** 0
                               0.2823330735D 04    FREQUENCY** 1
                              -0.2931293885D 04    FREQUENCY** 2
                               0.1793278968D 04    FREQUENCY** 3
                              -0.7046183117D 03    FREQUENCY** 4
                               0.1899887952D 03    FREQUENCY** 5
                              -0.3492397260D 02    FREQUENCY** 6
                               0.4395962415D 01    FREQUENCY** 7
                              -0.3586019692D 00    FREQUENCY** 8
                               0.1724337906D-01    FREQUENCY** 9
                              -0.3704209668D-03    FREQUENCY**10

NO.      FREQUENCY      CORRECTED OUTPUT VOLTAGE          NO.      FREQUENCY      CORRECTED OUTPUT VOLTAGE
 1       456.30000            43.50113                    28       469.10000            39.36226
 2       457.90000            43.10593                    29       468.90000            39.35773
 3       459.80000            43.34940                    30       468.40000            39.55119
 4       461.00000            43.21351                    31       467.90000            39.59975
 5       462.30000            42.86502                    32       467.50000            39.70703
 6       463.20000            42.79874                    33       467.00000            39.75425
 7       464.30000            42.76142                    34       466.40000            39.82713
 8       465.10000            42.10041                    35       465.70000            39.40097
 9       465.90000            41.70458                    36       464.90000            39.52084
10       466.50000            40.93028                    37       464.10000            39.72695
11       467.10000            40.67965                    38       463.20000            39.51336
12       467.60000            40.71537                    39       462.10000            39.34235
13       468.10000            40.83559                    40       461.20000            39.38368
14       468.40000            40.75231                    41       460.00000            39.13039
15       468.50000            39.86717                    42       458.70000            39.34437
16       468.60000            38.98320                    43       457.60000            39.23024
17       468.80000            39.01548                    44       456.10000            38.91682
18       469.00000            39.21839                    45       454.80000            39.00868
19       469.20000            39.24991                    46       453.00000            39.09749
20       469.30000            39.22293                    47       451.20000            38.97507
21       469.50000            39.33926                    48       449.70000            38.95796
22       469.70000            39.28502                    49       447.40000            39.07097
23       469.70000            39.54012                    50       446.20000            39.06827
24       469.70000            39.45508                    51       444.40000            38.74864
25       469.70000            39.28502                    52       430.60000            35.26138
26       469.50000            39.25411                    53       436.00000            36.94218
27       469.20000            39.33523                    54       440.40000            38.15778
```

Figure 65 (Continued)

```
NO.    POL.VOLTAGE     GAMMA(EXPT.)CALC.F=0      THETA FROM MODEL       ALPHA(EXPTL)     ALPHA(MODEL)
  1     -1.20000          382.36544                0.123477              0.532178         0.553410
  2     -1.15000          385.01773                0.359384              0.541214         0.564258
  3     -1.10000          388.19337                0.752644              0.535437         0.588297
  4     -1.07500          390.18838                0.941033              0.538745         0.585459
  5     -1.05000          392.36435                0.891711              0.546763         0.581754
  6     -1.02500          393.87553                0.923074              0.548235         0.578646
  7     -1.00000          395.72679                0.943536              0.549159         0.576675
  8     -0.97500          397.07124                0.957400              0.564583         0.574903
  9     -0.95000          398.41975                0.967064              0.573936         0.573408
 10     -0.92500          399.42858                0.973955              0.592492         0.572339
 11     -0.90000          400.44289                0.978959              0.598573         0.571296
 12     -0.87500          401.29123                0.982646              0.597704         0.570572
 13     -0.85000          402.14123                0.985399              0.594785         0.569918
 14     -0.82500          402.65030                0.987469              0.596805         0.569432
 15     -0.80000          402.81222                0.989035              0.618548         0.568877
 16     -0.77500          402.97351                0.990219              0.640749         0.568133
 17     -0.75000          403.31401                0.991106              0.639929         0.567846
 18     -0.72500          403.65640                0.991755              0.634793         0.567577
 19     -0.70000          403.99718                0.992212              0.633999         0.567431
 20     -0.67500          404.16720                0.992502              0.634679         0.567083
 21     -0.65000          404.50905                0.992642              0.631745         0.566963
 22     -0.62500          404.84933                0.992642              0.633112         0.567175
 23     -0.60000          404.85188                0.992502              0.626704         0.567292
 24     -0.57500          404.85103                0.992212              0.628835         0.566881
 25     -0.55000          404.84933                0.991756              0.633112         0.567454
 26     -0.52500          404.50820                0.991106              0.633891         0.567289
 27     -0.50000          403.99804                0.990219              0.631847         0.567252
 28     -0.47500          403.82806                0.989035              0.631167         0.567558
 29     -0.45000          403.31748                0.987469              0.631282         0.567895
 30     -0.42500          402.63918                0.985399              0.626427         0.568161
 31     -0.40000          401.79019                0.982646              0.625212         0.568153
 32     -0.37500          401.11231                0.978959              0.622533         0.569645
 33     -0.35000          400.26491                0.973955              0.621356         0.569561
 34     -0.32500          399.24938                0.967064              0.619543         0.570393
 35     -0.30000          398.06134                0.957400              0.630194         0.571084
 36     -0.27500          396.71159                0.943536              0.627187         0.572491
 37     -0.25000          395.36493                0.923074              0.622036         0.574406
 38     -0.22500          393.84847                0.891711              0.627374         0.576657
 39     -0.20000          391.99982                0.841033              0.631668         0.579346
 40     -0.17500          390.49227                0.752644              0.630629         0.582652
 41     -0.15000          388.48378                0.587455              0.637017         0.577296
 42     -0.12500          386.31848                0.359384              0.631617         0.555888
 43     -0.10000          384.48823                0.206863              0.634494         0.548072
 44     -0.07500          381.99794                0.123477              0.642436         0.547053
 45     -0.05000          379.84976                0.075240              0.640101         0.547366
 46     -0.02500          376.88501                0.046099              0.637850         0.547907
 47      0.0              373.92993                0.028125              0.640955         0.548225
 48      0.02500          370.66134                0.017004              0.641389         0.549016
 49      0.05000          367.73311                0.010149              0.638522         0.550043
 50      0.07500          365.78672                0.005969              0.638590         0.551844
 51      0.10000          362.87398                0.003452              0.646724         0.553474
 52      0.25000          340.91813                0.000089              0.740097         0.563773
 53      0.20000          349.43188                0.000324              0.693993         0.559431
 54      0.15000          356.44405                0.001096              0.661938         0.556270
```

Figure 65 (Continued)

```
NO.   PCL.VOLTAGE    RE(E)-EXPT.    RE(E)-MODEL    IM(E)-EXPT.    IM(E)-MODEL
 1     -1.20000       9.688335       0.026043       5.560930      -0.025445
 2     -1.15000       8.310536       0.454970       3.929454      -0.414995
 3     -1.10000       6.791542       1.505383       2.894295      -1.415043
 4     -1.07500       6.753361       1.392329       2.677224      -1.344394
 5     -1.05000       6.843100       1.288061       2.511453      -1.260575
 6     -1.02500       6.480452       1.213460       2.198510      -1.196349
 7     -1.00000       6.769591       1.162131       2.345945      -1.150739
 8     -0.97500       6.822136       1.126107       1.945932      -1.118114
 9     -0.95000       6.808164       1.100695       1.639683      -1.094841
10     -0.92500       7.004400       1.082347       1.205268      -1.077902
11     -0.90000       6.915726       1.069114       0.900999      -1.065621
12     -0.87500       6.854555       1.059320       0.855746      -1.056514
13     -0.85000       6.759506       1.052092       0.853076      -1.049774
14     -0.82500       6.695315       1.046602       0.716103      -1.044649
15     -0.80000       6.694826       1.042259      -0.102950      -1.040562
16     -0.77500       6.482070       1.038975      -1.297498      -1.037475
17     -0.75000       6.385731       1.036635      -1.356643      -1.035281
18     -0.72500       6.187052       1.034995      -1.315243      -1.033746
19     -0.70000       6.232179       1.033935      -1.247039      -1.032759
20     -0.67500       5.912364       1.033196      -1.582799      -1.032066
21     -0.65000       5.910858       1.033095      -1.454372      -1.031987
22     -0.62500       6.437445       1.033315      -1.039542      -1.032207
23     -0.60000       6.432287       1.033636      -0.755429      -1.032505
24     -0.57500       5.910899       1.034485      -1.327949      -1.033308
25     -0.55000       6.702786       1.035767      -0.779444      -1.034516
26     -0.52500       6.253542       1.037409      -1.239760      -1.036052
27     -0.50000       5.734554       1.039640      -1.598677      -1.038139
28     -0.47500       5.915216       1.042926      -1.399351      -1.041227
29     -0.45000       5.894005       1.047048      -1.406248      -1.045085
30     -0.42500       5.492383       1.052429      -1.500404      -1.050109
31     -0.40000       4.491931       1.059659      -2.196203      -1.056852
32     -0.37500       4.268171       1.069571      -2.198941      -1.066085
33     -0.35000       4.519779       1.082926      -1.933556      -1.078477
34     -0.32500       4.245052       1.101285      -2.005727      -1.095425
35     -0.30000       3.473179       1.126832      -3.045871      -1.118830
36     -0.27500       3.034667       1.162880      -3.112729      -1.151475
37     -0.25000       2.780814       1.214634      -2.934439      -1.197493
38     -0.22500       2.094221       1.289309      -3.570757      -1.261774
39     -0.20000       0.255175       1.393981      -4.682955      -1.345940
40     -0.17500       0.823947       1.507655      -4.293335      -1.417059
41     -0.15000      -0.403864       1.335311      -5.191425      -1.198127
42     -0.12500      -1.955164       0.457364      -5.272258      -0.415311
43     -0.10000      -2.461095       0.099495      -5.559268      -0.094725
44     -0.07500      -3.648542       0.026037      -6.407356      -0.025440
45     -0.05000      -4.456558       0.007910      -6.282345      -0.007846
46     -0.02500      -7.665921       0.002602      -6.283740      -0.002611
47      0.0         -13.717616       0.000888      -5.772827      -0.000901
48      0.02500     -18.428878       0.000305      -3.658197      -0.000315
49      0.05000     -20.022426       0.000104      -1.727628      -0.000110
50      0.07500     -13.217324       0.000034      -4.916709      -0.000038
51      0.10000     -11.290126       0.000011      -6.101139      -0.000013
52      0.25000     -11.288413      -0.000000     -17.695522      -0.000000
53      0.20000     -14.218185       0.000000     -11.118162      -0.000000
54      0.15000     -12.633580       0.000001      -7.293455      -0.000001
```

Figure 65 (Continued)

NO.	POL.VOLTAGE	Y1-EXPT.	Y1-MODEL	Y2-EXPT.	Y2-MODEL
1	-1.20000	1.005715	0.980942	0.007775	0.008074
2	-1.15000	0.997166	0.981406	0.007707	0.008183
3	-1.10000	0.992010	0.982246	0.007326	0.008552
4	-1.07500	0.991733	0.982182	0.007871	0.008509
5	-1.05000	0.991644	0.982129	0.007988	0.008455
6	-1.02500	0.990627	0.982097	0.008011	0.008412
7	-1.00000	0.991245	0.982075	0.008023	0.008382
8	-0.97500	0.990844	0.982065	0.008249	0.008357
9	-0.95000	0.990452	0.982062	0.008385	0.008337
10	-0.92500	0.990227	0.982060	0.008657	0.008322
11	-0.90000	0.989755	0.982063	0.008745	0.008309
12	-0.87500	0.989617	0.982065	0.008733	0.008298
13	-0.85000	0.989482	0.982069	0.008690	0.008289
14	-0.92500	0.989252	0.982071	0.008720	0.008283
15	-0.80000	0.989429	0.982074	0.009037	0.008277
16	-0.77500	0.987112	0.982081	0.009362	0.008270
17	-0.75000	0.986963	0.982083	0.009350	0.008266
18	-0.72500	0.986814	0.982086	0.009275	0.008262
19	-0.70000	0.986914	0.982088	0.009263	0.008260
20	-0.67500	0.986346	0.982092	0.009273	0.008257
21	-0.65000	0.986446	0.982095	0.009230	0.008255
22	-0.62500	0.987287	0.982094	0.009250	0.008255
23	-0.60000	0.987534	0.982093	0.009156	0.008256
24	-0.57500	0.986546	0.982099	0.009188	0.008253
25	-0.55000	0.987781	0.982093	0.009250	0.008258
26	-0.52500	0.986940	0.982095	0.009261	0.008258
27	-0.50000	0.986172	0.982096	0.009232	0.008260
28	-0.47500	0.986493	0.982095	0.009222	0.008263
29	-0.45000	0.986468	0.982093	0.009223	0.008268
30	-0.42500	0.986022	0.982093	0.009152	0.008273
31	-0.40000	0.984660	0.982097	0.009135	0.008277
32	-0.37500	0.984462	0.982099	0.009095	0.008285
33	-0.35000	0.984837	0.982098	0.009078	0.008297
34	-0.32500	0.984544	0.982103	0.009052	0.008310
35	-0.30000	0.983332	0.982116	0.009207	0.008323
36	-0.27500	0.982946	0.982130	0.009163	0.008345
37	-0.25000	0.982814	0.982154	0.009088	0.008373
38	-0.22500	0.982011	0.982196	0.009166	0.008409
39	-0.20000	0.980362	0.982261	0.009229	0.008452
40	-0.17500	0.980826	0.982329	0.009214	0.008499
41	-0.15000	0.979768	0.982218	0.009307	0.008424
42	-0.12500	0.978798	0.981529	0.009228	0.008112
43	-0.10000	0.978434	0.981202	0.009270	0.007998
44	-0.07500	0.977647	0.981112	0.009386	0.007985
45	-0.05000	0.977216	0.981073	0.009352	0.007990
46	-0.02500	0.975679	0.981041	0.009319	0.008002
47	0.0	0.973373	0.981018	0.009365	0.008013
48	0.02500	0.971775	0.980987	0.009371	0.008029
49	0.05000	0.971060	0.980955	0.009329	0.008046
50	0.07500	0.973247	0.980916	0.009330	0.008066
51	0.10000	0.973925	0.980875	0.009449	0.008087
52	0.25000	0.973119	0.980588	0.010913	0.008238
53	0.20000	0.972851	0.980706	0.010140	0.008176
54	0.15000	0.973375	0.980795	0.009671	0.008129

Figure 65 (Continued)

```
                                      ANALYSIS OF INTERFACIAL RIPPLE DATA AT POLARIZED .100-M PHENOL IN N/10
                              HCLO4/HG INTERFACE-DATA OF G.BIERWAGEN (5-17-67)
MEASUREMENTS MADE AT    WATER                                  /MERCURY                              INTERFACE
    0.100-M PHENOL      N/10 HCLO4



DENSITY OF UPPER PHASE   0.99700   DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE   0.0089400   VISCOSITY OF LOWER PHASE   0.0152700

ORIGINAL OUTPUT VOLTAGE    30.50000000 MV.

INITIAL DAMPING COEFFICIENT   0.83700 1/CM.

WAVELENGTH 0.09070 CM.

PROBE SEPARATION =    0.96800 CM.

WAVENUMBER =    69.274303 RECIPROCAL CM.

                    ----------------  ----------------------------------                          --------

                        INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM


SURFACTANT CONCENTRATION=      0.100-M PHENOL

ELECTROCAPILLARY MAXIMUM IS   -0.62500 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=    1.22000

ELECTRICAL DESORPTION EXPONENT =   15.00000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =    10.00000

DIFFUSION TERM=    10000.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000001

SURFACTANT SURFACE VISCOSITY= 0.000100

 1/BO = FRUMKIN CONCENTRATION CONSTANT=  0.005000
```

Figure 66. YCOR data listing for 0.1-M phenol in N/10 $HClO_4$

```
                                      INPUT DATA
NO.          POL.VOLTAGE         FREQUENCY         OUTPUT VOLTAGE(MV.)         GAMMA
  1          -1.250000           463.500000         53.000000               363.600000
  2          -1.200000           464.600000         53.000000               349.500000
  3          -1.150000           465.700000         52.000000               374.900000
  4          -1.100000           468.000000         52.600000               379.400000
  5          -1.075000           468.900000         52.700000               381.300000
  6          -1.050000           469.900000         52.400000               382.900000
  7          -1.025000           470.800000         52.500000               384.500000
  8          -1.000000           471.600000         52.500000               385.800000
  9          -0.975000           472.300000         52.700000               387.000000
 10          -0.950000           473.100000         52.900000               387.900000
 11          -0.925000           473.700000         52.800000               389.000000
 12          -0.900000           474.100000         52.500000               390.000000
 13          -0.875000           474.700000         53.300000               390.800000
 14          -0.850000           474.800000         53.500000               391.300000
 15          -0.825000           474.900000         52.000000               391.800000
 16          -0.800000           474.800000         51.200000               392.600000
 17          -0.775000           474.900000         51.200000               393.100000
 18          -0.750000           474.700000         51.500000               393.300000
 19          -0.725000           474.800000         51.300000               394.900000
 20          -0.700000           474.900000         51.100000               394.000000
 21          -0.675000           475.000000         51.100000               394.500000
 22          -0.650000           475.100000         51.100000               394.500000
 23          -0.625000           475.200000         51.100000               394.700000
 24          -0.600000           475.200000         51.100000               394.600000
 25          -0.575000           475.100000         51.500000               394.600000
 26          -0.550000           475.000000         51.100000               394.500000
 27          -0.525000           474.800000         51.500000               394.600000
 28          -0.500000           474.500000         51.200000               394.200000
 29          -0.475000           474.400000         51.000000               394.000000
 30          -0.450000           474.000000         51.000000               393.600000
 31          -0.425000           473.600000         50.800000               393.200000
 32          -0.400000           473.100000         50.400000               392.900000
 33          -0.375000           472.700000         50.200000               391.900000
 34          -0.350000           472.100000         49.900000               391.200000
 35          -0.325000           471.400000         49.500000               390.500000
 36          -0.300000           470.700000         48.900000               389.500000
 37          -0.275000           469.900000         48.300000               388.900000
 38          -0.250000           469.200000         48.300000               387.600000
 39          -0.225000           468.100000         47.100000               386.600000
 40          -0.200000           467.200000         46.800000               385.200000
 41          -0.175000           466.300000         46.200000               383.900000
 42          -0.150000           465.200000         45.900000               381.900000
 43          -0.125000           463.900000         45.300000               380.600000
 44          -0.100000           462.700000         45.000000               378.700000
 45          -0.075000           461.600000         44.600000               376.700000
 46          -0.050000           460.100000         44.000000               374.800000
 47          -0.025000           458.500000         44.100000               372.700000
 48           0.0                456.800000         42.100000               370.200000
 49           0.025000           454.900000         41.800000               367.900000
 50           0.050000           453.200000         41.100000               365.400000
 51           0.075000           451.400000         41.000000               362.700000
 52           0.100000           449.300000         41.000000               359.800000
 53           0.150000           445.200000         39.100000               353.600000
 54           0.200000           440.300000         37.300000               346.500000
```

Figure 66 (Continued)

```
INITIAL FREQUENCY =  419.00000


POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                          -0.1208608915D 04     FREQUENCY** 0
                           0.2823330235D 04     FREQUENCY** 1
                          -0.2931203885D 04     FREQUENCY** 2
                           0.1783278968D 04     FREQUENCY** 3
                          -0.7046193117D 03     FREQUENCY** 4
                           0.1890887852D 03     FREQUENCY** 5
                          -0.3492397260D 02     FREQUENCY** 6
                           0.4385962415D 01     FREQUENCY** 7
                          -0.3586019692D 00     FREQUENCY** 8
                           0.1724337906D-01     FREQUENCY** 9
                          -0.3704209668D-03     FREQUENCY**10

NO.     FREQUENCY     CORRECTED OUTPUT VOLTAGE          NO.     FREQUENCY     CORRECTED OUTPUT VOLTAGE
 1      463.50000           47.02294                    28      474.50000           42.13428
 2      464.60000           46.68991                    29      474.40000           41.99988
 3      465.70000           45.47966                    30      474.00000           42.12054
 4      468.00000           45.30115                    31      473.60000           42.07553
 5      468.90000           45.10958                    32      473.10000           41.89325
 6      469.90000           44.54503                    33      472.70000           41.84571
 7      470.80000           44.35182                    34      472.10000           41.77254
 8      471.60000           44.10407                    35      471.40000           41.64227
 9      472.30000           44.05423                    36      470.70000           41.33937
10      473.10000           43.97128                    37      469.90000           41.05964
11      473.70000           43.70082                    38      469.20000           41.25831
12      474.10000           43.32832                    39      468.10000           40.53691
13      474.70000           43.79940                    40      467.20000           40.52441
14      474.80000           43.93211                    41      466.30000           40.24649
15      474.90000           42.66961                    42      465.20000           40.27692
16      474.80000           42.04344                    43      463.90000           40.08908
17      474.90000           42.01316                    44      462.70000           40.12921
18      474.70000           42.32025                    45      461.60000           40.04820
19      474.80000           42.12555                    46      460.10000           39.87526
20      474.90000           41.93110                    47      458.50000           40.34957
21      475.00000           41.90089                    48      456.80000           38.89958
22      475.10000           41.87066                    49      454.90000           39.03104
23      475.20000           41.84044                    50      453.20000           38.72389
24      475.20000           41.84044                    51      451.40000           38.98054
25      475.10000           42.19841                    52      449.30000           39.36780
26      475.00000           41.90089                    53      445.20000           38.18902
27      474.80000           42.28978                    54      440.30000           37.01986
```

Figure 66 (Continued)

```
NO.   PPL.VOLTAGE   GAMMA(EXPT.)CALC.F=0   THETA FROM MODEL   ALPHA(EXPTL)   ALPHA(MODEL)
 1     -1.25000         380.52545             0.062283          0.389739       0.573194
 2     -1.20000         382.31199             0.178145          0.397123       0.569596
 3     -1.15000         384.09939             0.551678          0.424254       0.581339
 4     -1.10000         387.85936             0.840544          0.428316       0.582636
 5     -1.07500         389.33378             0.894899          0.432694       0.579705
 6     -1.05000         390.97488             0.927544          0.445705       0.577695
 7     -1.02500         392.45611             0.948321          0.450195       0.575987
 8     -1.00000         393.77475             0.962089          0.455982       0.574787
 9     -0.97500         394.93114             0.971492          0.457150       0.573778
10     -0.95000         396.25469             0.978073          0.459097       0.573333
11     -0.92500         397.24777             0.982769          0.465471       0.572537
12     -C.90000         397.90948             0.986179          0.474314       0.571702
13     -0.87500         398.90841             0.988689          0.463143       0.571341
14     -0.85000         399.07528             0.990560          0.460018       0.570813
15     -0.82500         399.23475             0.991967          0.490140       0.570307
16     -0.80000         399.06474             0.993031          0.505413       0.569281
17     -0.77500         399.23079             0.993838          0.506157       0.568805
18     -0.75000         398.90024             0.994447          0.498633       0.568348
19     -0.72500         399.06525             0.994899          0.503397       0.566704
20     -0.70000         399.23027             0.995225          0.508177       0.567766
21     -0.67500         399.39635             0.995446          0.508921       0.567319
22     -0.65000         399.56246             0.995573          0.509667       0.567419
23     -0.62500         399.72860             0.995614          0.510413       0.567304
24     -0.60000         399.72860             0.995573          0.510413       0.567415
25     -0.57500         399.56451             0.995446          0.501612       0.567315
26     -0.55000         399.39635             0.995225          0.508921       0.567330
27     -0.52500         399.06626             0.994899          0.499377       0.567027
28     -0.50000         398.56681             0.994447          0.503183       0.567164
29     -0.47500         398.39988             0.993838          0.506483       0.567305
30     -0.45000         397.73659             0.993031          0.503520       0.567356
31     -0.42500         397.07283             0.991967          0.504624       0.567418
32     -0.40000         396.24312             0.990560          0.509110       0.567281
33     -0.37500         395.58059             0.988689          0.510282       0.568033
34     -0.35000         394.58783             0.986179          0.512090       0.568276
35     -0.32500         393.43090             0.982769          0.515317       0.568456
36     -0.30000         392.27453             0.978073          0.522859       0.569021
37     -0.27500         390.95544             0.971492          0.529873       0.569122
38     -0.25000         389.80605             0.962088          0.524887       0.570227
39     -0.22500         387.99622             0.948321          0.543112       0.570743
40     -0.20000         386.52258             0.927544          0.543429       0.572192
41     -0.17500         385.04984             0.894899          0.550537       0.573927
42     -0.15000         383.25633             0.840544          0.549756       0.576754
43     -0.12500         381.14051             0.741936          0.554611       0.578479
44     -0.10000         379.19425             0.551678          0.553552       0.574167
45     -0.07500         377.41370             0.316681          0.555639       0.561315
46     -0.05000         374.99200             0.178145          0.560110       0.557938
47     -0.02500         372.42222             0.104368          0.547894       0.557794
48      0.0             369.68710             0.062289          0.585702       0.558568
49      0.02500         366.65537             0.037300          0.582216       0.559053
50      0.05000         363.95002             0.022217          0.590378       0.560023
51      0.07500         361.10111             0.013095          0.593554       0.561139
52      0.10000         357.79215             0.007615          0.573341       0.562182
53      0.15000         351.36115             0.002454          0.604746       0.554905
54      0.20000         343.75314             0.000738          0.636868       0.567921
```

Figure 66 (Continued)

```
NO.   POL.VOLTAGE    RE(E)-EXPT.    RE(E)-MODEL    IM(E)-EXPT.    IM(E)-MODEL
 1     -1.25000      10.293893      0.003193       7.793174      -0.003109
 2     -1.20000       9.221478      0.040370       6.753410      -0.030467
 3     -1.15000       7.672488      0.740967       5.447810      -0.691606
 4     -1.10000       7.238631      0.842620       5.152622      -0.826093
 5     -1.07500       6.944990      0.773974       4.967362      -0.765333
 6     -1.05000       7.035968      0.726527       4.817339      -0.721557
 7     -1.02500       7.034690      0.694500       4.714926      -0.691402
 8     -1.00000       7.097133      0.672688       4.645691      -0.670644
 9     -0.97500       7.080037      0.657576       4.612363      -0.656155
10     -0.95000       7.424514      0.647062       4.755902      -0.646031
11     -0.92500       7.398633      0.639500       4.630957      -0.638727
12     -0.90000       7.208818      0.633952       4.368839      -0.633354
13     -0.87500       7.290784      0.630077       4.601654      -0.629601
14     -0.85000       7.007405      0.626909       4.507461      -0.626521
15     -0.82500       6.950450      0.624572       3.922298      -0.624249
16     -0.80000       6.155166      0.622687       3.195048      -0.622410
17     -0.77500       5.800657      0.621355       2.995419      -0.621113
18     -0.75000       5.107493      0.620089       2.885175      -0.619874
19     -0.72500       3.068578      0.619441       2.158335      -0.619245
20     -0.70000       4.708194      0.618951       2.493337      -0.618769
21     -0.67500       4.247861      0.618606       2.313197      -0.618433
22     -0.65000       4.491481      0.618489       2.373504      -0.618322
23     -0.62500       4.450921      0.618428       2.337725      -0.618262
24     -0.60000       4.590701      0.618554       2.387088      -0.618387
25     -0.57500       4.289429      0.618671       2.522244      -0.618498
26     -0.55000       4.247861      0.619016       2.313197      -0.618834
27     -0.52500       3.529749      0.619441       2.378695      -0.619245
28     -0.50000       3.395228      0.619958       2.242274      -0.619743
29     -0.47500       3.469575      0.621028       2.166538      -0.620786
30     -0.45000       3.017393      0.622162       2.155778      -0.621886
31     -0.42500       2.567374      0.623717       2.042943      -0.623393
32     -0.40000       1.593357      0.625787       1.769561      -0.625399
33     -0.37500       2.244517      0.628750       1.824879      -0.628274
34     -0.35000       1.690520      0.632615       1.697228      -0.632018
35     -0.32500       0.752455      0.637947       1.512326      -0.637176
36     -0.30000       0.419129      0.645420       1.225013      -0.644393
37     -0.27500      -1.361356      0.655906       0.953907      -0.654489
38     -0.25000      -0.955717      0.670978       1.170466      -0.668940
39     -0.22500      -3.342076      0.692510       0.568511      -0.689433
40     -0.20000      -3.574864      0.724443       0.622654      -0.719496
41     -0.17500      -4.209227      0.771833       0.375203      -0.763238
42     -0.15000      -3.511837      0.840107       0.343863      -0.823667
43     -0.12500      -6.430926      0.912133       0.833354      -0.877919
44     -0.10000      -6.566883      0.738597       1.019062      -0.689533
45     -0.07500      -5.787936      0.194845       0.668503      -0.185307
46     -0.05000      -7.862135      0.040175       1.237218      -0.039280
47     -0.02500      -9.173841      0.010363       3.118465      -0.010282
48      0.0         -11.857821      0.003080       1.446820      -0.003086
49      0.02500     -14.763759      0.000983       4.903254      -0.000995
50      0.05000     -16.143809      0.000323       5.696110      -0.000331
51      0.07500     -15.838704      0.000106       7.117357      -0.000111
52      C.10000     -15.730629      0.000034      10.191552      -0.000037
53      0.15000     -19.007343      0.000003      11.517443      -0.000004
54      0.20000     -22.500219      0.000000      14.816818      -0.000000
```

Figure 66 (Continued)

NO.	POL.VOLTAGE	Y1-EXPT.	Y1-MODEL	Y2-EXPT.	Y2-MODEL
1	-1.25000	1.019564	0.980754	0.005627	0.008150
2	-1.20000	1.008051	0.980881	0.005733	0.008116
3	-1.15000	0.998242	0.981562	0.006124	0.008334
4	-1.10000	0.996169	0.981684	0.006183	0.008353
5	-1.07500	0.995021	0.981652	0.006246	0.008313
6	-1.05000	0.995094	0.981632	0.006434	0.008284
7	-1.02500	0.994753	0.981624	0.006499	0.008261
8	-1.00000	0.994773	0.981621	0.006582	0.008244
9	-0.97500	0.994635	0.981622	0.006599	0.008230
10	-0.95000	0.995692	0.981622	0.006627	0.008220
11	-0.92500	0.995396	0.981628	0.006719	0.008210
12	-0.90000	0.994521	0.981635	0.006847	0.008200
13	-0.87500	0.994999	0.981640	0.006686	0.008194
14	-0.85000	0.994146	0.981644	0.006641	0.008189
15	-0.82500	0.993296	0.981649	0.007075	0.008184
16	-0.80000	0.990854	0.981660	0.007296	0.008176
17	-0.77500	0.990011	0.981665	0.007307	0.008171
18	-0.75000	0.988674	0.981669	0.007198	0.008168
19	-0.72500	0.985083	0.981690	0.007267	0.008155
20	-0.70000	0.987750	0.981676	0.007336	0.008163
21	-0.67500	0.986913	0.981683	0.007346	0.008159
22	-0.65000	0.987329	0.981682	0.007357	0.008159
23	-0.62500	0.987244	0.981684	0.007368	0.008157
24	-0.60000	0.987494	0.981683	0.007368	0.008158
25	-0.57500	0.987079	0.981684	0.007241	0.008158
26	-0.55000	0.986913	0.981683	0.007346	0.008159
27	-0.52500	0.985832	0.981686	0.007209	0.008157
28	-0.50000	0.985586	0.981683	0.007264	0.008160
29	-0.47500	0.985671	0.981681	0.007311	0.008162
30	-0.45000	0.985009	0.981679	0.007268	0.008164
31	-0.42500	0.984348	0.981677	0.007284	0.008167
32	-0.40000	0.983021	0.981678	0.007349	0.008169
33	-0.37500	0.983863	0.981669	0.007366	0.008177
34	-0.35000	0.983123	0.981665	0.007392	0.008183
35	-0.32500	0.981967	0.981664	0.007439	0.008188
36	-0.30000	0.981566	0.981660	0.007548	0.008198
37	-0.27500	0.979742	0.981665	0.007649	0.008204
38	-0.25000	0.980101	0.981663	0.007577	0.008219
39	-0.22500	0.978034	0.981672	0.007840	0.008232
40	-0.20000	0.977818	0.981683	0.007845	0.008254
41	-0.17500	0.977353	0.981707	0.007947	0.008280
42	-0.15000	0.977842	0.981738	0.007936	0.008319
43	-0.12500	0.975705	0.981786	0.008006	0.008350
44	-0.10000	0.975534	0.981638	0.007991	0.008288
45	-0.07500	0.976056	0.981159	0.008021	0.008100
46	-0.05000	0.974639	0.981001	0.008085	0.008054
47	-0.02500	0.973325	0.980950	0.007909	0.008056
48	0.0	0.972645	0.980914	0.008455	0.008068
49	0.02500	0.970601	0.980887	0.008405	0.008081
50	0.05000	0.969951	0.980856	0.008522	0.008096
51	0.07500	0.969425	0.980822	0.008424	0.008114
52	0.10000	0.968167	0.980787	0.008276	0.008132
53	0.15000	0.967246	0.980709	0.008730	0.008174
54	0.20000	0.965457	0.980617	0.009193	0.008222

Figure 66 (Continued)

```
                                       ANALYSIS OF INTERFACIAL RIPPLE DATA MEASURED USING THE CONSTANT "K" METHCD

                             DATA FOR PURE C.050-M NA2SO4 MEASURED BY G.BIERWAGEN  (10/14/67)  2ND TRY

MEASUREMENTS MACE AT PURE 0.050-M NA2SC4 IN WATER            /   PURE MERCURY                         INTERFACE
0.050-M NA2SO4         PURE H2C




DENSITY CF UPPER PHASE   0.99700   DENSITY OF LOWER PHASE  13.5340C

VISCOSITY OF UPPER PHASE   0.0089400   VISCCSITY OF LOWER PHASE   0.0152700

ORIGINAL OUTPUT VOLTAGE     8.7950000C MV.

INITIAL DAMPING COEFFICIENT   0.45830 1/CM.

WAVELENGTH 0.08650 CM.

PROBE SEPARATICN =    1.25800 CM.

WAVENUMBER =    72.637911 RECIPROCAL CM.



                    INPUT DATA FOR MOCELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM



SURFACTANT CCNCENTRATICN= 0.050-M NA2SC4

ELECTROCAPILLARY MAXIMUM IS   -0.46000 VOLTS VS. S.C.E.

FRUMKIN EXPCNENT=    1.50000

ELECTRICAL DESORPTION EXPONENT =   25.00000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =    0.0

DIFFUSICN TERM=       0.0

SURFACE VISCOSITY OF PURE INTERFACE= C.000010

SURFACTANT SURFACE VISCOSITY= 0.000500

 1/B0 = FRUMKIN CCNCENTRATICN CONSTANT=  1.000000
```

Figure 67. YCOR listing for pure .05-M Na_2SO_4

```
                                   INPUT DATA

NO.        POL.VOLTAGE        FREQUENCY        OUTPUT VOLTAGE(MV.)        GAMMA
  1         -1.200000         499.100000           5.048000            371.490000
  2         -1.150000         501.300000           5.590000            380.980000
  3         -1.125000         503.300000           5.739000            381.230000
  4         -1.100000         505.700000           5.698000            384.290000
  5         -1.075000         507.700000           6.022000            387.250000
  6         -1.050000         508.600000           6.470000            390.130000
  7         -1.025000         510.300000           6.195000            392.910000
  8         -1.000000         511.700000           6.221000            395.590000
  9         -0.975000         514.400000           6.636000            398.170000
 10         -0.950000         515.900000           6.887000            400.650000
 11         -0.925000         516.900000           6.881000            403.020000
 12         -0.900000         518.100000           6.891000            405.280000
 13         -0.875000         520.200000           6.970000            407.420000
 14         -0.850000         521.400000           7.032000            409.490000
 15         -0.825000         522.800000           7.292000            411.500000
 16         -0.800000         524.000000           7.455000            413.260000
 17         -0.775000         525.400000           7.770000            415.010000
 18         -0.750000         525.600000           8.145000            415.600000
 19         -0.725000         526.900000           8.170000            416.170000
 20         -0.700000         527.800000           8.024000            419.490000
 21         -0.675000         529.200000           7.718000            420.760000
 22         -0.650000         529.200000           8.437000            421.910000
 23         -0.625000         529.700000           8.173000            422.950000
 24         -0.600000         530.300000           8.199000            423.850000
 25         -0.575000         531.500000           7.456000            424.620000
 26         -0.550000         531.100000           8.991000            425.240000
 27         -0.525000         531.700000           8.572000            425.720000
 28         -0.500000         531.600000           8.179000            426.000000
 29         -0.475000         532.300000           7.139000            426.190000
 30         -0.450000         531.600000           8.795000            426.180000
 31         -0.425000         532.100000           8.821000            425.990000
 32         -0.400000         531.400000           8.099000            425.610000
 33         -0.375000         523.700000           4.078000            425.050000
 34         -0.350000         531.000000           8.535000            424.290000
 35         -0.325000         523.400000           3.970000            423.350000
 36         -0.300000         530.400000           7.427000            422.200000
 37         -0.275000         521.200000           3.796000            420.870000
 38         -0.250000         528.700000           7.930000            419.350000
 39         -0.225000         521.600000           4.024000            417.640000
 40         -0.200000         526.800000           6.961000            415.760000
 41         -0.175000         519.700000           4.125000            413.700000
 42         -0.150000         519.200000           4.460000            411.460000
 43         -0.125000         518.400000           5.717000            409.070000
 44         -0.100000         519.400000           6.421000            406.500000
 45         -0.075000         515.700000           5.759000            403.950000
 46         -0.050000         514.400000           5.827000            400.990000
 47         -0.025000         513.100000           5.965000            397.500000
 48          0.0              511.200000           5.840000            394.580000
 49          0.025000         508.600000           5.585000            390.990000
 50          0.050000         505.800000           5.398000            387.490000
 51          0.075000         502.900000           5.004000            383.490000
 52          0.100000         500.000000           4.958000            379.460000
 53          0.125000         496.300000           4.637000            375.900000
 54          0.150000         493.300000           4.500000            370.320000
 55          0.175000         489.400000           4.215000            365.000000
 56          0.200000         484.600000           4.066000            356.000000
```

Figure 67 (Continued)

```
INITIAL FREQUENCY =   530.50000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                               -0.1205608915D 04     FREQUENCY** 0
                                0.2822330235D 04     FREQUENCY** 1
                               -0.2931291835D 04     FREQUENCY** 2
                                0.1783278963D 04     FREQUENCY** 3
                               -0.7046183117D 03     FREQUENCY** 4
                                0.1890887852D 03     FREQUENCY** 5
                               -0.3492397260D 02     FREQUENCY** 6
                                0.4385962415D 01     FREQUENCY** 7
                               -0.3586019692D 00     FREQUENCY** 8
                                0.1724337906D-01     FREQUENCY** 9
                               -0.3704209668D-03     FREQUENCY**10

NO.     FREQUENCY     CORRECTED OUTPUT VOLTAGE         NO.     FREQUENCY     CORRECTED OUTPUT VOLTAGE
 1      498.10000            6.46413                   29      532.30000            7.05151
 2      501.30000            6.98050                   30      531.60000            8.72869
 3      503.30000            7.05466                   31      532.10000            8.72473
 4      505.70000            6.87317                   32      531.40000            8.04895
 5      507.70000            7.15062                   33      523.70000            4.28180
 6      508.60000            7.62845                   34      531.00000            8.50558
 7      510.30000            7.20747                   35      523.40000            4.17766
 8      511.70000            7.15890                   36      530.40000            7.43215
 9      514.40000            7.47763                   37      521.20000            4.06068
10      515.90000            7.67094                   38      528.70000            8.03050
11      516.90000            7.60547                   39      521.60000            4.29167
12      518.10000            7.54680                   40      526.80000            7.14541
13      520.20000            7.51241                   41      519.70000            4.46287
14      521.40000            7.51102                   42      519.20000            4.84366
15      522.80000            7.70768                   43      518.40000            6.24674
16      524.00000            7.81026                   44      519.40000            6.96276
17      525.40000            8.05715                   45      515.70000            6.42445
18      525.60000            8.43371                   46      514.40000            6.56603
19      526.90000            8.38040                   47      513.10000            6.78977
20      527.80000            8.17776                   48      511.20000            6.74677
21      529.20000            7.78832                   49      508.60000            6.58499
22      529.20000            8.51387                   50      505.80000            6.50618
23      529.70000            8.21862                   51      502.80000            6.17542
24      530.30000            8.21038                   52      500.00000            6.25489
25      531.50000            7.40485                   53      496.90000            5.99392
26      531.10000            8.95385                   54      493.30000            5.98257
27      531.70000            8.50156                   55      489.40000            5.77543
28      531.60000            8.11734                   56      484.60000            5.77948
```

Figure 67 (Continued)

```
NO.     POL.VOLTAGE     GAMMA(EXPT.)CALC.F=0     THETA FROM MODEL     ALPHA(EXPT.)     ALPHA(MODEL)
  1      -1.20000          380.96692                0.000000            0.703066         0.591263
  2      -1.15000          385.84495                0.000000            0.641975         0.594526
  3      -1.12500          388.85885                0.000000            0.633575         0.595250
  4      -1.10000          392.56925                0.000000            0.654292         0.594216
  5      -1.07500          395.65740                0.000000            0.622835         0.592830
  6      -1.05000          397.06165                0.000000            0.571415         0.590583
  7      -1.02500          399.67852                0.000000            0.616539         0.589211
  8      -1.00000          401.84539                0.000000            0.621915         0.587668
  9      -0.97500          406.06687                0.000000            0.587288         0.587543
 10      -0.95000          408.41936                0.000000            0.567000         0.586346
 11      -0.92500          409.98561                0.000000            0.573813         0.584791
 12      -0.90000          411.86962                0.000000            0.579970         0.583566
 13      -0.87500          415.17911                0.000000            0.593600         0.583355
 14      -0.85000          417.07679                0.000000            0.593747         0.582349
 15      -0.82500          419.30238                0.000000            0.563202         0.581609
 16      -0.80000          421.21252                0.000000            0.552692         0.580942
 17      -0.77500          423.44969                0.000000            0.527953         0.580483
 18      -0.75000          423.77752                0.000000            0.491644         0.580069
 19      -0.72500          425.85376                0.000000            0.496694         0.580729
 20      -0.70000          427.29028                0.000000            0.516142         0.578204
 21      -0.67500          429.57650                0.000000            0.554928         0.578249
 22      -0.65000          429.54442                0.000000            0.494124         0.577071
 23      -0.62500          430.34170                0.000000            0.512180         0.576520
 24      -0.60000          431.30706                0.000000            0.512978         0.576186
 25      -0.57500          433.21767                0.000000            0.595063         0.576548
 26      -0.55000          432.61101                0.000000            0.444071         0.575555
 27      -0.52500          433.57079                0.000000            0.485274         0.575642
 28      -0.50000          433.40052                0.000000            0.522037         0.575270
 29      -0.47500          434.49600                0.000000            0.633929         0.575738
 30      -0.45000          433.41382                0.000000            0.464316         0.575091
 31      -0.42500          434.22119                0.000000            0.464677         0.575749
 32      -0.40000          433.07601                0.000000            0.528763         0.575469
 33      -0.37500          420.49480                0.000000            1.030486         0.568780
 34      -0.35000          432.44152                0.000000            0.484898         0.576407
 35      -0.32500          420.00375                0.000000            1.050058         0.570173
 36      -0.30000          431.44541                0.000000            0.592138         0.577934
 37      -0.27500          416.50001                0.000000            1.072635         0.570550
 38      -0.25000          428.73017                0.000000            0.530587         0.579201
 39      -0.22500          417.16546                0.000000            1.028656         0.574169
 40      -0.20000          425.65717                0.000000            0.673414         0.581054
 41      -0.17500          414.18524                0.000000            0.997552         0.576354
 42      -0.15000          413.43961                0.000000            0.932476         0.578174
 43      -0.12500          412.28678                0.000000            0.730258         0.579978
 44      -0.10000          413.89650                0.000000            0.643997         0.583545
 45      -0.07500          408.05744                0.000000            0.707960         0.582675
 46      -0.05000          406.03128                0.000000            0.690633         0.594609
 47      -0.02500          404.01330                0.000000            0.663997         0.596981
 48       0.0              401.05651                0.000000            0.669047         0.588275
 49       0.02500          397.02339                0.000000            0.698340         0.589628
 50       0.05000          392.70699                0.000000            0.697912         0.590704
 51       0.07500          388.09607                0.000000            0.739387         0.592176
 52       0.10000          383.83656                0.000000            0.729222         0.593900
 53       0.12500          379.12985                0.000000            0.763100         0.595865
 54       0.15000          373.71603                0.000000            0.764606         0.597615
 55       0.17500          367.88402                0.000000            0.792617         0.599369
 56       0.20000          360.78414                0.000000            0.792060         0.605797
```

Figure 67 (Continued)

```
NO.   POL.VOLTAGE    RE(F)-EXPT.    RE(F)-MODEL    IM(F)-EXPT.    IM(F)-MODEL
 1     -1.20000      10.010711       0.0            3.607120      -0.031288
 2     -1.15000       6.731439       0.0            1.165375      -0.031499
 3     -1.12500       8.361098       0.0            2.833963      -0.031614
 4     -1.10000       9.066520       0.0            3.039340      -0.031765
 5     -1.07500       8.833508       0.0            3.424256      -0.031891
 6     -1.05000       7.171546       0.0            3.080678      -0.031947
 7     -1.02500       7.565818       0.0            2.271070      -0.032054
 8     -1.00000       7.171677       0.0            1.750118      -0.032142
 9     -0.97500       8.235052       0.0            3.421320      -0.032311
10     -0.95000       7.954080       0.0            3.588506      -0.032406
11     -0.92500       7.357806       0.0            2.976857      -0.032469
12     -0.90000       7.085515       0.0            2.610996      -0.032544
13     -0.87500       8.197854       0.0            3.320115      -0.032676
14     -0.85000       8.083878       0.0            3.191046      -0.032751
15     -0.82500       8.059350       0.0            3.598798      -0.032839
16     -0.80000       8.091544       0.0            3.821002      -0.032914
17     -0.77500       8.251049       0.0            4.400843      -0.033002
18     -0.75000       7.761486       0.0            4.751572      -0.033015
19     -0.72500       8.845815       0.0            5.339339      -0.033097
20     -0.70000       7.687723       0.0            4.227601      -0.033153
21     -0.67500       8.799663       0.0            4.219808      -0.033241
22     -0.65000       7.311451       0.0            4.619540      -0.033241
23     -0.62500       7.328482       0.0            4.076342      -0.033273
24     -0.60000       7.401128       0.0            4.092518      -0.033310
25     -0.57500       9.165612       0.0            3.611371      -0.033386
26     -0.55000       6.845636       0.0            5.135421      -0.033360
27     -0.52500       7.531908       0.0            4.687024      -0.033398
28     -0.50000       7.448938       0.0            3.913088      -0.033392
29     -0.47500       9.484920       0.0            2.923795      -0.033436
30     -0.45000       6.849295       0.0            4.768209      -0.033392
31     -0.42500       7.694730       0.0            5.133044      -0.033423
32     -0.40000       7.567199       0.0            3.842808      -0.033379
33     -0.37500      67.967443       0.0           23.966831      -0.032896
34     -0.35000       7.762430       0.0            4.821227      -0.033354
35     -0.32500      62.978702       0.0            3.241897      -0.032877
36     -0.30000       9.519212       0.0            4.072663      -0.033317
37     -0.27500      58.540938       0.0           18.132421      -0.032739
38     -0.25000       8.964306       0.0            4.828508      -0.033210
39     -0.22500      35.431445       0.0          -15.868803      -0.032764
40     -0.20000      10.130471       0.0            4.210551      -0.033090
41     -0.17500      26.749443       0.0          -16.256738      -0.032644
42     -0.15000      16.758879       0.0          -12.556835      -0.032613
43     -0.12500       5.408085       0.0           -5.192783      -0.032563
44     -0.10000       8.660733       0.0            2.254737      -0.032626
45     -0.07500       6.193185       0.0           -2.724573      -0.032393
46     -0.05000       7.169116       0.0           -0.761853      -0.032311
47     -0.02500       8.075853       0.0            1.285638      -0.032230
48      0.0           8.077729       0.0            1.213379      -0.032110
49      0.02500       7.930752       0.0            0.511704      -0.031947
50      0.05000       7.178744       0.0           -0.556782      -0.031771
51      0.07500       7.324805       0.0           -2.128311      -0.031583
52      0.10000       6.659056       0.0           -2.214078      -0.031407
53      0.12500       7.145949       0.0           -3.246502      -0.031212
54      0.15000       5.942016       0.0           -4.647724      -0.030986
55      0.17500       5.890933       0.0           -6.493238      -0.030741
56      0.20000       8.173499       0.0           -2.086366      -0.030440
```

Figure 67 (Continued)

```
NC.    FCL.VCLTAGE      Y1-EXPT.        Y1-MODEL        Y2-EXPT.        Y2-MODEL

  1     -1.20000        0.999657        0.981648        0.009679        0.008229
  2     -1.15000        0.989659        0.980771        0.008838        0.008145
  3     -1.12500        0.994562        0.980777        0.008722        0.008142
  4     -1.10000        0.996075        0.980811        0.009008        0.008124
  5     -1.07500        0.996295        0.980846        0.008575        0.008105
  6     -1.05000        0.992450        0.980887        0.007967        0.008084
  7     -1.02500        0.992026        0.980920        0.008488        0.008067
  8     -1.00000        0.990720        0.980954        0.008562        0.008049
  9     -0.97500        0.994715        0.980977        0.008085        0.008037
 10     -0.95000        0.994331        0.981006        0.007806        0.008022
 11     -0.92500        0.992320        0.981036        0.007900        0.008006
 12     -0.90000        0.991373        0.981063        0.007984        0.007992
 13     -0.87500        0.994177        0.981083        0.008034        0.007982
 14     -0.85000        0.993720        0.981107        0.008036        0.007969
 15     -0.82500        0.994183        0.981128        0.007754        0.007958
 16     -0.80000        0.994499        0.981147        0.007609        0.007948
 17     -0.77500        0.995604        0.981165        0.007268        0.007939
 18     -0.75000        0.994948        0.981172        0.006768        0.007935
 19     -0.72500        0.998506        0.981173        0.006838        0.007935
 20     -0.70000        0.993991        0.981216        0.007106        0.007913
 21     -0.67500        0.996255        0.981226        0.007640        0.007907
 22     -0.65000        0.993539        0.981243        0.006665        0.007899
 23     -0.62500        0.992970        0.981255        0.007051        0.007892
 24     -0.60000        0.993107        0.981264        0.007062        0.007888
 25     -0.57500        0.995798        0.981268        0.008192        0.007885
 26     -0.55000        0.992850        0.981280        0.006113        0.007880
 27     -0.52500        0.993973        0.981283        0.006681        0.007878
 28     -0.50000        0.992946        0.981288        0.007187        0.007876
 29     -0.47500        0.995119        0.981286        0.008727        0.007876
 30     -0.45000        0.992526        0.981290        0.006392        0.007874
 31     -0.42500        0.994838        0.981284        0.006397        0.007877
 32     -0.40000        0.993108        0.981283        0.007279        0.007878
 33     -0.37500        0.965807        0.981321        0.014187        0.007859
 34     -0.35000        0.994698        0.981267        0.006676        0.007886
 35     -0.32500        0.968575        0.981298        0.014456        0.007870
 36     -0.30000        0.997365        0.981240        0.008152        0.007900
 37     -0.27500        0.966109        0.981276        0.014767        0.007882
 38     -0.25000        0.997717        0.981209        0.007305        0.007916
 39     -0.22500        0.975076        0.981226        0.014161        0.007908
 40     -0.20000        0.999112        0.981167        0.008582        0.007938
 41     -0.17500        0.977204        0.981180        0.013733        0.007932
 42     -0.15000        0.980634        0.981150        0.012837        0.007947
 43     -0.12500        0.983326        0.981119        0.010053        0.007963
 44     -0.10000        0.993364        0.981074        0.008866        0.007986
 45     -0.07500        0.985444        0.981058        0.009746        0.007995
 46     -0.05000        0.987966        0.981019        0.009508        0.008015
 47     -0.02500        0.991362        0.980975        0.009141        0.008038
 48      0.0            0.991315        0.980941        0.009211        0.008056
 49      0.02500        0.990267        0.980900        0.009476        0.008077
 50      0.05000        0.988240        0.980862        0.009608        0.008097
 51      0.07500        0.986763        0.980817        0.010179        0.008121
 52      0.10000        0.986141        0.980769        0.010039        0.008146
 53      0.12500        0.985535        0.980715        0.010506        0.008174
 54      0.15000        0.983581        0.980660        0.010526        0.008203
 55      0.17500        0.982201        0.980595        0.010912        0.008238
 56      0.20000        0.987375        0.980469        0.010904        0.008304
```

Figure 67 (Continued)

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                                         ANALYSIS OF INTERFACIAL RIPPLE DATA MEASURED AT THE POLARIZED 10**(-6) M NADS

                                   IN M/20 NA2SO4---DATA OF G.P.BIERWAGEN(3-19-68) TRY#2

MEASUREMENTS MADE AT M/10**6 NADS IN M/20 NA2SO4             /      PURE MERCURY                          INTERFACE
0.000001-M NADS        IN 0.050-M NA2SO4



DENSITY OF UPPER PHASE   0.99700   DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE   0.0089400   VISCOSITY OF LOWER PHASE   0.0152700

ORIGINAL OUTPUT VOLTAGE     4.87900000 MV.

INITIAL DAMPING COEFFICIENT   0.57782 1/CM.

WAVELENGTH 0.11770 CM.

PROBE SEPARATION =    1.72800 CM.

WAVENUMBER =    53.383002 RECIPROCAL CM.



                   INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM


SURFACTANT CONCENTRATION= 0.000001-M NADS

ELECTROCAPILLARY MAXIMUM IS   -0.47500 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=    1.50000

ELECTRICAL DESORPTION EXPONENT =   12.50000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =   13.50000

DIFFUSION TERM=     455.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000010

SURFACTANT SURFACE VISCOSITY= 0.000500

 1/BC = FRUMKIN CONCENTRATION CONSTANT=  0.000250
```

Figure 68. YCOR data listing for 10^{-6}-M NaDS in .05-M Na_2SO_4

```
                                                  INPUT DATA

 NO.          POL.VOLTAGE          FREQUENCY          OUTPUT VOLTAGE(MV.)          GAMMA
  1            0.225000           302.200000            13.323000             344.500000
  2            0.200000           304.700000            13.039000             352.300000
  3            0.175000           307.300000            12.581000             360.000000
  4            0.150000           309.400000            12.441000             366.500000
  5            0.125000           311.400000            12.597000             372.000000
  6            0.100000           313.300000            12.291000             378.500000
  7            0.075000           315.100000            11.714000             384.000000
  8            0.050000           316.600000            12.457000             389.452300
  9            0.025000           318.300000            11.705000             392.949400
 10           -0.0                319.500000            11.365000             396.499700
 11           -0.025000           320.800000            11.274000             399.989700
 12           -0.050000           321.300000            12.043000             403.338800
 13           -0.075000           322.200000            11.927000             406.488000
 14           -0.100000           323.400000            10.762000             409.398600
 15           -0.125000           324.900000             9.733000             412.049800
 16           -0.150000           325.400000             9.279000             414.432100
 17           -0.175000           326.400000             6.503000             416.546100
 18           -0.200000           326.600000             6.606000             418.398900
 19           -0.225000           326.800000             5.251000             420.004100
 20           -0.250000           326.400000             4.313000             421.378100
 21           -0.275000           327.400000             4.560000             422.536800
 22           -0.300000           327.300000             4.480000             423.498000
 23           -0.325000           327.600000             4.594000             424.278300
 24           -0.350000           330.900000             4.685000             424.892300
 25           -0.375000           331.600000             4.410000             425.352500
 26           -0.400000           331.900000             4.376000             425.669900
 27           -0.425000           332.000000             4.447000             425.851300
 28           -0.450000           332.300000             4.576000             425.902800
 29           -0.475000           332.500000             4.699000             425.826400
 30           -0.500000           332.300000             4.879000             425.622800
 31           -0.525000           332.600000             5.092000             425.291700
 32           -0.550000           332.100000             5.278000             424.829100
 33           -0.575000           332.000000             5.299000             424.233600
 34           -0.600000           331.600000             5.301000             423.500700
 35           -0.625000           331.700000             5.173000             422.627400
 36           -0.650000           331.100000             5.912000             421.612000
 37           -0.675000           331.100000             6.532000             420.452800
 38           -0.700000           330.300000             6.485000             419.150900
 39           -0.725000           329.900000             6.759000             417.708400
 40           -0.750000           329.300000             7.147000             416.130800
 41           -0.775000           328.500000             7.791000             414.424500
 42           -0.800000           327.900000             7.891000             412.598600
 43           -0.825000           327.300000             7.902000             410.665700
 44           -0.850000           326.600000             8.147000             408.638400
 45           -0.875000           325.600000             8.674000             406.529700
 46           -0.900000           324.700000             8.638000             404.354000
 47           -0.925000           324.200000             8.688000             402.125000
 48           -0.950000           323.300000             9.378000             399.852700
 49           -0.975000           322.300000             9.308000             397.544600
 50           -1.000000           321.200000            10.024000             395.202100
 51           -1.025000           320.600000            10.181000             392.816400
 52           -1.050000           320.100000            10.039000             390.360300
 53           -1.075000           319.200000            10.653000             387.804900
 54           -1.100000           318.600000            10.791000             385.116600
 55           -1.125000           318.100000            10.695000             382.201400
 56           -1.150000           317.100000            11.426000             378.966000
 57           -1.175000           316.800000            11.446000             375.288300
 58           -1.200000           316.500000            11.445000             370.994600
```

Figure 68. (Continued)

```
INITIAL FREQUENCY =  332.30000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                          0.3830480050D 05    FREQUENCY** 0
                         -0.9174423636D 05    FREQUENCY** 1
                          0.9407638208D 05    FREQUENCY** 2
                         -0.5353771778D 05    FREQUENCY** 3
                          0.1826156901D 05    FREQUENCY** 4
                         -0.3733478368D 04    FREQUENCY** 5
                          0.4236053609D 03    FREQUENCY** 6
                         -0.2057672356D 02    FREQUENCY** 7
                          0.0                 FREQUENCY** 8
                          0.0                 FREQUENCY** 9
                          0.0                 FREQUENCY**10

NO.     FREQUENCY     CORRECTED OUTPUT VOLTAGE          NO.     FREQUENCY     CORRECTED OUTPUT VOLTAGE
  1     302.20000          7.03561                      30      332.30000          4.87900
  2     304.70000          7.16365                      31      332.60000          5.43733
  3     307.30000          7.22393                      32      332.10000          5.07752
  4     309.40000          7.41807                      33      332.00000          5.00660
  5     311.40000          7.74727                      34      331.60000          4.69599
  6     313.30000          7.76614                      35      331.70000          4.65201
  7     315.10000          7.55145                      36      331.10000          4.90272
  8     316.60000          8.12271                      37      331.10000          5.41688
  9     318.30000          7.68231                      38      330.30000          4.96367
 10     319.50000          7.46396                      39      329.90000          5.01559
 11     320.80000          7.38712                      40      329.30000          5.10782
 12     321.30000          7.87938                      41      328.50000          5.36621
 13     322.20000          7.77988                      42      327.90000          5.32783
 14     323.40000          6.99439                      43      327.30000          5.25744
 15     324.90000          6.32179                      44      326.60000          5.35661
 16     325.40000          6.03722                      45      325.60000          5.64958
 17     326.40000          4.26496                      46      324.70000          5.60857
 18     326.60000          4.34341                      47      324.20000          5.63984
 19     326.80000          3.46245                      48      323.30000          6.09638
 20     326.40000          2.82866                      49      322.30000          6.06945
 21     327.40000          3.04038                      50      321.20000          6.56046
 22     327.30000          2.98068                      51      320.60000          6.67439
 23     327.60000          3.07726                      52      320.10000          6.58825
 24     330.90000          3.79814                      53      319.20000          6.99720
 25     331.60000          3.90668                      54      318.60000          7.08562
 26     331.90000          4.06395                      55      318.10000          7.01651
 27     332.00000          4.20162                      56      317.10000          7.47008
 28     332.30000          4.57600                      57      316.80000          7.47188
 29     332.50000          4.90375                      58      316.50000          7.45836
```

Figure 68 (Continued)

```
NO.   FLL.VOLTAGE   GAMMA(EXPT.)CALC.E=0   THETA FROM MODEL   ALPHA(EXPTL)   ALPHA(MODEL)
 1      0.22500         355.10165             0.000009          0.365989       0.411688
 2      0.20000         360.90520             0.000014          0.355548       0.407899
 3      0.17500         366.99966             0.000021          0.350702       0.404463
 4      0.15000         371.94435             0.000030          0.335356       0.401582
 5      0.12500         376.69625             0.000044          0.310227       0.399473
 6      0.10000         381.23373             0.000064          0.308819       0.396555
 7      0.07500         385.55382             0.000091          0.325042       0.394377
 8      0.05000         389.18420             0.000127          0.282841       0.391976
 9      0.02500         393.30331             0.000176          0.315100       0.391267
10     -0.0             396.22456             0.000239          0.331786       0.390003
11     -0.02500         399.40432             0.000318          0.337775       0.388905
12     -0.05000         400.64015             0.000419          0.300442       0.387088
13     -0.07500         402.85202             0.000542          0.307796       0.385846
14     -0.10000         405.79598             0.000691          0.369390       0.385092
15     -0.12500         409.48999             0.000866          0.427900       0.384831
16     -0.15000         410.72036             0.001070          0.454554       0.383736
17     -0.17500         413.07986             0.001302          0.655660       0.383340
18     -0.20000         413.58730             0.001559          0.645111       0.382312
19     -0.22500         413.96571             0.001838          0.776294       0.381456
20     -0.25000         412.83581             0.002134          0.893293       0.380154
21     -0.27500         415.38161             0.002438          0.851523       0.380406
22     -0.30000         415.11819             0.002742          0.862998       0.379683
23     -0.32500         415.88980             0.003038          0.844546       0.379482
24     -0.35000         424.31603             0.003313          0.722743       0.382388
25     -0.37500         426.10248             0.003555          0.706438       0.382790
26     -0.40000         426.88368             0.003756          0.683599       0.382886
27     -0.42500         427.15432             0.003908          0.664319       0.382871
28     -0.45000         427.95630             0.004001          0.614924       0.383138
29     -0.47500         428.49413             0.004033          0.574891       0.383389
30     -0.50000         427.98417             0.004001          0.577820       0.383323
31     -0.52500         428.78771             0.003908          0.515119       0.383837
32     -0.55000         427.49270             0.003756          0.554740       0.383639
33     -0.57500         427.23346             0.003555          0.562879       0.383927
34     -0.60000         426.19279             0.003313          0.599945       0.384006
35     -0.62500         426.44201             0.003038          0.605390       0.384678
36     -0.65000         424.94537             0.002742          0.575013       0.384744
37     -0.67500         424.98326             0.002438          0.517299       0.385509
38     -0.70000         422.92921             0.002134          0.567864       0.385567
39     -0.72500         421.92457             0.001838          0.561842       0.386125
40     -0.75000         420.42072             0.001559          0.551297       0.386575
41     -0.77500         418.42839             0.001302          0.522738       0.386912
42     -0.80000         416.92126             0.001070          0.526892       0.387537
43     -0.82500         415.41467             0.000866          0.534588       0.388241
44     -0.85000         413.67254             0.000691          0.523774       0.388913
45     -0.87500         411.19830             0.000542          0.492958       0.389335
46     -0.90000         408.95983             0.000419          0.497174       0.389911
47     -0.92500         407.72190             0.000318          0.493957       0.390944
48     -0.95000         405.51766             0.000239          0.448911       0.391595
49     -0.97500         403.04951             0.000176          0.451473       0.392170
50     -1.00000         400.36348             0.000127          0.406454       0.392668
51     -1.02500         398.89557             0.000091          0.396490       0.393735
52     -1.05000         397.66853             0.000064          0.404008       0.394976
53     -1.07500         395.48162             0.000044          0.369157       0.395882
54     -1.10000         394.02129             0.000030          0.361890       0.397230
55     -1.12500         392.80284             0.000021          0.367562       0.398882
56     -1.15000         390.38517             0.000014          0.331312       0.400266
57     -1.17500         389.65834             0.000009          0.331173       0.402792
58     -1.20000         388.93190             0.000005          0.332221       0.405858
```

Figure 68 (Continued)

NO.	POL.VOLTAGE	RE(E)-EXPT.	RE(E)-MODEL	IM(E)-EXPT.	IM(E)-MODEL
1	0.22500	7.447820	-0.000304	4.272338	-0.000891
2	0.20000	6.025104	-0.001184	3.484890	-0.001383
3	0.17500	4.366969	-0.001675	2.860765	-0.002103
4	0.15000	2.107692	-0.002244	2.900093	-0.003114
5	0.12500	0.926057	-0.002819	3.830145	-0.004470
6	0.10000	-2.650714	-0.003275	5.300587	-0.006174
7	0.07500	-5.567637	-0.003467	6.596795	-0.008150
8	0.05000	-5.467562	-0.003266	12.123165	-0.010240
9	0.02500	-7.010221	-0.002625	9.927379	-0.012289
10	-0.0	-8.830081	-0.001556	11.578118	-0.014119
11	-0.02500	-9.587862	-0.000126	12.603236	-0.015679
12	-0.05000	-5.495356	0.001653	18.704850	-0.016916
13	-0.07500	-4.332687	0.003726	21.013273	-0.017916
14	-0.10000	-7.443202	0.006111	24.635093	-0.018722
15	-0.12500	-17.435963	0.008811	26.821489	-0.019381
16	-0.15000	-11.422366	0.011853	35.682207	-0.019854
17	-0.17500	44.167418	0.015228	52.141967	-0.020261
18	-0.20000	27.477629	0.018908	45.628495	-0.020546
19	-0.22500	28.396736	0.022873	27.454323	-0.020778
20	-0.25000	23.173980	0.027041	21.797296	-0.020931
21	-0.27500	25.642421	0.031314	23.207070	-0.021135
22	-0.30000	23.552051	0.035578	22.863200	-0.021247
23	-0.32500	23.539381	0.039718	23.562947	-0.021363
24	-0.35000	52.866712	0.043567	0.099427	-0.021643
25	-0.37500	42.635503	0.046962	-12.318681	-0.021749
26	-0.40000	37.613093	0.049783	-18.327072	-0.021815
27	-0.42500	34.977136	0.051910	-23.285897	-0.021856
28	-0.45000	18.475898	0.053222	-26.169943	-0.021894
29	-0.47500	8.732003	0.053664	-20.868486	-0.021913
30	-0.50000	8.822036	0.053222	-23.768702	-0.021894
31	-0.52500	2.596954	0.051910	-11.649073	-0.021892
32	-0.55000	4.769380	0.049783	-19.667513	-0.021827
33	-0.57500	7.097996	0.046962	-17.741864	-0.021773
34	-0.60000	13.554928	0.043568	-20.824243	-0.021686
35	-0.62500	13.665190	0.039722	-13.345517	-0.021613
36	-0.65000	9.366326	0.035581	-15.938994	-0.021478
37	-0.67500	5.514183	0.031316	-7.998491	-0.021360
38	-0.70000	8.833062	0.027043	-13.157811	-0.021166
39	-0.72500	8.676584	0.022874	-10.899227	-0.020964
40	-0.75000	7.685900	0.018908	-10.201612	-0.020708
41	-0.77500	4.439178	0.015228	-9.834993	-0.020386
42	-0.80000	5.499945	0.011851	-8.886403	-0.020002
43	-0.82500	6.856748	0.008808	-7.770801	-0.019521
44	-0.85000	6.546848	0.006104	-6.456516	-0.018907
45	-0.87500	3.916803	0.003715	-5.877979	-0.018108
46	-0.90000	3.939559	0.001638	-6.189163	-0.017103
47	-0.92500	5.765922	-0.000148	-3.825403	-0.015859
48	-0.95000	4.197618	-0.001587	-1.837800	-0.014309
49	-0.97500	3.935511	-0.002666	-2.109014	-0.012473
50	-1.00000	2.167191	-0.003323	-0.334835	-0.010427
51	-1.02500	3.735810	-0.003540	0.749369	-0.008337
52	-1.05000	5.602319	-0.003365	1.441046	-0.006359
53	-1.07500	5.513849	-0.002913	2.591621	-0.004630
54	-1.10000	6.613508	-0.002336	3.414995	-0.003249
55	-1.12500	7.880998	-0.001758	4.194640	-0.002213
56	-1.15000	7.971172	-0.001254	5.002151	-0.001467
57	-1.17500	9.184993	-0.000861	6.054044	-0.000956
58	-1.20000	10.067492	-0.000572	7.059225	-0.000611

Figure 68 (Continued)

```
NO.     POL.VOLTAGE       Y1-EXPT.        Y1-MODEL        Y2-EXPT.        Y2-MODEL

  1       0.22500         0.995645        0.981798        0.006856        0.007635
  2       0.20000         0.993753        0.981903        0.006660        0.007581
  3       0.17500         0.989165        0.982002        0.006570        0.007529
  4       0.15000         0.984947        0.982085        0.006282        0.007487
  5       0.12500         0.982971        0.982150        0.005811        0.007453
  6       0.10000         0.977915        0.982231        0.005785        0.007412
  7       0.07500         0.975016        0.982296        0.006089        0.007379
  8       0.05000         0.970541        0.982363        0.005298        0.007346
  9       0.02500         0.972261        0.982398        0.005903        0.007329
 10      -0.0             0.970834        0.982439        0.006215        0.007309
 11      -0.02500         0.970211        0.982478        0.006327        0.007290
 12      -0.05000         0.965156        0.982522        0.005628        0.007269
 13      -0.07500         0.963052        0.982559        0.005766        0.007251
 14      -0.10000         0.963341        0.982591        0.006920        0.007237
 15      -0.12500         0.966042        0.982616        0.008016        0.007225
 16      -0.15000         0.963447        0.982646        0.008515        0.007211
 17      -0.17500         0.964458        0.982669        0.012282        0.007202
 18      -0.20000         0.961365        0.982695        0.012085        0.007190
 19      -0.22500         0.958864        0.982719        0.014542        0.007180
 20      -0.25000         0.953399        0.982744        0.016734        0.007170
 21      -0.27500         0.956619        0.982754        0.015951        0.007166
 22      -0.30000         0.953865        0.982772        0.016166        0.007160
 23      -0.32500         0.953857        0.982783        0.015821        0.007156
 24      -0.35000         0.971764        0.982765        0.013539        0.007167
 25      -0.37500         0.974824        0.982768        0.013233        0.007167
 26      -0.40000         0.975861        0.982772        0.012806        0.007166
 27      -0.42500         0.976033        0.982775        0.012444        0.007165
 28      -0.45000         0.977679        0.982774        0.011519        0.007166
 29      -0.47500         0.979032        0.982772        0.010769        0.007168
 30      -0.50000         0.978323        0.982770        0.010824        0.007168
 31      -0.52500         0.980853        0.982762        0.009649        0.007172
 32      -0.55000         0.978971        0.982759        0.010392        0.007172
 33      -0.57500         0.979755        0.982749        0.010544        0.007176
 34      -0.60000         0.979087        0.982740        0.011238        0.007179
 35      -0.62500         0.981702        0.982724        0.011340        0.007185
 36      -0.65000         0.980509        0.982712        0.010771        0.007189
 37      -0.67500         0.983212        0.982693        0.009690        0.007197
 38      -0.70000         0.981506        0.982679        0.010638        0.007202
 39      -0.72500         0.982512        0.982660        0.010525        0.007210
 40      -0.75000         0.982652        0.982640        0.010327        0.007218
 41      -0.77500         0.981910        0.982621        0.009792        0.007225
 42      -0.80000         0.982656        0.982598        0.009870        0.007235
 43      -0.82500         0.983671        0.982574        0.010014        0.007246
 44      -0.85000         0.984327        0.982550        0.009812        0.007256
 45      -0.87500         0.983383        0.982528        0.009234        0.007266
 46      -0.90000         0.983216        0.982504        0.009313        0.007277
 47      -0.92500         0.985624        0.982476        0.009253        0.007290
 48      -0.95000         0.985729        0.982451        0.008409        0.007302
 49      -0.97500         0.985328        0.982426        0.008457        0.007314
 50      -1.00000         0.984415        0.982402        0.007614        0.007325
 51      -1.02500         0.986697        0.982373        0.007427        0.007339
 52      -1.05000         0.989810        0.982343        0.007568        0.007354
 53      -1.07500         0.990738        0.982314        0.006915        0.007369
 54      -1.10000         0.993907        0.982281        0.006779        0.007386
 55      -1.12500         0.998347        0.982242        0.006885        0.007405
 56      -1.15000         1.000549        0.982203        0.006206        0.007425
 57      -1.17500         1.008444        0.982150        0.006204        0.007452
 58      -1.20000         1.018184        0.982087        0.006223        0.007484
```

Figure 68 (Continued)

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                                   ANALYSIS OF INTERFACIAL RIPPLE DATA MEASURED AT THE POLARIZED 10**(-5) M NADS
                          IN M/20 NA2SO4---DATA OF G.P.BIERWAGEN(3-22-68) TRY#1
MEASUREMENTS MADE AT M/10**5 NADS IN M/20 NA2SO4            /      PURE MERCURY                        INTERFACE
0.000010-M NADS        IN 0.050-M NA2SO4



DENSITY OF UPPER PHASE   0.99700   DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE   0.0089400   VISCOSITY OF LOWER PHASE   0.0152700

ORIGINAL OUTPUT VOLTAGE    10.44400000 MV.

INITIAL DAMPING COEFFICIENT   0.56110 1/CM.

WAVELENGTH 0.12820 CM.

PROBE SEPARATION =    2.10100  CM.

WAVENUMBER =    49.010759 RECIPROCAL CM.



                  INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM



SURFACTANT CONCENTRATION= 0.000010-M NADS

ELECTROCAPILLARY MAXIMUM IS   -0.45000 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=     1.50000

ELECTRICAL DESORPTION EXPONENT =   12.50000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =   13.50000

DIFFUSION TERM=      455.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000010

SURFACTANT SURFACE VISCOSITY= 0.000500

 1/B0 = FRUMKIN CONCENTRATION CONSTANT=  0.000250
```

Figure 69. Data listing from YCOR for 10^{-5}-M NaDS in .05-M Na_2SO_4

```
                                                  INPUT DATA

 NO.          POL.VOLTAGE          FREQUENCY          OUTPUT VOLTAGE(MV.)          GAMMA
  1            0.200000           267.700000              14.961000              361.300000
  2            0.150000           271.800000              13.912000              371.000000
  3            0.125000           273.500000              13.567000              375.700000
  4            0.100000           275.300000              12.710000              380.000000
  5            0.075000           277.300000              12.123000              384.354400
  6            0.050000           279.100000              12.028000              388.427200
  7            0.025000           280.700000              12.426000              392.503100
  8           -0.0                282.400000              12.208000              396.399400
  9           -0.025000           283.300000              12.055000              400.008500
 10           -0.050000           284.100000              12.776000              403.281700
 11           -0.075000           284.900000              12.690000              406.207200
 12           -0.100000           285.700000              12.269000              408.800200
 13           -0.125000           286.400000              10.637000              411.089100
 14           -0.150000           286.900000               9.031000              413.110500
 15           -0.175000           287.100000               7.103000              414.901600
 16           -0.200000           287.100000               5.850000              416.496000
 17           -0.225000           287.300000               6.391000              417.923800
 18           -0.250000           290.500000               7.369000              419.207000
 19           -0.275000           291.100000               7.379000              420.361300
 20           -0.300000           291.700000               7.836000              421.395700
 21           -0.325000           292.100000               8.199000              422.313200
 22           -0.350000           292.600000               8.363000              423.112700
 23           -0.375000           292.900000               8.349000              423.787800
 24           -0.400000           293.200000               8.848000              424.331500
 25           -0.425000           293.300000               9.219000              424.735100
 26           -0.450000           293.400000               9.668000              424.990700
 27           -0.475000           293.500000               9.951000              425.089500
 28           -0.500000           293.400000              10.444000              425.027500
 29           -0.525000           293.400000              10.267000              424.799800
 30           -0.550000           293.200000              10.870000              424.407400
 31           -0.575000           293.100000              11.053000              423.850000
 32           -0.600000           292.800000              11.424000              423.133700
 33           -0.625000           292.500000              11.572000              422.263400
 34           -0.650000           292.300000              11.304000              421.247000
 35           -0.675000           291.800000              11.951000              420.094700
 36           -0.700000           291.500000              12.225000              418.815600
 37           -0.725000           290.900000              12.260000              417.417400
 38           -0.750000           290.300000              12.629000              415.910100
 39           -0.775000           289.800000              12.733000              414.295400
 40           -0.800000           289.200000              12.568000              412.590800
 41           -0.825000           288.700000              12.253000              410.784100
 42           -0.850000           287.800000              12.681000              408.887200
 43           -0.875000           287.100000              12.582000              406.892500
 44           -0.900000           286.400000              12.490000              404.906800
 45           -0.925000           285.700000              12.285000              402.598300
 46           -0.950000           284.900000              12.437000              400.284900
 47           -0.975000           284.300000              12.291000              397.868400
 48           -1.000000           283.400000              12.094000              395.322900
 49           -1.025000           282.600000              11.979000              392.680400
 50           -1.050000           281.900000              12.247000              389.889800
 51           -1.075000           281.000000              12.129000              386.957500
 52           -1.100000           280.600000              11.810000              383.968200
 53           -1.125000           279.800000              11.747000              380.859100
 54           -1.150000           279.200000              11.528000              377.640600
 55           -1.175000           278.100000              11.754000              374.382800
 56           -1.200000           277.400000              12.048000              371.015600
 57           -1.225000           276.600000              11.854000              367.574200
 58           -1.250000           276.000000              12.135000              364.023400
```

Figure 69 (Continued)

```
INITIAL FREQUENCY =  293.40000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                          0.3830490050D 05     FREQUENCY** 0
                         -0.9174423635D 05     FREQUENCY** 1
                          0.9407638208D 05     FREQUENCY** 2
                         -0.5353771775D 05     FREQUENCY** 3
                          0.1826156901D 05     FREQUENCY** 4
                         -0.3733478368D 04     FREQUENCY** 5
                          0.4236053609D 03     FREQUENCY** 6
                         -0.2057672356D 00     FREQUENCY** 7
                          0.0                  FREQUENCY** 8
                          0.0                  FREQUENCY** 9
                          0.0                  FREQUENCY**10

NO.      FREQUENCY     CORRECTED OUTPUT VOLTAGE          NO.      FREQUENCY     CORRECTED OUTPUT VOLTAGE
 1       267.70000          28.42121                     30       293.20000          10.92201
 2       271.80000          23.76096                     31       293.10000          11.13244
 3       273.50000          22.18212                     32       292.80000          11.58888
 4       275.30000          19.84827                     33       292.50000          11.82356
 5       277.30000          17.99624                     34       292.30000          11.60516
 6       279.10000          17.06457                     35       291.80000          12.41732
 7       280.70000          16.93773                     36       291.50000          12.79380
 8       282.40000          15.95190                     37       290.90000          13.01683
 9       283.30000          15.40501                     38       290.30000          13.60381
10       284.10000          16.00726                     39       289.80000          13.88234
11       284.90000          15.58961                     40       289.20000          13.90269
12       285.70000          14.77945                     41       288.70000          13.71942
13       286.40000          12.59589                     42       287.80000          14.51238
14       286.90000          10.56435                     43       287.10000          14.64664
15       287.10000           8.26857                     44       286.40000          14.79013
16       287.10000           6.80996                     45       285.70000          14.79872
17       287.30000           7.40355                     46       284.90000          15.27880
18       290.50000           7.89962                     47       284.30000          15.32392
19       291.10000           7.79692                     48       283.40000          15.41671
20       291.70000           8.16132                     49       282.60000          15.51028
21       292.10000           8.45786                     50       281.90000          16.20261
22       292.60000           8.52438                     51       281.00000          16.40973
23       292.90000           8.44928                     52       280.60000          16.13827
24       293.20000           8.89033                     53       279.80000          16.37622
25       293.30000           9.24102                     54       279.20000          16.31424
26       293.40000           9.66800                     55       278.10000          17.10013
27       293.50000           9.92729                     56       277.40000          17.83982
28       293.40000          10.44400                     57       276.60000          17.91102
29       293.40000          10.26700                     58       276.00000          18.61645
```

Figure 69 (Continued)

```
NO.     POL.VOLTAGE     GAMMA(EXPT.)CALC.E=0     THETA FROM MODEL     ALPHA(EXPTL)     ALPHA(MODEL)
 1        0.20000          360.67934               0.000204            0.094609         0.359047
 2        0.15000          371.60989               0.000445            0.169850         0.355870
 3        0.12500          376.18668               0.000642            0.202576         0.354554
 4        0.10000          381.05837               0.000913            0.255489         0.353663
 5        0.07500          386.50549               0.001279            0.302111         0.352986
 6        0.05000          391.44316               0.001764            0.327413         0.352301
 7        0.02500          395.86432               0.002395            0.330964         0.351416
 8       -0.0              400.58005               0.003203            0.359505         0.350773
 9       -0.02500          403.08667               0.004219            0.376109         0.349474
10       -0.05000          405.33514               0.005473            0.357856         0.348304
11       -0.07500          407.57712               0.006994            0.370440         0.347370
12       -0.10000          409.81899               0.008804            0.395841         0.346658
13       -0.12500          411.75318               0.010917            0.471932         0.346043
14       -0.15000          413.10729               0.013336            0.555647         0.345398
15       -0.17500          413.56535               0.016047            0.672269         0.344595
16       -0.20000          413.45984               0.019020            0.764642         0.343720
17       -0.22500          414.07406               0.022203            0.724864         0.343166
18       -0.25000          423.22939               0.025524            0.693995         0.345796
19       -0.27500          424.94362               0.028888            0.700224         0.345831
20       -0.30000          426.69276               0.032184            0.678483         0.345942
21       -0.32500          427.86304               0.035286            0.661495         0.345918
22       -0.35000          429.30914               0.038063            0.657767         0.346059
23       -0.37500          430.17110               0.040387            0.661979         0.346056
24       -0.40000          431.06385               0.042139            0.637760         0.346111
25       -0.42500          431.37168               0.043231            0.619346         0.346019
26       -0.45000          431.68182               0.043602            0.597847         0.345984
27       -0.47500          431.98306               0.043231            0.585250         0.346011
28       -0.50000          431.71495               0.042139            0.561100         0.345899
29       -0.52500          431.70786               0.040387            0.569235         0.345961
30       -0.55000          431.15395               0.038063            0.539799         0.345896
31       -0.57500          430.87198               0.035286            0.530717         0.346018
32       -0.60000          430.01947               0.032184            0.511591         0.346024
33       -0.62500          429.16009               0.028888            0.502049         0.346122
34       -0.65000          428.57636               0.025524            0.510923         0.346414
35       -0.67500          427.15814               0.022203            0.478727         0.346488
36       -0.70000          426.30399               0.019020            0.464511         0.346854
37       -0.72500          424.58467               0.016047            0.456285         0.346995
38       -0.75000          422.87629               0.013336            0.435292         0.347213
39       -0.77500          421.45022               0.010917            0.425645         0.347611
40       -0.80000          419.73595               0.008804            0.424948         0.347971
41       -0.82500          418.30624               0.006994            0.431264         0.348506
42       -0.85000          415.75959               0.005473            0.404520         0.348688
43       -0.87500          413.77536               0.004219            0.400137         0.349144
44       -0.90000          411.79599               0.003203            0.395497         0.349663
45       -0.92500          409.81929               0.002395            0.395220         0.350264
46       -0.95000          407.57294               0.001764            0.380025         0.350832
47       -0.97500          405.88763               0.001279            0.378621         0.351688
48       -1.00000          403.36659               0.000913            0.375748         0.352321
49       -1.02500          401.13245               0.000642            0.372868         0.353142
50       -1.05000          399.18996               0.000445            0.352083         0.354190
51       -1.07500          396.69102               0.000303            0.346037         0.355139
52       -1.10000          395.57898               0.000204            0.353977         0.356698
53       -1.12500          393.36810               0.000135            0.347010         0.357925
54       -1.15000          391.71146               0.000087            0.348815         0.359475
55       -1.17500          388.69227               0.000056            0.326422         0.360520
56       -1.20000          386.77825               0.000036            0.306266         0.362114
57       -1.22500          384.59031               0.000022            0.304371         0.363677
58       -1.25000          382.95775               0.000014            0.285984         0.365578
```

Figure 69 (Continued)

```
NO.   PCL.VOLTAGE      RE(E)-EXPT.      RE(F)-MODEL      IM(E)-EXPT.      IM(F)-MODEL
 1      0.20000          1.066380        -0.001130        13.284027        -0.001927
 2      0.15000         -1.390147        -0.001217        12.127912        -0.004486
 3      0.12500         -2.662423        -0.000497        12.321190        -0.006516
 4      0.10000         -5.119389         0.001298        10.760045        -0.009057
 5      0.07500         -6.573802         0.004691         6.541491        -0.011970
 6      0.05000         -5.726021         0.010163         3.077174        -0.014998
 7      0.02500         -4.845530         0.019134         2.217167        -0.017894
 8     -0.0             -2.711784         0.028966        -0.694662        -0.020500
 9     -0.02500         -7.323919         0.043012        -1.764916        -0.022698
10     -0.05000        -11.046809         0.060668         2.430458        -0.024524
11     -0.07500        -15.323973         0.082360         3.859317        -0.026032
12     -0.10000        -21.190498         0.108491         2.739462        -0.027281
13     -0.12500        -51.584521         0.139413       -22.258498        -0.028326
14     -0.15000        169.075901         0.175352       -76.698995        -0.029213
15     -0.17500         46.701438         0.216354        19.381660        -0.029978
16     -0.20000         31.491281         0.262194        19.401947        -0.030654
17     -0.22500         31.174242         0.312336        23.722626        -0.031279
18     -0.25000         26.423740         0.365875        -3.532465        -0.031998
19     -0.27500         24.818685         0.421289        -2.695293        -0.032551
20     -0.30000         22.502722         0.476777        -3.482468        -0.033059
21     -0.32500         21.380448         0.530095        -4.148428        -0.033508
22     -0.35000         19.988564         0.578729        -3.325614        -0.033904
23     -0.37500         19.861518         0.620069        -2.846286        -0.034222
24     -0.40000         18.379640         0.651660        -3.276409        -0.034462
25     -0.42500         17.660692         0.671511        -4.110729        -0.034606
26     -0.45000         16.450168         0.678287        -4.665426        -0.034658
27     -0.47500         15.550492         0.671515        -4.521541        -0.034617
28     -0.50000         14.180353         0.651664        -5.434619        -0.034472
29     -0.52500         14.575253         0.620080        -4.777175        -0.034248
30     -0.55000         12.715566         0.578743        -5.441351        -0.033934
31     -0.57500         12.111262         0.530117        -4.747997        -0.033558
32     -0.60000         10.835271         0.476801        -4.950396        -0.033114
33     -0.62500         10.206327         0.421320        -4.785045        -0.032619
34     -0.65000         10.912514         0.365914        -3.878747        -0.032085
35     -0.67500          8.888488         0.312433        -3.916228        -0.031492
36     -0.70000          8.523636         0.262287        -2.717103        -0.030861
37     -0.72500          7.760345         0.216432        -3.067687        -0.030156
38     -0.75000          6.498159         0.175420        -2.717827        -0.029372
39     -0.77500          6.335737         0.139479        -2.035962        -0.028485
40     -0.80000          6.265349         0.108555        -1.991974        -0.027445
41     -0.82500          6.970882         0.082424        -1.596046        -0.026212
42     -0.85000          5.053918         0.060724        -1.526530        -0.024700
43     -0.87500          4.904799         0.043060        -1.296917        -0.022880
44     -0.90000          4.913170         0.029002        -0.944948        -0.020691
45     -0.92500          5.240375         0.018159        -0.630288        -0.018127
46     -0.95000          4.920603         0.010164         0.032088        -0.015253
47     -0.97500          5.855299         0.004661         0.793002        -0.012249
48     -1.00000          5.796663         0.001235         0.929652        -0.009331
49     -1.02500          6.182382        -0.000585         1.384411        -0.006762
50     -1.05000          6.632515        -0.001315         2.527416        -0.004690
51     -1.07500          6.888981        -0.001414         2.943750        -0.003138
52     -1.10000          8.237951        -0.001220         3.917765        -0.002054
53     -1.12500          8.567376        -0.000936         4.469850        -0.001318
54     -1.15000          9.173659        -0.000669         5.160440        -0.000836
55     -1.17500          9.001088        -0.000453         5.435869        -0.000523
56     -1.20000          9.254939        -0.000296         6.078209        -0.000324
57     -1.22500          9.523095        -0.000188         6.451417        -0.000199
58     -1.25000          9.774651        -0.000116         7.019489        -0.000120
```

Figure 69 (Continued)

```
 NO.     POL.VOLTAGE        Y1-EXPT.        Y1-MODEL        Y2-EXPT.        Y2-MODEL

  1        0.20000          0.966519        0.982453        0.001726        0.007311
  2        0.15000          0.970300        0.982556        0.003466        0.007259
  3        0.12500          0.970195        0.982609        0.004133        0.007233
  4        0.10000          0.971874        0.982655        0.005213        0.007211
  5        0.07500          0.974875        0.982700        0.006164        0.007190
  6        0.05000          0.977217        0.982744        0.006680        0.007171
  7        0.02500          0.978189        0.982793        0.006753        0.007151
  8       -0.0              0.980341        0.982840        0.007335        0.007133
  9       -0.02500          0.977698        0.982894        0.007674        0.007114
 10       -0.05000          0.975248        0.982947        0.007302        0.007096
 11       -0.07500          0.973684        0.982999        0.007558        0.007081
 12       -0.10000          0.972950        0.983050        0.008077        0.007069
 13       -0.12500          0.972279        0.983102        0.009629        0.007058
 14       -0.15000          0.970903        0.983157        0.011337        0.007048
 15       -0.17500          0.969060        0.983216        0.013717        0.007039
 16       -0.20000          0.964354        0.983279        0.015602        0.007030
 17       -0.22500          0.962395        0.983342        0.014790        0.007024
 18       -0.25000          0.980945        0.983375        0.014160        0.007034
 19       -0.27500          0.982297        0.983435        0.014287        0.007031
 20       -0.30000          0.983929        0.983493        0.013844        0.007030
 21       -0.32500          0.984486        0.983550        0.013497        0.007028
 22       -0.35000          0.985992        0.983600        0.013421        0.007028
 23       -0.37500          0.986441        0.983644        0.013507        0.007027
 24       -0.40000          0.987196        0.983677        0.013013        0.007026
 25       -0.42500          0.986931        0.983699        0.012637        0.007025
 26       -0.45000          0.997010        0.983707        0.012198        0.007024
 27       -0.47500          0.987454        0.983701        0.011941        0.007024
 28       -0.50000          0.986925        0.983683        0.011449        0.007023
 29       -0.52500          0.987454        0.983651        0.011615        0.007023
 30       -0.55000          0.987020        0.983609        0.011014        0.007022
 31       -0.57500          0.987644        0.983558        0.010829        0.007023
 32       -0.60000          0.987292        0.983503        0.010438        0.007024
 33       -0.62500          0.987300        0.983444        0.010244        0.007026
 34       -0.65000          0.988329        0.983382        0.010425        0.007029
 35       -0.67500          0.987653        0.983323        0.009768        0.007032
 36       -0.70000          0.988633        0.983263        0.009478        0.007037
 37       -0.72500          0.987866        0.983209        0.009310        0.007041
 38       -0.75000          0.987360        0.983158        0.008882        0.007046
 39       -0.77500          0.987797        0.983109        0.008685        0.007053
 40       -0.80000          0.987775        0.983064        0.008671        0.007060
 41       -0.82500          0.988692        0.983021        0.008799        0.007069
 42       -0.85000          0.987095        0.982984        0.008254        0.007076
 43       -0.87500          0.987115        0.982948        0.008164        0.007085
 44       -0.90000          0.987368        0.982914        0.008070        0.007095
 45       -0.92500          0.987938        0.982881        0.008064        0.007105
 46       -0.95000          0.988090        0.982850        0.007754        0.007116
 47       -0.97500          0.989909        0.982818        0.007725        0.007129
 48       -1.00000          0.989985        0.982788        0.007667        0.007141
 49       -1.02500          0.991028        0.982758        0.007608        0.007155
 50       -1.05000          0.993183        0.982725        0.007184        0.007171
 51       -1.07500          0.994329        0.982692        0.007060        0.007187
 52       -1.10000          0.999220        0.982653        0.007222        0.007207
 53       -1.12500          1.001641        0.982616        0.007080        0.007225
 54       -1.15000          1.005850        0.982575        0.007117        0.007246
 55       -1.17500          1.006623        0.982539        0.006660        0.007265
 56       -1.20000          1.010652        0.982495        0.006249        0.007287
 57       -1.22500          1.014219        0.982451        0.006210        0.007310
 58       -1.25000          1.019694        0.982403        0.005835        0.007334
```

Figure 69 (Continued)

```
                                    ANALYSIS OF INTERFACIAL RIPPLE DATA MEASURED AT THE POLARIZED 0.000025-M NADS

                          IN M/20 NA2SO4---DATA OF G.P.BIERWAGEN(3-20-68) TRY#1

MEASUREMENTS MADE AT 0.000025-M NADS IN M/20 NA2SO4          /   PURE MERCURY                         INTERFACE
0.000025-M NADS        IN 0.050-M NA2SO4



DENSITY OF UPPER PHASE   0.99700   DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE   0.0089400   VISCOSITY OF LOWER PHASE   0.0152700

ORIGINAL OUTPUT VOLTAGE     6.92600000 MV.

INITIAL DAMPING COEFFICIENT   0.57495 1/CM.

WAVELENGTH 0.12880 CM.

PROBE SEPARATION =    1.19100 CM.

WAVENUMBER =    48.782448 RECIPROCAL CM.



                    INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM



SURFACTANT CONCENTRATION= 0.000025-M NADS

ELECTROCAPILLARY MAXIMUM IS   -0.45000 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=    1.50000

ELECTRICAL DESCRPTION EXPONENT =   12.50000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =   13.50000

DIFFUSION TERM=      455.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000010

SURFACTANT SURFACE VISCOSITY= 0.000500

 1/B0 = FRUMKIN CONCENTRATION CONSTANT=  0.000250
```

Figure 70. YCOR data listing for 2.5 x 10^{-5}-M NaDS in .05-M Na_2SO_4

```
                                  INPUT DATA
NC.        PCL.VOLTAGF        FREQUENCY      OUTPUT VCLTAGF(MV.)       GAMMA
  1         0.200000         264.000000           8.829000          353.822000
  2         0.150000         268.200000           8.629000          365.715500
  3         0.125000         270.400000           8.738000          371.894200
  4         0.100000         272.100000           8.544000          377.808800
  5         0.075000         273.900000           8.445000          383.293900
  6         0.050000         275.900000           7.859000          388.265100
  7         0.025000         277.900000           7.939000          392.695300
  8        -0.0              279.200000           7.807000          396.599600
  9        -0.025000         280.200000           8.804000          400.015300
 10        -0.050000         281.600000           8.470000          402.998000
 11        -0.075000         282.500000           7.866000          405.606200
 12        -0.100000         283.300000           7.734000          407.899100
 13        -0.125000         284.000000           7.131000          409.930900
 14        -0.150000         284.400000           6.044000          411.750000
 15        -0.175000         284.600000           5.630000          413.395700
 16        -0.200000         284.600000           5.320000          414.897900
 17        -0.225000         285.000000           5.248000          416.279000
 18        -0.250000         285.300000           5.172000          417.552000
 19        -0.275000         285.700000           5.088000          418.725500
 20        -0.300000         288.300000           5.674000          419.799000
 21        -0.325000         289.100000           5.491000          420.770000
 22        -0.350000         289.400000           5.785000          421.632800
 23        -0.375000         290.100000           5.934000          422.379100
 24        -0.400000         290.400000           6.044000          422.999200
 25        -0.425000         290.700000           6.218000          423.484800
 26        -0.450000         290.900000           6.464000          423.827600
 27        -0.475000         290.900000           6.689000          424.019500
 28        -0.500000         291.100000           6.926000          424.056600
 29        -0.525000         291.100000           7.160000          423.935300
 30        -0.550000         291.100000           7.408000          423.652500
 31        -0.575000         291.000000           7.599000          423.210400
 32        -0.600000         290.800000           7.743000          422.610300
 33        -0.625000         290.600000           8.133000          421.854700
 34        -0.650000         290.200000           8.336000          420.948900
 35        -0.675000         289.700000           8.585000          419.898100
 36        -0.700000         289.300000           8.674000          418.708200
 37        -0.725000         289.000000           8.734000          417.384500
 38        -0.750000         288.400000           9.195000          415.933800
 39        -0.775000         287.800000           9.472000          414.359600
 40        -0.800000         287.200000           8.912000          412.666000
 41        -0.825000         286.500000           9.036000          410.862500
 42        -0.850000         285.800000           8.674000          408.945300
 43        -0.875000         285.100000           8.839000          406.923000
 44        -0.900000         285.000000           8.911000          404.793400
 45        -0.925000         284.700000           8.623000          402.547800
 46        -0.950000         283.700000           8.586000          400.214500
 47        -0.975000         283.000000           8.466000          397.762600
 48        -1.000000         282.000000           8.576000          395.203100
 49        -1.025000         281.400000           8.641000          392.556600
 50        -1.050000         280.800000           8.422000          389.781000
 51        -1.075000         279.900000           8.001000          386.890600
 52        -1.100000         279.200000           8.149000          383.910400
 53        -1.125000         278.300000           7.908000          380.820500
 54        -1.150000         277.600000           8.056000          377.599300
 55        -1.175000         277.100000           7.994000          374.317600
 56        -1.200000         276.000000           8.160000          370.908600
```

Figure 70 (Continued)

```
INITIAL FREQUENCY =  291.20000


PCLYNCMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                          0.3830480050D 05     FREQUENCY** 0
                         -0.9174423636D C5     FREQUFNCY** 1
                          0.9407638208D 05     FREQUFNCY** 2
                         -0.5353771778D 05     FREQUENCY** 3
                          0.1826156901D 05     FREQUFNCY** 4
                         -0.3733478368D 04     FREQUFNCY** 5
                          0.4236C536C9D 03     FREQUENCY** 6
                         -0.2057672356D 02     FREQUENCY** 7
                          0.0                  FREQUENCY** 8
                          0.0                  FREQUENCY** 9
                          0.0                  FREQUENCY**10

NC.     FREQUENCY     CORRECTED OUTPUT VOLTAGE          NO.     FREQUENCY     CCRRECTED OUTPUT VOLTAGE
 1      264.00000           5.75901                     29      291.10000           7.15088
 2      268.2000C           6.02587                     30      291.10000           7.39856
 3      270.40000           6.29812                     31      291.00000           7.57962
 4      272.1CC00           6.31519                     32      290.80000           7.70346
 5      273.9C000           6.41905                     33      290.60000           8.07060
 6      275.90000           6.17246                     34      290.20000           8.22906
 7      277.8C0CC           6.44031                     35      289.70000           8.41908
 8      279.20000           6.48861                     36      289.30000           8.46086
 9      280.20000           7.44520                     37      289.00000           8.48478
10      281.6C000           7.33723                     38      288.40000           8.85903
11      282.50000           6.91856                     39      287.80000           9.04908
12      283.3CC0C           6.89360                     40      287.20000           8.44082
13      284.00000           6.42924                     41      286.50000           8.47036
14      284.40000           5.48441                     42      285.80000           8.04540
15      284.6C000           5.12508                     43      285.10000           8.11005
16      284.60000           4.84288                     44      285.00000           8.16329
17      285.00000           4.80765                     45      284.70000           7.86213
18      285.3CCC0           4.76031                     46      283.70000           7.70340
19      285.70000           4.71205                     47      283.00000           7.50870
20      288.30000           5.41095                     48      282.00000           7.47972
21      289.10000           5.34158                     49      281.40000           7.45985
22      289.40000           5.65046                     50      280.80000           7.19631
23      290.10C0C           5.85019                     51      279.90000           6.73108
24      290.40000           5.98207                     52      279.20000           6.77286
25      290.70000           6.17828                     53      278.30000           6.47080
26      290.90000           6.43926                     54      277.60000           6.51275
27      290.90000           6.66340                     55      277.10000           6.40743
28      291.10000           6.91718                     56      276.00000           6.41963
```

Figure 70 (Continued)

```
NO.   POL.VOLTAGE   GAMMA(EXPT.)CALC.F=0   THETA FROM MODEL   ALPHA(EXPTL)   ALPHA(MODEL)
 1      0.20000        355.58051            0.000509          0.729876       0.359222
 2      0.15000        366.80436            0.001113          0.691844       0.355526
 3      0.12500        372.76542            0.001609          0.654742       0.353744
 4      0.10000        377.38713            0.002290          0.652468       0.351664
 5      0.07500        382.31822            0.003210          0.538772       0.350060
 6      0.05000        387.78572            0.004433          0.671663       0.349072
 7      0.02500        393.08835            0.006031          0.635996       0.348362
 8     -0.0            396.99640            0.008086          0.629722       0.347476
 9     -0.02500        399.89064            0.010684          0.514255       0.346497
10     -0.05000        403.81839            0.013914          0.526521       0.345241
11     -0.07500        406.32009            0.017867          0.575852       0.345712
12     -0.10000        409.58264            0.022622          0.578887       0.345306
13     -0.12500        410.51592            0.028245          0.637440       0.344997
14     -0.15000        411.50405            0.034783          0.770896       0.344557
15     -0.17500        411.99834            0.042242          0.827794       0.344082
16     -0.20000        411.93069            0.050591          0.875347       0.343571
17     -0.22500        413.06069            0.059739          0.881478       0.343653
18     -0.25000        413.90356            0.069525          0.889786       0.343916
19     -0.27500        415.03234            0.079712          0.898342       0.344274
20     -0.30000        422.65950            0.089979          0.782219       0.347206
21     -0.32500        424.95495            0.099917          0.793052       0.348441
22     -0.35000        425.88414            0.109057          0.745853       0.349279
23     -0.37500        427.94861            0.116888          0.716686       0.350568
24     -0.40000        428.84167            0.122918          0.697969       0.351363
25     -0.42500        429.74428            0.126727          0.670872       0.351958
26     -0.45000        430.36320            0.128029          0.636133       0.352158
27     -0.47500        430.39190            0.126727          0.607404       0.351829
28     -0.50000        431.00364            0.122918          0.576020       0.351424
29     -0.52500        431.02799            0.116888          0.548122       0.350631
30     -0.55000        431.05122            0.109057          0.519532       0.349785
31     -0.57500        430.77536            0.099917          0.499231       0.348899
32     -0.60000        430.20290            0.089979          0.485625       0.348064
33     -0.62500        429.64699            0.079712          0.446532       0.347433
34     -0.65000        428.49416            0.069525          0.430206       0.346818
35     -0.67500        427.05380            0.059739          0.411039       0.346320
36     -0.70000        425.89685            0.050591          0.406887       0.346127
37     -0.72500        425.02976            0.042242          0.404512       0.346219
38     -0.75000        423.31337            0.034783          0.368271       0.346161
39     -0.77500        421.59046            0.028245          0.350449       0.346243
40     -0.80000        419.83618            0.022622          0.408874       0.346449
41     -0.82500        417.82759            0.017867          0.405941       0.346656
42     -0.85000        415.79809            0.013914          0.449158       0.346961
43     -0.87500        413.80184            0.010684          0.442438       0.347351
44     -0.90000        413.51968            0.008086          0.436944       0.348458
45     -0.92500        412.64503            0.006031          0.468506       0.349443
46     -0.95000        409.78889            0.004433          0.495630       0.349754
47     -0.97500        407.78860            0.003210          0.507124       0.350476
48     -1.00000        404.95844            0.002290          0.510371       0.350966
49     -1.02500        403.26492            0.001609          0.512605       0.351971
50     -1.05000        401.55428            0.001113          0.542804       0.353093
51     -1.07500        398.98269            0.000759          0.598919       0.354002
52     -1.10000        397.02860            0.000509          0.593724       0.355205
53     -1.12500        394.48345            0.000336          0.632030       0.356296
54     -1.15000        392.54114            0.000219          0.626605       0.357724
55     -1.17500        391.14057            0.000140          0.640294       0.359446
56     -1.20000        388.09740            0.000088          0.638697       0.360611
```

Figure 70 (Continued)

```
NO.    POL.VOLTAGE      RE(F)-EXPT.      RE(F)-MODEL      IM(F)-EXPT.      IM(F)-MODEL
  1      0.20000         33.203329        -0.000594         1.015892        -0.002239
  2      0.15000         40.786301         0.000722         1.009617        -0.005750
  3      0.12500         49.873297         0.003338        -2.651089        -0.008776
  4      0.10000         53.753599         0.004498        16.707950        -0.012724
  5      0.07500         53.987460         0.017426        26.387578        -0.017424
  6      0.05000         47.360670         0.031433        14.265594        -0.022510
  7      0.02500         58.104995         0.051748        -0.255731        -0.027530
  8     -0.0             60.170592         0.079646        -1.947202        -0.032145
  9     -0.02500        **********         0.116486        41.789447        -0.036192
 10     -0.05000         -8.383966         0.163907       **********        -0.039679
 11     -0.07500         75.044957         0.223775       -44.732867        -0.042648
 12     -0.10000         74.847336         0.298209       -39.581067        -0.045210
 13     -0.12500         53.670690         0.389516        -3.401299        -0.047470
 14     -0.15000         33.409879         0.500054        10.747091        -0.049518
 15     -0.17500         29.423115         0.631982        13.575487        -0.051428
 16     -0.20000         26.446924         0.787000        15.457581        -0.053252
 17     -0.22500         26.117935         0.965900        15.660263        -0.055038
 18     -0.25000         25.594522         1.167822        16.001086        -0.056788
 19     -0.27500         25.381295         1.389687        15.878453        -0.058503
 20     -0.30000         28.185565         1.625579         3.750611        -0.060228
 21     -0.32500         25.429678         1.865579         3.134065        -0.061811
 22     -0.35000         25.923997         2.096582         0.646135        -0.063233
 23     -0.37500         22.909700         2.302477        -0.790344        -0.064459
 24     -0.40000         22.060733         2.466025        -1.578700        -0.065393
 25     -0.42500         20.561426         2.571583        -2.488505        -0.065988
 26     -0.45000         18.777564         2.608105        -3.614742        -0.066196
 27     -0.47500         17.560357         2.571595        -5.055247        -0.065996
 28     -0.50000         15.136254         2.466070        -4.608464        -0.065421
 29     -0.52500         13.376294         2.302541        -4.630999        -0.064497
 30     -0.55000         11.662400         2.096689        -3.951953        -0.063293
 31     -0.57500         10.575587         1.865697        -3.418445        -0.061874
 32     -0.60000          9.854068         1.625734        -3.159650        -0.060304
 33     -0.62500          8.155160         1.389989        -1.954798        -0.058640
 34     -0.65000          7.184753         1.168120        -1.869409        -0.056915
 35     -0.67500          5.892070         0.966182        -1.766353        -0.055153
 36     -0.70000          5.772954         0.787277        -1.538716        -0.053362
 37     -0.72500          6.315846         0.632236        -0.832696        -0.051530
 38     -0.75000          4.900713         0.500280         0.213214        -0.049612
 39     -0.77500          4.283940         0.389724         0.807821        -0.047563
 40     -0.80000          5.727680         0.298416        -1.526178        -0.045312
 41     -0.82500          5.280863         0.223977        -1.657143        -0.042763
 42     -0.85000          6.883615         0.164105        -3.423161        -0.039814
 43     -0.87500          6.555427         0.116694        -3.097209        -0.036366
 44     -0.90000          8.296297         0.079856        -0.112676        -0.032372
 45     -0.92500         10.009255         0.051943         1.064307        -0.027818
 46     -0.95000         10.231476         0.031581         0.319728        -0.022842
 47     -0.97500         10.946767         0.017514         0.737519        -0.017793
 48     -1.00000         10.903321         0.008513         0.427781        -0.013077
 49     -1.02500         11.090831         0.003294         1.512817        -0.009093
 50     -1.05000         11.819483         0.000638         2.462131        -0.006023
 51     -1.07500         12.826053        -0.000476         2.818279        -0.003843
 52     -1.10000         12.549263        -0.000787         3.549986        -0.002396
 53     -1.12500         12.968999        -0.000743         4.001846        -0.001474
 54     -1.15000         12.669088        -0.000584         4.685914        -0.000903
 55     -1.17500         12.589667        -0.000419         5.546948        -0.000551
 56     -1.20000         12.452979        -0.000281         5.679112        -0.000334
```

Figure 70 (Continued)

NC.	PCL.VCLTAGE	Y1-EXPT.	Y1-MODEL	Y2-EXPT.	Y2-MODEL
1	0.20000	0.973391	0.982378	0.014962	0.007351
2	0.15000	0.971938	0.982518	0.014182	0.007281
3	0.12500	0.971535	0.982590	0.013422	0.007246
4	0.10000	0.968398	0.982665	0.013375	0.007212
5	0.07500	0.967201	0.982734	0.013094	0.007182
6	0.05000	0.968812	0.982797	0.013769	0.007159
7	0.02500	0.971121	0.982859	0.013037	0.007139
8	-0.0	0.971277	0.982925	0.012909	0.007121
9	-0.02500	0.969894	0.982996	0.010542	0.007105
10	-0.05000	0.972360	0.983067	0.010793	0.007094
11	-0.07500	0.972292	0.983149	0.011804	0.007084
12	-0.10000	0.972310	0.983241	0.011867	0.007076
13	-0.12500	0.972278	0.983347	0.013067	0.007070
14	-0.15000	0.970711	0.983471	0.015803	0.007065
15	-0.17500	0.968207	0.983616	0.016969	0.007062
16	-0.20000	0.964702	0.983783	0.017944	0.007060
17	-0.22500	0.964206	0.983968	0.018070	0.007064
18	-0.25000	0.963291	0.984176	0.018240	0.007070
19	-0.27500	0.963287	0.984404	0.018415	0.007080
20	-0.30000	0.978391	0.984622	0.016035	0.007104
21	-0.32500	0.981558	0.984865	0.016257	0.007122
22	-0.35000	0.981583	0.985104	0.015289	0.007140
23	-0.37500	0.984595	0.985314	0.014691	0.007160
24	-0.40000	0.985186	0.985484	0.014308	0.007175
25	-0.42500	0.986090	0.985594	0.013752	0.007185
26	-0.45000	0.986649	0.985632	0.013040	0.007188
27	-0.47500	0.986202	0.985596	0.012451	0.007183
28	-0.50000	0.987473	0.985485	0.011808	0.007171
29	-0.52500	0.987755	0.985316	0.011236	0.007154
30	-0.55000	0.988414	0.985103	0.010650	0.007134
31	-0.57500	0.988767	0.984867	0.010234	0.007115
32	-0.60000	0.988811	0.984623	0.009955	0.007097
33	-0.62500	0.989220	0.984384	0.009154	0.007083
34	-0.65000	0.988621	0.984162	0.008819	0.007071
35	-0.67500	0.987683	0.983959	0.008426	0.007062
36	-0.70000	0.987756	0.983778	0.008341	0.007058
37	-0.72500	0.988035	0.983618	0.008292	0.007057
38	-0.75000	0.988168	0.983481	0.007549	0.007057
39	-0.77500	0.987799	0.983363	0.007184	0.007059
40	-0.80000	0.987722	0.983262	0.008382	0.007063
41	-0.82500	0.987227	0.983176	0.008321	0.007068
42	-0.85000	0.987015	0.983102	0.009207	0.007074
43	-0.87500	0.987067	0.983038	0.009070	0.007082
44	-0.90000	0.991564	0.982976	0.008957	0.007093
45	-0.92500	0.994997	0.982922	0.009604	0.007105
46	-0.95000	0.993780	0.982882	0.009955	0.007114
47	-0.97500	0.994978	0.982842	0.010396	0.007125
48	-1.00000	0.994357	0.982808	0.010462	0.007137
49	-1.02500	0.996805	0.982772	0.010508	0.007151
50	-1.05000	0.999627	0.982737	0.011127	0.007167
51	-1.07500	1.000676	0.982704	0.012277	0.007182
52	-1.10000	1.003380	0.982668	0.012171	0.007200
53	-1.12500	1.005010	0.982632	0.012956	0.007218
54	-1.15000	1.008491	0.982592	0.012845	0.007238
55	-1.17500	1.013672	0.982549	0.013125	0.007260
56	-1.20000	1.014882	0.982509	0.013093	0.007281

Figure 70 (Continued)

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                                   ANALYSIS OF INTERFACIAL RIPPLE DATA MEASURED AT THE POLARIZED M/20,000 NADS

                         IN M/20 NA2SO4---DATA OF G.P.BIERWAGEN(3-14-68) TRY#1

MEASUREMENTS MADE AT M/20,000 NADS IN M/20 NA2SO4            /    PURE MERCURY                              INTERFACE
0.00005-M NADS         IN 0.050-M NA2SO4



DENSITY OF UPPER PHASE   0.99700   DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE   0.0089400   VISCOSITY OF LOWER PHASE   0.0152700

ORIGINAL OUTPUT VOLTAGE     8.45900000 MV.

INITIAL DAMPING COEFFICIENT   0.57478 1/CM.

WAVELENGTH 0.12066 CM.

PROBE SEPARATION =    1.56700 CM.

WAVENUMBER =    52.073424 RECIPROCAL CM.



                  INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM


SURFACTANT CONCENTRATION= 0.00005-M NADS

ELECTROCAPILLARY MAXIMUM IS   -0.52500 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=    1.50000

ELECTRICAL DESORPTION EXPONENT =   12.50000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =   13.50000

DIFFUSION TERM=     455.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000010

SURFACTANT SURFACE VISCOSITY= 0.000500

 1/B0 = FRUMKIN CONCENTRATION CONSTANT=  0.000250
```

Figure 71. YCOR data listing for 5×10^{-5}-M NaDS in .05-M Na_2SO_4

```
                                   INPUT DATA

NO.          PCL.VOLTAGE       FREQUENCY      OUTPUT VOLTAGE(MV.)      GAMMA
  1            0.200000        290.500000          8.126000         375.000000
  2            0.150000        295.600000          8.396000         381.200000
  3            0.125000        297.300000          8.410000         384.000000
  4            0.100000        299.600000          8.419000         386.500000
  5            0.075000        301.800000          8.762000         388.961600
  6            0.050000        304.200000          8.940000         391.139600
  7            0.025000        305.900000          8.965000         393.700600
  8           -0.0             307.400000          9.123000         396.399600
  9           -0.025000        308.600000          8.893000         399.074700
 10           -0.050000        310.000000          8.974000         401.629600
 11           -0.075000        311.400000          8.707000         404.010900
 12           -0.100000        311.800000          8.177000         406.199700
 13           -0.125000        312.700000          7.658000         408.196200
 14           -0.150000        313.400000          7.370000         410.013400
 15           -0.175000        314.500000          7.482000         411.671100
 16           -0.200000        315.100000          7.453000         413.190100
 17           -0.225000        315.700000          7.576000         414.589300
 18           -0.250000        316.200000          7.630000         415.882800
 19           -0.275000        316.600000          7.582000         417.081700
 20           -0.300000        317.200000          7.718000         418.190900
 21           -0.325000        317.800000          7.908000         419.211100
 22           -0.350000        318.100000          7.884000         420.137600
 23           -0.375000        318.300000          7.879000         420.963800
 24           -0.400000        318.500000          7.880000         421.679600
 25           -0.425000        318.500000          7.959000         422.273900
 26           -0.450000        319.000000          8.187000         422.735300
 27           -0.475000        319.100000          8.277000         423.052900
 28           -0.500000        319.200000          8.459000         423.217000
 29           -0.525000        318.900000          8.639000         423.219400
 30           -0.550000        318.700000          8.687000         423.055900
 31           -0.575000        318.600000          8.912000         422.722400
 32           -0.600000        318.500000          9.021000         422.219400
 33           -0.625000        318.300000          9.271000         421.547300
 34           -0.650000        318.100000          9.473000         420.710400
 35           -0.675000        318.000000          9.670000         419.715000
 36           -0.700000        317.100000          9.468000         418.567100
 37           -0.725000        316.700000          9.724000         417.274900
 38           -0.750000        316.100000          9.729000         415.846100
 39           -0.775000        315.700000          9.925000         414.286300
 40           -0.800000        315.400000         10.042000         412.602700
 41           -0.825000        314.400000          9.927000         410.806800
 42           -0.850000        313.700000          9.801000         408.891300
 43           -0.875000        312.800000          9.627000         406.874700
 44           -0.900000        311.900000          9.552000         404.745600
 45           -0.925000        311.200000          9.452000         402.495600
 46           -0.950000        310.300000          9.466000         400.150300
 47           -0.975000        309.400000          9.497000         397.690900
 48           -1.000000        308.100000          9.270000         395.132300
 49           -1.025000        306.800000          9.089000         392.464300
 50           -1.050000        306.000000          9.243000         389.677900
 51           -1.075000        305.000000          9.100000         386.761700
 52           -1.100000        303.900000          9.247000         383.787500
 53           -1.125000        302.600000          9.090000         380.710900
 54           -1.150000        301.400000          9.041000         377.507800
 55           -1.175000        299.900000          8.802000         374.273400
 56           -1.200000        299.000000          8.967000         370.914000
 57           -1.225000        297.600000          8.804000         367.503900
 58           -1.250000        296.400000          8.753000         363.925700
```

Figure 71 (Continued)

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INITIAL FREQUENCY =  319.20000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                          0.3830480050D 05     FREQUENCY** 0
                         -0.9174423636D 05     FREQUENCY** 1
                          0.9407638208D 05     FREQUENCY** 2
                         -0.5353771778D 05     FREQUENCY** 3
                          0.1826156901D 05     FREQUENCY** 4
                         -0.3733478368D 04     FREQUENCY** 5
                          0.4236053609D 03     FREQUENCY** 6
                         -0.2057672356D 02     FREQUENCY** 7
                          0.0                  FREQUENCY** 8
                          0.0                  FREQUENCY** 9
                          0.0                  FREQUENCY**10

NO.      FREQUENCY      CORRECTED OUTPUT VOLTAGE        NO.      FREQUENCY      CORRECTED OUTPUT VOLTAGE
 1       290.60000            5.62009                   30       318.70000            8.68520
 2       295.60000            6.17779                   31       318.60000            8.90921
 3       297.80000            6.36068                   32       318.50000            9.01702
 4       299.60000            6.52071                   33       318.30000            9.26392
 5       301.80000            7.00237                   34       318.10000            9.46185
 6       304.20000            7.41689                   35       318.00000            9.65629
 7       305.90000            7.65110                   36       317.10000            9.42404
 8       307.40000            7.98904                   37       316.70000            9.65895
 9       308.60000            7.95065                   38       316.10000            9.62722
10       310.00000            8.21567                   39       315.70000            9.79170
11       311.40000            8.15264                   40       315.40000            9.88244
12       311.80000            7.70312                   41       314.40000            9.67462
13       312.70000            7.30828                   42       313.70000            9.47551
14       313.40000            7.09883                   43       312.80000            9.19996
15       314.50000            7.29957                   44       311.90000            9.01187
16       315.10000            7.31483                   45       311.20000            8.82275
17       315.70000            7.47425                   46       310.30000            8.70913
18       316.20000            7.55541                   47       309.40000            8.60741
19       316.60000            7.52695                   48       308.10000            8.21659
20       317.20000            7.68566                   49       306.80000            7.87729
21       317.80000            7.89242                   50       306.00000            7.90178
22       318.10000            7.87472                   51       305.00000            7.64964
23       318.30000            7.87298                   52       303.90000            7.63445
24       318.50000            7.87652                   53       302.60000            7.35290
25       318.50000            7.95549                   54       301.40000            7.18281
26       319.00000            8.18684                   55       299.90000            6.84545
27       319.10000            8.27700                   56       299.00000            6.88918
28       319.20000            8.45900                   57       297.60000            6.64165
29       318.90000            8.63847                   58       296.40000            6.50432
```

Figure 71 (Continued)

NO.	POL.VOLTAGE	GAMMA(EXPT.)CALC.SEC	THETA FROM MODEL	ALPHA(EXPT.)	ALPHA(MODEL)
1	0.20000	353.65800	0.000281	0.835714	0.374333
2	0.15000	365.77527	0.000673	0.776335	0.375030
3	0.12500	371.16796	0.001019	0.756718	0.375511
4	0.10000	375.60770	0.001520	0.740960	0.375726
5	0.07500	381.29315	0.002232	0.695381	0.374424
6	0.05000	387.10945	0.003229	0.658680	0.373547
7	0.02500	391.35387	0.004601	0.638840	0.377712
8	-0.0	395.20134	0.006462	0.611259	0.377590
9	-0.02500	398.24115	0.008946	0.614331	0.377201
10	-0.05000	401.82107	0.012211	0.593406	0.377135
11	-0.07500	405.39761	0.016442	0.598321	0.377216
12	-0.10000	406.39487	0.021844	0.634516	0.376419
13	-0.12500	408.67386	0.028652	0.668094	0.376333
14	-0.15000	410.46528	0.037116	0.686651	0.376247
15	-0.17500	413.32124	0.047509	0.668855	0.376821
16	-0.20000	414.87867	0.060121	0.667522	0.377187
17	-0.22500	415.44813	0.075252	0.653764	0.377981
18	-0.25000	417.75411	0.093203	0.646871	0.379304
19	-0.27500	418.79344	0.114266	0.649290	0.381510
20	-0.30000	420.36961	0.138696	0.635963	0.385530
21	-0.32500	421.95151	0.166666	0.619023	0.392235
22	-0.35000	422.73524	0.198180	0.620455	0.403138
23	-0.37500	423.25982	0.232908	0.620596	0.421336
24	-0.40000	423.78308	0.269939	0.620309	0.450757
25	-0.42500	423.78836	0.307438	0.613943	0.493968
26	-0.45000	425.11466	0.342446	0.595650	0.548784
27	-0.47500	425.38271	0.371188	0.588660	0.601944
28	-0.50000	425.65600	0.390051	0.574780	0.639087
29	-0.52500	424.87822	0.396612	0.561382	0.651615
30	-0.55000	424.35598	0.390051	0.557940	0.638636
31	-0.57500	424.10519	0.371188	0.541689	0.601797
32	-0.60000	423.84825	0.342446	0.534012	0.548901
33	-0.62500	423.33550	0.307438	0.516773	0.494629
34	-0.65000	422.82019	0.269939	0.503287	0.451305
35	-0.67500	422.56626	0.232908	0.490301	0.422115
36	-0.70000	420.20447	0.198180	0.505837	0.403319
37	-0.72500	419.17054	0.166666	0.490126	0.392513
38	-0.75000	417.60667	0.138696	0.492225	0.386048
39	-0.77500	416.57279	0.114266	0.481415	0.382513
40	-0.80000	415.75684	0.093203	0.475528	0.380720
41	-0.82500	413.19701	0.075252	0.489091	0.379206
42	-0.85000	411.37962	0.060121	0.502361	0.378652
43	-0.87500	409.04741	0.047509	0.521195	0.378310
44	-0.90000	406.72503	0.037116	0.534377	0.378267
45	-0.92500	404.92099	0.028652	0.547912	0.378659
46	-0.95000	402.61330	0.021844	0.556183	0.378229
47	-0.97500	400.31272	0.016442	0.563681	0.379477
48	-1.00000	396.98787	0.012211	0.593335	0.379641
49	-1.02500	393.67782	0.008946	0.620247	0.379912
50	-1.05000	391.65172	0.006462	0.618266	0.380336
51	-1.07500	389.13105	0.004601	0.638962	0.381681
52	-1.10000	386.37348	0.003229	0.640230	0.382509
53	-1.12500	383.10931	0.002232	0.664210	0.383244
54	-1.15000	380.11403	0.001520	0.679145	0.384231
55	-1.17500	376.37582	0.001019	0.709845	0.384950
56	-1.20000	374.16115	0.000673	0.705781	0.386465
57	-1.22500	370.70326	0.000439	0.729132	0.387494
58	-1.25000	367.75785	0.000281	0.742466	0.388908

Figure 71 (Continued)

```
NO.    POL.VOLTAGE      RE(E)-EXPT.     RE(E)-MODEL      IM(E)-EXPT.      IM(E)-MODEL
 1        0.20000       13.055211       -0.000336        16.270539        -0.000643
 2        0.15000       14.194940       -0.000508        18.705421        -0.001881
 3        0.12500       15.113800       -0.000172        20.320714        -0.003208
 4        0.10000       16.136129        0.000993        22.001067        -0.005393
 5        0.07500       18.237365        0.003899        26.519353        -0.008928
 6        0.05000       29.255486        0.009997        39.924952        -0.013842
 7        0.02500       54.880806        0.021396        55.282728        -0.020480
 8       -0.0          147.789827        0.040633        73.185033        -0.028433
 9       -0.02500      161.802442        0.070516         1.331711        -0.037055
10       -0.05000       43.535073        0.114079       -95.063674        -0.045642
11       -0.07500       21.092365        0.174785       -40.881130        -0.053652
12       -0.10000       65.297390        0.256839       -36.473726        -0.060811
13       -0.12500       51.862745        0.365967       -17.186610        -0.067153
14       -0.15000       49.173536        0.509457       -10.424586        -0.072791
15       -0.17500       35.133210        0.697012       -17.335913        -0.077921
16       -0.20000       34.734797        0.941116       -17.435697        -0.082742
17       -0.22500       31.923499        1.258015       -19.962751        -0.087436
18       -0.25000       31.044841        1.668386       -21.399075        -0.092163
19       -0.27500       33.062973        2.198324       -21.589913        -0.097066
20       -0.30000       26.909849        2.879973       -21.516877        -0.102290
21       -0.32500       20.793311        3.751171       -19.791351        -0.108002
22       -0.35000       21.782829        4.852867       -20.669576        -0.114416
23       -0.37500       23.544250        6.220917       -23.052042        -0.121813
24       -0.40000       24.825969        7.867235       -24.748165        -0.130524
25       -0.42500       28.544675        9.744530       -32.506676        -0.140729
26       -0.45000       17.630507       11.702416       -25.150692        -0.152155
27       -0.47500       15.989184       13.469605       -26.188745        -0.163304
28       -0.50000       12.148474       14.713268       -25.455550        -0.171728
29       -0.52500        6.594104       15.162198       -36.100520        -0.174838
30       -0.55000        3.082456       14.713205       -42.988033        -0.171646
31       -0.57500       -4.246704       13.469543       -37.670658        -0.163230
32       -0.60000       -4.431149       11.702356       -31.796623        -0.152095
33       -0.62500       -7.367009        9.744506       -25.475915        -0.140710
34       -0.65000       -6.556249        7.867189       -19.841551        -0.130497
35       -0.67500       -2.630126        6.220882       -13.857178        -0.121800
36       -0.70000      -11.519594        4.852751       -23.190412        -0.114390
37       -0.72500      -10.465866        3.751046       -17.470850        -0.107989
38       -0.75000      -11.855253        2.879849       -18.367560        -0.102286
39       -0.77500       -7.670124        2.198224       -14.024848        -0.097068
40       -0.80000       -2.184791        1.668299       -10.352181        -0.092167
41       -0.82500       -6.367848        1.257877       -14.877871        -0.087444
42       -0.85000       -4.320416        0.940971       -16.697773        -0.082749
43       -0.87500       -4.202388        0.696843       -22.067090        -0.077924
44       -0.90000       -3.317940        0.509314       -26.375738        -0.072787
45       -0.92500        2.815388        0.365832       -23.660773        -0.067138
46       -0.95000        4.687945        0.256715       -23.986874        -0.060784
47       -0.97500        6.699923        0.174639       -22.796350        -0.053598
48       -1.00000       14.815159        0.113965       -33.270243        -0.045576
49       -1.02500       31.565013        0.070434       -39.642008        -0.036983
50       -1.05000       21.616142        0.040592       -28.596193        -0.028375
51       -1.07500       23.222062        0.021382       -21.487412        -0.020445
52       -1.10000       21.804591        0.009996       -19.755111        -0.013833
53       -1.12500       26.163945        0.003888       -17.580326        -0.008848
54       -1.15000       25.928721        0.000984       -14.463792        -0.005424
55       -1.17500       31.079007       -0.000184       -11.051816        -0.003233
56       -1.20000       23.683813       -0.000524        -9.471357        -0.001906
57       -1.22500       24.663844       -0.000520        -7.398752        -0.001120
58       -1.25000       22.360260       -0.000410        -5.430602        -0.000660
```

Figure 71 (Continued)

NO.	POL.VOLTAGE	Y1-EXPT.	Y1-MODEL	Y2-EXPT.	Y2-MODEL
1	0.20000	0.914886	0.982413	0.016049	0.007325
2	0.15000	0.931243	0.982454	0.014889	0.007304
3	0.12500	0.938264	0.982473	0.014532	0.007294
4	0.10000	0.943498	0.982493	0.014227	0.007285
5	0.07500	0.951346	0.982509	0.013354	0.007279
6	0.05000	0.961155	0.982522	0.012649	0.007276
7	0.02500	0.965605	0.982552	0.012268	0.007268
8	-0.0	0.968459	0.982594	0.011738	0.007259
9	-0.02500	0.969493	0.982648	0.011797	0.007249
10	-0.05000	0.972086	0.982711	0.011396	0.007242
11	-0.07500	0.975104	0.982787	0.011490	0.007237
12	-0.10000	0.972343	0.982890	0.012185	0.007229
13	-0.12500	0.973191	0.983011	0.012830	0.007225
14	-0.15000	0.973210	0.983164	0.013186	0.007224
15	-0.17500	0.976108	0.983354	0.012844	0.007228
16	-0.20000	0.976234	0.983602	0.012819	0.007236
17	-0.22500	0.976648	0.983923	0.012555	0.007251
18	-0.25000	0.976696	0.984341	0.012422	0.007277
19	-0.27500	0.976354	0.984888	0.012469	0.007322
20	-0.30000	0.977459	0.985601	0.012213	0.007398
21	-0.32500	0.978773	0.986532	0.011887	0.007526
22	-0.35000	0.978459	0.987729	0.011915	0.007739
23	-0.37500	0.977767	0.989205	0.011918	0.008095
24	-0.40000	0.977334	0.990866	0.011912	0.008666
25	-0.42500	0.975959	0.992418	0.011790	0.009506
26	-0.45000	0.977957	0.993383	0.011439	0.010557
27	-0.47500	0.977835	0.993506	0.011304	0.011581
28	-0.50000	0.978069	0.993129	0.011038	0.012293
29	-0.52500	0.976226	0.992901	0.010781	0.012541
30	-0.55000	0.975379	0.993127	0.010714	0.012296
31	-0.57500	0.975536	0.993504	0.010402	0.011587
32	-0.60000	0.976085	0.993386	0.010255	0.010566
33	-0.62500	0.976414	0.992423	0.009924	0.009517
34	-0.65000	0.977127	0.990874	0.009665	0.008677
35	-0.67500	0.978828	0.989210	0.009416	0.008107
36	-0.70000	0.975965	0.987736	0.009714	0.007749
37	-0.72500	0.976519	0.986534	0.009412	0.007537
38	-0.75000	0.976165	0.985596	0.009453	0.007411
39	-0.77500	0.977362	0.984873	0.009245	0.007339
40	-0.80000	0.979486	0.984317	0.009132	0.007297
41	-0.82500	0.977539	0.983895	0.009392	0.007272
42	-0.85000	0.977750	0.983566	0.009647	0.007260
43	-0.87500	0.976966	0.983312	0.010009	0.007255
44	-0.90000	0.976462	0.983112	0.010262	0.007254
45	-0.92500	0.977518	0.982951	0.010522	0.007259
46	-0.95000	0.977569	0.982823	0.010681	0.007265
47	-0.97500	0.977917	0.982719	0.010825	0.007272
48	-1.00000	0.975995	0.982638	0.011394	0.007280
49	-1.02500	0.974355	0.982572	0.011911	0.007289
50	-1.05000	0.976211	0.982511	0.011873	0.007302
51	-1.07500	0.977154	0.982461	0.012270	0.007315
52	-1.10000	0.977636	0.982417	0.012295	0.007329
53	-1.12500	0.977123	0.982379	0.012755	0.007345
54	-1.15000	0.977614	0.982340	0.013042	0.007362
55	-1.17500	0.976272	0.982305	0.013637	0.007379
56	-1.20000	0.979210	0.982262	0.013554	0.007400
57	-1.22500	0.979063	0.982223	0.014002	0.007420
58	-1.25000	0.980732	0.982180	0.014258	0.007442

Figure 71 (Continued)

```
                              ANALYSIS OF INTERFACIAL RIPPLE DATA FROM THE  POLARIZED M/10,000 NADS IN

                         0.050-M NA2SO4/PURE HG INTERFACE---DATA OF G.P.BIERWAGEN(3-13-63)

MEASUREMENTS MADE AT M/10,000 NA DECYL-SULFONATE+M/20 NA2SO4 /      PURE MERCURY                       INTERFACE
0.00010-M NADS         IN 0.050-M NA2SO4



DENSITY OF UPPER PHASE    0.99700    DENSITY OF LOWER PHASE   13.53400

VISCOSITY OF UPPER PHASE    0.0089400    VISCOSITY OF LOWER PHASE    0.0152700

ORIGINAL OUTPUT VOLTAGE     5.09900000 MV.

INITIAL DAMPING COEFFICIENT    0.59180 1/CM.

WAVELENGTH 0.13940 CM.

PROBE SEPARATION =    2.16800 CM.

WAVENUMBER =    45.073022 RECIPROCAL CM.



                 INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM


SURFACTANT CONCENTRATION= 0.00010-M NADS

ELECTROCAPILLARY MAXIMUM IS   -0.52500 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=     1.50000

ELECTRICAL DESORPTION EXPONENT =   12.50000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =    13.50000

DIFFUSION TERM=     455.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000010

SURFACTANT SURFACE VISCOSITY= 0.000500

 1/B0 = FRUMKIN CONCENTRATION CONSTANT=  0.000250
```

Figure 72. YCOR data listing for 10^{-4}-M NaDS in .05-M Na_2SO_4

```
                                        INPUT DATA

 NO.          PUL.VOLTAGE        FREQUENCY        OUTPUT VOLTAGE(MV.)        GAMMA
  1            0.200000         236.000000            8.946000            374.000000
  2            0.175000         237.600000            8.630000            376.528800
  3            0.150000         239.500000            8.460000            378.791400
  4            0.125000         241.100000            8.273000            380.546600
  5            0.100000         243.000000            7.914000            383.304600
  6            0.075000         244.300000            8.067000            386.279200
  7            0.050000         245.100000            8.173000            389.319300
  8            0.025000         246.900000            8.165000            392.318300
  9           -0.0              248.100000            8.000000            395.201100
 10           -0.025000         248.800000            7.615000            397.918200
 11           -0.050000         249.600000            6.984000            400.444500
 12           -0.075000         250.000000            6.626000            402.767500
 13           -0.100000         250.400000            6.374000            404.889100
 14           -0.125000         251.000000            6.102000            406.817100
 15           -0.150000         251.500000            5.772000            408.564600
 16           -0.175000         252.200000            5.887000            410.149900
 17           -0.200000         252.700000            5.657000            411.589300
 18           -0.225000         253.100000            5.644000            412.899100
 19           -0.250000         253.600000            5.659000            414.094900
 20           -0.275000         254.000000            5.461000            415.188700
 21           -0.300000         254.400000            5.392000            416.190400
 22           -0.325000         254.700000            5.392000            417.104900
 23           -0.350000         254.900000            5.341000            417.937000
 24           -0.375000         255.300000            5.278000            418.684500
 25           -0.400000         255.300000            5.164000            419.346100
 26           -0.425000         255.200000            5.125000            419.916200
 27           -0.450000         255.400000            5.089000            420.386700
 28           -0.475000         255.500000            5.085000            420.750200
 29           -0.500000         255.400000            5.099000            420.996500
 30           -0.525000         255.600000            5.139000            421.116600
 31           -0.550000         255.600000            5.196000            421.101300
 32           -0.575000         255.600000            5.276000            420.940900
 33           -0.600000         255.400000            5.367000            420.629100
 34           -0.625000         255.300000            5.468000            420.157700
 35           -0.650000         255.300000            5.600000            419.523100
 36           -0.675000         255.100000            5.742000            418.723300
 37           -0.700000         254.900000            5.911000            417.756100
 38           -0.725000         254.700000            6.206000            416.623700
 39           -0.750000         254.200000            6.320000            415.328600
 40           -0.775000         254.000000            6.394000            413.875900
 41           -0.800000         253.500000            6.684000            412.270900
 42           -0.825000         252.900000            6.842000            410.521700
 43           -0.850000         252.500000            6.969000            408.636400
 44           -0.875000         251.900000            7.077000            406.624000
 45           -0.900000         251.200000            7.207000            404.491600
 46           -0.925000         250.600000            7.302000            402.246800
 47           -0.950000         249.900000            7.446000            399.897400
 48           -0.975000         249.300000            7.376000            397.448400
 49           -1.000000         248.400000            7.412000            394.901800
 50           -1.025000         247.800000            7.547000            392.266100
 51           -1.050000         246.800000            7.631000            389.528300
 52           -1.075000         246.200000            7.487000            386.694300
 53           -1.100000         245.100000            7.712000            383.769200
 54           -1.125000         244.200000            7.802000            380.731200
 55           -1.150000         243.500000            7.850000            377.572000
 56           -1.175000         242.900000            7.817000            374.311000
 57           -1.200000         242.400000            7.877000            370.918200
```

Figure 72 (Continued)

```
INITIAL FREQUENCY =  255.40000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                                  0.[illegible]D 05      FREQUENCY** 0
                                 -0.[illegible]D 05      FREQUENCY** 1
                                  0.940753[illegible]D 05      FREQUENCY** 2
                                 -0.535317177[illegible]D 05      FREQUENCY** 3
                                  0.1825155931D 05      FREQUENCY** 4
                                 -0.37334783[illegible]D 04      FREQUENCY** 5
                                  0.42360536[illegible]D 03      FREQUENCY** 6
                                 -0.2057672355D 02      FREQUENCY** 7
                                  0.0                   FREQUENCY** 8
                                  0.0                   FREQUENCY** 9
                                  0.0                   FREQUENCY**10

NO.     FREQUENCY      CORRECTED OUTPUT VOLTAGE       NO.     FREQUENCY      CORRECTED OUTPUT VOLTAGE
 1      236.00000             0.80730                  29     255.40000             5.09900
 2      237.60000             0.96344                  30     255.60000             5.21460
 3      239.50000             1.22197                  31     255.60000             5.27244
 4      241.10000             1.48919                  32     255.60000             5.35361
 5      243.00000             1.85368                  33     255.40000             5.36700
 6      244.30000             2.26135                  34     255.30000             5.42747
 7      245.10000             2.55784                  35     255.30000             5.55849
 8      246.80000             3.21527                  36     255.10000             5.61370
 9      248.10000             3.73418                  37     254.90000             5.68989
10      248.80000             3.88422                  38     254.70000             5.87964
11      249.60000             3.93069                  39     254.20000             5.74508
12      250.00000             3.91195                  40     254.00000             5.71333
13      250.40000             3.94367                  41     253.50000             5.71224
14      251.00000             4.04216                  42     252.90000             5.52665
15      251.50000             4.03949                  43     252.50000             5.41215
16      252.20000             4.43508                  44     251.90000             5.16827
17      252.70000             4.48125                  45     251.20000             4.88130
18      253.10000             4.64710                  46     250.60000             4.62310
19      253.60000             4.88042                  47     249.90000             4.34470
20      254.00000             4.87965                  48     249.30000             4.00256
21      254.40000             4.98463                  49     248.40000             3.59478
22      254.70000             5.10845                  50     247.80000             3.38909
23      254.90000             5.14121                  51     246.80000             3.00499
24      255.30000             5.23888                  52     246.20000             2.72076
25      255.30000             5.12572                  53     245.10000             2.41357
26      255.20000             5.04984                  54     244.20000             2.15759
27      255.40000             5.08900                  55     243.50000             1.97061
28      255.50000             5.12250                  56     242.90000             1.80574
```

Figure 72 (Continued)

```
NO.   POL.VOLTAGE   GAMMA(EXPT.)CALC.E=0   THETA FROM MODEL   ALPHA(EXPTL)   ALPHA(MODEL)
 1     0.20000        357.44653             0.000561           1.441940       0.313135
 2     0.17500        364.44864             0.000877           1.360386       0.313401
 3     0.15000        370.45030             0.001348           1.250738       0.314540
 4     0.12500        375.52373             0.002042           1.159516       0.314978
 5     0.10000        381.55906             0.003043           1.059531       0.315506
 6     0.07500        385.74798             0.004484           0.966735       0.315268
 7     0.05000        388.32930             0.006499           0.910010       0.314496
 8     0.02500        393.79908             0.009288           0.904500       0.314817
 9    -0.0            397.97659             0.013095           0.735488       0.314840
10    -0.02500        400.20619             0.018224           0.717317       0.314381
11    -0.05000        402.74118             0.025052           0.711932       0.314222
12    -0.07500        404.00909             0.034046           0.714037       0.313845
13    -0.10000        405.27896             0.045794           0.710312       0.313734
14    -0.12500        407.20123             0.061045           0.699934       0.314217
15    -0.15000        408.79362             0.080783           0.699238       0.315211
16    -0.17500        411.08403             0.106362           0.656145       0.317584
17    -0.20000        412.69047             0.139753           0.651368       0.322242
18    -0.22500        413.99347             0.184052           0.634605       0.333039
19    -0.25000        415.62615             0.244525           0.612009       0.362460
20    -0.27500        416.91351             0.330424           0.612082       0.453217
21    -0.30000        416.21410             0.451509           0.602264       0.633329
22    -0.32500        419.19511             0.580846           0.590946       0.641240
23    -0.35000        419.84463             0.671774           0.587997       0.596012
24    -0.37500        421.14813             0.728954           0.579317       0.570212
25    -0.40000        421.13718             0.766207           0.599389       0.554610
26    -0.42500        420.80576             0.791244           0.596360       0.544607
27    -0.45000        421.45735             0.808096           0.597705       0.538604
28    -0.47500        421.78465             0.818966           0.589679       0.534743
29    -0.50000        421.45835             0.825076           0.591800       0.532296
30    -0.52500        422.11772             0.827049           0.581460       0.531897
31    -0.55000        422.12320             0.825076           0.576372       0.532575
32    -0.57500        422.13068             0.818966           0.569324       0.534778
33    -0.60000        421.48380             0.808096           0.568172       0.538418
34    -0.62500        421.16533             0.791244           0.563005       0.544607
35    -0.65000        421.17656             0.766207           0.552002       0.554475
36    -0.67500        420.53377             0.728954           0.547443       0.569792
37    -0.70000        419.89304             0.671774           0.541225       0.596152
38    -0.72500        419.26117             0.580846           0.526094       0.641654
39    -0.75000        417.63727             0.451509           0.536772       0.634147
40    -0.77500        416.99019             0.330424           0.539329       0.454828
41    -0.80000        415.38080             0.244525           0.539417       0.363818
42    -0.82500        413.43893             0.184052           0.554652       0.334384
43    -0.85000        412.14715             0.139753           0.564308       0.323815
44    -0.87500        410.20585             0.106362           0.585576       0.319325
45    -0.90000        407.94394             0.080783           0.611926       0.317239
46    -0.92500        406.00616             0.061045           0.636993       0.316411
47    -0.95000        403.75032             0.045794           0.665694       0.316062
48    -0.97500        401.80338             0.034046           0.703474       0.316153
49    -1.00000        398.89632             0.025052           0.753037       0.316127
50    -1.02500        396.97004             0.018224           0.780216       0.316584
51    -1.05000        393.75076             0.013095           0.835698       0.316742
52    -1.07500        391.80166             0.009288           0.881530       0.317484
53    -1.10000        388.28219             0.006499           0.936790       0.317807
54    -1.12500        385.39796             0.004484           0.988504       0.318499
55    -1.15000        383.15548             0.003048           1.030315       0.319558
56    -1.17500        381.22683             0.002042           1.070615       0.320850
57    -1.20000        379.63179             0.001348           1.099077       0.322385
```

Figure 72 (Continued)

```
NO.   POL.VOLTAGE   RE(F)-EXPT.   RE(F)-MODEL   IM(F)-EXPT.   IM(F)-MODEL
 1     0.20000      [illegible]   -0.000173     12.590361     -0.000566
 2     0.17500      [illegible]   -0.000081     12.736674     -0.001379
 3     0.15000      [illegible]    0.000313     12.837942     -0.002904
 4     0.12500      [illegible]    0.001451     12.776444     -0.003716
 5     0.10000      [illegible]    0.004236     12.132591     -0.006795
 6     0.07500      [illegible]    0.010363     11.938552     -0.011957
 7     0.05000      [illegible]    0.022707     12.531739     -0.020022
 8     0.02500      25.513817      0.045698      9.710161     -0.031540
 9    -0.0          27.635465      0.085239      6.027149     -0.046279
10    -0.02500      29.496747      0.143654      6.441532     -0.063273
11    -0.05000      29.880554      0.245067      6.242864     -0.081199
12    -0.07500      30.990837      0.386231      9.236577     -0.098834
13    -0.10000      31.537342      0.539065     11.812131     -0.115455
14    -0.12500      32.620131      0.879082     11.871616     -0.130812
15    -0.15000      32.597775      1.296256     12.371881     -0.145044
16    -0.17500      37.361671      1.906186      9.286474     -0.158420
17    -0.20000      37.850278      2.821580      8.258834     -0.171385
18    -0.22500      40.497017      4.251450      7.643313     -0.184539
19    -0.25000      43.481518      6.623270      2.899378     -0.199529
20    -0.27500      42.536566     10.911345      1.538971     -0.223619
21    -0.30000      42.541393     19.163692     -1.860345     -0.292883
22    -0.32500      43.963309     32.005321     -4.477554     -0.510074
23    -0.35000      45.999524     45.187168     -3.878479     -0.913018
24    -0.37500      42.152691     56.611805     -9.205164     -1.433555
25    -0.40000      46.564738     66.229200     -2.662180     -2.006738
26    -0.42500      49.474555     74.142961      7.078031     -2.575914
27    -0.45000      49.970111     80.370642      4.776396     -3.086504
28    -0.47500      51.037092     84.873397      4.857142     -3.491226
29    -0.50000      51.376895     87.600036     11.798221     -3.751748
30    -0.52500      53.997350     88.515434      4.350706     -3.840486
31    -0.55000      55.874090     87.601443      3.409291     -3.750847
32    -0.57500      57.701757     84.874045     -0.367435     -3.490815
33    -0.60000      60.472433     80.370642      5.136375     -3.086504
34    -0.62500      62.304313     74.143422      1.519843     -2.575640
35    -0.65000      59.010745     66.229200    -13.425404     -2.006738
36    -0.67500      57.522718     56.611334    -17.785325     -1.433776
37    -0.70000      51.580101     45.187168    -23.854270     -0.913018
38    -0.72500      39.479271     32.005321    -31.660524     -0.510074
39    -0.75000      48.004303     19.163612    -27.201354     -0.292887
40    -0.77500      34.147553     10.911345    -22.909628     -0.223619
41    -0.80000      34.144295      6.623238    -23.078354     -0.199543
42    -0.82500      38.024745      4.251386    -18.479557     -0.184570
43    -0.85000      31.993529      2.821517    -14.591431     -0.171415
44    -0.87500      31.975855      1.906096     -9.975718     -0.158462
45    -0.90000      32.372284      1.296169     -5.381015     -0.145079
46    -0.92500      29.937901      0.878974     -2.483552     -0.130847
47    -0.95000      28.547180      0.588340      0.146291     -0.115483
48    -0.97500      25.966486      0.386078      2.196533     -0.098850
49    -1.00000      25.131996      0.244849      4.886488     -0.081189
50    -1.02500      23.378320      0.148515      5.119298     -0.063241
51    -1.05000      22.595909      0.085115      6.900635     -0.046219
52    -1.07500      21.012342      0.045664      7.108923     -0.031513
53    -1.10000      20.446771      0.022707      8.153894     -0.020022
54    -1.12500      19.608066      0.010362      8.530917     -0.011954
55    -1.15000      18.747781      0.004236      8.445081     -0.006795
56    -1.17500      17.899265      0.001448      9.290691     -0.003739
57    -1.20000      17.095104      0.000305      8.064948     -0.002027
```

Figure 72 (Continued)

```
NO.    APL.VOLTAGE      Y1-EXPT.        Y1-MODEL        Y2-EXPT.        Y2-MODEL

  1     0.20000         0.932944        0.983034        0.031991        0.007039
  2     0.17500         0.939290        0.983050        0.030187        0.007021
  3     0.15000         0.953151        0.983051        0.027749        0.007021
  4     0.12500         0.955955        0.983066        0.025725        0.007014
  5     0.10000         0.965133        0.983084        0.023485        0.007036
  6     0.07500         0.967945        0.983116        0.021446        0.006995
  7     0.05000         0.966697        0.983160        0.020190        0.006981
  8     0.02500         0.972651        0.983203        0.017849        0.006974
  9    -0.0             0.975755        0.983264        0.016318        0.006968
 10    -0.02500         0.974568        0.983352        0.015915        0.006961
 11    -0.05000         0.974657        0.983467        0.015793        0.006958
 12    -0.07500         0.972144        0.983627        0.015842        0.006956
 13    -0.10000         0.970147        0.983944        0.015759        0.006959
 14    -0.12500         0.970182        0.984143        0.015507        0.006970
 15    -0.15000         0.969885        0.984570        0.015513        0.006994
 16    -0.17500         0.971522        0.985197        0.014557        0.007045
 17    -0.20000         0.971967        0.986165        0.014451        0.007149
 18    -0.22500         0.971954        0.987721        0.014079        0.007393
 19    -0.25000         0.972980        0.990276        0.013578        0.008050
 20    -0.27500         0.973480        0.993457        0.013580        0.010075
 21    -0.30000         0.974198        0.989452        0.013362        0.014053
 22    -0.32500         0.974356        0.977365        0.013111        0.014174
 23    -0.35000         0.973944        0.973799        0.013045        0.013160
 24    -0.37500         0.975259        0.972681        0.012953        0.012580
 25    -0.40000         0.973720        0.972222        0.013076        0.012240
 26    -0.42500         0.971637        0.971997        0.013231        0.012027
 27    -0.45000         0.972071        0.971872        0.013150        0.011892
 28    -0.47500         0.971992        0.971803        0.013083        0.011807
 29    -0.50000         0.970663        0.971772        0.013130        0.011758
 30    -0.52500         0.971907        0.971759        0.012900        0.011745
 31    -0.55000         0.971942        0.971771        0.012788        0.011759
 32    -0.57500         0.972312        0.971806        0.012631        0.011807
 33    -0.60000         0.971511        0.971878        0.012606        0.011891
 34    -0.62500         0.971839        0.972001        0.012491        0.012026
 35    -0.65000         0.973309        0.972226        0.012247        0.012239
 36    -0.67500         0.973641        0.972685        0.012146        0.012578
 37    -0.70000         0.974366        0.973793        0.012008        0.013161
 38    -0.72500         0.975482        0.977344        0.011672        0.014177
 39    -0.75000         0.974685        0.988410        0.011909        0.014068
 40    -0.77500         0.976568        0.993455        0.011966        0.010101
 41    -0.80000         0.976514        0.990281        0.011968        0.008071
 42    -0.82500         0.976038        0.987717        0.012306        0.007412
 43    -0.85000         0.977442        0.986148        0.012520        0.007171
 44    -0.87500         0.977616        0.985170        0.012992        0.007068
 45    -0.90000         0.977316        0.984531        0.013576        0.007021
 46    -0.92500         0.978081        0.984095        0.014132        0.007000
 47    -0.95000         0.978338        0.983789        0.014769        0.006991
 48    -0.97500         0.979646        0.983568        0.015607        0.006989
 49    -1.00000         0.979857        0.983409        0.016707        0.006989
 50    -1.02500         0.980679        0.983288        0.017310        0.006995
 51    -1.05000         0.979617        0.983202        0.018541        0.007000
 52    -1.07500         0.982005        0.983132        0.019558        0.007011
 53    -1.10000         0.980667        0.983082        0.020784        0.007020
 54    -1.12500         0.981246        0.983038        0.021931        0.007034
 55    -1.15000         0.983792        0.982995        0.022859        0.007051
 56    -1.17500         0.987478        0.982952        0.023753        0.007070
 57    -1.20000         0.992413        0.982907        0.024384        0.007092
```

Figure 72 (Continued)

```
                          ANALYSIS OF INTERFACIAL RIPPL  DATA MEASURED AT  THE POLARIZED 0.00025-M
                    NADS IN M/20 NA2SO4--HG INTERFACE(TAKEN BY G.BIERWAGEN ON 1-1[illegible]-65) [illegible]
MEASUREMENTS MADE AT 0.00025-M NADS IN .05-M NA2SO4          /PURE MERCURY                          INTERFACE
0.00025-M NADS        0.050-M NA2SO4



DENSITY OF UPPER PHASE   0.99700   DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE   0.0089400   VISCOSITY OF LOWER PHASE   0.0152700

ORIGINAL OUTPUT VOLTAGE    13.49400000 MV.

INITIAL DAMPING COEFFICIENT    0.91262 1/CM.

WAVELENGTH 0.09815 CM.

PROBE SEPARATION =    1.39700 CM.

WAVENUMBER =    64.016091 RECIPROCAL CM.


                 INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM


SURFACTANT CONCENTRATION= 0.00025-M NADS

ELECTROCAPILLARY MAXIMUM IS   -0.55000 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=    1.50000

ELECTRICAL DESORPTION EXPONENT =   12.50000

MAXIMUM SURFACE COVERAGE X P X TEMPERATURE =   13.50000

DIFFUSION TERM=     455.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000010

SURFACTANT SURFACE VISCOSITY= 0.000500

 1/B0 = FRUMKIN CONCENTRATION CONSTANT=  0.000250
```

Figure 73. YCOR data listing for 2.5 x 10^{-4}-M NaDS in .05-M Na_2SO_4

```
                                           INPUT DATA
NO.          POL.VOLTAGE          FREQUENCY          OUTPUT VOLTAGE(MV.)          GAMMA
 1           -1.250000            420.010000         15.228000                    363.932300
 2           -1.225000            419.300000         15.600000                    367.460900
 3           -1.200000            420.300000         15.822000                    370.905000
 4           -1.175000            420.400000         15.614000                    374.242700
 5           -1.150000            421.700000         15.952000                    377.548000
 6           -1.125000            424.000000         15.330000                    380.757000
 7           -1.100000            422.900000         15.971000                    383.855700
 8           -1.075000            423.600000         16.282000                    386.833000
 9           -1.050000            426.400000         16.182000                    389.739200
10           -1.025000            427.500000         16.507000                    392.513600
11           -1.000000            426.800000         17.141000                    395.150100
12           -0.975000            427.700000         16.809000                    397.680600
13           -0.950000            430.700000         16.729000                    400.080300
14           -0.925000            431.100000         16.764000                    402.346900
15           -0.900000            430.600000         17.055000                    404.485300
16           -0.875000            431.300000         16.558000                    406.488000
17           -0.850000            432.800000         15.101000                    408.344200
18           -0.825000            432.600000         13.990000                    410.066100
19           -0.800000            432.600000         13.760000                    411.645500
20           -0.775000            432.400000         13.012000                    413.079100
21           -0.750000            433.100000         13.152000                    414.360800
22           -0.725000            432.800000         13.233000                    415.491900
23           -0.700000            431.900000         13.554000                    416.466300
24           -0.675000            432.400000         13.193000                    417.284400
25           -0.650000            433.100000         13.023000                    417.942800
26           -0.625000            432.800000         13.438000                    418.446200
27           -0.600000            432.000000         13.620000                    418.793200
28           -0.575000            432.400000         13.552000                    418.985900
29           -0.550000            433.200000         13.173000                    419.036100
30           -0.525000            432.900000         13.233000                    418.946700
31           -0.500000            432.100000         13.494000                    418.728700
32           -0.475000            432.400000         13.720000                    418.392500
33           -0.450000            433.200000         13.280000                    417.950100
34           -0.425000            432.800000         13.477000                    417.415200
35           -0.400000            431.800000         13.427000                    416.800500
36           -0.375000            432.100000         13.308000                    416.116400
37           -0.350000            432.500000         13.483000                    415.373500
38           -0.325000            432.300000         13.226000                    414.578800
39           -0.300000            430.900000         13.236000                    413.737000
40           -0.275000            431.200000         13.168000                    412.846400
41           -0.250000            430.500000         13.771000                    411.900800
42           -0.225000            430.000000         13.592000                    410.898400
43           -0.200000            428.600000         13.651000                    409.791200
44           -0.175000            427.800000         13.626000                    408.584700
45           -0.150000            427.300000         14.138000                    407.240000
46           -0.125000            426.200000         14.464000                    405.727700
47           -0.100000            426.800000         14.503000                    404.011400
48           -0.075000            426.700000         14.481000                    402.063400
49           -0.050000            424.100000         14.480000                    399.862000
50           -0.025000            423.200000         14.079000                    397.401300
51           -0.0                 423.200000         14.317000                    394.698400
52            0.025000            422.800000         14.153000                    391.804900
53            0.050000            419.700000         15.086000                    388.922700
54            0.075000            417.400000         14.931000                    384.800000
55            0.100000            417.700000         14.540000                    380.400000
56            0.125000            412.800000         13.985000                    376.000000
57            0.150000            410.300000         13.044000                    371.000000
58            0.200000            403.900000         11.665000                    360.100000
```

Figure 73 (Continued)

```
INITIAL FREQUENCY =  432.10000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                         -0.1208608915D 04    FREQUENCY** 0
                          0.2923330235D 04    FREQUENCY** 1
                         -0.2931293885D 04    FREQUENCY** 2
                          0.1783278968D 04    FREQUENCY** 3
                         -0.7046183117D 03    FREQUENCY** 4
                          0.1890887852D 03    FREQUENCY** 5
                         -0.3492397260D 02    FREQUENCY** 6
                          0.4385962415D 01    FREQUENCY** 7
                         -0.3586019692D 00    FREQUENCY** 8
                          0.1724337906D-01    FREQUENCY** 9
                         -0.3704209668D-03    FREQUENCY**10

NO.     FREQUENCY     CORRECTED OUTPUT VOLTAGE         NO.     FREQUENCY     CORRECTED OUTPUT VOLTAGE
 1      420.01000          15.14224                     30     432.90000          13.22262
 2      419.80000          15.50646                     31     432.10000          13.49400
 3      420.30000          15.74065                     32     432.40000          13.71620
 4      420.40000          15.53630                     33     433.20000          13.26517
 5      423.70000          15.94248                     34     432.80000          13.46786
 6      424.00000          15.32529                     35     431.80000          13.43043
 7      422.90000          15.94769                     36     432.10000          13.30800
 8      423.60000          16.27064                     37     432.50000          13.47796
 9      426.40000          16.20331                     38     432.30000          13.72359
10      427.50000          16.53406                     39     430.90000          13.24789
11      426.80000          17.16612                     40     431.20000          13.17728
12      427.70000          16.83705                     41     430.50000          13.78647
13      430.70000          16.74599                     42     430.00000          13.61039
14      431.10000          16.77694                     43     428.60000          13.67406
15      430.60000          17.07326                     44     427.80000          13.64889
16      431.30000          16.56853                     45     427.30000          14.16064
17      432.80000          15.09076                     46     426.20000          14.48178
18      432.60000          13.98338                     47     426.80000          14.52426
19      432.60000          13.75349                     48     426.70000          14.50173
20      432.40000          13.00840                     49     424.10000          14.47689
21      433.10000          13.13980                     50     423.20000          14.06322
22      432.80000          13.22403                     51     423.20000          14.39095
23      431.90000          13.55634                     52     422.80000          14.13069
24      432.40000          13.19935                     53     419.70000          14.99289
25      433.10000          13.00993                     54     417.40000          14.77121
26      432.90000          13.42885                     55     417.70000          14.39371
27      432.00000          13.62119                     56     412.80000          13.67557
28      432.40000          13.54825                     57     410.30000          12.66103
29      433.20000          13.15825                     58     403.90000          11.08563
```

Figure 73 (Continued)

```
NO.      PCL.VOLTAGE      GAMMA(EXPT.)CALC.F=0        TA FROM MODEL        SIGMA(EXPT1)        ALPHA[illegible]
  1       -1.25000           395.87303                  0.002197              [illegible]           [illegible]
  2       -1.22500           395.49376                  0.003384              [illegible]           [illegible]
  3       -1.20000           396.43198                  0.005139              [illegible]           [illegible]
  4       -1.17500           396.61207                  0.007693              [illegible]           [illegible]
  5       -1.15000           402.79846                  0.011363              0.793243              [illegible]
  6       -1.12500           403.34286                  0.016576              0.821575              [illegible]
  7       -1.10000           401.25745                  0.023903              [illegible]           [illegible]
  8       -1.07500           402.62021                  0.034128              0.779678              [illegible]
  9       -1.05000           407.89341                  0.049338              0.731646              0.51165[illegible]
 10       -1.02500           409.98470                  0.068119              0.767131              0.512417
 11       -1.00000           408.67613                  0.095909              0.740327              0.51275[illegible]
 12       -0.97500           410.37210                  0.135839              0.754193              0.51932[illegible]
 13       -0.95000           416.07725                  0.195846              0.759765              0.541[illegible]
 14       -0.92500           416.84211                  0.294123              0.756743              0.6311
 15       -0.90000           415.89515                  0.468910              0.744210              0.7959
 16       -0.87500           417.21855                  0.657510              0.765691              0.9709
 17       -0.85000           420.04413                  0.760932              0.832564              0.8967[illegible]
 18       -0.82500           419.61827                  0.819560              0.887119              0.85852[illegible]
 19       -0.80000           419.60859                  0.856837              0.898985              0.836011
 20       -0.77500           419.19154                  0.882254              0.938855              0.820593
 21       -0.75000           420.53997                  0.900342              0.931714              0.810902
 22       -0.72500           419.96844                  0.913557              0.927087              0.802373
 23       -0.70000           418.25924                  0.923354              0.909320              0.794865
 24       -0.67500           419.20009                  0.930644              0.928966              0.791015
 25       -0.65000           420.53384                  0.936019              0.938770              0.788618
 26       -0.62500           419.97781                  0.939874              0.916082              0.785620
 27       -0.60000           418.45349                  0.942467              0.905904              0.782677
 28       -0.57500           419.21636                  0.943964              0.909748              0.782312
 29       -0.55000           420.73281                  0.944452              0.930654              0.783236
 30       -0.52500           420.16017                  0.943964              0.927162              0.783128
 31       -0.50000           418.63934                  0.942467              0.912620              0.782910
 32       -0.47500           419.22368                  0.939874              0.900929              0.785070
 33       -0.45000           420.73780                  0.936019              0.924863              0.788763
 34       -0.42500           419.97956                  0.930644              0.914008              0.791475
 35       -0.40000           418.06229                  0.923354              0.916000              0.794297
 36       -0.37500           418.63096                  0.913557              0.922555              0.800495
 37       -0.35000           419.40487                  0.900342              0.913471              0.808687
 38       -0.32500           419.01010                  0.882254              0.927110              0.819565
 39       -0.30000           416.33377                  0.856837              0.925796              0.830590
 40       -0.27500           416.90353                  0.819560              0.929621              0.852665
 41       -0.25000           415.59404                  0.760932              0.897271              0.888159
 42       -0.22500           414.63321                  0.657510              0.906472              0.962724
 43       -0.20000           411.97253                  0.468910              0.903131              0.980409
 44       -0.17500           410.45338                  0.294123              0.904450              0.617812
 45       -0.15000           409.52689                  0.195846              0.878103              0.530616
 46       -0.12500           407.45869                  0.135838              0.862050              0.509867
 47       -0.10000           408.59444                  0.095909              0.859954              0.504492
 48       -0.07500           408.40446                  0.068119              0.861065              0.502519
 49       -0.05000           403.50139                  0.048338              0.862292              0.499695
 50       -0.02500           401.79576                  0.034128              0.883044              0.499516
 51       -0.0               401.80488                  0.023903              0.871044              0.500994
 52        0.02500           401.04846                  0.016576              0.879618              0.502368
 53        0.05000           395.29113                  0.011363              0.837222              0.501416
 54        0.07500           391.01629                  0.007693              0.847885              0.502497
 55        0.10000           391.55831                  0.005139              0.866416              0.506857
 56        0.12500           382.51191                  0.003384              0.903053              0.505886
 57        0.15000           377.90866                  0.002197              0.958229              0.508137
 58        0.20000           366.28145                  0.000985              1.053347              0.512413
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Figure 73 (Continued)

```
NO.     POL.VOLTAGE        RE(F)-EXPT.        RE(F)-MODEL       IM(F)-EXPT.        IM(F)-MODEL
 1        -1.25000          12.947750           0.000111          9.555884          -0.002965
 2        -1.22500          12.932262           0.001996          9.049149          -0.005624
 3        -1.20000          12.919433           0.006312          8.663108          -0.010597
 4        -1.17500          12.956655           0.015359          9.034912          -0.019430
 5        -1.15000          13.055695           0.037969          8.669888          -0.034227
 6        -1.12500          13.180557           0.083838          8.132082          -0.056443
 7        -1.10000          12.995412           0.159795          6.711042          -0.086691
 8        -1.07500          12.926660           0.297163          6.093903          -0.123955
 9        -1.05000          13.108562           0.525901          6.973248          -0.165198
10        -1.02500          13.066306           0.897380          6.752957          -0.207838
11        -1.00000          12.700395           1.509626          5.048583          -0.250179
12        -0.97500          12.864633           2.560422          4.550408          -0.291503
13        -0.95000          13.144063           4.523077          4.200213          -0.332758
14        -0.92500          13.124216           8.802429          5.518938          -0.384558
15        -0.90000          12.848643          20.407815          3.693763          -0.563592
16        -0.87500          13.194416          42.195563          3.136918          -1.500762
17        -0.85000          14.179833          63.173451          3.902999          -3.443897
18        -0.82500          15.426516          82.039119          2.454647          -6.236751
19        -0.80000          16.316357          99.537337          1.041940          -9.799859
20        -0.77500          18.553242         115.873480         -0.446632         -14.031212
21        -0.75000          18.397227         130.999999         -0.501842         -18.754598
22        -0.72500          20.431948         144.705682         -2.885088         -23.771845
23        -0.70000          26.821707         155.805683         -8.489072         -28.928334
24        -0.67500          26.986275         167.237228         -6.756359         -33.622382
25        -0.65000          25.035752         175.863124         -5.148918         -37.918186
26        -0.62500          28.262720         182.551928         -8.317050         -41.517617
27        -0.60000          40.067934         187.293486        -10.787079         -44.232092
28        -0.57500          35.547878         190.196632        -10.418840         -45.896291
29        -0.55000          27.973809         191.210770         -6.861564         -46.444533
30        -0.52500          30.005480         190.231447         -7.721781         -45.885745
31        -0.50000          37.881990         187.300179         -9.965709         -44.229999
32        -0.47500          31.423541         182.527010        -10.980705         -41.525824
33        -0.45000          24.082936         175.868745         -5.635610         -37.916207
34        -0.42500          24.340555         167.256899         -6.662742         -33.614898
35        -0.40000          29.419094         156.801538         -8.803370         -28.830049
36        -0.37500          24.695437         144.682376         -6.270537         -23.782358
37        -0.35000          20.760300         130.984739         -4.051292         -18.762074
38        -0.32500          20.450793         115.871645         -2.959833         -14.032176
39        -0.30000          24.401548          99.516602         -5.997495          -9.811346
40        -0.27500          21.054937          82.027936         -3.460828          -6.242447
41        -0.25000          20.603607          63.164995         -5.309081          -3.448202
42        -0.22500          20.779042          42.193739         -4.867631          -1.501356
43        -0.20000          24.686944          20.406861         -8.333690          -0.563703
44        -0.17500          25.836617           8.801202         -8.975141          -0.384995
45        -0.15000          22.952715           4.521860         -9.775964          -0.333274
46        -0.12500          23.882559           2.559913        -12.832302          -0.291698
47        -0.10000          17.301008           1.509626         -4.550994          -0.250179
48        -0.07500          15.820457           0.897666         -1.360448          -0.207872
49        -0.05000          19.413324           0.525297         -6.725736          -0.165198
50        -0.02500          18.030162           0.297097         -4.388016          -0.123843
51        -0.0              15.327635           0.159828         -0.150830          -0.086705
52         0.02500          14.632680           0.087735          2.206468          -0.056386
53         0.05000          14.447690           0.037954         -1.287799          -0.034048
54         0.07500          14.660025           0.016328         -1.559945          -0.019345
55         0.10000          13.669511           0.006309          3.693868          -0.010549
56         0.12500          15.482639           0.002009         -0.593225          -0.005545
57         0.15000          16.099226           0.000356          0.646068          -0.002899
58         0.20000          17.474757          -0.000272          1.424990          -0.000811
```

Figure 73 (Continued)

```
NO.      POL.VOLTAGE        Y1-EXPT.        Y1-MODEL        Y2-EXPT.        Y2-MODEL

  1       -1.25000          1.060040        0.981076        0.012967        0.007997
  2       -1.22500          1.048725        0.981139        0.012702        0.007956
  3       -1.20000          1.041463        0.981196        0.012534        0.007930
  4       -1.17500          1.032556        0.981260        0.012680        0.007906
  5       -1.15000          1.039759        0.981308        0.012392        0.007897
  6       -1.12500          1.032456        0.981397        0.012833        0.007880
  7       -1.10000          1.018915        0.981529        0.012388        0.007864
  8       -1.07500          1.014323        0.981701        0.012164        0.007861
  9       -1.05000          1.020113        0.981943        0.012210        0.007873
 10       -1.02500          1.018135        0.982337        0.011984        0.007891
 11       -1.00000          1.008032        0.982987        0.011565        0.007927
 12       -0.97500          1.005847        0.984093        0.011781        0.008035
 13       -0.95000          1.013889        0.986198        0.011842        0.008369
 14       -0.92500          1.010051        0.990530        0.011821        0.009773
 15       -0.90000          1.002382        0.987153        0.011625        0.015444
 16       -0.87500          1.000689        0.972402        0.011961        0.014989
 17       -0.85000          1.003081        0.969862        0.013006        0.013820
 18       -0.82500          0.997946        0.969229        0.013858        0.013251
 19       -0.80000          0.994117        0.969000        0.014043        0.012919
 20       -0.77500          0.989751        0.968907        0.014666        0.012699
 21       -0.75000          0.989887        0.968860        0.014554        0.012548
 22       -0.72500          0.985825        0.968850        0.014482        0.012433
 23       -0.70000          0.979432        0.968861        0.014205        0.012344
 24       -0.67500          0.979776        0.968859        0.014511        0.012283
 25       -0.65000          0.981403        0.968857        0.014665        0.012239
 26       -0.62500          0.978865        0.968867        0.014310        0.012203
 27       -0.60000          0.974441        0.968881        0.014151        0.012175
 28       -0.57500          0.975795        0.968879        0.014211        0.012164
 29       -0.55000          0.979294        0.968869        0.014538        0.012164
 30       -0.52500          0.978147        0.968872        0.014483        0.012167
 31       -0.50000          0.975043        0.968878        0.014256        0.012177
 32       -0.47500          0.977182        0.968870        0.014073        0.012201
 33       -0.45000          0.981839        0.968856        0.014447        0.012239
 34       -0.42500          0.981282        0.968858        0.014278        0.012284
 35       -0.40000          0.978194        0.968871        0.014309        0.012340
 36       -0.37500          0.981164        0.968875        0.014411        0.012424
 37       -0.35000          0.984739        0.968894        0.014269        0.012536
 38       -0.32500          0.985715        0.968948        0.014482        0.012685
 39       -0.30000          0.981333        0.969077        0.014467        0.012891
 40       -0.27500          0.984820        0.969324        0.014522        0.013219
 41       -0.25000          0.983878        0.969996        0.014016        0.013777
 42       -0.22500          0.984013        0.972586        0.014160        0.014946
 43       -0.20000          0.980233        0.987415        0.014108        0.015317
 44       -0.17500          0.979461        0.990535        0.014128        0.009665
 45       -0.15000          0.980397        0.986250        0.013717        0.008286
 46       -0.12500          0.978994        0.984174        0.013466        0.007960
 47       -0.10000          0.985923        0.983089        0.013433        0.007855
 48       -0.07500          0.990236        0.982468        0.013451        0.007811
 49       -0.05000          0.983590        0.982102        0.013470        0.007784
 50       -0.02500          0.985485        0.981859        0.013794        0.007775
 51       -0.0              0.992233        0.981691        0.013607        0.007778
 52        0.02500          0.997672        0.981577        0.013741        0.007787
 53        0.05000          0.990636        0.981515        0.013078        0.007790
 54        0.07500          0.990051        0.981451        0.013245        0.007808
 55        0.10000          1.002943        0.981370        0.013534        0.007841
 56        0.12500          0.991013        0.981333        0.014107        0.007857
 57        0.15000          0.992240        0.981270        0.014969        0.007888
 58        0.20000          0.990907        0.981136        0.016454        0.007957
```

Figure 73 (Continued)

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                              ANALYSIS OF INTERFACIAL RIPPLE DATA  FROM THE POLARIZED .0005-M NADS +.050-M

                    NA2SO4 / PURE HG INTERFACE:  DATA OF G.BIERWAGEN (1-11-68) TRY#1

MEASUREMENTS MADE AT M/2000 NA DECYLSULFONATE+M/20 NA2SO4    /    PURE MERCURY                        INTERFACE
0.0005-M NADS         IN 0.050-M NA2SO4



DENSITY OF UPPER PHASE    0.99700    DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE    0.0089400    VISCOSITY OF LOWER PHASE    0.0152700

ORIGINAL OUTPUT VOLTAGE     10.59500000 MV.

INITIAL DAMPING COEFFICIENT    0.66257 1/CM.

WAVELENGTH 0.12980 CM.

PROBE SEPARATION =     1.47300 CM.

WAVENUMBER =    48.406620 RECIPROCAL CM.



                 INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM



SURFACTANT CONCENTRATION= 0.0005-M NADS

ELECTROCAPILLARY MAXIMUM IS   -0.57500 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=     1.50000

ELECTRICAL DESORPTION EXPONENT =    12.50000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =    13.50000

DIFFUSION TERM=     455.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000010

SURFACTANT SURFACE VISCOSITY= 0.000500

 1/BO = FRUMKIN CONCENTRATION CONSTANT=  0.000250
```

Figure 74. YCOR data listing for 5×10^{-4}-M NaDS in .05-M Na_2SO_4

INPUT DATA

NO.	PCL.VOLTAGE	FREQUENCY	OUTPUT VOLTAGE(MV.)	GAMMA
1	-1.200000	271.200000	14.203000	370.894500
2	-1.175000	271.500000	14.414000	374.235100
3	-1.150000	273.200000	13.767000	377.481600
4	-1.125000	273.600000	13.707000	380.639400
5	-1.100000	274.700000	13.945000	383.703600
6	-1.075000	275.300000	13.648000	386.671300
7	-1.050000	276.500000	13.623000	389.537800
8	-1.025000	277.400000	13.454000	392.291700
9	-1.000000	277.800000	13.709000	394.924000
10	-0.975000	278.500000	13.584000	397.426700
11	-0.950000	279.500000	13.415000	399.790500
12	-0.925000	280.000000	12.811000	402.006300
13	-0.900000	280.400000	13.311000	404.068100
14	-0.875000	280.700000	12.442000	405.969400
15	-0.850000	281.400000	11.994000	407.706000
16	-0.825000	281.400000	11.241000	409.275600
17	-0.800000	281.800000	11.551000	410.677400
18	-0.775000	281.700000	10.939000	411.911600
19	-0.750000	281.900000	10.775000	412.980900
20	-0.725000	281.800000	10.657000	413.888900
21	-0.700000	282.100000	10.555000	414.640600
22	-0.675000	281.500000	10.618000	415.240900
23	-0.650000	282.100000	10.572000	415.698900
24	-0.625000	282.000000	10.562000	416.019700
25	-0.600000	282.100000	10.567000	416.212400
26	-0.575000	281.700000	10.656000	416.284900
27	-0.550000	282.300000	10.611000	416.243800
28	-0.525000	282.000000	10.605000	416.098800
29	-0.500000	282.000000	10.595000	415.854900
30	-0.475000	281.600000	10.656000	415.518700
31	-0.450000	282.000000	10.673000	415.095700
32	-0.425000	282.000000	10.472000	414.588600
33	-0.400000	281.800000	10.701000	414.000900
34	-0.375000	281.400000	10.722000	413.334200
35	-0.350000	281.800000	10.869000	412.588300
36	-0.325000	281.600000	10.928000	411.760900
37	-0.300000	281.100000	11.151000	410.851000
38	-0.275000	280.700000	11.263000	409.854400
39	-0.250000	279.500000	11.521000	408.767000
40	-0.225000	279.200000	11.513000	407.585200
41	-0.200000	279.600000	11.831000	406.303900
42	-0.175000	278.900000	11.818000	404.919600
43	-0.150000	278.200000	11.960000	403.429400
44	-0.125000	277.700000	12.183000	401.832500
45	-0.100000	277.700000	12.067000	400.132500
46	-0.075000	276.900000	12.293000	398.334200
47	-0.050000	276.300000	12.251000	396.449200
48	-0.025000	275.100000	12.470000	394.494300
49	-0.0	274.800000	12.365000	391.200000
50	0.025000	273.900000	12.621000	388.200000
51	0.050000	272.700000	13.052000	385.500000
52	0.075000	271.500000	13.145000	382.000000
53	0.100000	269.800000	13.951000	378.000000
54	0.125000	268.000000	15.345000	373.500000
55	0.150000	265.300000	17.159000	368.500000
56	0.200000	262.700000	17.715000	357.000000

Figure 74 (Continued)

```
INITIAL FREQUENCY =   282.00000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                           0.3830490050D 05      FREQUENCY** 0
                          -0.3174421636D 05      FREQUENCY** 1
                           0.9407638208D 05      FREQUENCY** 2
                          -0.5353771773D 05      FREQUENCY** 3
                           0.1826156901D 05      FREQUENCY** 4
                          -0.3733479368D 04      FREQUENCY** 5
                           0.4236053609D 03      FREQUENCY** 6
                          -0.2057572356D 02      FREQUENCY** 7
                           0.0                   FREQUENCY** 8
                           0.0                   FREQUENCY** 9
                           0.0                   FREQUENCY**10

NO.     FREQUENCY     CORRECTED OUTPUT VOLTAGE        NO.     FREQUENCY     CORRECTED OUTPUT VOLTAGE
 1      271.20000          11.87580                   29      282.00000          10.59500
 2      271.50000          12.10596                   30      281.60000          10.58381
 3      273.20000          11.86616                   31      282.00000          10.67300
 4      273.60000          11.99896                   32      282.00000          10.47200
 5      274.70000          12.31095                   33      281.80000          10.66475
 6      275.30000          12.16804                   34      281.40000          10.61307
 7      276.50000          12.39239                   35      281.80000          10.83218
 8      277.40000          12.42805                   36      281.60000          10.85397
 9      277.80000          12.75105                   37      281.10000          10.98114
10      278.50000          12.78859                   38      280.70000          11.01539
11      279.50000          12.85045                   39      279.50000          11.03616
12      280.00000          12.37871                   40      279.20000          10.97123
13      280.40000          12.95115                   41      279.60000          11.35279
14      280.70000          12.16847                   42      278.90000          11.20341
15      281.40000          11.87215                   43      278.20000          11.20136
16      281.40000          11.12680                   44      277.70000          11.31218
17      281.80000          11.51187                   45      277.70000          11.20447
18      281.70000          10.78393                   46      276.90000          11.25884
19      281.90000          10.75675                   47      276.30000          11.10669
20      281.80000          10.62090                   48      275.10000          11.08115
21      282.10000          10.57288                   49      274.80000          10.93392
22      281.50000          10.52810                   50      273.90000          10.99928
23      282.10000          10.58991                   51      272.70000          11.16296
24      282.00000          10.56200                   52      271.50000          11.04015
25      282.10000          10.58490                   53      269.80000          11.42981
26      281.70000          10.60186                   54      268.00000          12.25094
27      282.30000          10.66491                   55      265.90000          13.27098
28      282.00000          10.60500                   56      262.70000          12.88326
```

Figure 74 (Continued)

NO.	PCL.VOLTAGE	GAMMA(EXPT.)CALC.E=0)	THETA FROM MODEL	ALPHA(EXPTL)	ALPHA(MODEL)
1	-1.20000	383.70259	0.015630	0.585095	0.355750
2	-1.17500	384.54721	0.023270	0.572064	0.354301
3	-1.15000	389.27938	0.034335	0.585647	0.354929
4	-1.12500	390.40081	0.050353	0.584343	0.354821
5	-1.10000	393.50966	0.073711	0.560664	0.356626
6	-1.07500	395.19358	0.108473	0.568591	0.360074
7	-1.05000	398.59537	0.162518	0.556188	0.370761
8	-1.02500	401.15038	0.254566	0.554237	0.414692
9	-1.00000	402.30166	0.436701	0.536819	0.670282
10	-0.97500	404.29784	0.666667	0.534823	0.665653
11	-0.95000	407.15853	0.783380	0.531547	0.615031
12	-0.92500	408.57107	0.845213	0.556938	0.592473
13	-0.90000	409.74367	0.883102	0.526248	0.579438
14	-0.87500	410.57147	0.908299	0.568567	0.570702
15	-0.85000	412.57191	0.925916	0.585304	0.565172
16	-0.82500	412.53046	0.938650	0.629322	0.560066
17	-0.80000	413.70636	0.948071	0.606225	0.556758
18	-0.77500	413.37399	0.955153	0.650571	0.553448
19	-0.75000	413.94938	0.960529	0.652284	0.551278
20	-0.72500	413.65171	0.964627	0.660912	0.549128
21	-0.70000	414.51462	0.967738	0.663989	0.548057
22	-0.67500	412.78013	0.970066	0.666870	0.545879
23	-0.65000	414.51579	0.971753	0.662896	0.545965
24	-0.62500	414.22505	0.972896	0.664688	0.545191
25	-0.60000	414.51544	0.973558	0.663218	0.544992
26	-0.57500	413.36190	0.973775	0.662131	0.544218
27	-0.55000	415.09882	0.973558	0.658105	0.545289
28	-0.52500	414.22799	0.972896	0.661930	0.545122
29	-0.50000	414.22731	0.971753	0.662570	0.545668
30	-0.47500	413.07226	0.970066	0.663287	0.545801
31	-0.45000	414.23257	0.967738	0.657590	0.547498
32	-0.42500	414.21883	0.964627	0.670497	0.548846
33	-0.40000	413.65466	0.960529	0.658115	0.550222
34	-0.37500	412.49770	0.955153	0.661413	0.551707
35	-0.35000	413.66565	0.948071	0.647540	0.555077
36	-0.32500	413.09008	0.938650	0.646176	0.558208
37	-0.30000	411.65745	0.925916	0.638268	0.561878
38	-0.27500	410.50886	0.908299	0.636154	0.567250
39	-0.25000	407.06775	0.883102	0.634875	0.573676
40	-0.22500	406.20549	0.845213	0.638881	0.586045
41	-0.20000	407.37260	0.783380	0.615672	0.609373
42	-0.17500	405.36196	0.666667	0.624663	0.659583
43	-0.15000	403.36477	0.436701	0.624788	0.657100
44	-0.12500	401.94765	0.254566	0.618105	0.406041
45	-0.10000	401.94152	0.162518	0.624600	0.364369
46	-0.07500	399.67242	0.108473	0.621313	0.353859
47	-0.05000	397.96383	0.073711	0.630550	0.349833
48	-0.02500	394.57366	0.050353	0.632113	0.347239
49	-0.0	393.72012	0.034335	0.641194	0.347507
50	0.02500	391.19488	0.023270	0.637147	0.347562
51	0.05000	387.84484	0.015630	0.627119	0.347499
52	0.07500	384.49318	0.010385	0.634629	0.348216
53	0.10000	379.80085	0.006815	0.611081	0.348865
54	0.12500	374.88023	0.004414	0.563982	0.349832
55	0.15000	369.17413	0.002819	0.509687	0.350968
56	0.20000	360.49321	0.001100	0.529816	0.355331

Figure 74 (Continued)

```
NO.   POL.VOLTAGE    RE(E)-EXPT.    RE(E)-MODEL    IM(E)-EXPT.    IM(E)-MODEL
  1    -1.20000      12.082426       0.333119       3.327252      -0.029419
  2    -1.17500      12.091079       0.075736       1.132865      -0.056944
  3    -1.15000      12.376645       0.166798       2.537940      -0.103748
  4    -1.12500      12.727159       0.353045       0.502829      -0.176318
  5    -1.10000      12.158414       0.723379       0.442789      -0.277434
  6    -1.07500      12.696851       1.452514      -1.344583      -0.403304
  7    -1.05000      12.284013       2.948318      -0.618790      -0.543290
  8    -1.02500      12.335242       6.445894      -0.949073      -0.684619
  9    -1.00000      11.714037      17.245918      -3.710964      -0.942250
 10    -0.97500      11.682451      41.731395      -4.947932      -3.059549
 11    -0.95000      11.630062      63.594278      -3.811714      -8.163612
 12    -0.92500      13.390769      80.964558      -5.702348     -15.279446
 13    -0.90000      11.203456      95.065882      -8.731187     -23.696538
 14    -0.87500      16.688393     106.399928     -12.592598     -32.756039
 15    -0.85000      18.064708     115.353718     -10.495624     -41.851204
 16    -0.82500      28.702899     122.170262     -11.263107     -50.514957
 17    -0.80000      28.722966     127.337970     -15.894453     -58.424009
 18    -0.77500      42.279631     131.093305      -5.331333     -65.398215
 19    -0.75000      45.774167     133.870637      -1.905124     -71.388223
 20    -0.72500      48.628416     135.824266      10.297085     -76.390905
 21    -0.70000      47.728734     137.284717       9.188816     -80.486148
 22    -0.67500      38.884127     138.149894      26.186359     -83.669067
 23    -0.65000      46.394556     138.941329      19.090743     -86.133629
 24    -0.62500      43.105501     139.352676      23.257772     -87.816232
 25    -0.60000      43.887879     139.617304      22.835553     -88.819831
 26    -0.57500      36.548759     139.609653      28.189883     -89.118103
 27    -0.55000      47.611888     139.658985      19.272763     -88.835048
 28    -0.52500      43.079882     139.352675      24.112835     -87.816232
 29    -0.50000      44.343797     138.920952      22.501069     -86.126716
 30    -0.47500      39.317142     138.169853      26.669775     -83.675381
 31    -0.45000      48.726482     137.265398      16.728307     -80.480631
 32    -0.42500      46.340807     135.861290      11.528621     -76.400067
 33    -0.40000      49.396723     133.853178      11.426205     -71.384714
 34    -0.37500      47.839433     131.044885      16.360052     -65.391155
 35    -0.35000      45.864657     127.337971      -3.598158     -58.424009
 36    -0.32500      44.015832     122.195362      -5.539093     -50.515100
 37    -0.30000      50.300364     115.322712      -3.255940     -41.853693
 38    -0.27500      52.293912     106.399929      -2.071150     -32.756038
 39    -0.25000      47.858092      95.015590      29.183595     -23.710959
 40    -0.22500      49.938204      80.937181      25.735275     -15.290574
 41    -0.20000      53.325101      63.595970     -12.755744      -8.162716
 42    -0.17500      58.792346      41.733676      -1.451720      -3.058135
 43    -0.15000      61.962096      17.246583       8.266997      -0.941837
 44    -0.12500      65.034231       6.446300       4.116060      -0.684395
 45    -0.10000      41.705310       2.949736     -14.019344      -0.542744
 46    -0.07500      48.758636       1.454012     -13.313381      -0.403009
 47    -0.05000      45.057349       0.724435     -11.397049      -0.277432
 48    -0.02500      59.072259       0.353664       7.199651      -0.176442
 49    -0.0          33.782143       0.167163     -11.104429      -0.103900
 50     0.02500      29.801083       0.076007     -11.621654      -0.057024
 51     0.05000      35.316020       0.033194     -14.888040      -0.029492
 52     0.07500      33.808363       0.013877     -13.215631      -0.014565
 53     0.10000      43.160107       0.005492     -21.433721      -0.006953
 54     0.12500      46.424237       0.002010     -62.700689      -0.003255
 55     0.15000     **********       0.000640     -53.195930      -0.001515
 56     0.20000       6.206026      -0.000014     -20.886845      -0.000343
```

Figure 74 (Continued)

```
NO.   POL.VOLTAGE     Y1-EXPT.      Y1-MODEL      Y2-EXPT.      Y2-MODEL

 1     -1.20000       1.002928      0.982595      0.012087      0.007256
 2     -1.17500       0.996175      0.982692      0.011818      0.007253
 3     -1.15000       1.000015      0.982799      0.012098      0.007259
 4     -1.12500       0.994525      0.983019      0.012072      0.007269
 5     -1.10000       0.994612      0.983408      0.011582      0.007307
 6     -1.07500       0.991314      0.984161      0.011746      0.007398
 7     -1.05000       0.992617      0.985716      0.011490      0.007609
 8     -1.02500       0.992076      0.988347      0.011450      0.008522
 9     -1.00000       0.988307      0.989161      0.011090      0.013792
10     -0.97500       0.987039      0.973804      0.011049      0.013631
11     -0.95000       0.988262      0.971913      0.010981      0.012582
12     -0.92500       0.986334      0.971541      0.011505      0.012127
13     -0.90000       0.984107      0.971443      0.010871      0.011869
14     -0.87500       0.981595      0.971426      0.011746      0.011700
15     -0.85000       0.982295      0.971431      0.012091      0.011584
16     -0.82500       0.978528      0.971458      0.013001      0.011494
17     -0.80000       0.977962      0.971481      0.012524      0.011429
18     -0.77500       0.974340      0.971513      0.013440      0.011375
19     -0.75000       0.973198      0.971536      0.013475      0.011335
20     -0.72500       0.970374      0.971561      0.013653      0.011302
21     -0.70000       0.970678      0.971575      0.013717      0.011279
22     -0.67500       0.965156      0.971602      0.013776      0.011255
23     -0.65000       0.968207      0.971603      0.013694      0.011245
24     -0.62500       0.966775      0.971613      0.013731      0.011235
25     -0.60000       0.967013      0.971616      0.013701      0.011230
26     -0.57500       0.964104      0.971626      0.013679      0.011225
27     -0.55000       0.968311      0.971613      0.013595      0.011231
28     -0.52500       0.966591      0.971615      0.013674      0.011234
29     -0.50000       0.967158      0.971608      0.013688      0.011243
30     -0.47500       0.965196      0.971607      0.013702      0.011253
31     -0.45000       0.968927      0.971588      0.013585      0.011274
32     -0.42500       0.970112      0.971574      0.013851      0.011297
33     -0.40000       0.970111      0.971562      0.013596      0.011325
34     -0.37500       0.968920      0.971553      0.013664      0.011360
35     -0.35000       0.973433      0.971528      0.013377      0.011412
36     -0.32500       0.974005      0.971516      0.013349      0.011474
37     -0.30000       0.972699      0.971515      0.013186      0.011554
38     -0.27500       0.972291      0.971524      0.013142      0.011666
39     -0.25000       0.966560      0.971580      0.013115      0.011822
40     -0.22500       0.967283      0.971704      0.013198      0.012074
41     -0.20000       0.973115      0.972096      0.012719      0.012531
42     -0.17500       0.971559      0.974063      0.012905      0.013580
43     -0.15000       0.970259      0.989505      0.012907      0.013606
44     -0.12500       0.970616      0.989344      0.012769      0.008406
45     -0.10000       0.974740      0.985780      0.012903      0.007523
46     -0.07500       0.973507      0.984272      0.012835      0.007306
47     -0.05000       0.973902      0.983553      0.013026      0.007220
48     -0.02500       0.970245      0.983192      0.013058      0.007174
49     -0.0           0.976283      0.982976      0.013246      0.007164
50      0.02500       0.977394      0.982859      0.013162      0.007162
51      0.05000       0.975634      0.982794      0.012955      0.007164
52      0.07500       0.975927      0.982739      0.013110      0.007178
53      0.10000       0.973942      0.982691      0.012624      0.007196
54      0.12500       0.972568      0.982641      0.011651      0.007219
55      0.15000       0.970376      0.982588      0.010529      0.007245
56      0.20000       0.977671      0.982445      0.010945      0.007317
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Figure 74 (Continued)

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                                              ANALYSIS OF INTERFACIAL RIPPLE DATA FROM THE POLARIZED M/1000 NADS IN 0.050-M
                                      NA2SO4 / PURE HG INTERFACE;  DATA OF G.BIERWAGEN (1-16-68) TRY#2
MEASUREMENTS MADE AT M/1000 NA DECYLSULFONATE+M/20 NA2SO4     /     PURE MERCURY                              INTERFACE
0.0010-M NADS          IN 0.050-M NA2SO4



DENSITY OF UPPER PHASE    0.99700    DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE    0.0089400    VISCOSITY OF LOWER PHASE    0.0152700

ORIGINAL OUTPUT VOLTAGE      6.47800000 MV.

INITIAL DAMPING COEFFICIENT    0.69952 1/CM.

WAVELENGTH 0.12820 CM.

PROBE SEPARATION =     2.13000 CM.

WAVENUMBER =    49.010759 RECIPROCAL CM.



                         INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM


SURFACTANT CONCENTRATION= 0.0010-M NADS

ELECTROCAPILLARY MAXIMUM IS   -0.57500 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=     1.50000

ELECTRICAL DESORPTION EXPONENT =    12.50000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =   13.50000

DIFFUSION TERM=      455.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000010

SURFACTANT SURFACE VISCOSITY= 0.000500

 1/B0 = FRUMKIN CONCENTRATION CONSTANT=  0.000250
```

Figure 75. YCOR data listing for 10^{-3}-M NaDS in .95-M Na_2SO_4

```
                                                  INPUT DATA

NO.               POL.VOLTAGE           FREQUENCY           OUTPUT VOLTAGE(MV.)           GAMMA
  1               -1.200000             276.800000              8.293000              370.968700
  2               -1.175000             277.400000              7.866000              374.175700
  3               -1.150000             278.700000              7.912000              377.542900
  4               -1.125000             279.600000              7.689000              380.632800
  5               -1.100000             280.500000              7.963000              383.777300
  6               -1.075000             280.800000              7.682000              386.949200
  7               -1.050000             281.500000              7.622000              389.574200
  8               -1.025000             281.900000              7.604000              392.230400
  9               -1.000000             282.600000              7.419000              394.744600
 10               -0.975000             282.200000              6.220000              396.968500
 11               -0.950000             283.000000              6.292000              399.079800
 12               -0.925000             283.000000              6.801000              400.931900
 13               -0.900000             283.100000              6.268000              402.690400
 14               -0.875000             282.600000              6.112000              404.231900
 15               -0.850000             283.500000              6.196000              405.598100
 16               -0.825000             283.500000              6.672000              406.816600
 17               -0.800000             283.500000              6.274000              407.891600
 18               -0.775000             283.200000              5.947000              408.817800
 19               -0.750000             283.900000              6.330000              409.614700
 20               -0.725000             284.000000              6.916000              410.266800
 21               -0.700000             283.900000              6.300000              410.806800
 22               -0.675000             283.400000              6.178000              411.231600
 23               -0.650000             284.400000              6.448000              411.540500
 24               -0.625000             284.200000              6.947000              411.746000
 25               -0.600000             284.200000              6.450000              411.858100
 26               -0.575000             283.500000              6.003000              411.880300
 27               -0.550000             284.800000              6.434000              411.820800
 28               -0.525000             284.600000              6.417000              411.688700
 29               -0.500000             284.200000              6.478000              411.491200
 30               -0.475000             283.400000              6.205000              411.232400
 31               -0.450000             284.700000              6.537000              410.916200
 32               -0.425000             284.700000              6.415000              410.542900
 33               -0.400000             284.000000              6.452000              410.107900
 34               -0.375000             283.500000              6.214000              409.605200
 35               -0.350000             284.700000              6.689000              409.026800
 36               -0.325000             284.500000              6.740000              408.362000
 37               -0.300000             284.000000              6.632000              407.597900
 38               -0.275000             283.500000              6.541000              406.725000
 39               -0.250000             284.100000              7.289000              405.735800
 40               -0.225000             283.900000              7.560000              404.676200
 41               -0.200000             283.600000              7.643000              403.397400
 42               -0.175000             282.900000              7.568000              402.058500
 43               -0.150000             282.600000              7.925000              400.620300
 44               -0.125000             282.100000              7.903000              399.098300
 45               -0.100000             282.000000              7.946000              397.499200
 46               -0.075000             281.000000              7.725000              395.815100
 47               -0.050000             280.800000              7.919000              394.003400
 48               -0.025000             280.200000              7.814000              391.963100
 49               -0.0                  279.800000              7.846000              389.499700
 50                0.025000             278.300000              7.915000              386.850000
 51                0.050000             277.500000              8.237000              383.950000
 52                0.075000             276.300000              8.420000              381.000000
 53                0.100000             275.800000              8.629000              377.500000
 54                0.125000             274.400000              8.916000              373.500000
 55                0.150000             273.000000              9.097000              368.250000
 56                0.200000             269.000000              9.517000              356.500000
```

Figure 75 (Continued)

```
INITIAL FREQUENCY =  284.20000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                          0.3830480050D 05     FREQUENCY** 0
                         -0.9174423636D 05     FREQUENCY** 1
                          0.9407638208D 05     FREQUENCY** 2
                         -0.5353771778D 05     FREQUENCY** 3
                          0.1826156901D 05     FREQUENCY** 4
                         -0.3733478368D 04     FREQUENCY** 5
                          0.4236053609D 03     FREQUENCY** 6
                         -0.2057672356D 02     FREQUENCY** 7
                          0.0                  FREQUENCY** 8
                          0.0                  FREQUENCY** 9
                          0.0                  FREQUENCY**10

NO.      FREQUENCY      CORRECTED OUTPUT VOLTAGE          NO.      FREQUENCY      CORRECTED OUTPUT VOLTAGE
 1       276.80000             7.31133                    29       284.20000             6.47800
 2       277.40000             7.00639                    30       283.40000             6.12474
 3       278.70000             7.11625                    31       284.70000             6.58944
 4       279.60000             7.11443                    32       284.70000             6.46646
 5       280.50000             7.48365                    33       284.00000             6.43120
 6       280.80000             7.25700                    34       283.50000             6.14370
 7       281.50000             7.28727                    35       284.70000             6.74266
 8       281.80000             7.30731                    36       284.50000             6.77249
 9       282.60000             7.22643                    37       284.00000             6.61062
10       282.20000             6.01794                    38       283.50000             6.46700
11       283.00000             6.16970                    39       284.10000             7.27726
12       283.00000             6.66880                    40       283.90000             7.52342
13       283.10000             6.15636                    41       283.60000             7.56893
14       282.60000             5.95335                    42       282.90000             7.40857
15       283.50000             6.12591                    43       282.60000             7.71929
16       283.50000             6.59652                    44       282.10000             7.63336
17       283.50000             6.20302                    45       282.00000             7.66192
18       283.20000             5.85075                    46       281.00000             7.32277
19       283.90000             6.29938                    47       280.80000             7.48089
20       284.00000             6.89371                    48       280.20000             7.30564
21       283.90000             6.26952                    49       279.80000             7.28492
22       283.40000             6.09808                    50       278.30000             7.16030
23       284.40000             6.46873                    51       277.50000             7.34946
24       284.20000             6.94700                    52       276.30000             7.36061
25       284.20000             6.45000                    53       275.80000             7.48020
26       283.50000             5.93509                    54       274.40000             7.55296
27       284.80000             6.49590                    55       273.00000             7.53710
28       284.60000             6.45821                    56       269.00000             7.43257
```

Figure 75 (Continued)

```
NO.   POL.VOLTAGE   GAMMA(EXPT.)CALC.F=0   THETA FROM MODEL   ALPHA(EXPTL)   ALPHA(MODEL)
  1    -1.20000          384.93609             0.032308         0.642706       0.362733
  2    -1.17500          386.55831             0.048945         0.662707       0.362541
  3    -1.15000          390.13263             0.074198         0.655403       0.364481
  4    -1.12500          392.61194             0.113648         0.655523       0.369316
  5    -1.10000          395.12169             0.179295         0.631769       0.383980
  6    -1.07500          395.93913             0.304938         0.646208       0.464919
  7    -1.05000          397.88320             0.564534         0.644253       0.718925
  8    -1.02500          398.71828             0.752734         0.642964       0.642249
  9    -1.00000          400.94119             0.837784         0.648190       0.613207
 10    -0.97500          399.73647             0.885093         0.734105       0.597024
 11    -0.95000          401.98014             0.914716         0.722413       0.588681
 12    -0.92500          402.01956             0.934544         0.685892       0.581869
 13    -0.90000          402.25826             0.948396         0.723429       0.576995
 14    -0.87500          400.84515             0.958370         0.739171       0.572254
 15    -0.85000          403.37367             0.965714         0.725757       0.570710
 16    -0.82500          403.41161             0.971215         0.691008       0.568238
 17    -0.80000          403.38025             0.975389         0.719884       0.566231
 18    -0.77500          402.51030             0.978586         0.747333       0.564104
 19    -0.75000          404.50789             0.981046         0.712647       0.563939
 20    -0.72500          404.83302             0.982941         0.670320       0.563048
 21    -0.70000          404.50543             0.984391         0.714878       0.562038
 22    -0.67500          403.09161             0.985482         0.727894       0.560562
 23    -0.65000          405.92328             0.986276         0.700192       0.561736
 24    -0.62500          405.39737             0.986816         0.666704       0.561089
 25    -0.60000          405.36079             0.987130         0.701554       0.560911
 26    -0.57500          403.35672             0.987233         0.740614       0.559715
 27    -0.55000          407.04861             0.987130         0.698225       0.561931
 28    -0.52500          406.48305             0.986816         0.700956       0.561798
 29    -0.50000          405.36299             0.986276         0.699520       0.561451
 30    -0.47500          403.09392             0.985482         0.725847       0.560561
 31    -0.45000          406.77488             0.984391         0.691512       0.563260
 32    -0.42500          406.76535             0.982941         0.700357       0.563956
 33    -0.40000          404.79865             0.981046         0.702924       0.563659
 34    -0.37500          403.37520             0.978586         0.724395       0.563891
 35    -0.35000          406.78629             0.975389         0.680720       0.567198
 36    -0.32500          406.22602             0.971215         0.678648       0.568503
 37    -0.30000          404.81255             0.965714         0.690005       0.569722
 38    -0.27500          403.40168             0.958370         0.700318       0.571493
 39    -0.25000          405.13862             0.948396         0.644899       0.575892
 40    -0.22500          404.59300             0.934544         0.629281       0.580042
 41    -0.20000          403.75558             0.914716         0.626450       0.585707
 42    -0.17500          401.78945             0.885093         0.636503       0.593511
 43    -0.15000          400.97017             0.837784         0.617214       0.607670
 44    -0.12500          399.57212             0.752734         0.622470       0.636295
 45    -0.10000          399.29536             0.564534         0.620717       0.710816
 46    -0.07500          396.49756             0.304938         0.641972       0.454946
 47    -0.05000          395.95247             0.179295         0.631943       0.376422
 48    -0.02500          394.28114             0.113648         0.643072       0.361928
 49    -0.0              393.17456             0.074198         0.644405       0.357386
 50     0.02500          389.03594             0.048945         0.652506       0.354770
 51     0.05000          386.85312             0.032308         0.640764       0.354484
 52     0.07500          383.57419             0.021222         0.639552       0.354497
 53     0.10000          382.21862             0.013822         0.631986       0.356027
 54     0.12500          378.42104             0.008907         0.627442       0.357091
 55     0.15000          374.63781             0.005669         0.628428       0.359148
 56     0.20000          363.93142             0.007204         0.634985       0.363058
```

Figure 75 (Continued)

```
NO.     PCL.VOLTAGE      RE(E)-EXPT.      RE(E)-MODEL      IM(E)-EXPT.      IM(E)-MODEL
  1      -1.20000        12.703642         0.080827         4.732137        -0.064871
  2      -1.17500        13.348097         0.195481         3.355126        -0.133890
  3      -1.15000        13.318204         0.475355         3.449084        -0.262590
  4      -1.12500        13.568986         1.154272         3.028897        -0.480593
  5      -1.10000        13.408656         2.891327         2.389344        -0.803797
  6      -1.07500        14.750887         8.133154         0.186683        -1.210643
  7      -1.05000        15.247385        27.307307        -0.702188        -2.703495
  8      -1.02500        17.169965        50.286265        -3.618312        -9.640568
  9      -1.00000        17.983397        63.408195        -3.959245       -19.116459
 10      -0.97500        29.578278        70.452530        -0.280332       -28.363198
 11      -0.95000        29.523383        74.046598        -1.384429       -36.357365
 12      -0.92500        41.166594        75.564354         0.005515       -42.844318
 13      -0.90000        39.006761        76.006005        11.402482       -47.942350
 14      -0.87500        30.884623        75.835083        22.097093       -51.857805
 15      -0.85000        35.557032        75.588869        20.018811       -54.942721
 16      -0.82500        32.906773        75.155440        26.687665       -57.282251
 17      -0.80000        28.083438        74.720227        24.848558       -59.088389
 18      -0.77500        23.545746        74.283047        23.354140       -60.461535
 19      -0.75000        26.430375        74.023834        25.539245       -61.605028
 20      -0.72500        24.843000        73.742680        28.573116       -62.452691
 21      -0.70000        23.458803        73.491929        25.071723       -63.088055
 22      -0.67500        20.395920        73.241800        23.476244       -63.527153
 23      -0.65000        25.049681        73.225826        26.318844       -63.976462
 24      -0.62500        22.363809        73.102459        27.774677       -64.198621
 25      -0.60000        22.910609        73.042392        25.705495       -64.337336
 26      -0.57500        20.110543        72.933353        22.876858       -64.313556
 27      -0.55000        27.716342        73.118165        26.714656       -64.396102
 28      -0.52500        26.290614        73.152988        26.426318       -64.237574
 29      -0.50000        23.695566        73.200556        26.060866       -63.957183
 30      -0.47500        20.366073        73.241800        23.546303       -63.527153
 31      -0.45000        30.048435        73.592971        27.226800       -63.162398
 32      -0.42500        31.403809        73.831012        26.039776       -62.515897
 33      -0.40000        25.817883        74.036440        26.215998       -61.613728
 34      -0.37500        23.615005        74.320787        24.555564       -60.486392
 35      -0.35000        40.173972        74.870069        24.691371       -59.181161
 36      -0.32500        40.953201        75.279030        24.543595       -57.352854
 37      -0.30000        36.208285        75.649595        25.495218       -54.973882
 38      -0.27500        32.954136        75.941283        25.494244       -51.904865
 39      -0.25000        57.237575        76.117965        14.689870       -47.982442
 40      -0.22500        64.054107        75.656841         3.965666       -42.368059
 41      -0.20000        62.058247        74.099968        -4.482641       -36.364593
 42      -0.17500        61.460827        70.501395         9.753800       -28.362729
 43      -0.15000        67.444413        63.408195        -7.247674       -19.116459
 44      -0.12500        63.100392        50.292692        -7.804752        -9.658025
 45      -0.10000        40.528311        27.309944       -19.986083        -2.701957
 46      -0.07500        53.506431         8.133663        -4.972049        -1.210399
 47      -0.05000        38.474910         2.891890       -15.679507        -0.803677
 48      -0.02500        34.463700         1.154967       -12.870986        -0.480617
 49      -0.0            24.827367         0.476030       -10.153247        -0.262768
 50       0.02500        35.575213         0.196743       -11.133143        -0.134018
 51       0.05000        29.046812         0.080915       -13.052539        -0.064934
 52       0.07500        31.649949         0.032824       -14.152449        -0.030242
 53       0.10000        19.171328         0.013033        -8.506592        -0.013700
 54       0.12500        18.044937         0.004985        -8.199287        -0.006074
 55       0.15000        15.259571         0.001797        -4.270259        -0.002665
 56       0.20000        13.935768         0.000149        -2.053001        -0.000519
```

Figure 75 (Continued)

```
NC.    PCL.VCLTAGE     Y1-EXPT.      Y1-MODEL      Y2-EXPT.      Y2-MODEL

 1      -1.20000       1.006412      0.982578      0.013114      0.007310
 2      -1.17500       1.002117      0.982730      0.013522      0.007317
 3      -1.15000       1.002510      0.983031      0.013373      0.007356
 4      -1.12500       1.000804      0.983715      0.013375      0.007460
 5      -1.10000       0.999004      0.985445      0.012890      0.007766
 6      -1.07500       0.992936      0.990163      0.013185      0.009437
 7      -1.05000       0.991169      0.979011      0.013145      0.014547
 8      -1.02500       0.986556      0.972970      0.013119      0.012989
 9      -1.00000       0.985846      0.972351      0.013725      0.012402
10      -0.97500       0.977550      0.972272      0.014978      0.012109
11      -C.95000       0.977899      0.972283      0.014740      0.011938
12      -0.92500       0.97326C      0.972337      0.013995      0.011819
13      -0.90000       0.969816      0.972394      0.014761      0.011734
14      -0.87500       0.962708      0.972460      0.015082      0.011667
15      -0.85000       0.965586      0.972493      0.014808      0.011624
16      -0.82500       0.962694      0.972537      0.014099      0.011585
17      -C.80000       0.960157      0.972575      0.014688      0.011555
18      -0.77500       0.955955      0.972614      0.015248      0.011528
19      -C.75000       0.958818      0.972627      0.014541      0.011514
20      -0.72500       0.957969      0.972648      0.013677      0.011499
21      -0.70000       0.956036      0.972668      0.014586      0.011486
22      -0.67500       0.951687      0.972692      0.014852      0.011474
23      -0.65000       0.957696      0.972683      0.014286      0.011474
24      -0.62500       0.955872      0.972694      0.013603      0.011468
25      -0.60000       0.955612      0.972698      0.014314      0.011465
26      -0.57500       0.950859      0.972713      0.015111      0.011460
27      -C.55000       0.959738      0.972685      0.014246      0.011470
28      -0.52500       0.958698      0.972685      0.014302      0.011471
29      -0.50000       0.956464      0.972686      0.014273      0.011473
30      -0.47500       0.951685      0.972692      0.014810      0.011474
31      -0.45000       0.961175      0.972655      0.014109      0.011491
32      -0.42500       0.962049      0.972641      0.014290      0.011502
33      -C.40C00       0.958340      0.972638      0.014342      0.011510
34      -0.37500       0.956140      0.972628      0.014780      0.011524
35      -0.35000       0.965615      0.972581      0.013889      0.011553
36      -0.32500       C.965829      0.972558      0.013847      0.011579
37      -0.30000       0.964241      0.972535      0.014079      0.011610
38      -0.27500       0.962911      0.972508      0.014289      0.011651
39      -0.25000       C.969349      0.972456      0.013158      0.011714
40      -0.22500       0.970639      0.972418      0.012840      0.011793
41      -C.20000       0.971539      0.972389      0.012782      0.011905
42      -0.17500       0.969968      0.972400      0.012987      0.012069
43      -0.15000       0.971387      0.972520      0.012593      0.012352
44      -0.12500       0.971644      0.973184      0.012701      0.012935
45      -0.10000       0.974861      0.979391      0.012665      0.014465
46      -0.07500       0.972078      0.990176      0.013099      0.009301
47      -0.05000       0.975158      0.985524      0.012894      0.007675
48      -0.02500       0.976050      0.983845      0.013121      0.007373
49      -0.0           0.979421      0.983182      0.013148      0.007270
50       0.02500       0.975584      0.982903      0.013314      0.007225
51       0.05000       0.977310      0.982763      0.013064      0.007215
52       0.07500       0.976377      0.982688      0.013049      0.007217
53       0.10000       0.981867      0.982623      0.012895      0.007234
54       0.12500       0.982333      0.982571      0.012802      0.007254
55       0.15000       0.986197      0.982504      0.012822      0.007286
56       0.20000       0.989068      0.982363      0.012956      0.007357
```

Figure 75 (Continued)

```
                                    ANALYSES OF INTERFACIAL RIPPLE DATA FROM THE POLARIZED M/400  NADS IN 0.050-M

                              NA2SO4 / PURE HG INTERFACE:  DATA OF G.BIERWAGEN (1-22-68) TRY#1

MEASUREMENTS MADE AT  M/400 NA DODECYLSULFONATE+M/20 NA2SO4     /     PURE MERCURY                    INTERFACE
0.0025-M NADS         IN 0.050-M NA2SO4



DENSITY OF UPPER PHASE   0.99700   DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE   0.0089400   VISCOSITY OF LOWER PHASE   0.0152700

ORIGINAL OUTPUT VOLTAGE     7.45200000 MV.

INITIAL DAMPING COEFFICIENT   1.40000 1/CM.

WAVELENGTH 0.08700 CM.

PROBE SEPARATION =    1.40400 CM.

WAVENUMBER =    72.220452 RECIPROCAL CM.



                    INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM



SURFACTANT CONCENTRATION= 0.0025-M NADS

ELECTROCAPILLARY MAXIMUM IS   -0.60000 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=    1.50000

ELECTRICAL DESCRPTION EXPONENT =   12.50000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =   13.50000

DIFFUSION TERM=     455.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000010

SURFACTANT SURFACE VISCOSITY= 0.000500

 1/B0 = FRUMKIN CONCENTRATION CONSTANT=  0.000250
```

Figure 76. YCOR data listing for 2.5 x 10^{-3}-M NaDS in .05-M Na_2SO_4

```
                                        INPUT DATA
NO.          PCL.VOLTAGE        FREQUENCY        OUTPUT VOLTAGE(MV.)        GAMMA
  1          -1.250000          494.000000          9.908000             364.041900
  2          -1.225000          494.500000          9.054000             367.794400
  3          -1.200000          496.100000          9.846000             371.319500
  4          -1.175000          498.600000          8.631000             374.623200
  5          -1.150000          499.100000          8.426000             377.711100
  6          -1.125000          499.400000          7.807000             380.590000
  7          -1.100000          499.200000          7.650000             383.265800
  8          -1.075000          499.200000          7.239000             385.747300
  9          -1.050000          500.000000          7.218000             388.038300
 10          -1.025000          500.100000          7.212000             390.149600
 11          -1.000000          500.300000          7.152000             392.086600
 12          -0.975000          500.500000          7.149000             393.857900
 13          -0.950000          500.700000          7.148000             395.470400
 14          -0.925000          501.300000          7.215000             396.932600
 15          -0.900000          501.400000          7.230000             398.251200
 16          -0.875000          501.500000          7.200000             399.434300
 17          -0.850000          501.400000          7.212000             400.489700
 18          -0.825000          501.700000          7.240000             401.424500
 19          -0.800000          501.900000          7.339000             402.245100
 20          -0.775000          501.900000          7.348000             402.959400
 21          -0.750000          502.000000          7.276000             403.573700
 22          -0.725000          502.300000          7.348000             404.094700
 23          -0.700000          502.600000          7.338000             404.528300
 24          -0.675000          502.600000          7.349000             404.879100
 25          -0.650000          502.700000          7.347000             405.154200
 26          -0.625000          502.600000          7.324000             405.356900
 27          -0.600000          502.600000          7.369000             405.491900
 28          -0.575000          502.500000          7.344000             405.562900
 29          -0.550000          502.600000          7.354000             405.573200
 30          -0.525000          503.300000          7.439000             405.524600
 31          -0.500000          503.200000          7.452000             405.419900
 32          -0.475000          503.300000          7.416000             405.259000
 33          -0.450000          503.200000          7.457000             405.042700
 34          -0.425000          503.200000          7.488000             404.770700
 35          -0.400000          503.400000          7.525000             404.441600
 36          -0.375000          503.300000          7.577000             404.053200
 37          -0.350000          503.400000          7.623000             403.602000
 38          -0.325000          503.500000          7.681000             403.084200
 39          -0.300000          503.500000          7.724000             402.495300
 40          -0.275000          503.400000          7.761000             401.828100
 41          -0.250000          503.400000          7.824000             401.076100
 42          -0.225000          503.200000          7.937000             400.230700
 43          -0.200000          503.100000          8.111000             399.282400
 44          -0.175000          503.100000          8.278000             398.220700
 45          -0.150000          502.400000          8.454000             397.033400
 46          -0.125000          502.100000          8.578000             395.707700
 47          -0.100000          501.400000          8.669000             394.228200
 48          -0.075000          500.800000          8.815000             392.579800
 49          -0.050000          499.500000          8.915000             390.600000
 50          -0.025000          499.800000          9.165000             388.704300
 51          -0.0               498.100000          9.334000             386.438700
 52           0.025000          496.700000          9.437000             383.924500
 53           0.050000          495.300000          9.508000             381.140100
 54           0.075000          494.000000          9.239000             378.059800
 55           0.100000          492.100000          8.420000             374.656700
 56           0.125000          485.900000          7.948000             370.903900
 57           0.150000          487.500000          8.425000             366.768000
 58           0.200000          479.500000          5.966000             357.226300
```

Figure 76 (Continued)

```
INITIAL FREQUENCY =  503.20000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                             0.2736772425D 07     FREQUENCY** 0
                            -0.5425814034D 07     FREQUENCY** 1
                             0.4835019819D 07     FREQUENCY** 2
                            -0.2550290325D 07     FREQUENCY** 3
                             0.8817777317D 06     FREQUENCY** 4
                            -0.2088273819D 06     FREQUENCY** 5
                             0.3430641590D 05     FREQUENCY** 6
                            -0.3860420239D 04     FREQUENCY** 7
                             0.2847717075D 03     FREQUENCY** 8
                            -0.1243523629D 02     FREQUENCY** 9
                             0.2440995159D 00     FREQUENCY**10

NO.      FREQUENCY      CORRECTED OUTPUT VOLTAGE          NO.      FREQUENCY      CORRECTED OUTPUT VOLTAGE
  1      494.00000              9.50446                   30      503.30000              7.43292
  2      494.50000              9.73034                   31      503.20000              7.45200
  3      496.30000              9.36842                   32      503.30000              7.40994
  4      498.60000              8.96915                   33      503.70000              7.45700
  5      499.10000              8.72001                   34      503.20000              7.48800
  6      499.40000              8.05925                   35      503.40000              7.51236
  7      499.20000              7.91049                   36      503.30000              7.57080
  8      499.20000              7.48550                   37      503.40000              7.61020
  9      500.00000              7.41428                   38      503.50000              7.66166
 10      500.10000              7.40186                   39      503.50000              7.70455
 11      500.30000              7.32813                   40      503.40000              7.74796
 12      500.50000              7.31277                   41      503.40000              7.81086
 13      500.70000              7.29952                   42      503.20000              7.93700
 14      501.30000              7.33125                   43      503.10000              8.11797
 15      501.40000              7.34022                   44      503.10000              8.28512
 16      501.50000              7.30361                   45      502.40000              8.51111
 17      501.40000              7.32195                   46      502.10000              8.65783
 18      501.70000              7.33195                   47      501.40000              8.80116
 19      501.90000              7.41970                   48      500.80000              8.99429
 20      501.90000              7.42880                   49      499.50000              9.19545
 21      502.00000              7.34984                   50      499.80000              9.50840
 22      502.30000              7.40394                   51      498.10000              9.74000
 23      502.60000              7.37528                   52      496.70000              9.96142
 24      502.60000              7.38633                   53      495.30000             10.15200
 25      502.70000              7.37814                   54      494.00000              9.96954
 26      502.60000              7.36121                   55      492.10000              9.27604
 27      502.60000              7.40644                   56      489.30000              8.87033
 28      502.50000              7.38744                   57      487.50000              9.57508
 29      502.60000              7.39136                   58      479.50000              7.27269
```

Figure 76 (Continued)

NO.	POL.VOLTAGE	GAMMA(EXPT.)CALC.E=0	THETA FROM MODEL	ALPHA(EXPT.)	ALPHA(MODEL)
1	-1.25000	379.95054	0.056895	1.226724	0.604770
2	-1.22500	381.72731	0.090371	1.209995	0.610074
3	-1.20000	384.45765	0.147385	1.236993	0.622434
4	-1.17500	387.96251	0.258073	1.268013	0.692590
5	-1.15000	388.71441	0.521284	1.288078	1.130571
6	-1.12500	389.12442	0.753670	1.344233	1.074397
7	-1.10000	388.80350	0.848542	1.357473	1.024801
8	-1.07500	388.76475	0.898136	1.376805	1.000665
9	-1.05000	389.99118	0.927914	1.403614	0.987018
10	-1.02500	390.14426	0.947163	1.404808	0.976592
11	-1.00000	390.44569	0.960196	1.411939	0.969144
12	-0.97500	390.75295	0.969312	1.413433	0.963316
13	-0.95000	391.06054	0.975847	1.414725	0.958686
14	-0.92500	391.59117	0.980624	1.411635	0.955577
15	-0.90000	392.14675	0.984173	1.410764	0.952345
16	-0.87500	392.29782	0.986846	1.414326	0.949650
17	-0.85000	392.14493	0.988882	1.412539	0.947077
18	-0.82500	392.61017	0.990446	1.411567	0.945505
19	-0.80000	392.97848	0.991654	1.403093	0.944096
20	-0.77500	392.92937	0.992590	1.402220	0.942619
21	-0.75000	393.07647	0.993316	1.409831	0.941547
22	-0.72500	393.54661	0.993873	1.404608	0.940998
23	-0.70000	394.00886	0.994294	1.407371	0.940635
24	-0.67500	394.00996	0.994601	1.406304	0.939973
25	-0.65000	394.16423	0.994810	1.407094	0.939623
26	-0.62500	394.00747	0.994932	1.408731	0.939107
27	-0.60000	394.01194	0.994971	1.404368	0.938878
28	-0.57500	393.85501	0.994932	1.406197	0.938627
29	-0.55000	394.01045	0.994810	1.405819	0.938810
30	-0.52500	395.10080	0.994601	1.401826	0.940059
31	-0.50000	394.94739	0.994294	1.400000	0.940177
32	-0.47500	395.09854	0.993873	1.404031	0.940739
33	-0.45000	394.94788	0.993316	1.399522	0.941123
34	-0.42500	394.95089	0.992590	1.396567	0.941810
35	-0.40000	395.26383	0.991654	1.394254	0.942981
36	-0.37500	395.11412	0.990446	1.388734	0.943870
37	-0.35000	395.27316	0.988882	1.385038	0.945302
38	-0.32500	395.43334	0.996846	1.380237	0.947011
39	-0.30000	395.43733	0.984173	1.376261	0.948904
40	-0.27500	395.28598	0.980624	1.372259	0.951079
41	-0.25000	395.29171	0.975847	1.366501	0.953991
42	-0.22500	394.99236	0.969312	1.355090	0.957365
43	-0.20000	394.85274	0.960196	1.339032	0.961997
44	-0.17500	394.06667	0.947163	1.324516	0.969410
45	-0.15000	393.79867	0.927914	1.305349	0.976224
46	-0.12500	393.34494	0.898136	1.293175	0.999097
47	-0.10000	392.27162	0.848542	1.281490	1.010334
48	-0.07500	391.35755	0.753670	1.266020	1.056413
49	-0.05000	389.36451	0.521284	1.250266	1.099743
50	-0.02500	389.30648	0.258073	1.226429	0.661945
51	-0.0	387.24377	0.147385	1.209289	0.605708
52	0.02500	385.10712	0.090371	1.193278	0.593172
53	0.05000	382.97410	0.056895	1.179790	0.589820
54	0.07500	380.57838	0.036110	1.192698	0.599965
55	0.10000	378.04073	0.022893	1.247990	0.591084
56	0.12500	374.53098	0.014422	1.275905	0.592717
57	0.15000	371.10650	0.009998	1.221451	0.595048
58	0.20000	357.51683	0.003377	1.417348	0.596891

Figure 76 (Continued)

```
NO.   POL.VOLTAGE    RE(E)-EXPT.    RE(E)-MODEL    IM(E)-EXPT.    IM(E)-MODEL
 1    -1.25000       14.332031       0.153535       6.046573      -0.123773
 2    -1.22500       14.749371       0.441782       5.974959      -0.293188
 3    -1.20000       15.194922       1.366545       5.747397      -0.677751
 4    -1.17500       15.471902       4.945478       5.574527      -1.456019
 5    -1.15000       16.363540      21.197124       5.164133      -3.482040
 6    -1.12500       17.947339      43.987061       4.586216     -12.812442
 7    -1.10000       20.334254      45.937718       3.724774     -21.818609
 8    -1.07500       23.229070      45.977923       4.240442     -27.576802
 9    -1.05000       24.633097      44.553250       4.739485     -30.938861
10    -1.02500       27.265675      43.263634       6.220809     -32.994634
11    -1.00000       29.988428      42.039949       8.545909     -34.253790
12    -0.97500       29.927605      41.128942      11.113789     -35.068457
13    -0.95000       30.020445      40.388484      13.569046     -35.610617
14    -0.92500       29.987554      39.834211      14.563381     -35.996695
15    -0.90000       29.310478      39.391244      16.546590     -36.257389
16    -0.87500       28.300242      39.048916      17.943770     -36.445501
17    -0.85000       27.012641      38.777304      19.277858     -36.578410
18    -0.82500       26.515925      38.577394      19.689917     -36.698056
19    -0.80000       26.037873      38.421841      20.216322     -36.771642
20    -0.77500       25.208128      38.295279      20.625569     -36.830906
21    -0.75000       24.646748      38.196562      20.675729     -36.875970
22    -0.72500       24.649593      38.132662      20.800425     -36.921685
23    -0.70000       24.699557      38.087156      20.743460     -36.958846
24    -0.67500       24.322304      38.043822      20.882815     -36.976467
25    -0.65000       24.200137      38.019598      20.906646     -36.993407
26    -0.62500       23.806089      37.994297      20.967340     -36.992751
27    -0.60000       23.682763      37.994379      21.073414     -37.000292
28    -0.57500       23.435631      37.990524      21.080898     -36.989170
29    -0.55000       23.594388      38.015823      21.064115     -36.989829
30    -0.52500       24.911607      38.070252      20.828133     -37.001464
31    -0.50000       24.855654      38.109833      20.880614     -36.980226
32    -0.47500       25.196833      38.170509      20.673646     -36.957214
33    -0.45000       25.291000      38.242064      20.731606     -36.918440
34    -0.42500       25.634383      38.344685      20.656883     -36.876578
35    -0.40000       26.449323      38.479996      20.322043     -36.824085
36    -0.37500       26.793081      38.638576      20.268513     -36.743502
37    -0.35000       27.617293      38.854116      19.836092     -36.646911
38    -0.32500       28.553644      39.126115      19.226574     -36.512924
39    -0.30000       29.350222      39.472816      18.550552     -36.326702
40    -0.27500       30.021041      39.916393      17.861146     -36.063936
41    -0.25000       30.932054      40.495052      16.643270     -35.693745
42    -0.22500       31.723604      41.236425      15.717130     -35.146825
43    -0.20000       32.743243      42.193134      14.022416     -34.328156
44    -0.17500       33.324843      43.389706      11.263052     -33.053868
45    -0.15000       34.111341      44.747327      10.826192     -30.982517
46    -0.12500       33.878951      46.005749       8.184071     -27.560285
47    -0.10000       33.783886      46.003317       6.807996     -21.926463
48    -0.07500       32.945094      41.010399       4.497393     -12.808892
49    -0.05000       33.545454      21.191758       3.901463      -3.481358
50    -0.02500       31.940886       4.846859       1.116762      -1.455958
51    -0.0           28.410291       1.369167      -0.940185      -0.678044
52     0.02500       27.214987       0.442777      -1.851692      -0.293551
53     0.05000       25.148275       0.153711      -2.343221      -0.123990
54     0.07500       22.559714       0.055261      -1.204088      -0.051836
55     0.10000       21.998751       0.029004       0.589827      -0.021603
56     0.12500       21.580521       0.007096       1.302392      -0.009002
57     0.15000       19.983905       0.002380       0.421803      -0.003773
58     0.20000       25.610658       0.000149       5.281720      -0.000695
```

Figure 76 (Continued)

NO.	POL.VOLTAGE	Y1-EXPT.	Y1-MODEL	Y2-EXPT.	Y2-MODEL
1	-1.25000	1.020386	0.980695	0.016986	0.008301
2	-1.22500	1.012516	0.981027	0.016754	0.008343
3	-1.20000	1.010219	0.981938	0.017125	0.008521
4	-1.17500	1.010612	0.985166	0.017558	0.009354
5	-1.15000	1.004361	0.983092	0.017835	0.015514
6	-1.12500	0.997963	0.972453	0.018613	0.014721
7	-1.10000	0.990202	0.971703	0.018796	0.014074
8	-1.07500	0.983832	0.971726	0.019341	0.013773
9	-1.05000	0.981160	0.971857	0.019435	0.013598
10	-1.02500	0.976241	0.972006	0.019452	0.013479
11	-1.00000	0.972196	0.972139	0.019550	0.013394
12	-0.97500	0.968597	0.972253	0.019571	0.013330
13	-0.95000	0.965419	0.972350	0.019589	0.013281
14	-0.92500	0.964169	0.972426	0.019546	0.013244
15	-0.90000	0.961360	0.972496	0.019534	0.013213
16	-0.87500	0.958895	0.972555	0.019583	0.013187
17	-0.85000	0.955987	0.972607	0.019559	0.013165
18	-0.82500	0.954902	0.972647	0.019545	0.013149
19	-0.80000	0.953714	0.972682	0.019428	0.013134
20	-0.77500	0.952024	0.972713	0.019416	0.013122
21	-0.75000	0.950953	0.972738	0.019521	0.013112
22	-0.72500	0.950863	0.972755	0.019449	0.013105
23	-0.70000	0.950978	0.972769	0.019487	0.013099
24	-0.67500	0.950155	0.972783	0.019472	0.013094
25	-0.65000	0.949887	0.972792	0.019483	0.013090
26	-0.62500	0.949035	0.972802	0.019506	0.013087
27	-0.60000	0.948719	0.972805	0.019446	0.013085
28	-0.57500	0.948175	0.972810	0.019471	0.013084
29	-0.55000	0.948528	0.972807	0.019466	0.013085
30	-0.52500	0.951286	0.972794	0.019410	0.013090
31	-0.50000	0.951154	0.972790	0.019385	0.013092
32	-0.47500	0.951910	0.972780	0.019441	0.013096
33	-0.45000	0.952040	0.972769	0.019378	0.013101
34	-0.42500	0.952680	0.972754	0.019338	0.013108
35	-0.40000	0.954213	0.972733	0.019306	0.013117
36	-0.37500	0.954751	0.972711	0.019229	0.013127
37	-0.35000	0.956198	0.972682	0.019178	0.013140
38	-0.32500	0.957807	0.972647	0.019111	0.013156
39	-0.30000	0.959208	0.972607	0.019056	0.013176
40	-0.27500	0.960419	0.972559	0.019001	0.013200
41	-0.25000	0.962220	0.972499	0.018921	0.013232
42	-0.22500	0.963486	0.972429	0.018763	0.013273
43	-0.20000	0.965391	0.972342	0.018541	0.013328
44	-0.17500	0.967964	0.972239	0.018340	0.013404
45	-0.15000	0.968159	0.972133	0.018075	0.013511
46	-0.12500	0.970241	0.972037	0.017906	0.013679
47	-0.10000	0.971171	0.972073	0.017744	0.013968
48	-0.07500	0.972916	0.972915	0.017530	0.014600
49	-0.05000	0.972777	0.983727	0.017312	0.015256
50	-0.02500	0.974784	0.985261	0.016982	0.009180
51	-0.0	0.977749	0.982131	0.016744	0.008384
52	0.02500	0.978627	0.981266	0.016523	0.008205
53	0.05000	0.980227	0.980969	0.016336	0.008153
54	0.07500	0.983033	0.980838	0.016515	0.008147
55	0.10000	0.984346	0.980762	0.017279	0.008159
56	0.12500	0.985035	0.980703	0.017667	0.008179
57	0.15000	0.986807	0.980643	0.016913	0.008206
58	0.20000	0.976102	0.980536	0.019625	0.008260

Figure 76 (Continued)

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                                             ANALYSIS OF INTERFACIAL RIPPLE DATA FROM THE POLARIZED M/200  NADS IN 0.050-M

                                     NA2SO4 / PURE HG INTERFACE:  DATA OF G.BIERWAGEN (1-26-68) TRY#2

MEASUREMENTS MADE AT M/200  NA DECYLSULFONATE+M/20 NA2SO4     /     PURE MERCURY                                     INTERFACE
0.0050-M NADS          IN 0.050-M NA2SO4



DENSITY OF UPPER PHASE   0.99700   DENSITY OF LOWER PHASE  13.53400

VISCOSITY OF UPPER PHASE   0.0089400   VISCOSITY OF LOWER PHASE   0.0152700

ORIGINAL OUTPUT VOLTAGE     9.1050000C MV.

INITIAL DAMPING COEFFICIENT   0.83935 1/CM.

WAVELENGTH 0.09000 CM.

PROBE SEPARATION =    1.45300 CM.

WAVENUMBER =    69.813103 RECIPROCAL CM.


                 INPUT DATA FOR MODELED BEHAVIOR:MODIFIED FRUMKIN  ISOTHERM


SURFACTANT CONCENTRATION= 0.0050-M NADS

ELECTROCAPILLARY MAXIMUM IS   -0.55000 VOLTS VS. S.C.E.

FRUMKIN EXPONENT=    1.50000

ELECTRICAL DESORPTION EXPONENT =   12.50000

MAXIMUM SURFACE COVERAGE X R X TEMPERATURE =   13.50000

DIFFUSION TERM=     455.00

SURFACE VISCOSITY OF PURE INTERFACE= 0.000010

SURFACTANT SURFACE VISCOSITY= 0.000500

 1/B0 = FRUMKIN CONCENTRATION CONSTANT=  0.000250
```

Figure 77. YCOR data listing for 5 x 10^{-3}-M NaDS in .05-M Na_2SO_4

```
                                         INPUT DATA

NO.          APPL.VOLTAGE        FREQUENCY        OUTPUT VOLTAGE(MV.)        GAMMA
  1           -1.274910         457.000000          10.935000           359.750000
  2           -1.250000         457.300000          10.978000           363.750000
  3           -1.225000         469.400000          11.002000           367.331400
  4           -1.200000         470.400000          10.982000           370.515600
  5           -1.175000         472.400000          10.743000           373.636700
  6           -1.150000         473.300000          10.351000           376.496400
  7           -1.125000         474.100000          10.007000           379.746000
  8           -1.100000         474.400000           9.642000           382.566400
  9           -1.075000         475.000000           9.446000           385.250000
 10           -1.050000         475.100000           9.214000           387.133500
 11           -1.025000         475.500000           9.148000           389.121000
 12           -1.000000         476.000000           9.134000           390.914000
 13           -0.975000         476.300000           9.138000           392.316400
 14           -0.950000         476.000000           9.080000           393.605400
 15           -0.925000         477.000000           9.123000           394.695300
 16           -0.900000         477.500000           9.144000           395.458000
 17           -0.875000         477.600000           9.163000           396.199600
 18           -0.850000         477.300000           9.202000           396.916200
 19           -0.825000         478.000000           9.212000           397.596300
 20           -0.800000         478.400000           9.236000           398.056100
 21           -0.775000         478.500000           9.241000           398.536100
 22           -0.750000         478.700000           9.236000           398.987300
 23           -0.725000         478.700000           9.225000           399.363200
 24           -0.700000         478.700000           9.234000           399.700900
 25           -0.675000         478.800000           9.228000           399.982100
 26           -0.650000         478.800000           9.196000           400.206700
 27           -0.625000         478.800000           9.159000           400.373200
 28           -0.600000         478.800000           9.064000           400.496500
 29           -0.575000         478.300000           9.059000           400.576600
 30           -0.550000         478.900000           9.105000           400.613000
 31           -0.525000         479.200000           9.088000           400.608300
 32           -0.500000         478.900000           9.126000           400.578600
 33           -0.475000         478.900000           9.175000           400.515600
 34           -0.450000         479.000000           9.238000           400.423000
 35           -0.425000         479.300000           9.255000           400.295100
 36           -0.400000         479.000000           9.320000           400.123000
 37           -0.375000         478.900000           9.326000           399.890600
 38           -0.350000         478.900000           9.327000           399.582500
 39           -0.325000         479.100000           9.355000           399.177000
 40           -0.300000         479.000000           9.384000           398.655500
 41           -0.275000         478.600000           9.325000           398.000200
 42           -0.250000         478.400000           9.362000           397.200600
 43           -0.225000         478.000000           9.301000           396.255300
 44           -0.200000         477.400000           9.306000           395.173000
 45           -0.175000         477.100000           9.354000           393.976500
 46           -0.150000         476.900000           9.343000           392.695300
 47           -0.125000         475.500000           9.330000           391.363700
 48           -0.100000         474.500000           9.226000           390.005300
 49           -0.075000         473.700000           9.210000           388.611800
 50           -0.050000         472.500000           9.160000           387.112500
 51           -0.025000         471.400000           9.133000           385.326900
 52           -0.0              470.400000           9.185000           382.898900
 53            0.025000         469.600000           9.135000           379.208400
 54            0.050000         467.200000           9.103000           375.700000
 55            0.075000         465.700000           8.935000           371.300000
 56            0.100000         464.100000           8.476000           367.000000
 57            0.125000         461.300000           7.816000           362.500000
 58            0.150000         455.700000           8.105000           358.000000
```

Figure 77 (Continued)

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INITIAL FREQUENCY =  478.80000

POLYNOMIAL COEFFICIENTS  OF AMPLITUDE CORRECTION
                                 0.2736772425D 07     FREQUENCY** 0
                                -0.5425814034D 07     FREQUENCY** 1
                                 0.4835019819D 07     FREQUENCY** 2
                                -0.2550290325D 07     FREQUENCY** 3
                                 0.8817777317D 06     FREQUENCY** 4
                                -0.2088273819D 06     FREQUENCY** 5
                                 0.3430641590D 05     FREQUENCY** 6
                                -0.3860420239D 04     FREQUENCY** 7
                                 0.2847717075D 03     FREQUENCY** 8
                                -0.1243523629D 02     FREQUENCY** 9
                                 0.2440995155D 00     FREQUENCY**10

NO.      FREQUENCY       CORRECTED OUTPUT VOLTAGE            NO.      FREQUENCY       CORRECTED OUTPUT VOLTAGE
 1       467.00000             12.01758                       30       478.80000              9.10500
 2       467.80000             11.98482                       31       479.20000              9.06000
 3       468.60000             11.93150                       32       478.90000              9.11892
 4       470.40000             11.73549                       33       478.90000              9.16789
 5       472.40000             11.29666                       34       479.00000              9.22378
 6       473.00000             10.83277                       35       479.00000              9.24075
 7       474.00000             10.38994                       36       479.00000              9.30565
 8       474.40000              9.97949                       37       478.90000              9.31877
 9       475.00000              9.73051                       38       478.90000              9.31977
10       475.10000              9.48394                       39       479.10000              9.33330
11       475.50000              9.38650                       40       479.00000              9.36955
12       476.00000              9.33550                       41       478.60000              9.33955
13       476.90000              9.27400                       42       478.40000              9.39112
14       476.00000              9.28031                       43       478.00000              9.35911
15       477.00000              9.26180                       44       477.40000              9.40780
16       477.50000              9.23701                       45       477.10000              9.47859
17       477.60000              9.24896                       46       476.90000              9.48295
18       477.80000              9.27394                       47       475.50000              9.57324
19       478.00000              9.26955                       48       474.50000              9.54109
20       478.40000              9.26472                       49       473.70000              9.58502
21       478.50000              9.26266                       50       472.50000              9.62436
22       478.70000              9.24306                       51       471.40000              9.68113
23       478.70000              9.23205                       52       470.40000              9.81529
24       478.70000              9.24106                       53       468.60000              9.90677
25       478.80000              9.22900                       54       467.20000              9.98767
26       478.80000              9.19600                       55       465.70000              9.92852
27       478.80000              9.15900                       56       464.10000              9.54910
28       478.80000              9.06400                       57       461.30000              9.02654
29       478.90000              9.05900                       58       455.70000              9.86191
```

Figure 77 (Continued)

NO.	POL.VOLTAGE	GAMMA(EXPT.)(CALC.)	THETA FROM MODEL	ALPHA(EXPTL)	ALPHA(CALC)
1	-1.27443	377.35680	0.025737	0.649328	0.581315
2	-1.25000	378.64518	0.048111	0.650212	0.573241
3	-1.22500	379.93528	0.073391	0.653291	0.573502
4	-1.20000	382.81169	0.130936	0.664631	0.584581
5	-1.17500	384.32596	0.234303	0.699910	0.619520
6	-1.15000	386.58365	0.495732	0.719768	0.959760
7	-1.12500	388.58959	0.756019	0.748494	1.005178
8	-1.10000	389.22527	0.856005	0.776234	0.967442
9	-1.07500	390.19047	0.906306	0.793622	0.946070
10	-1.05000	390.34368	0.935708	0.811287	0.932011
11	-1.02500	390.98999	0.954272	0.818394	0.922104
12	-1.00000	391.80136	0.966567	0.822144	0.914845
13	-0.97500	393.26512	0.974983	0.826692	0.910397
14	-0.95000	391.79513	0.980893	0.826225	0.904129
15	-0.92500	393.42771	0.985128	0.827598	0.902059
16	-0.90000	394.24262	0.988216	0.829443	0.900292
17	-0.87500	394.40640	0.990500	0.829553	0.898089
18	-0.85000	394.73411	0.992212	0.826697	0.896402
19	-0.82500	395.06075	0.993510	0.827023	0.895129
20	-0.80000	395.71455	0.994503	0.827381	0.894397
21	-0.77500	395.87810	0.995268	0.827535	0.893387
22	-0.75000	396.20458	0.995961	0.828993	0.892678
23	-0.72500	396.20412	0.996323	0.829813	0.891813
24	-0.70000	396.20450	0.996680	0.829142	0.891096
25	-0.67500	396.36765	0.996955	0.830115	0.890640
26	-0.65000	396.36631	0.997163	0.832506	0.890164
27	-0.62500	396.36475	0.997315	0.835280	0.889816
28	-0.60000	396.36068	0.997418	0.842456	0.889574
29	-0.57500	396.36046	0.997479	0.842836	0.889378
30	-0.55000	396.36245	0.997498	0.839350	0.889330
31	-0.52500	397.01562	0.997479	0.842760	0.889978
32	-0.50000	396.52677	0.997418	0.838298	0.889598
33	-0.47500	396.52885	0.997315	0.834613	0.889739
34	-0.45000	396.69497	0.997163	0.830430	0.890125
35	-0.42500	396.69567	0.996955	0.829164	0.890438
36	-0.40000	396.69835	0.996680	0.824348	0.890872
37	-0.37500	396.53512	0.996323	0.823378	0.891246
38	-0.35000	396.53516	0.995861	0.823305	0.891995
39	-0.32500	396.66328	0.995268	0.822306	0.893291
40	-0.30000	396.70095	0.994503	0.819638	0.894360
41	-0.27500	396.04488	0.993510	0.821846	0.895272
42	-0.25000	395.71973	0.992212	0.818056	0.896904
43	-0.22500	395.06439	0.990500	0.820405	0.898636
44	-0.20000	394.08628	0.988216	0.816834	0.900527
45	-0.17500	393.59950	0.985128	0.811675	0.903467
46	-0.15000	393.27342	0.980893	0.811423	0.907206
47	-0.12500	390.59721	0.974983	0.804836	0.909712
48	-0.10000	389.37170	0.966567	0.807152	0.913908
49	-0.07500	388.07637	0.954272	0.803990	0.919947
50	-0.05000	386.13641	0.935708	0.801171	0.927689
51	-0.02500	384.36313	0.906306	0.797123	0.939694
52	-0.0	382.75749	0.856005	0.787658	0.959757
53	0.02500	379.87042	0.756019	0.781257	0.997158
54	0.05000	377.63277	0.495732	0.775670	0.952395
55	0.07500	375.23781	0.234303	0.779757	0.614999
56	0.10000	372.68061	0.130936	0.806574	0.581900
57	0.12500	368.22972	0.073391	0.845306	0.575923
58	0.15000	359.47757	0.048111	0.784390	0.572598

Figure 77 (Continued)

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NO.   PCL.VOLTAGE     RE(F)-EXPT.     RE(F)-MODEL     IM(F)-EXPT.     IM(F)-MODEL
 1     -1.27497        11.436451        0.017563        7.225822       -0.019757
 2     -1.25000        11.097143        0.052226        6.341429       -0.050150
 3     -1.22500        10.755006        0.163378        5.510420       -0.139428
 4     -1.20000        10.760234        0.579580        5.168871       -0.412134
 5     -1.17500        11.068452        2.596982        5.104353       -1.310851
 6     -1.15000        10.805353       15.707355        3.571563       -4.421277
 7     -1.12500        10.848086       27.754712        2.401151      -13.471181
 8     -1.10000        10.577761       26.317558       -0.213743      -17.553052
 9     -1.07500        10.246031       24.074740       -3.253123      -18.678319
10     -1.05000         9.809830       22.395528       -8.141619      -18.899862
11     -1.02500         9.068996       21.238245      -13.787438      -18.863169
12     -1.00000         8.067573       20.440570      -20.441006      -18.762773
13     -0.97500         8.934195       19.892824      -20.106558      -18.667818
14     -0.95000       -10.641271       19.470550      -84.203751      -18.554696
15     -0.92500         0.597078       19.199611      -58.079125      -18.494751
16     -0.90000         2.490246       18.993485      -56.438537      -18.441384
17     -0.87500        -5.398996       18.836749      -83.198374      -18.395254
18     -0.85000       -21.180773       18.721635      ***********     -18.361839
19     -0.82500       -40.270232       18.633944      ***********     -18.335499
20     -0.80000       -28.004365       18.572589      ***********     -18.320559
21     -0.77500       -69.460204       18.519980      ***********     -18.303599
22     -0.75000       -94.533688       18.482901      ***********     -18.294100
23     -0.72500       ***********      18.447663      ***********     -18.280297
24     -0.70000       ***********      18.426931      476.841657      -18.275959
25     -0.67500       -66.171584       18.406299      376.556548      -18.268050
26     -0.65000         3.749353       18.391650      253.424631      -18.262963
27     -0.62500        22.422918       18.381971      202.112216      -18.260235
28     -0.60000        43.715926       18.377550      171.891810      -18.260504
29     -0.57500        40.901638       18.366593      158.924077      -18.252433
30     -0.55000        31.256797       18.369954      155.918474      -18.256608
31     -0.52500       166.607511       18.374259      388.871299      -18.260008
32     -0.50000        34.003392       18.379468      191.642112      -18.262398
33     -0.47500        19.933839       18.383889      208.186560      -18.262129
34     -0.45000       -25.768342       18.395488      304.301508      -18.266750
35     -0.42500       -87.077530       18.410140      385.627057      -18.271836
36     -0.40000       ***********      18.432700      386.519487      -18.281637
37     -0.37500       ***********      18.451513      306.149753      -18.284080
38     -0.35000       ***********      18.486758      ***********     -18.297882
39     -0.32500       -35.701709       18.531474      ***********     -18.314935
40     -0.30000       -18.902191       18.584216      -90.253391      -18.331886
41     -0.27500       -16.845676       18.645616      -91.875522      -18.346815
42     -0.25000        -7.600322       18.733363      -63.932140      -18.373139
43     -0.22500        -1.988546       18.844615      -54.109376      -18.402770
44     -0.20000        -2.861067       18.991503      -50.277089      -18.439511
45     -0.17500         1.628853       19.200615      -34.464435      -18.496615
46     -0.15000         5.897323       19.488836      -22.778669      -18.571365
47     -0.12500        -0.557828       19.863861      -33.343959      -18.642186
48     -0.10000        -2.691534       20.408768      -38.014655      -18.735810
49     -0.07500        -2.878001       21.198869      -35.705002      -18.831871
50     -0.05000       -10.127614       22.336426      -43.129659      -18.857431
51     -0.02500       -11.747699       23.989670      -41.497611      -18.626992
52     -0.0            -3.611209       26.222477      -27.398586      -17.512469
53      0.02500         0.777378       27.649586      -19.272561      -13.456561
54      0.05000         4.927371       15.672042      -11.592467       -4.428612
55      0.07500         8.413759        2.584394       -4.963347       -1.398627
56      0.10000        10.377560        0.576210       -1.619584       -0.410397
57      0.12500        11.257048        0.162705       -1.643173       -0.138516
58      0.15000         3.147202        0.051609      -13.338881       -0.049520
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Figure 77 (Continued)

NO.	POL.VOLTAGE	Y1-EXPT.	Y1-MODEL	Y2-EXPT.	Y2-MODEL
1	-1.27499	1.022142	0.980677	0.009297	0.008776
2	-1.25000	1.014293	0.980773	0.009314	0.008183
3	-1.22500	1.008684	0.980927	0.009358	0.008123
4	-1.20000	1.006853	0.981354	0.009521	0.008345
5	-1.17500	1.006966	0.983160	0.009807	0.009786
6	-1.15000	1.000805	0.985773	0.010310	0.012651
7	-1.12500	0.997488	0.975429	0.010721	0.014241
8	-1.10000	0.991805	0.976150	0.011119	0.013756
9	-1.07500	0.987391	0.976492	0.011368	0.013474
10	-1.05000	0.982873	0.976825	0.011621	0.013296
11	-1.02500	0.979627	0.977097	0.011723	0.013170
12	-1.00000	0.977185	0.977310	0.011776	0.013073
13	-0.97500	0.977379	0.977461	0.011842	0.013015
14	-0.95000	0.970504	0.977601	0.011835	0.012956
15	-0.92500	0.971893	0.977687	0.011854	0.012921
16	-0.90000	0.972055	0.977753	0.011881	0.012894
17	-0.87500	0.970666	0.977811	0.011868	0.012870
18	-0.85000	0.969701	0.977858	0.011842	0.012850
19	-0.82500	0.969072	0.977895	0.011846	0.012835
20	-0.80000	0.969354	0.977923	0.011851	0.012824
21	-0.77500	0.968591	0.977950	0.011854	0.012813
22	-0.75000	0.968305	0.977971	0.011874	0.012804
23	-0.72500	0.967394	0.977991	0.011886	0.012795
24	-0.70000	0.966576	0.978006	0.011877	0.012789
25	-0.67500	0.966300	0.978019	0.011891	0.012784
26	-0.65000	0.965758	0.978030	0.011925	0.012779
27	-0.62500	0.965356	0.978037	0.011965	0.012776
28	-0.60000	0.965059	0.978042	0.012067	0.012774
29	-0.57500	0.964866	0.978048	0.012073	0.012772
30	-0.55000	0.964779	0.978047	0.012023	0.012772
31	-0.52500	0.966403	0.978044	0.012072	0.012774
32	-0.50000	0.965264	0.978043	0.012008	0.012773
33	-0.47500	0.965416	0.978040	0.011955	0.012775
34	-0.45000	0.966043	0.978034	0.011895	0.012777
35	-0.42500	0.966352	0.978027	0.011877	0.012781
36	-0.40000	0.966767	0.978015	0.011808	0.012785
37	-0.37500	0.966925	0.978006	0.011794	0.012790
38	-0.35000	0.967671	0.977987	0.011793	0.012797
39	-0.32500	0.969463	0.977962	0.011779	0.012807
40	-0.30000	0.970326	0.977934	0.011740	0.012819
41	-0.27500	0.970301	0.977903	0.011772	0.012832
42	-0.25000	0.971442	0.977859	0.011718	0.012850
43	-0.22500	0.972132	0.977807	0.011751	0.012871
44	-0.20000	0.972349	0.977745	0.011700	0.012897
45	-0.17500	0.974076	0.977662	0.011626	0.012931
46	-0.15000	0.976435	0.977559	0.011623	0.012974
47	-0.12500	0.974013	0.977448	0.011528	0.013022
48	-0.10000	0.973299	0.977299	0.011562	0.013092
49	-0.07500	0.973498	0.977194	0.011516	0.013167
50	-0.05000	0.972324	0.976857	0.011476	0.013292
51	-0.02500	0.972286	0.976543	0.011418	0.013452
52	-0.0	0.974305	0.976214	0.011282	0.013728
53	0.02500	0.976272	0.976469	0.011191	0.014255
54	0.05000	0.979510	0.985751	0.011111	0.013643
55	0.07500	0.984763	0.983168	0.011169	0.008786
56	0.10000	0.989467	0.991340	0.011553	0.008295
57	0.12500	0.989695	0.989901	0.012108	0.008207
58	0.15000	0.977956	0.989759	0.011236	0.008122

Figure 77 (Continued)