Performance Study of a 20-Ton Chiller When Using R407C as a Replacement To R22

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January 2001

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Dedication

To ------

My Parents

My Brothers

My Company

Who Gave Meaning to This Effort

Acknowledgment

I wish to extend my thanks and appreciation to all those who helped in advancing the work, which enabled me to accomplish this project. All helped in aiding me throughout the project by their expertise and their advice.
My gratitude goes to the following people:

-Dr. Mahmood Hammad (supervisor, for his great guidance and support)

-Petra Engineering Industries company staff (for their kindness in providing us the necessary research chiller for the project).

-My parents, family, and friends for their great support.

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Nomenclature

Symbol	Description	Unit
COP	Coefficient of performance.	
C_P	Constant pressure specific heat.	kJ/kg°C
h_a	Enthalpy of refrigerant leaving evaporator	kJ/kg
h_b	Enthalpy of refrigerant entering condenser	kJ/kg
h_c	Enthalpy of refrigerant leaving condenser	kJ/kg
h_d	Enthalpy of refrigerant entering evaporator	kJ/kg
m`	Mass flow rate	kg/s
p	Pressure	bar
P	Power consumption	KW
Q_{cap}	Refrigeration capacity	KW
Q_{ref}	Refrigeration effect	kJ/kg
Q_{wat}	Chilled water heat removal power	KW
T	Temperature	°C
T_e	Evaporating temperature	°C
T_c	Condensing temperature	°C
W	Compression work	kJ/kg

Abbreviations:

ASHRAE	American Society of Heating, Refrigerating and Air-conditioning Engineers.
ASERCOM	Association of European Refrigeration Compressor Manufacturer.
CFC	Chlorofluorocarbon.
GWE	Global Warming Effect.
HCFC	Hydrochlorofluorocarbon.

HFC	Hydrofluorocarbon.
ODP	Ozone Depletion Potential.
UNEP	United Nations Environmental Program.

Abstract

Performance study of a 20-ton chiller when using R407C as a replacement to R22

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The new R407C refrigerant was used and tested in a locally manufactured air cooled water chiller as a replacement to R22.

Performance tests were conducted under different condensing and evaporating temperatures to the study performance parameters such as the operating pressures, compressor exit temperature, sub-cooling effects, COP, power , and heat rejection, for both refrigerants.

The experiment was conducted on the same chiller, for both R407C and R22, with some modifications on the case when R407C is being used.

The results show that refrigerant R407C is a suitable alternative for R22, since it is ozone friendly and has similar physical and thermodynamic properties as R22.

Chapter One

Introduction

Refrigeration and Air conditioning is the art of controlling an atmospheric environment that is used for the comfort of human beings or for the proper performance of some industrial or scientific process.

Refrigeration and air conditioning systems use refrigerants which are chemicals that goes under pressure. Therefore, refrigerants should whenever possible be non-flammable, non explosive, and of very low toxicity for the humans and the environment. Several chlorofluorocarbons (CFCs) and hydrochlorоufluorocarbons (HCFCs) are being extensively used as refrigerants for air conditioning and refrigeration purposes. They posses most of the desirable characteristics such as thermal and chemical stability, thermodynamic efficiency, non flammability, and low cost.

The chlorine contained in the CFCs and HCFCs substances is thought to cause damage to the Ozone layer in the upper atmosphere, thereby allowing harmful ultra violet radiation to pass through the atmosphere unfiltered. This proportion of chlorine contained in the various refrigerants in common use, varies from substance to substance and the severity of its effect in the environment also varies and is known as the Ozone depletion potential (ODP). Each refrigerant has a different ODP. The impact of refrigerants containing chlorine on the environment has been assessed and as a basis, an index of 1 is used which relates to the environmentally destructive potential of CFC11 (R11) within a particular decay period. Therefore R11 has an ODP of 1.

By comparison with this scale R22 has an ODP of 0.055, R407C contains no chlorine and therefore has an ODP of zero.

Due to the emission of CFCs to the atmosphere, a serious environmental problem affecting the whole climate of the earth arises to be a global problem. Greenhouse gases absorb and retain some of the outgoing heat energy that is converted from the solar radiation reaching the earth by raising the temperature of the earth's surface, an effect analogous to that of a greenhouse.

The most significant greenhouse gas is carbon dioxide which is emitted and is present in the atmosphere in very large quantities. Other gases, including CFCs and HCFCs, are also greenhouse gases. These are presenting in a very much smaller quantities but have more effect per unit mass.

Due to the influence of the (CFCs) on the environment, alternative refrigerants must be found to replace the (CFCs). Such alternative refrigerants should posses good thermodynamical and physical properties, high chemical and thermal stability, low toxicity, good miscibility with lubricants, compatibility with materials, less expensive and low flammability with no environmental side effect.

Thermodynamic properties are of most importance since they decide whether a substance is applicable as a refrigerant in a certain temperature range or not, if the thermodynamic properties meet the requirements, the other characters must be taken into consideration and at least to be acceptable.

Refrigerant R407C, a blend of R32, R125, and R134a (all of them are free of chlorine atoms) is a new refrigerant being used in Europe and America for the last two years. It has proven to have friendly effect on the Ozone layer and low effect in the global warming (GWE) compared to the other refrigerants. R407C performs under evaporator temperatures ranging from –7 to 10 °C.It is designed to be used in new equipment and as a service refrigerant for existing HCFC-22 air conditioner and heat pump equipment.

In this work we will experimentally study the performance of an air conditioning air cooled water chiller using refrigerant R407C and will compare it with the performance of the chiller when using refrigerant R22 under different condensing and evaporating temperatures. Complete performance and characteristics curves of the new refrigerant R407C will be constructed for a locally manufactured chiller with a refrigeration capacity of twenty tons of .

The work aims to find the advantages and disadvantages of using R407C. Many parameters such as the operating pressures, compressor exit temperature, sub-cooling effects, COP, power and heat rejection will be investigated and compared with those of R22.

The project comprises several chapters, these chapters are arranged in a way that the first chapter is the introduction previously discussed.

Chapter two covers the literature survey about the new refrigerants, and the new blend R407C; Chapter three clarifies the development of thermodynamic and physical properties of R407C in a simplified theoretical analysis. Experimental work, including illustrative chiller refrigeration circuits drawings are demonstrated in chapter four. Chapter five presents the experimental results tables. Discussions, recommendations and conclusions were discussed in the last chapter with the aid of the results figures.

Chapter Two

Literature Survey

The future of refrigeration and air conditioning has never been discussed so controversially as at present. The world trend towards environmental issues made it eager for the researchers and scientists to conduct experiments for an appropriate substitute of CFCs.

More studies and researches were carried out on different R22 refrigerant alternatives, concerning their properties, system performance (theoretically and experimentally). In this chapter, some of the previous works and efforts concerning the proposed area of study will be presented.

The Association of European Refrigeration Compressor Manufacturers (1997) (ASERCOM) was approached for assistance in selecting the appropriate alternative refrigerant for use in air-conditioning systems as substitutes which are acceptable from an ecological and technical point of view. Several experiments were conducted on the use of R407C to replace R22 in their systems. The study was carried out at different evaporating and condensing temperatures to find the coefficient of performance (COP) of the system using R407C.

They concluded that the advantages of R407C as nonflammable, nontoxic, available in the market, has lower discharge temperature than R22 and has large sub-cooling effect. The disadvantages were: critical temperature lower than R22, and limited availability of system components.

The German Compressors Manufacturing Company BITZER (1998), studied the performance of R407C on their new generation of compressors to cope with the world trend regarding the environmental cases. BITZER found that R407C refrigerant has nearly similar thermodynamic properties and performances as R22 in the A/C and medium temperature cooling range which is illustrated in figures (2.1) and (2.2).
BITZER found that the distinctive temperature glide requires a special design for main system components; such as evaporator, condenser and the expansion valve, they recommended that R407C is not preferred to be used in plants with flooded evaporators.

The Air Conditioning and Refrigeration institute (1999) carried out experiments on the refrigerants properties and their alternatives of new blends. They studied the chemical behavior of R407C on the global warming effect and the ozone layer. They found that R407C has small harmful effect on the environment.

Richardson and Butler Warth (1995) studied different non-traditional refrigerant performance in hermetic vapor compression systems. They showed that blends of refrigerants are the most suitable solution for the environmental cases without enormous change in the capacity or the behavior of the system

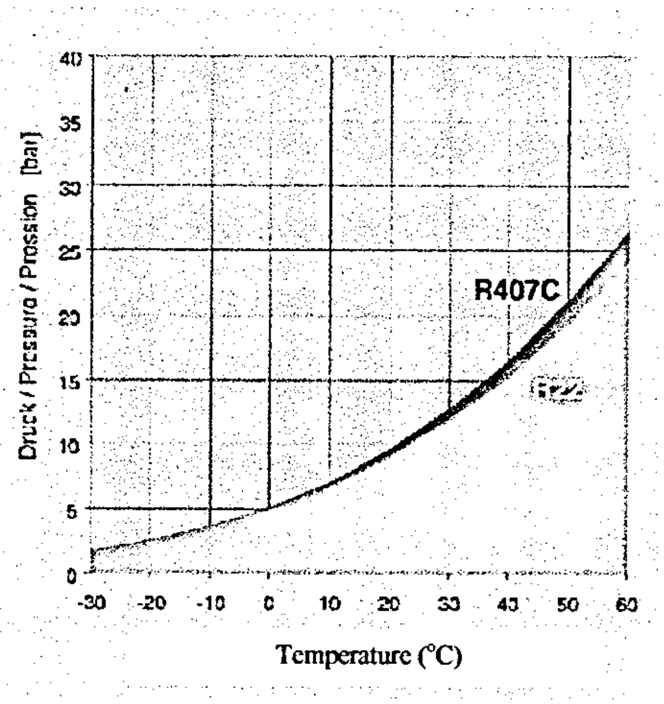


Figure (2.1): Comparison of system pressures for R407C/R22 (adopted from BITZER products catalog 1998)

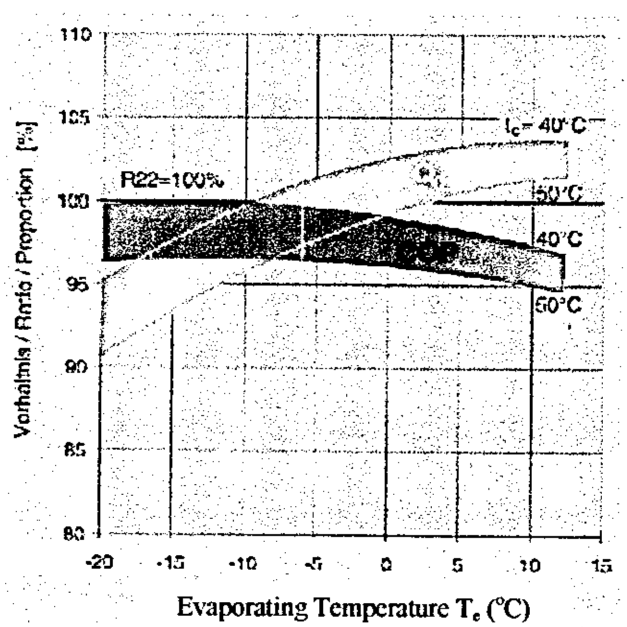


Figure (2.2): Comparison of performances data for R407C/R22 (adopted from BITZER products catalog 1998) believe it to be a good alternative in these applications, he tested R407C in several chillers and the result showed that there is an increase in condensing temperature of, 3-5 °K in most cases, which is not a major problem in Sweden climate.

Toshiba Air Conditioning (1999), designed new series of heat pump mini split A/Cs using R407C instead of R22. They conducted several experiments on the new blend and specially studied the effect of the temperature glide. They defined it as the difference in temperature between the bubble point temperature and the dew point temperature .
They concluded that R407C is a non-azeotropic refrigerant. It does not have a single boiling point such as R22, and the lowest temperature at which it begins to boil is the "bubble point". They found that as the refrigerant is passed through the evaporator, the three components begin to evaporate at slightly different temperatures and at different rates. When condensing, the process is reversed and the temperature of the first component to reach saturation is known as the dew point. Many phenomenon such as leak detection, pressure testing and refrigerant charging were taken into considerations for R407C.

Kruse (1994) presented the CFCs phase out schedule adopted by the United Nations Environmental Program (UNEP) and European Community which was based on the amendments of the Montreal protocol revised in London, 1990 and Copenhagen, 1992. He presented the regulations of CFCs phase out and European Community consumption and the alternative technologies.

Kramer (1999), wrote an article that addresses only HFC refrigerants and blends that are not miscible with mineral oil. It explores factors that favor using mineral oil when retrofitting existing systems. It also discusses potential problems arising from such use or retention. (IIR Bulletin)

Morely (1999), presented all the considerations that led to the phase out of R22 in the world. The application possibilities and characteristics of various replacement refrigerants are described. Environmental aspects are also covered . The researcher concluded that the HFC refrigerants will be favored for commercial – and air –conditioning applications. (IIR Bulletin)

Tominaga (1999), described in his article the current trend of refrigeration oil for alternative refrigerants, which he presented PVE (polyvinylether) as an alternative candidate for POE (polyolester) for air conditioning systems. The advantages of PVE over POE are better lubricating ability with process fluids, better miscibility with HFCs etc. PVE is commercially available and implemented for use with HFC products. (IIR Bulletin)

Wahlstorm and Vamling (1999), the researchers developed a model of the group contribution type that can predict the solubility of mixtures of HFC working fluids and pentaerythritol ester compressor oils. They investigated solubility data for twenty systems of five different HFCs in four different esters. (international journal of refrigeration IIR)

Al-Shaafe'i (1997) presented in his research a new extended three parameter equation of state which arose from the two parameter Canaham-Starling-de Santis equation of state. The research also deals with the utilization and application of the equation of state in computation of vapor-liquid equilibrium both of pure substances and mixture, the researcher programmed a new software that provides computation of phase equilibrium of binary mixtures, computation of refrigerants thermodynamic properties, computation of standard thermodynamic changes, simulation and evaluation of cooling cycles and graphic creation of heat diagrams(p-h and T-s).

DuPont Flourochemicals, Suva refrigerants manufacturer (1997) was one of the first manufacturers in the world that created refrigerant R407C under its trade name Suva 9000 or Suva 407C, DuPont carried out extensive experiments on the new refrigerant, they started with thermodynamic properties of Suva9000 using the equation of state (PRSV) which lead to build a computer software that enabled DuPont to establish thermodynamic tables for Suva 9000. DuPont published their experiments regarding the properties, uses, storage and handling in a service manual, they illustrated the different uses of Suva 9000 in new A/C systems – since it proven to be an ozone friendly refrigerant – and in old systems as a retrofitting refrigerant for R22. They found that nearly similar system operation conditions of R407C and R22 exists with some difference in pressures and COP's.

Transport properties of Suva 9000 like viscosity, thermal conductivity and heat capacity for liquid and vapor were established by charts that compare these properties with those of R22, which are illustrated in figures (2.3) – (2.7)

DuPont published an article about their new series of refrigerants that is used to retrofit the old systems with new blends of refrigerants, they carried several tests on the behavior of Suva 9000 in the A/C systems, they came up with new graphs that illustrated the refrigerant velocity and the pressure drop in the discharge, liquid and suction line, these charts are illustrated in figures (2.8), (2.9).

This work will report on experimental results of using R407C as a replacement to R22 in a locally manufactured chiller of twenty tons of refrigeration, performance comparison will be supplied.

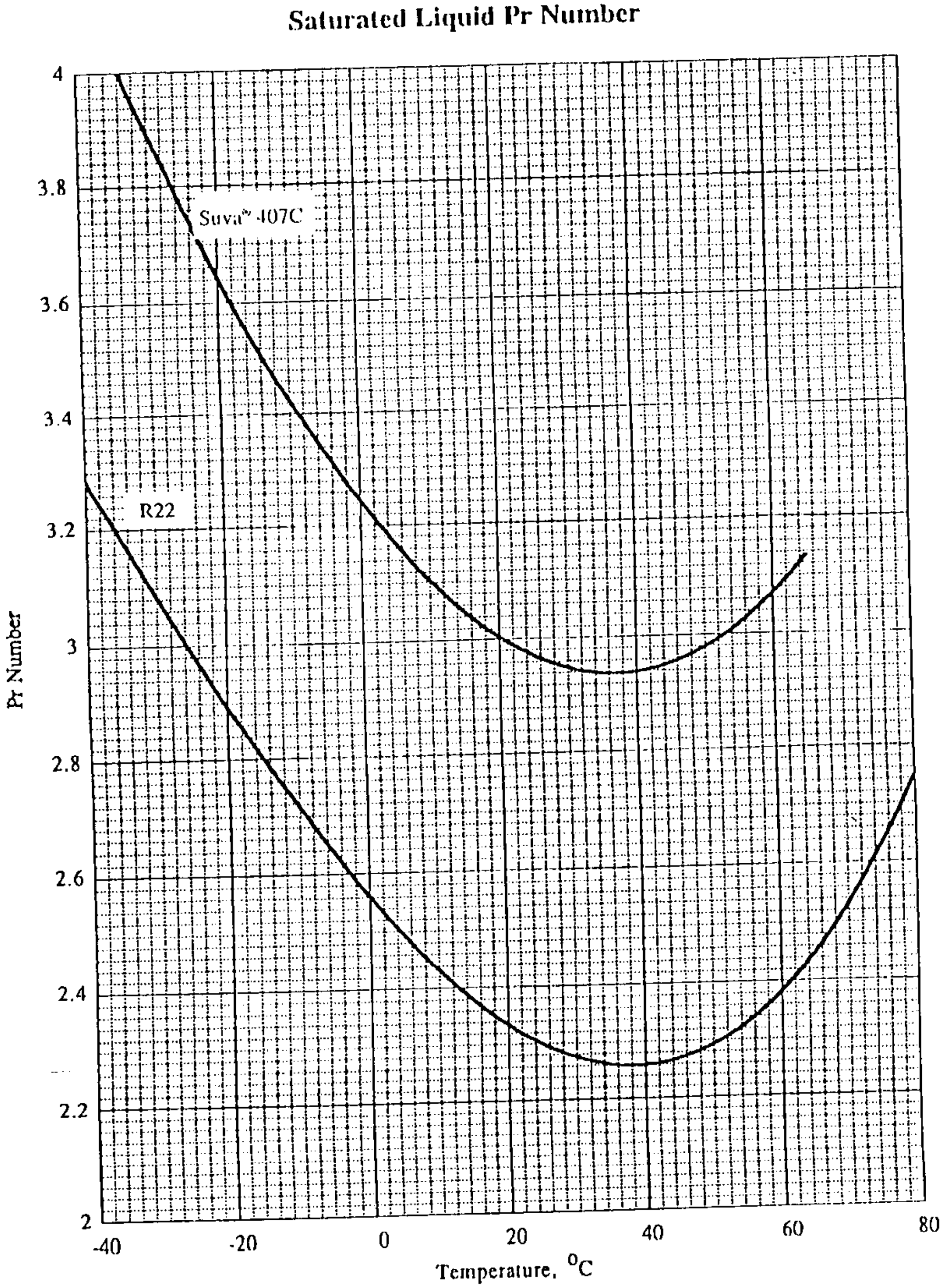


Figure (2.3): Saturated liquid Pr number for R407C/R22

(Adopted from DuPont flourochemicals products catalog 1999)

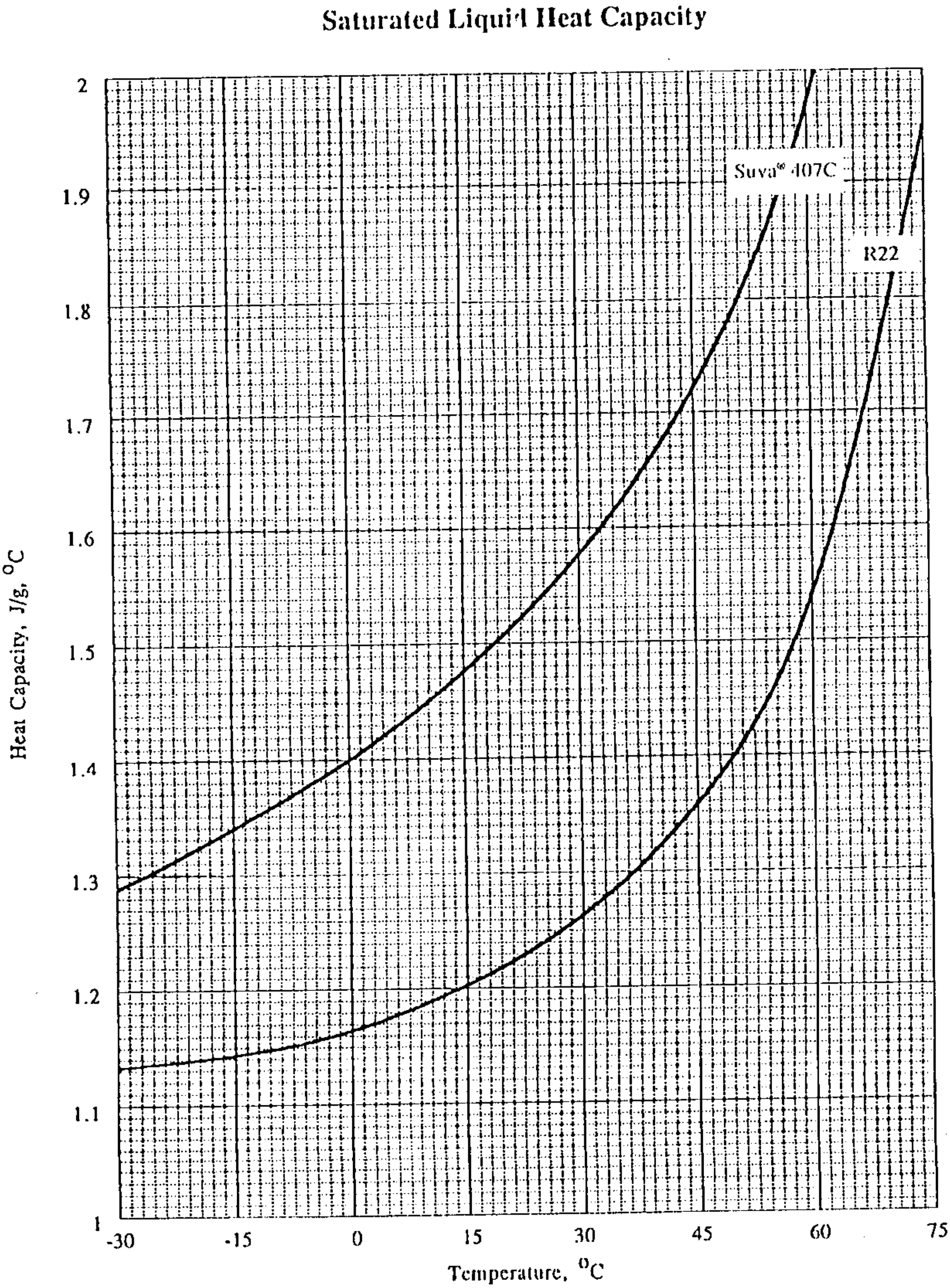


Figure (2.4): Saturated liquid heat capacity for R407C/R22

(Adopted from DuPont flourochemicals products catalog 1999)

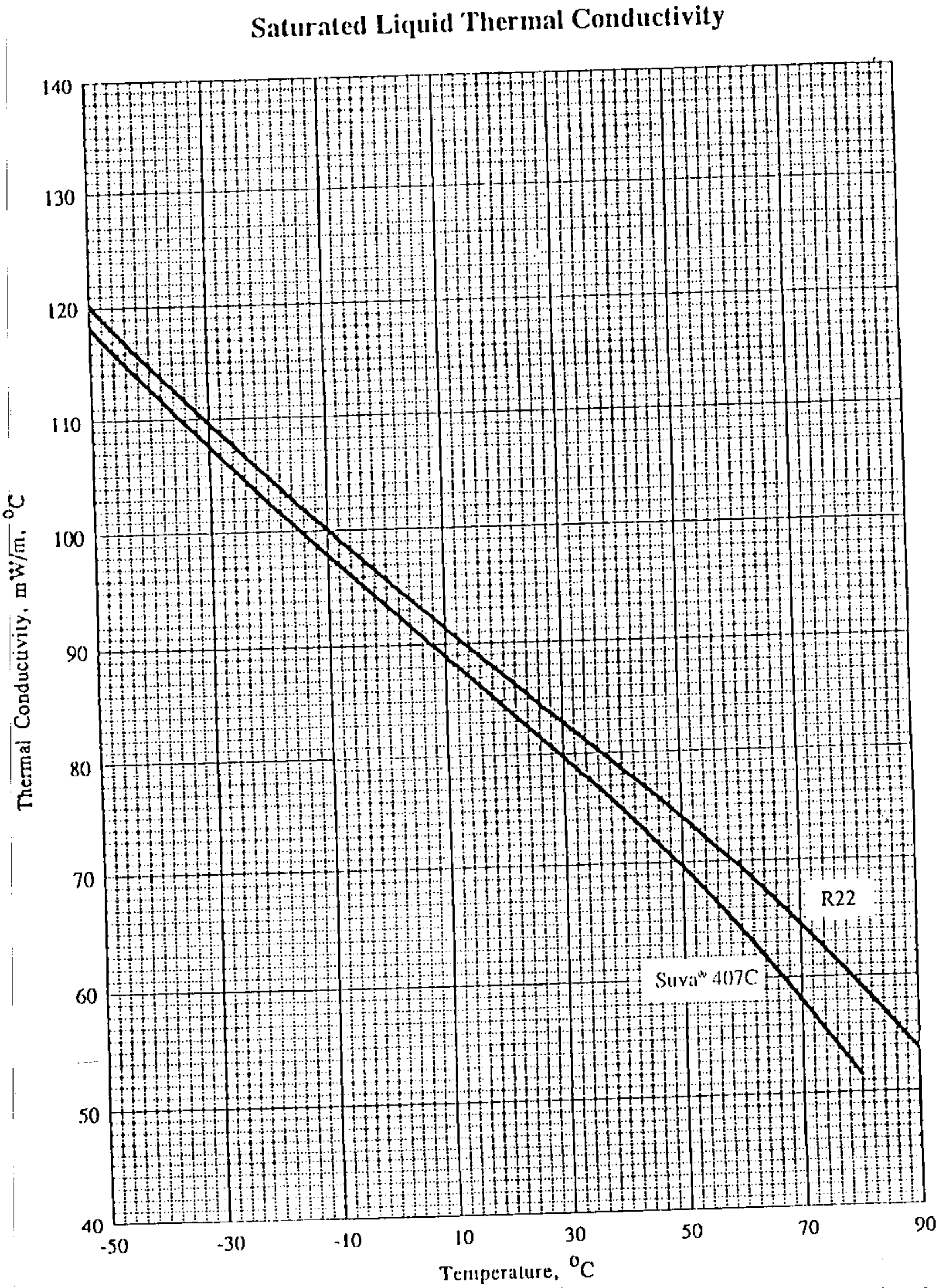


Figure (2.5): Saturated liquid thermal conductivity for R407C/R22

(Adopted from DuPont flourochemicals products catalog 1999)

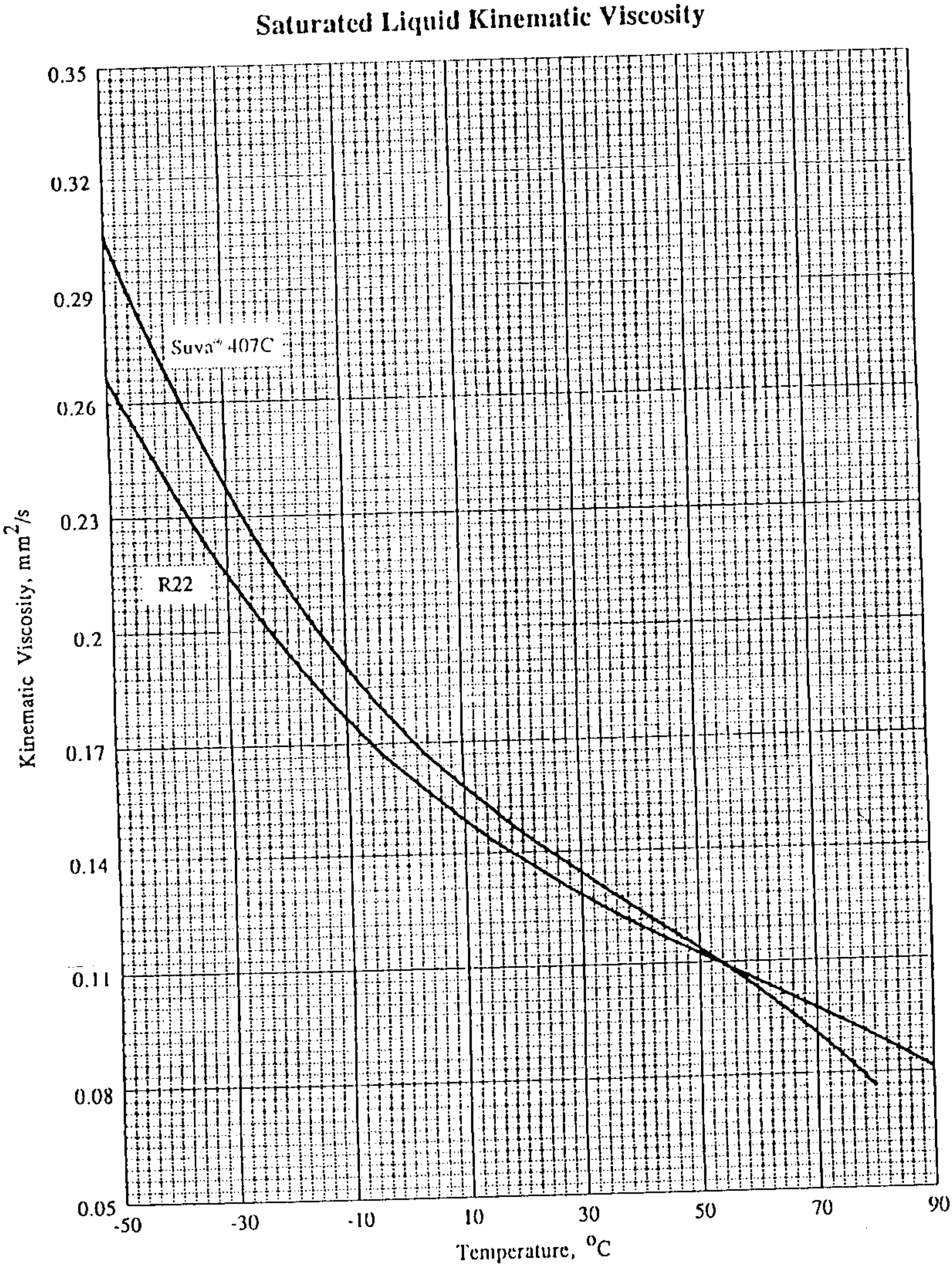


Figure (2.6): Saturated liquid kinematic viscosity for R407C/R22

(Adopted from DuPont flourochemicals products catalog 1999)

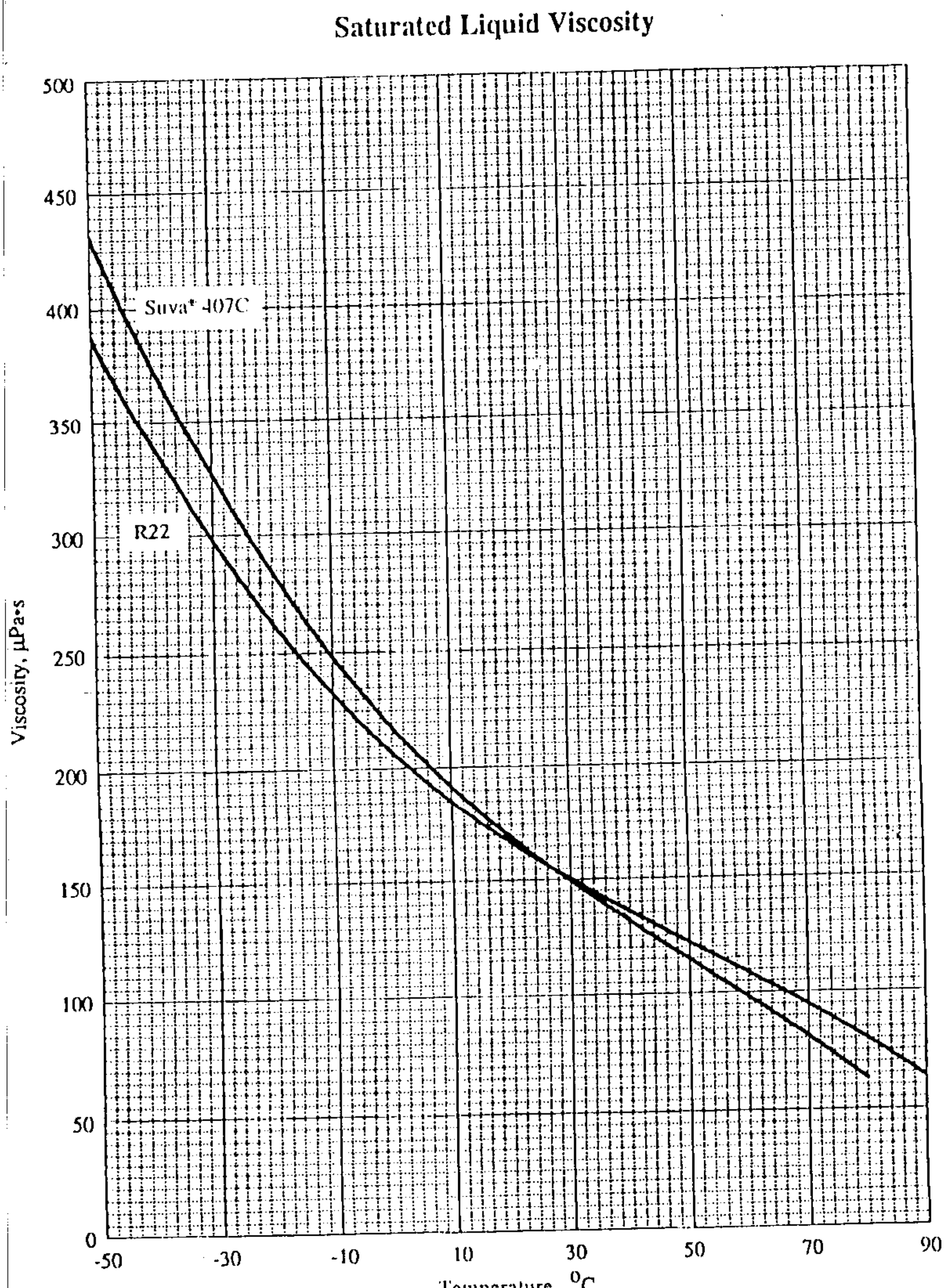
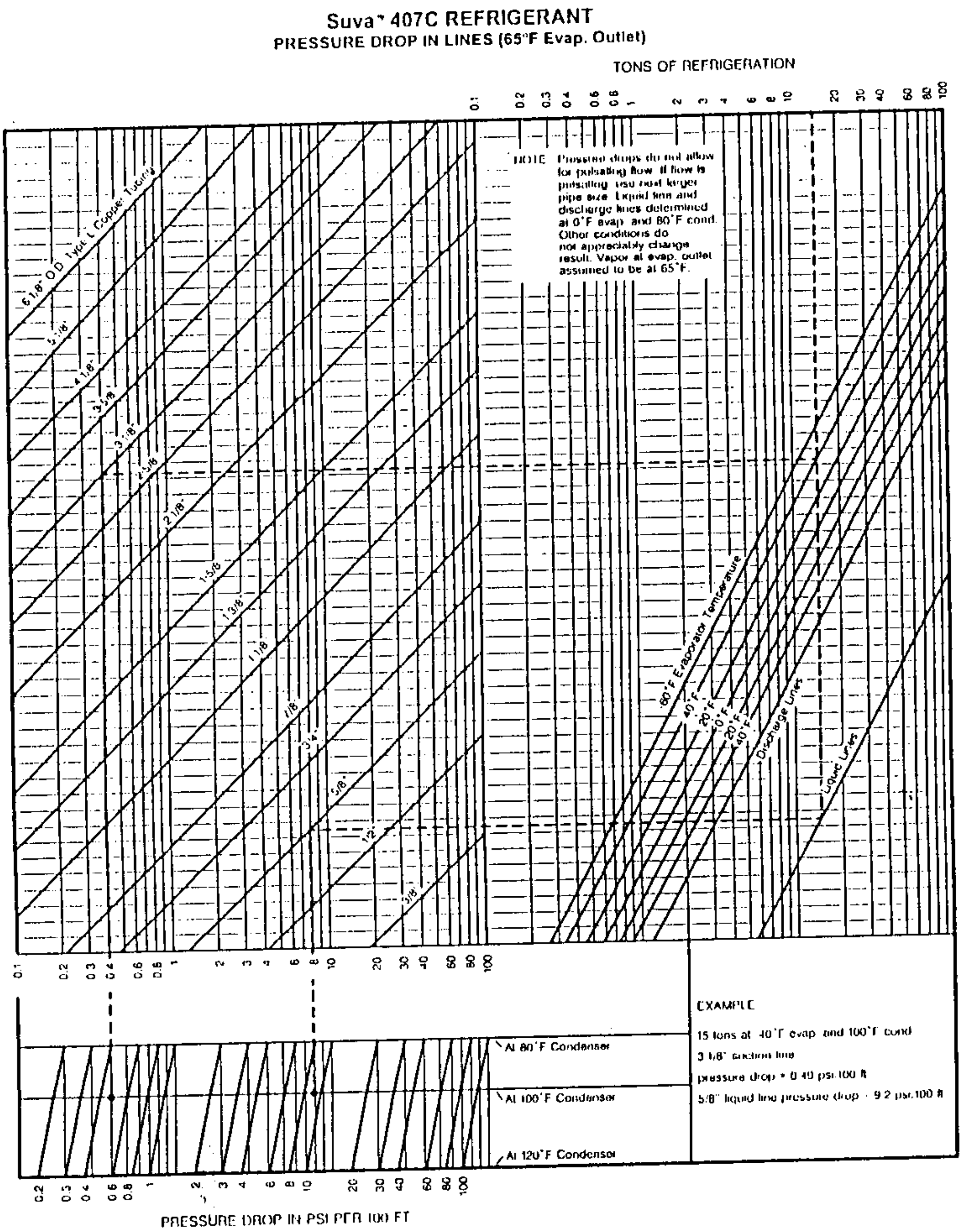


Figure (2.7): Saturated liquid viscosity for R407C/R22

(Adopted from DuPont flourochemicals products catalog 1999)



Figure(2.8): Pressure drop in lines for R407C

(Adopted from DuPont flourochemicals products catalog 1999)

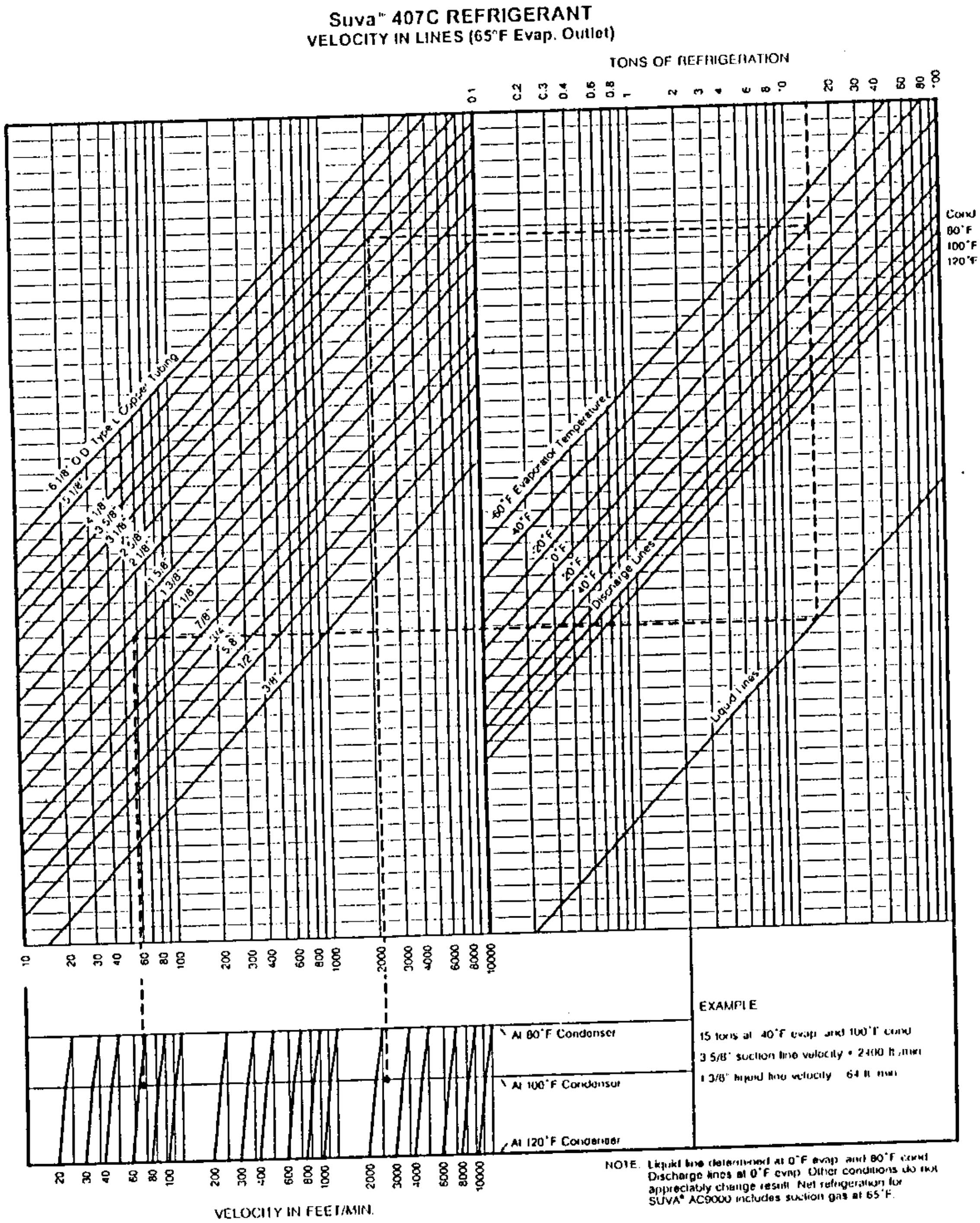


Figure (2.9): Velocity in lines for R407C.

(Adopted from DuPont flourochemicals products catalog 1999)

Chapter Three

Theoretical Analysis

3.1 Introduction:

Over the past five decades HCFC-22 (R22) has been used as a refrigerant in various refrigeration, industrial cooling, air conditioning and heating applications. The low ozone depletion potential of R22 compared to CFC-11 and CFC-12, along with its excellent refrigerant properties have helped facilitate the transition from CFCs. However HCFCs including R22, are scheduled for eventual phase out.

R407C has been developed as the similar pressure replacement, for R22 in positive displacement, direct expansion air conditioners and heat pumps. R407C is commercially available for retrofit of existing equipment and as a long term replacement option for R22 in new equipment to continue to operate safely and efficiently even after R22 is no longer available.

R407C Refrigerant:

R407C is a blended refrigerant, it's components by mass proportion are:

- R32	23%	(CF_2H_2) Difluoromethane
- R125	25%	(CF_3CHF_2) Pentafluoroethane
- R134a	52%	(CF_3CH_2F) 1,1,1,2-Tetraflouroethane

R407C is a non-azeotropic mixture of these components. This means that it evaporates over a temperature range of 5 °C-6 °C, when at the same pressure. An azeotropic mixture contains components which all boil at the same temperature. This difference in boiling points results in a variance in temperature through the length of an evaporator or condenser, as the mixture ratio changes and is referred to as the temperature glide. The distillation process of R407C favors R32, being the first component to evaporate. Therefore, complex temperature and mixture changes occur within the evaporator coil throughout its length and for this reason conventional parallel-flow evaporator coils are not considered suitable by most manufacturers.

Azeotopic mixtures have no glide, and mixtures with a very small amount of glide (fraction of 1) are some times referred to as near azeotropes. Where non-azeotropic mixtures exist together in both liquid and vapor phases, for example, in an evaporator or condenser, the composition ratio will alter. In the saturated liquid state they recombine in the correct proportions.

This process of separation, or fractionation, will occur in the evaporator and condenser sections of the chiller system, in addition to storage vessels, such as liquid receivers, accumulators and service cylinders. This fractionation results in the vapor which occupies the free space above the liquid level becoming more enriched with the more volatile components of the blend. Typically this vapor is R32.

The degree of fractionation is affected by both the available space in the vessel, which can be occupied by vapor and the saturation temperature of the vapor. An increase in temperature or vapor space tends to increase the degree of fractionation.

3.2 Temperature Glide:

Where conventional, single component refrigerants are concerned, such as R22, a direct relationship exists between the pressure and saturation temperature of the refrigerant and if one value is known, the other can be predicted. When this is portrayed on a pressure enthalpy diagram the isotherms (lines of constant temperature) are horizontal and whilst there is an exchange of heat within the loop, there is no rise in sensible temperature-this only begins to rise when the vapor is evaporated and the refrigerant begins to superheat.

In contrast to R22, R407C is a non-azeotropic refrigerant. It doesn't have a single boiling point as such, and the lowest temperature at which it begins to boil is the "bubble point". As the refrigerant is passed through the evaporator, the three components begin to evaporate at slightly different temperatures and at different rates. When condensing, the process is reversed and the temperature of the first component to reach saturation is known as the "dew point". From the bubble point temperature to the dew point temperature is a difference which is called the glide temperature figure (3.1). It is worth to mention that temperature glide is excluded in the super heat process where it acts as a vapor mixture.

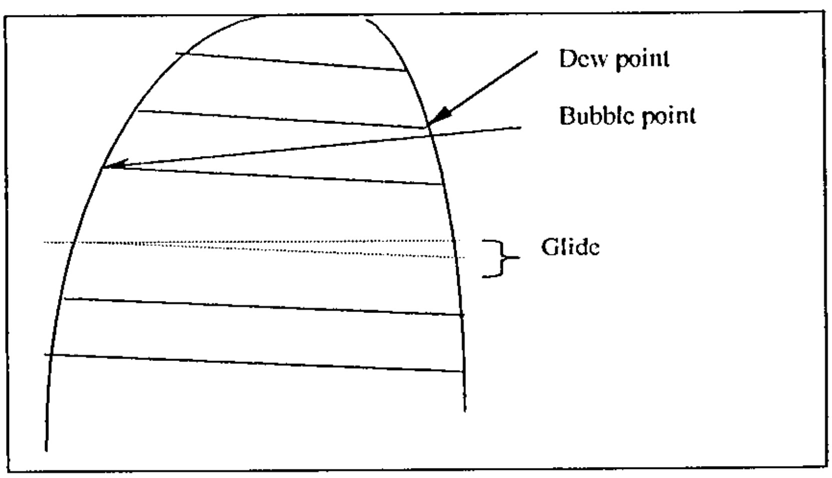


Figure (3.1): Temperature glide

3.3 Thermodynamic and Physical Properties:

Thermodynamic and physical properties are the most important properties in selecting refrigerants for any application.These properties are presented in table (3.1). Refrigerant manufacturers developed and presented new tables of thermodynamic properties which are illustrated in the appendix. Thermodynamic equations have been developed, based on the Peng-Robinson-Stryjek-Vetra (PRSV) equation of state, which represent the data of temperature, pressure, and density.

Table (3.1):Thermodynamic and physical properties of R407C and R22. (Adopted from DuPont products catalog 1999)

Property	**R407C**	**R22**
Molecular weight.	86.2	86.47
Vapor pressure at 25 °C (kPa)	1147.1	1043.1
Boiling point at 1 atm.(°C)	-43.56	-40.8
Critical temperature (°C)	86.74	96.24
Critical pressure (kPa)	4619.1	4980.7
Critical density (kg/m^3)	527.3	524.21
Liquid density at 25 °C (kg/m^3)	1134	1195
Sat. vapor density at 25 °C (kg/m^3)	41.98	44.21
Liquid specific heat at 25 °C (kJ/kg.k)	1.54	1.24
Vapor specific heat at 25 °C (kJ/kg.k)	0.83	0.685
Sat. liquid vapor pressure (kPa)	1173.4	1043.1
Heat of vaporization (kJ/kg)	245.1	233.5
Liquid thermal conductivity (W/m.k)	0.0819	0.0849
Vapor thermal conductivity (W/m.k)	0.01314	0.01074
Liquid viscosity (Pa.s)	0.00016	0.000159
Vapor viscosity (Pa.s)	0.0000123	0.000013
Ozone depletion potential (CFC-11 =1)	0	0.05
Global warming potential (CO_2)	1600	1700

A theoretical cycle performance which is adopted from DuPont Flourochemicals is presented in table (3.2) for R407C and R22 thermodynamic comparison, the performance cycle is calculated at the following conditions:

Condensing temperature : 43.3 °C .

Evaporating temperature : 7.2 °C .

Subcooling difference : 2.8 °C

Superheat difference : 8.3 °C

	R407C	**R22**
Refrigeration capacity (R22= 1)	1.1	1.0
Coefficient of performance	6.0	6.43
Compression ratio	2.83	2.66
Compressor discharge temperature(°C)	75.1	77.3
Compressor design pressure (kPa)	1763	1662
Temperature glide (°C)	4.9	0

Table (3.2): Theoretical cycle performance for 407C and R22. (DuPont flourochemicals)

As it can be seen from tables (3.1), and (3.2) the boiling temperature of R407C is lower than that of R22 which means more compressor work to reach the temperature that the refrigerant starts boiling to accomplish the vapor phase. The critical temperature and pressure of the refrigerant should be higher than the condensing temperature in the condenser in order to prevent any decomposition of the refrigerant material, we notice that this is higher for R22 than for R407C. The theoretical value of the COP is higher for R22 than for R407C, and that is predicted since the refrigeration capacity are nearly the same for the two Refrigerants, but the work of compression for R407C is higher than that of R22.

Low compressor discharge temperature is desirable in all systems, since high temperature could result in oil breakdown , causing excessive wear or a reduction in the life of the compressor discharge valves and the overheating of the compressor.

The thermal conductivity of R407C vapor is higher than that of R22, which implies a higher value of the heat transfer coefficient and a higher heat transfer in the condenser. The thermal conductivity of R407C liquid is lower than that of R22 .

Viscosity is a measure of flowing quality; it is desirable to use refrigerants with low viscosity in both liquid and vapor phases for higher heat transfer in the evaporator and the condenser, low pumping power and small pressure drops during flow. As shown in table (3.2), both refrigerants have nearly the same values of viscosity.

3.4 Chemical and Thermal Stability:

Stability with metals:

Stability tests for refrigerants with materials are typically performed in the presence of refrigeration lubricants. This test is run in sealed glass tubes at temperatures much higher than those encountered in refrigeration and air conditioning systems and is therefore referred to as an accelerated aging test. Results of sealed tube stability tests for HCFC-22/mineral oil and alky-benzene lubricants have shown long-term stability in contact with copper, steel, and aluminum. And the fact that HCFC-22/mineral oil and alkybnzene systems have been performing in the field in air conditioner and refrigeration systems for the last 50 years verifies the results from these stability tests. (POEs) lubricants are among the proposed lubricants to be used with R407C. Results obtained from these tests for R407C/POEs indicate acceptable chemical stability in the presence of common metals used in refrigeration and air conditioning systems. Beside metals tests have shown

That R407C and is compatible with elastomers and plastics materials that are used as an accessories in the refrigeration system.

Thermal decomposition:

R407C will decompose when exposed to high temperature around 100 °C or flame sources . Decomposition may produce toxic and irritating compounds, such as hydrogen fluoride. The decomposition products released will irritate the nose and the throat.

Refrigeration lubricants and miscibility:

There are different types of lubricants that can be used with refrigerant blends but in almost all cases the mineral oils (MO) previously used with CFC refrigerants should not be used with new HFC refrigerants. This is because the new refrigerants have very different solvent properties from CFCs.

Synthetic oils are now available and have been tested by lubricants manufacturers extensively with R407C, the three types that are used with general blends refrigerants are:

- Alkyl Benzene (AB).
- Polyster (POE) lubricants.
- Polyalkylene Glycol (PAG).

In general R407C is miscible with polyol ester lubricant and immiscible with alkylbenzene and mineral oil lubricant.

Another important point is that residual mineral oil or alkybenzene left in a refrigeration system after a retrofit to R407C refrigerant is performed decreases the lubricant/refrigerant miscibility. This is one of the reasons why three oil changes are generally recommended when a system is being

3.5 Charging, Recovery and Reclamation:

As with any other refrigerant blend, when charging equipment with R407C, only liquid refrigerant must be charged from the cylinder, it is advisable to use a gauge manifold set equipped with a liquid sight glass fitted in the center port. Usually R407C cylinders are equipped with liquid and vapor valves to insure that we can get liquid refrigerant only.

Recovery refers to the removal of any refrigerant from equipment and collection in an appropriate external container. R407C may be recovered from refrigeration equipment using permanent on site equipment or one of the portable recovery devices. At the end of recovery cycle, the system is evacuated to remove vapors.

Reclamation refers to the reprocessing of used 407C to new product specifications. Quality of reclaimed product is verified by chemical analysis Reclamation offers advantages over on-site refrigerant recycling procedures, because these systems cannot guarantee complete removal of contaminants.

Leak detection is an important procedure that must be carried out before or during operation of an A/C equipment. There are four methods of checking a system for leaks which are:

- High pressure test with oxygen free nitrogen (OFN).
- Drop test (minimum 24 hours- the longer the better).
- Water soap solution (tested only on positive pressures).
- Electronic leak detector .

Each of these methods have their merits; the first three during commissioning when the system is likely to contain oxygen free nitrogen, the third and fourth during service when the system contains refrigerant.

3.6 Cycle Analysis:

Refrigeration and vapor compression cycle:

The vapor-compression cycle -which is illustrated in figure (3.2) is the most widely used refrigeration cycle in practice. The vapor processes, which comprise the standard (ideal) vapor-compression cycle, are:

- Reversible adiabatic compression from saturated vapor to the condenser pressure.
- Heat rejection at constant pressure and condensed to saturated liquid.
- Irreversible expansion at constant enthalpy from saturated liquid to the evaporator pressure.
- Heat addition at constant pressure in evaporation to saturated vapor.

Assumptions:

When conducting the mathematical calculations for the performance of the R407C refrigerant, number of assumptions were taken into considerations for the research which is listed below:

- the behavior of the ideal cycle is considered in the research, when setting the different points of the cycle.
- Constant entropy is considered through the compressor, to set the location of the condenser super-heat when drawing the cycle using the P-h diagram.
- Constant enthalpy through the expansion valve is considered, to set the location of the evaporator inlet point.
- Experiment was conducted on the basis that steady state conditions was achieved in all data acquisition, deviation effects due to unsteadiness was excluded.
- A circulating pump and a 3 m^3 water tank are considered to be the evaporator low temperature reservoir.

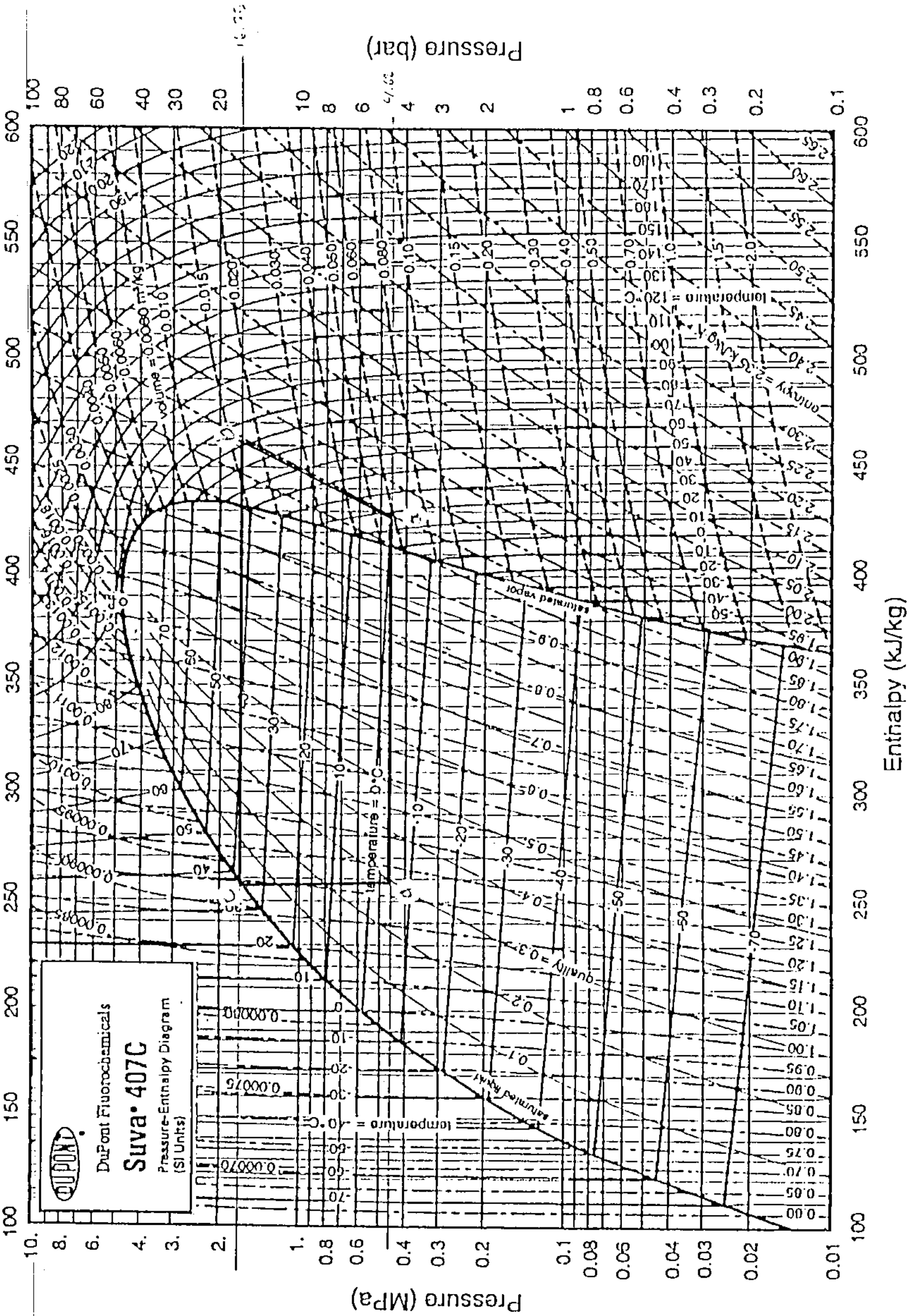


Figure (3.2): Mullier chart –Ph diagram- for R407C

- An average between the bubble point and the dew point (temperature glide) is taken to find the evaporating and condensing temperatures for the different tests that carried out.

Measured Data:

All data were recorded and listed in the appendix. For the calculations of this work, the data required for the various tests that were conducted, is listed in chapter five for the T_e variation test, T_c variation test, and for the performance comparison between R407C and R22.

All the mathematical and enthalpy calculations were done using the Mullier (P-h) diagram for both R407C and R22 refrigerants.

Refrigeration Effect:

The liquid refrigerant flowing through an evaporator boils as it exchanges heat from the water that is flowing in the evaporator. The quantity of heat that is exchanged in kJ/kg of refrigerant circulated in this process is known as the refrigeration effect.

The net refrigeration effect depends upon the temperature at which the refrigerant leaving the evaporator and the temperature of the liquid after the expansion. It is thus given by :

$$Q_{ref} = h_a - h_d$$

Where h_a and h_d are the enthalpies in (kJ/kg) of the refrigerant leaving and entering the evaporator, respectively, (see figure (3.2)).

Refrigeration Capacity:

The refrigeration capacity is the rate of heat exchanged in (kW) in the evaporator. It depends on the mass of refrigerant circulated per unit time (m`) and the refrigerating effect. It is given by :

$$Q_{cap} = m`Q_{ref}$$

Where, Q_{cap} is the refrigeration capacity in (kW), m` is the refrigerant mass flow rate in kg/s and Q_{ref} is the refrigerating effect in kJ/kg.

Refrigerant Mass flow rate:

The mass flow rate of a refrigerant is the mass of that refrigerant in kg which must be circulated per second time for any operating conditions. It is given through the chilled water heat removal in the evaporator Q_{wat}, which is equal to the refrigeration capacity Q_{cap}, and is given by:

$$Q_{wat} = m`_{wat}\, C_p\, (T_{in} - T_{out})$$

Where: - Q_{wat} is the chilled water heat removal power.

- C_p is the specific heat capacity of water evaluated at the average inlet and outlet water evaporator temperature.

- T_{in}, T_{out} is the inlet and outlet evaporator water temperature respectively.

$$Q_{wat} = Q_{cap}$$

And the refrigerant mass flow rate can be calculated as:

$$Q_{cap} = m`_{ref}\,(h_a - h_d)$$

Compression Work:

The compression work is the increase in the refrigerant enthalpy during the compression process done by the compressor, which is given by:

$$W = h_b - h_a$$

Where, W is the compression work in kJ/kg, h_a and h_b are the refrigerants enthalpies at compressor suction and discharge respectively.

The power consumption P in (kw) can be found as:

$$P = m`_{ref}\, W$$

Coefficient of performance:

The coefficient of performance of a system is an expression of the system efficiency . It is obtained by dividing the refrigeration capacity over the power consumption .

$$COP = Q_{cap}/P = (h_a - h_d)/(h_b - h_a)$$

Chapter Four
Experimental Work

4.1 Introduction:

A locally manufactured water chiller was tested in this research. The original refrigerant R22 was replaced by the refrigerant R407C.

The work involves the assembly of the experimental research chiller shown in figure (4.1) to measure the different parameters such as temperatures, and pressures at different locations of the chiller refrigeration cycle. Evaporator water inlet and outlet temperatures were recorded by the use of thermocouples.

The temperatures and pressures of interest in the experiment for refrigerant R407C are as shown in figure (4.2), and in figure (4.3) for refrigerant R22 .

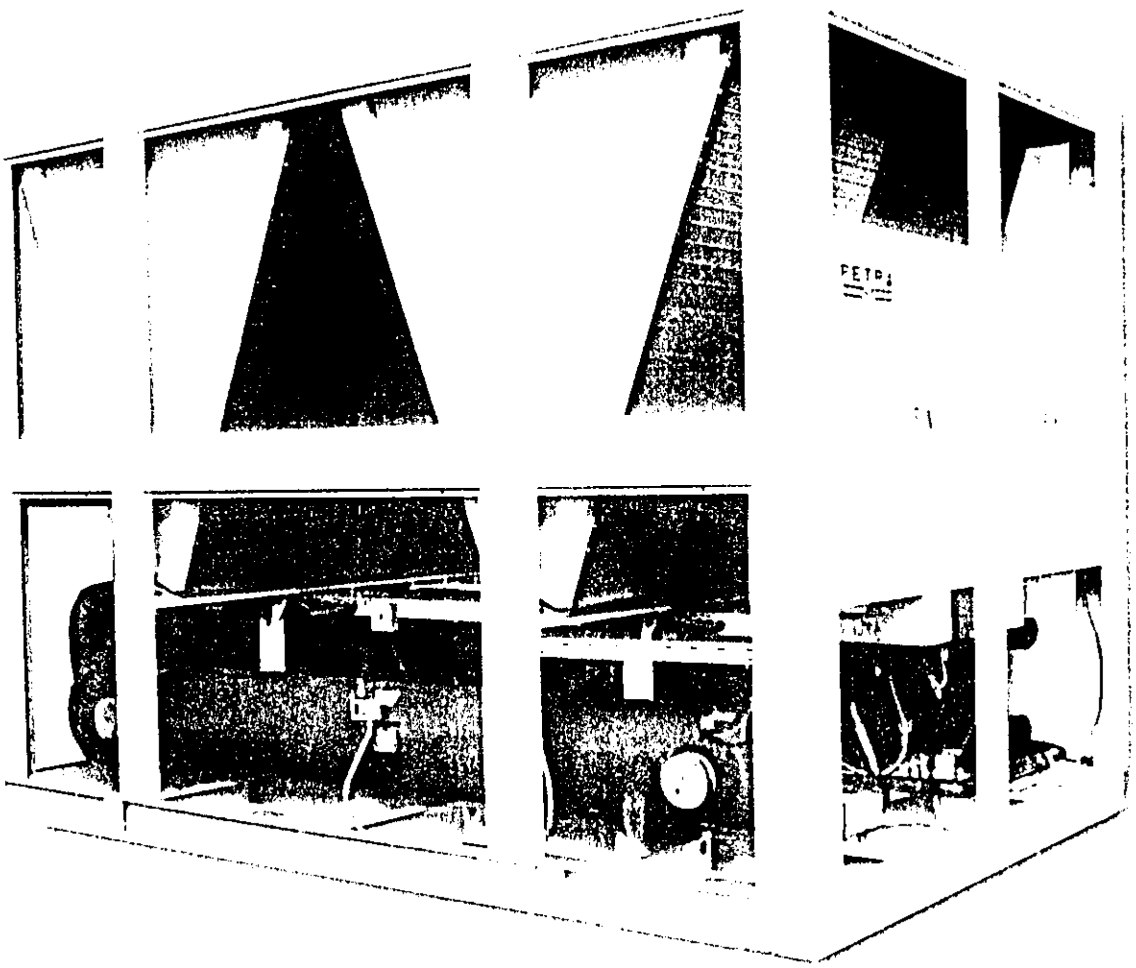


Figure (4.1): Research chiller picture

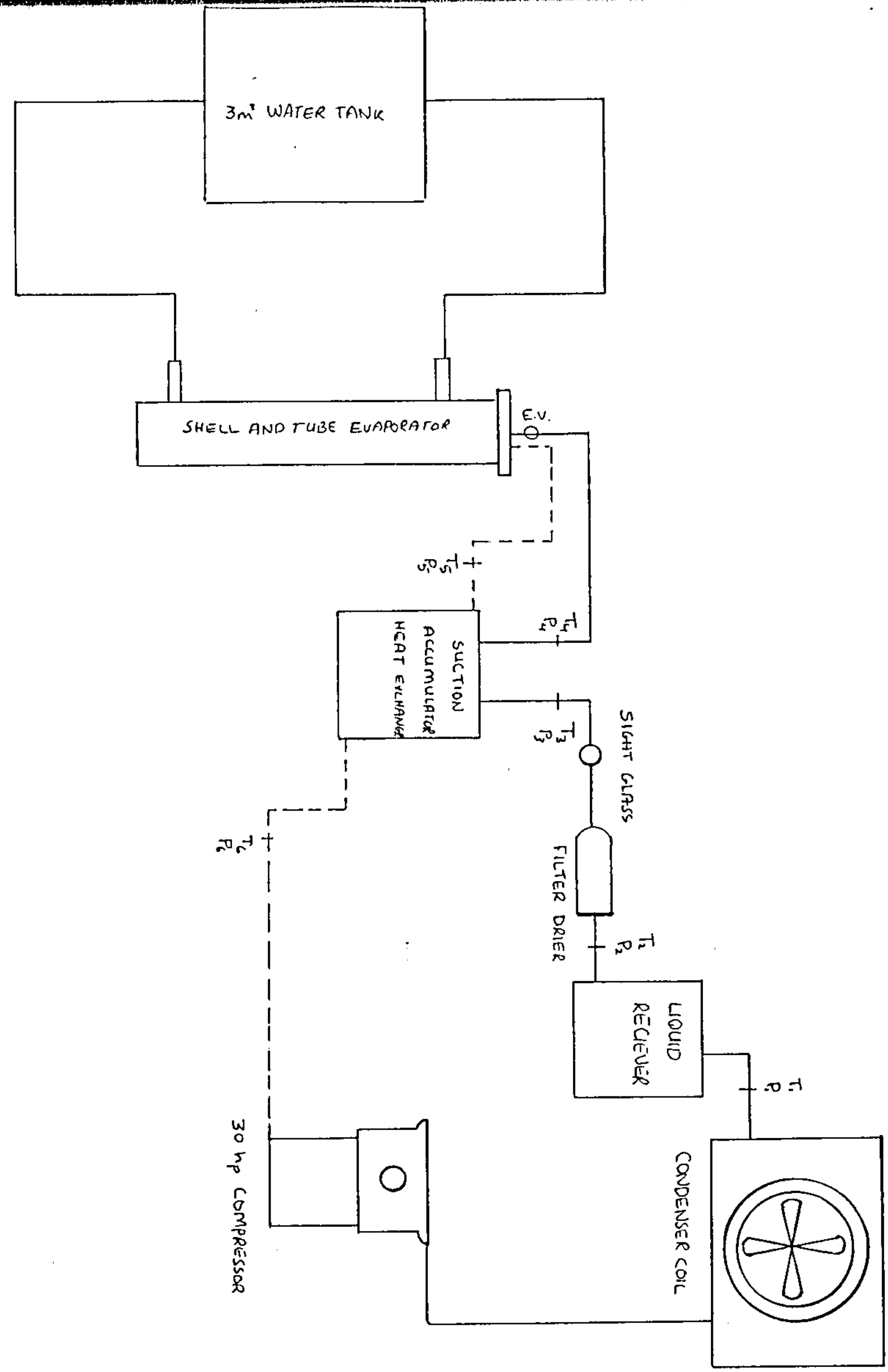


Figure (4.2): Refrigeration circuit schematic drawing for the chiller where R407C is used

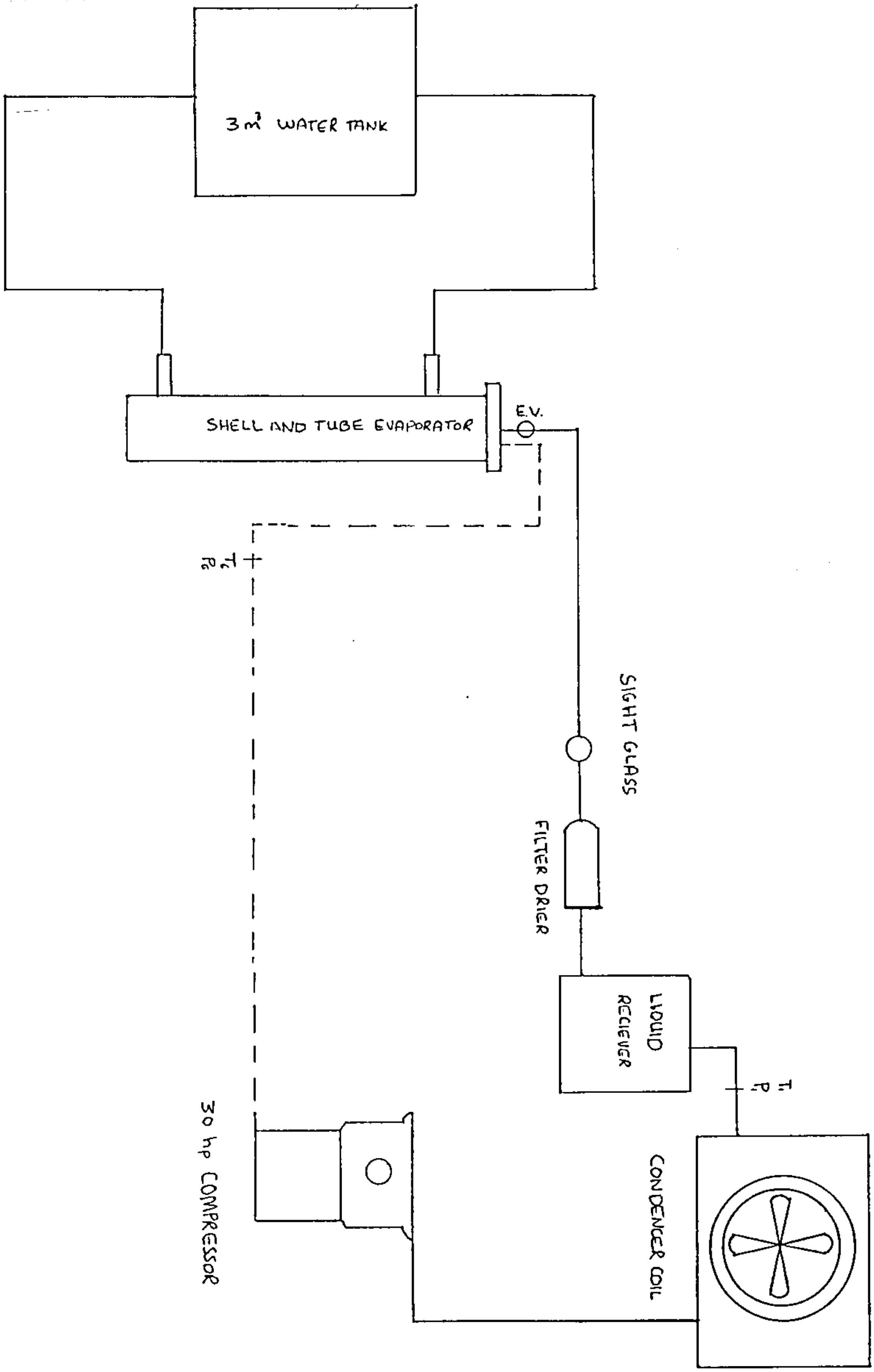


Figure (4.3): Refrigeration circuit schematic drawing for the chiller where R22 is used

4.2 Experimental Chiller Description:

The experimental research chiller was manufactured by a local manufacturer twice in this experiment, once for the use of R407C refrigerant, and the other for the use of R22 refrigerant. This is done due to some different components that were added to the chiller when using R407C which will be illustrated below:

- ***Air-cooled condenser:***

The air-cooled condensers are designed to deliver their respective duties at optimum performance at all experimental designed condensing temperatures. Coils are manufactured from seamless copper tubes mechanically expanded into aluminum fins. All coils are tested at 3145 kPa, air pressure, under water to avoid any leakage. They also undergo chemical cleaning after manufacturing for optimum system cleanness.

- ***Compressor:***

The compressor used is a semi-hermetic reciprocating, refrigerant gas cooled, solid-state overload protection in each phase.

The compressor is pressure lubricated by a reversible oil pump, the oil being used in R407C refrigerant is polyester oil which is different from the alkyl benzene oil that is used in the case of R22.

-***Shell and tube heat evaporator:***

Shell tubes are made of high efficiency seamless copper tubes. They are rollers expanded into double grooved tube sheet. Evaporator baffles are designed to achieve high heat transfer efficiency to reduce the case of flooded evaporators when using R407C .

All shell and tube evaporators are tested for refrigerant side working pressure of 2515 kPa, and a design waterside working pressure of 1050 kPa.

Expansion valve:

The expansion valve is a valve where the refrigerant expands from the high pressure side to the low pressure side, in order to obtain the lower temperatures needed. The expansion valve used in R407C refrigerant test is of an electronic type where it is modulated automatically to prevent any excess liquid refrigerant in the evaporator, while the one used in R22 refrigerant test is of a thermostatic type where it is modulated by a thermostatic spring.

Suction accumulator heat exchanger:

This device is only used in the case of using R407C, it exchanges heat from the high temperature liquid line after the condenser and the low temperature saturated gas to vaporize any amounts of liquid that could be presented in the gas before entering the compressor at the suction valve.

4.3 Measuring Devices:

The variables that were measured during the experiments are temperatures, pressures, and the compressor current ampere.

Temperature measurement:

Copper –constantan (Type T) thermocouple that is tied and ended with a sensor is used to measure the temperature at each point of the system as follows:

1. Condenser outlet refrigerant side temperature, T_1 .
2. Liquid receiver outlet refrigerant side temperature, T_2 .
3. Suction accumulator heat exchanger inlet (liquid) refrigerant temperature, T_3
4. Suction accumulator heat exchanger outlet (liquid) refrigerant temperature, T_4
5. Suction accumulator heat exchanger inlet (gas) refrigerant temperature T_5.
6. Suction accumulator heat exchanger outlet (gas) refrigerant temperature T_6.
8. Condenser inlet air side temperature, $T_{con,in}$.
8. Condenser outlet air side temperature, $T_{con,out}$.
9. Evaporator inlet water side temperature, $T_{evap,in}$.
10. Evaporator outlet water side temperature, $T_{evap,out}$.

Points are numbered in accordance with figure (4.2)

Each thermocouple was connected to a digital logging LCD screen, (MicroTec sensors), made by MicroTec electronics company, Italy) with an accuracy of 0.01 °C .

Pressure measurement:

Pressure was measured using a gauge manifold, which is comprised of a compound gauge, a pressure gauge, and the valve manifold.

The compound gauge is used to measure pressure both above and below atmospheric (vacuum).

Readings were taken at locations (1-6), beside the discharge and suction pressures of the compressor.

Compressor current ampere:

The electrical current of the compressor was taken as an indication to the compression work. The clamp ohmmeter was used for reading acquisition.

4.4 Experimental Procedure:

The procedure of the experiment can be summarized as follows:

-The chiller where R22 refrigerant to be used, is assembled from the main components being illustrated previously, refrigeration circuit copper pipes were connected and brazed properly to each other with the system components.

The leak test was done by pressurizing the whole system with nitrogen free oxygen gas, to insure no leaks in the system from points where it is brazed. The system is to be evacuated properly from the nitrogen, humidity and any contaminants that may exist in the refrigeration circuit using a vacuum pump, the vacuum process is to prepare the system for refrigerant charging.

Water pipes were connected to the evaporator inlet and outlet ports, to start the commissioning of the chiller.

The same procedures were done for the previous chiller. When using refrigerant R407C the suction accumulator heat exchanger being illustrated previously, was added to the circuit to make sure that all refrigerant gas entering the compressor is free of liquid. The compressor oil was changed to polyester oil which works with R407C refrigerant.

- After finishing the manufacturing processes, commissioning is operated inside a special testing room, designed to simulate different commissioning conditions through number of axial fans mounted at the side and the top of the room, in order to control the inside temperature of the testing room.

A three cubic meter water tank is to supply water to the chiller evaporator, which is connected at the inlet and outlet of the evaporator ports in a closed circuit to obtain the water temperature required.

- When commissioning the following tests on R407C and R22 refrigerants were carried out to study the performance of the new refrigerant:

- ***Evaporating temperature (T_e) variation test:***

This test is conducted to study the performance of the chiller and thus refrigerant under different evaporating temperatures. This test is done by varying the temperature of water enters the chiller evaporator through the water tank piped immediately as a closed circuit to the chiller.

Temperatures and pressures at the different locations were recorded for each evaporating temperature being chosen.

- ***Condensing temperature (T_c) variation test:***

This test is conducted to study the performance of the chiller and thus refrigerant under different condensing temperatures. This test is done by varying the temperature of air enters through the fan condensers.

Temperatures and pressures at different locations were recorded for each condensing temperature being chosen.

Chapter Five

Results

5.1 Data:

The experiment consisted of measuring, temperatures, pressures, and compressor current of a chiller that R407C is used, a full general commissioning data for the temperature and pressures at different condensing and evaporating temperatures were taken at different positions as was illustrated in chapter four.

Two tests were carried out on the chiller, the first test was the variation of the evaporating temperature at constant condensing temperatures which was called as T_e variation test. The second test was the variation of the condensing temperatures at constant evaporating temperatures which was called T_c variation test.

A third test was conducted for the chiller when R22 was used , the data were taken for the T_e variation test, so the comparison between the two refrigerants is achieved.

The full general commissioning data, and the referring Mullier (P-h) diagrams are illustrated in the appendix, the T_e and T_c variation tests data and results tables are illustrated in this chapter, while the (P-h) diagrams are illustrated in the appendix. All the performance figures are illustrated in chapter six. A sample calculation is carried out in this chapter for the three tests being mentioned above.

5.2 Sample Calculation:

T_e variation test:

The data readings for the T_e variation test is illustrated in table (5.1). The value of enthalpies were taken from Mullier diagram that is illustrated in Fig (5.1).

Water mass flow rate ($m`_{wat}$)= 60 Gpm =3.79 kg/s

Water specific heat (C_p) = 4.12 kJ/kg.k

Condensing temperature (T_c) = 39 °C

Evaporating temperature (T_e) = -3.5 °C

Refrigeration effect: $Q_{ref} = h_a - h_d$ =428-456=172 kJ/kg

Chilled water heat removal: $Q_{wat} = m`_{wat}\, C_p\, (T_{evap,in} - T_{evap,out})$ =

=(3.79)(4.12)(20-14.8)

= 81.2 kW

Refrigeration capacity: $Q_{cap} = Q_{wat}$ = 81.2 kW

Refrigerant mass flow rate: $m`_{ref} = Q_{cap}/ Q_{ref}$

= 81.2/172 =0.472 kg/s

compression work: $W= h_b - h_a$

= 461-428= 33 kJ/kg

Power consumption: $P= m`_{ref}\, W$

= 0.472 * 33=15.576 kW

Heat removal: $Q_{removal} = Q_{ref} + W$

= 172+33=205 kJ/kg

Coefficient of performance: $COP= h_a - h_d/ h_b - h_a$

= (428-256)/(461-428)

=5.2

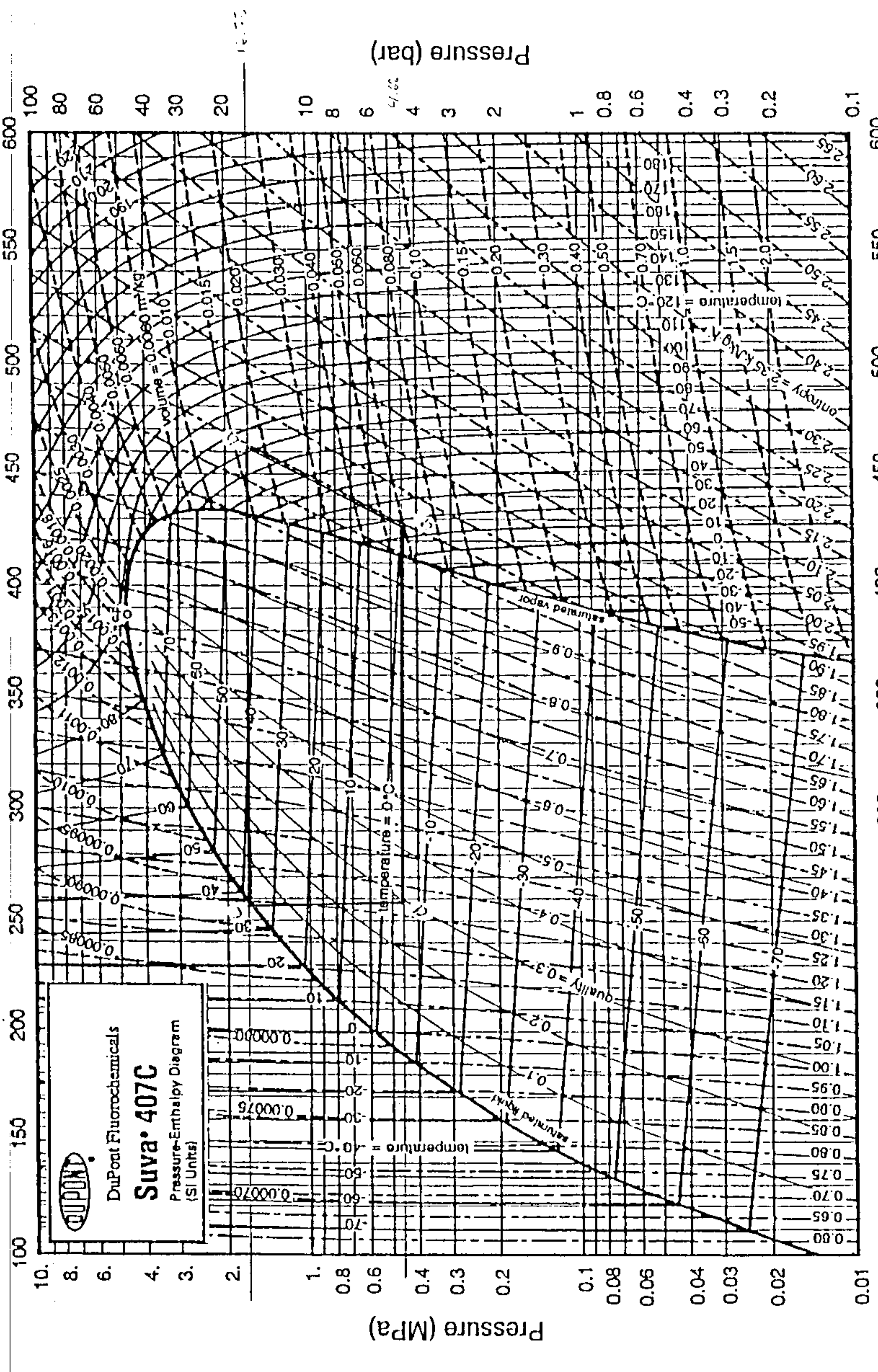


Figure (5.1): Sample calculation Ph diagram

Table(5.1): Te variation test sample calculation data
Tc=39 c

Condenser in (C°)	Condenser out (C°)	Evaporator in (C°)	Evaporator out (C°)	Discaharge pr. (bar)	Suction pr. (bar)	P1 (bar)	P2 (bar)	P3 (bar)	P4 (bar)	P5 (bar)	P6 (bar)
29	38	14.8	9.9	17.23	4.27	16.34	16.34	16.34	16.34	4.62	4.2
29	38	11.7	7.1	17.03	3.86	16.2	16.2	16.2	16.26	4.2	3.86
29	39	20	14.8	17.92	4.62	16.75	16.89	17.03	16.75	4.34	4.62

T1 (C°)	T2 (C°)	T3 (C°)	T4 (C°)	T5 (C°)	T6 (C°)	Comp. amp. (A)
36	36	36	36	14.6	15.5	36.8
36	36	36	35	11.8	12.6	35.5
36	37	35	36	17.2	18.2	37.5

Table(5.2): Te variation tes data
Tc=45 C

Condenser in (C°)	Condenser out (C°)	Evaporator in (C°)	Evaporator out (C°)	Discaharge pr. (bar)	Suction pr. (bar)	P1 (bar)	P2 (bar)	P3 (bar)	P4 (bar)	P5 (bar)	P6 (bar)
33	44	24	19	20	5.03	18.75	18.96	18.96	18.96	5.38	5.03
33	44	21	16.4	20	4.82	18.61	18.96	18.96	18.75	5.1	4.82
33	45	18.2	13.9	19.51	4.48	18.61	18.96	19.3	18.96	4.82	4.4

T1 (C°)	T2 (C°)	T3 (C°)	T4 (C°)	T5 (C°)	T6 (C°)	Comp. amp. (A)
40	41	39	40	19.3	20	40
40	42	39	40	17	18.1	41.5
40	41	39	39	13.4	14.9	40

Table(5.3): Tc variation test data
Te= 0 C

Condenser in (C°)	Condenser out (C°)	Evaporator in (C°)	Evaporator out (C°)	Discaharge pr. (bar)	Suction pr. (bar)	P1 (bar)	P2 (bar)	P3 (bar)	P4 (bar)	P5 (bar)	P6 (bar)
29	40	20	14.8	18.27	4.62	17.1	17.23	17.58	17.23	5.03	4.62
33	44	24	19	20	5.03	18.75	18.96	18.96	18.96	5.38	5.03
36	48	19.6	14.8	20.08	4.9	20	20.2	20.55	20.34	5.38	5.03

T1 (C°)	T2 (C°)	T3 (C°)	T4 (C°)	T5 (C°)	T6 (C°)	Comp. amp. (A)
36	38	35	36	17.4	18.2	38
40	41	39	40	19.3	20	40
43	45	43	43	17.4	18.7	42.4

Table(5.4): Tc variation test data
Te= -5 C

Condenser in (C°)	Condenser out (C°)	Evaporator in (C°)	Evaporator out (C°)	Discaharge pr. (bar)	Suction pr. (bar)	P1 (bar)	P2 (bar)	P3 (bar)	P4 (bar)	P5 (bar)	P6 (bar)
29	38	14.8	9.9	17.23	4.27	16.34	16.34	16.34	16.34	4.62	4.2
34	45	17.1	12.6	19.3	4.2	17.92	17.92	18.27	17.92	4.55	4.2
37	48	13.2	8.9	20.82	4.29	19.65	20	20.13	20	4.55	4.2

T1 (C°)	T2 (C°)	T3 (C°)	T4 (C°)	T5 (C°)	T6 (C°)	Comp. amp. (A)
36	36	36	36	14.6	15.5	36.8
40	41	39	39	11.8	13.5	38
43	44	42	42	10.8	12.6	39.2

Table(5.5): R22 Te variation test data

Tc= 39 C

Condenser in (C°)	Condenser out (C°)	Evaporator in (C°)	Evaporator out (C°)	P1 (bar)	P6 (bar)	T1 (C°)	T6 (C°)	Comp. amp. (A)
26	38	17.8	13.3	15.5	3.75	39	-7	34.4
26	39	16	11.2	15.5	4.2	39	10	35.2
26	38	15.3	20.4	15.5	4.5	39	18	36.1

Table (5.6): Te variation test results

Condensing temperature Tc=39 C							
Te (C)	Capacity (kw)	Refrigeration Effect (kj/kg)	Compression Work (kj/kg)	Mass Flow Rate (kg/s)	Heat Removal (kj/kg)	Compressor Current (A)	COP
-8.2	71.8	157	37	0.43	194	35.5	4.2
-5	76.5	165	35	0.455	200	36.8	4.58
-3.5	81.2	172	33	0.472	205	37.5	5.2

Condensing Temperature Tc=45 C							
Te (C)	Capacity (kw)	Refrigeration Effect (kj/kg)	Compression Work (kj/kg)	Mass Flow Rate (kg/s)	Heat Removal (kj/kg)	Compressor Current (A)	COP
-3	67	161	41	0.416	202	40	3.93
-1	71.8	169	38	0.42	207	41.5	4.5
1	78.1	171	36	0.46	210	43	4.75

Table (5.7): Tc variation test results

Evaporating temperature Te=0 C							
Tc (C)	Capacity (kw)	Refrigeration Effect (kj/kg)	Compression Work (kj/kg)	Mass Flow Rate (kg/s)	Heat Removal (kj/kg)	Compressor Current (A)	COP
40	81.2	171	32	0.48	203	3	5.34
47	78.1	166	34	0.47	200	40	4.88
50	75	163	36	0.46	199	42.4	4.53

Evaporating Temperature Te=-5 C							
Tc (C)	Capacity (kw)	Refrigeration Effect (kj/kg)	Compression Work (kj/kg)	Mass Flow Rate (kg/s)	Heat Removal (kj/kg)	Compressor Current (A)	COP
39	76.5	165	36	0.455	201	36.8	4.58
43	70.3	161	37	0.436	198	38	4.3
47	67	158	41	0.42	199	39.2	3.85

Table (5.8): Te variation comparison R407C, R22 test results

R407C

Condensing temperature Tc=39 C							
Te (C)	Capacity (kw)	Refrigeration Effect (kj/kg)	Compression Work (kj/kg)	Mass Flow Rate (kg/s)	Heat Removal (kj/kg)	Compressor Current (A)	COP
-8.2	71.8	157	37	0.43	194	35.5	4.2
-5	76.5	165	35	0.455	200	36.8	4.58
-3.5	81.2	172	33	0.472	205	37.5	5.2

R22

Condensing Temperature Tc=39 C							
Te (C)	Capacity (kw)	Refrigeration Effect (kj/kg)	Compression Work (kj/kg)	Mass Flow Rate (kg/s)	Heat Removal (kj/kg)	Compressor Current (A)	COP
-9	70.3	156	35	0.45	191	34.4	4.46
-5	75	164	32	0.46	196	35.2	5.13
-1	79.6	170	31	0.478	201	36.1	5.48

rate of (8 kJ/kg). This is expected since higher T_e values means large demand on cooling, and large values of enthalpy at higher T_e thus an increase in refrigeration effect. It can be said that the effect of the shape of saturation region results in decreasing the refrigeration effect with T_c increase.

- In the T_c variation test figure (6.2), the compression work decreases as the value of T_e increases at constant T_c value, while it increases as the value T_c increases at a rate of (7 kJ/kg), this is expected since at higher T_e the cooling demand is increased, which implies higher compressor work to satisfy the new needs in the load. The suction enthalpy will increase as T_e increases, which satisfies the decrease in compression work.

- In the T_e variation test figure (6.3), the COP increases as T_e increases, at constant T_c, this is expected since the enthalpy difference across the evaporator will increase, and the enthalpy difference across the compressor will decrease. While it decreases as T_c increases at a rate of (1-1.5), this is expected since the enthalpy difference across the evaporator and the increase in the enthalpy difference across the compressor.

- In the T_e variation test figure (6.4), the refrigeration capacity was calculated by using chilled water heat removal energy balance in the evaporator. It is noticed that for constant T_c, the refrigeration capacity increases with increasing T_e. Since refrigeration capacity equals to the mass flow rate multiplied by the enthalpy difference across the evaporator.

  Increasing T_e will cause both mass flow rate and the enthalpy difference to Be increased.

- In the T_e variation test figure (6.5), as the evaporating temperature increases at constant condensing temperature, the mass flow rate increases. This is expected since the mass flow rate is inversely proportional to the specific volume, as T_e increases, the specific volume decreases yielding to an increase in the mass flow rate.
  As T_c increases the mass flow rate decreases for the same T_e, that is due to the decrease in the specific volume at the exit of the compressor while the it remains constant at the compressor inlet.

- In the T_e variation test figure (6.6), as T_e increases at constant T_c the heat removal increases due to the increase in the refrigeration effect with the slight decrease in the compression work. As T_c increases at constant T_e, the heat removal will be decreased due to the decrease in the refrigeration effect with the slight increase in the compression work.

- In the T_c variation test figure (6.8), as T_c increases at constant T_e the refrigeration effect decreases because increasing T_c causes to an increase in the enthalpy of the refrigerant entering the evaporator while keeping the one leaving the evaporator constant. As T_e decreases the refrigeration effect decreases as illustrated in the T_e variation test.

- In the T_c variation test figure (6.9), as the condensing temperature increases at constant T_e, the compression work increases, since the discharge pressure (and though the discharge enthalpy) will increase while keeping the suction enthalpy constant. The increase of the condensing temperature yields to add another load on the condenser and therefore on the compressor, so the compression work is increased. From the same figure as T_e increases the compression work will increase as illustrated in the T_e variation test.

- In the T_c variation test figure (6.10), as T_c increases at constant T_e the COP decreases, since the enthalpy difference across the evaporator will decrease, and the enthalpy difference across the compressor will increases. As T_e decreases the COP decreases at a rate of (1-1.5) as illustrated in the T_e variation test.

- In the T_c variation test figure (6.11), as T_c increases at constant T_e the refrigeration capacity decreases. This is expected, since the increase in T_c will increase the saturated liquid enthalpy at that condensing temperature, causing the decrease in the enthalpy difference across the evaporator and the slight decrease in the mass flow rate. As T_e decreases the refrigeration capacity will be decreased as illustrated in the T_e variation test.

- In the T_c variation test, the refrigerant mass flow rate variation with the condensing temperatures for two values of evaporating temperatures are presented in figure (6-12). Increasing T_c at constant T_e, will decrease the mass flow rate, since the specific volume of the refrigerant at the compressor suction remains constant , while it decreases at the compressor discharge.

As T_e increases, the mass flow rate will be decreased as illustrated in the T_e variation test.

- In the T_c variation test figure (6.13), as T_c increases at constant T_e the heat removal decreases, since the refrigeration effect increases, with a slight decrease in the compression work.

As T_e increases at constant T_c the heat removal is increased due to the increase of the refrigeration effect.

6.2 Conclusions:

The performance curves for R407C and R22 are illustrated in figures, the following conclusions were deduced:

- From the experimental results of the performance evaporating temperature test, it has been found that the refrigeration effect for R407C has a slightly higher value than R22 figure (6.15). In contrast to the refrigeration effect, the coefficient of performance for R22 has a higher COP than R407C, and this is due to the increase of the compression work for R407C.

- From the previous tests, R407C has higher values of the heat removal, compression 'work and the refrigeration capacity than R22. The mass flow rate for R22 has a slightly higher value than that for R407C. This implies using larger condenser for R407C that is occurred in the suction accumulator heat exchanger.

- The presence of the temperature glide which has a rate of (5-6) °C, can be more or less pronounced, it is mainly dependent upon the boiling and the percentage proportions of the individual components.

  This affected the behavior of R407C with a small increase in temperature in the evaporation phase, and reduction during condensation.

- Refrigerant R407C has a lower discharge temperature and slightly higher discharge pressure than R22. Therefore minimal system modifications like adding a suction accumulator heat exchanger to the A/C machine to ensure full vapor phase entering the compressor.

- R407C is non-flammable, non toxic, and an accepted thermal and chemical stability refrigerant, it is considered a good alternative for R22 in high and medium temperature systems.

6.3 Recommendations:

- A chemical study has to be made to check the effect of heat on the composition of the mixture and their stability.

- An addition of a suction accumulator heat exchanger to ensure only vapor phase to be returned to the compressor. It is recommended to have a more study to remove this part and to find a way like enlarging the evaporator , to make it easier in the future for the retrofitting process from R22 to R407C, not to add any component to the existing system.

- Further study is to be conducted in the cases when a heat pump option is added to the chiller. The whole cycle is reversed when this option is added, the condenser is used as an evaporator and vise versa.

- More work to be done on calculating the properties of the mixture for a wide range of working and environmental conditions.

- More experimental studies are recommended to be conducted on different types of air-conditioning equipment like packages, condensing units and split units.

Figure (6.1): Refrigeration Effect Vs Te

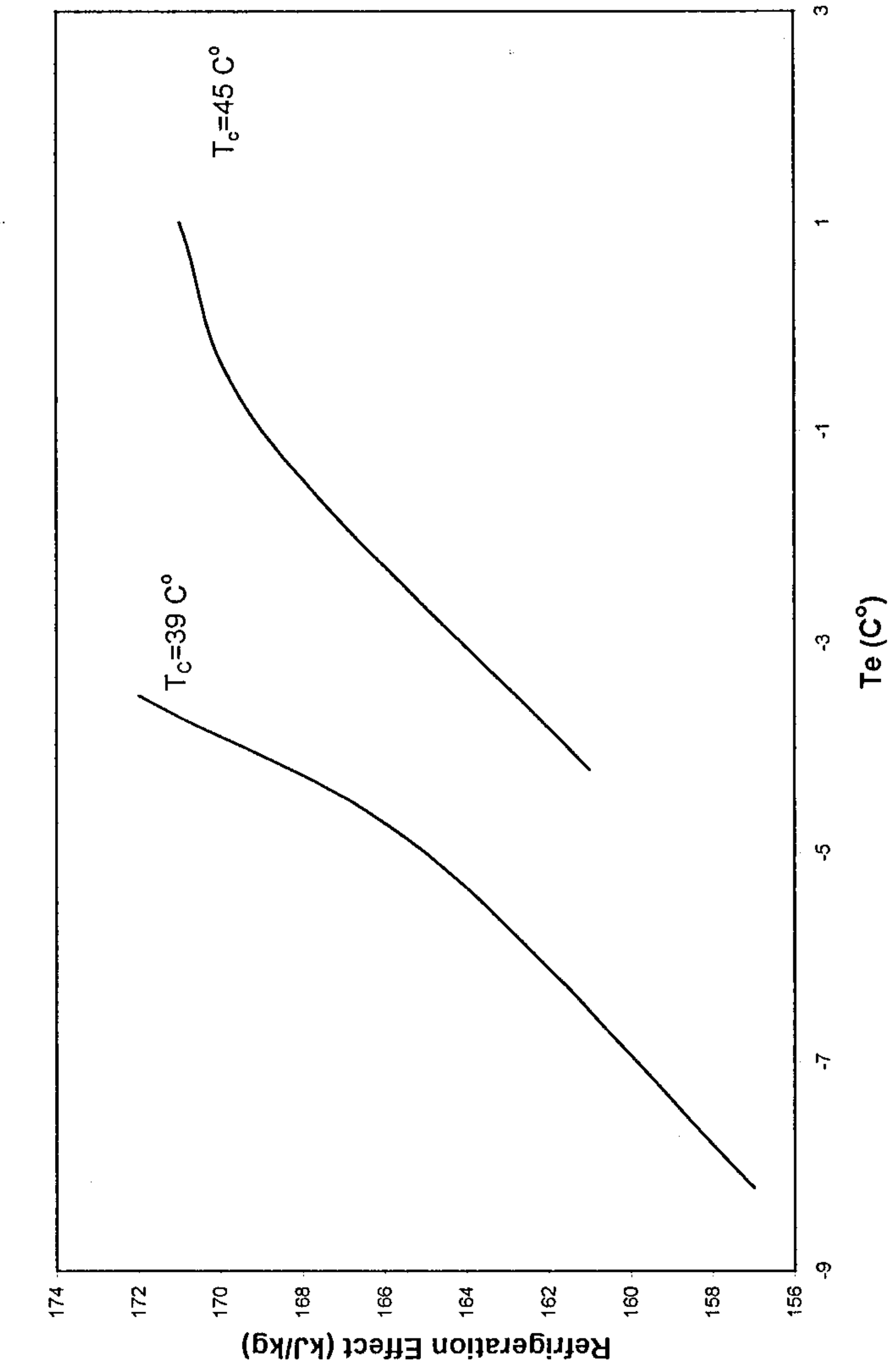


Figure (6.2): Compression Work Vs Te

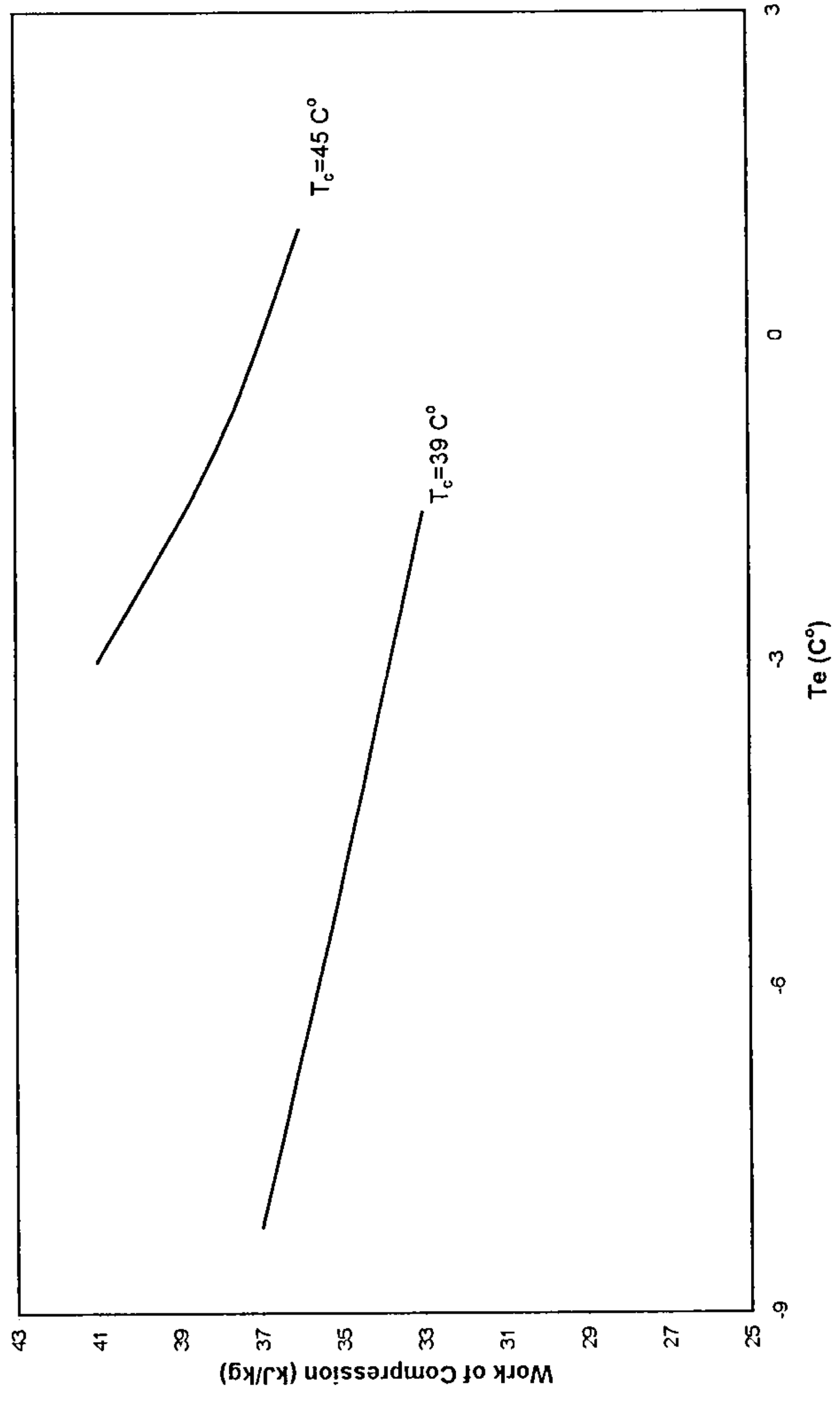


Figure (6.3): Coefficient of Performance Vs Te

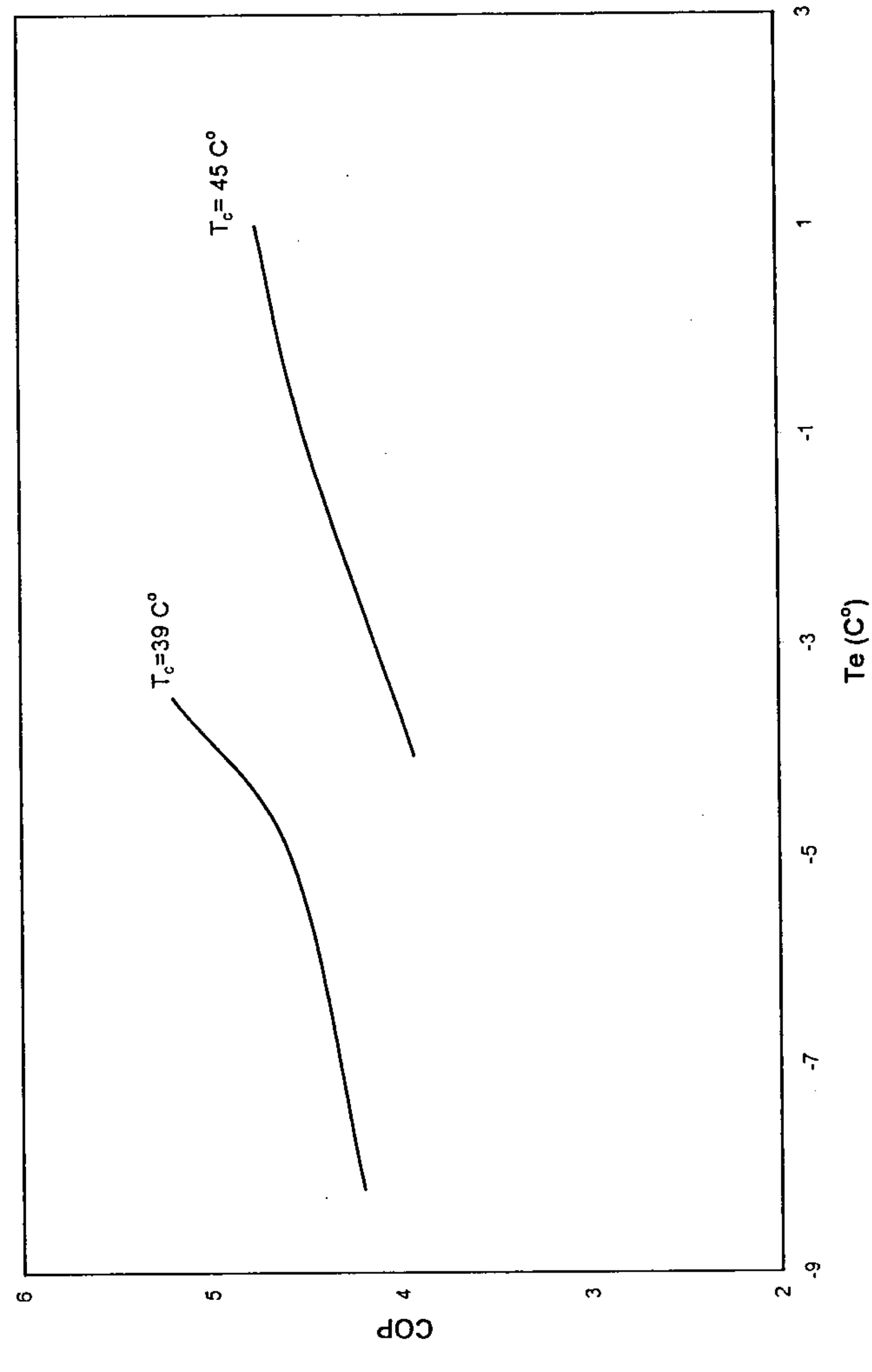


Figure (6.4): Refrigeration Capacity Vs Te

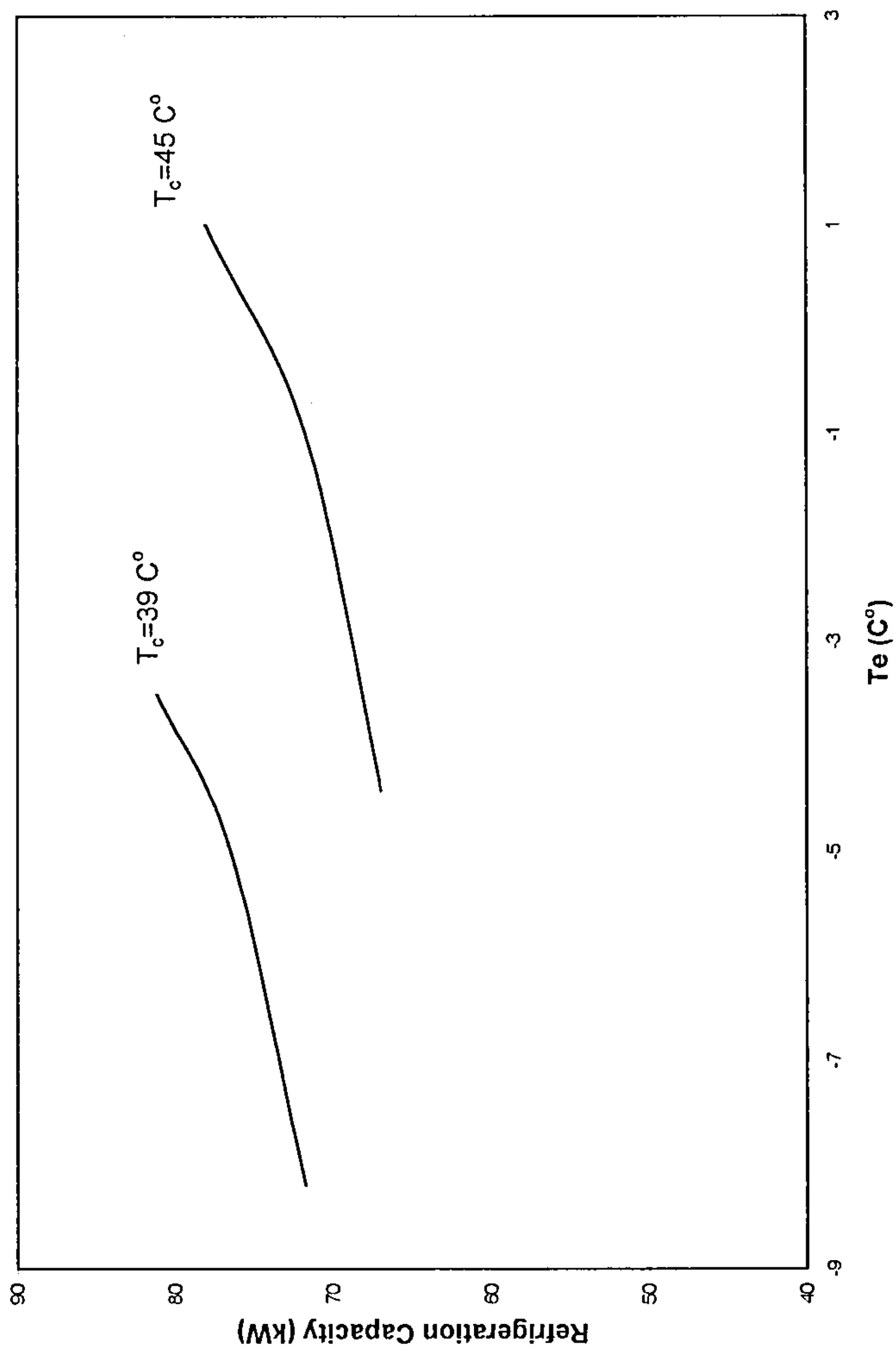


Figure (6.5): Mass Flow Rate Vs Te

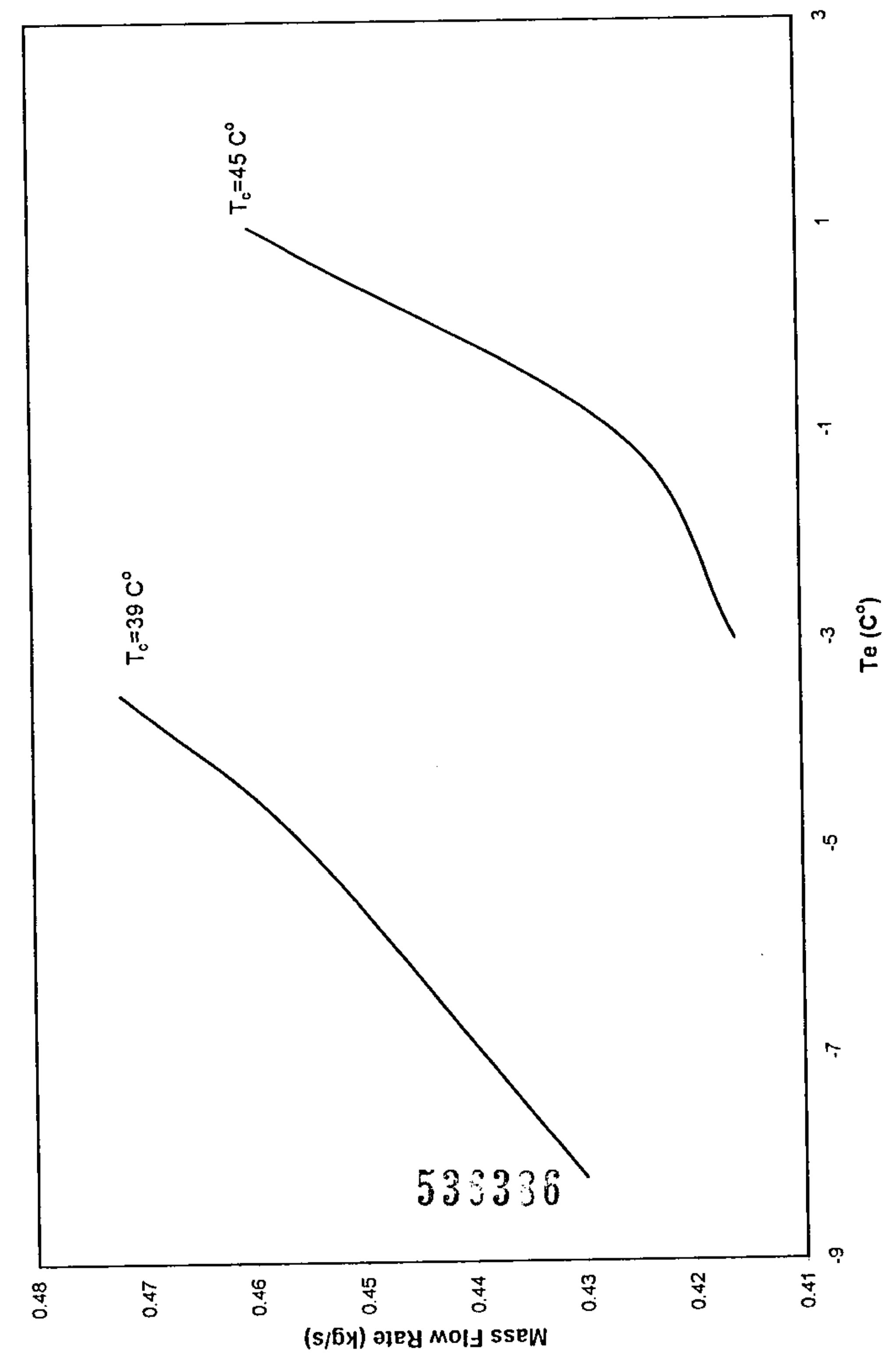
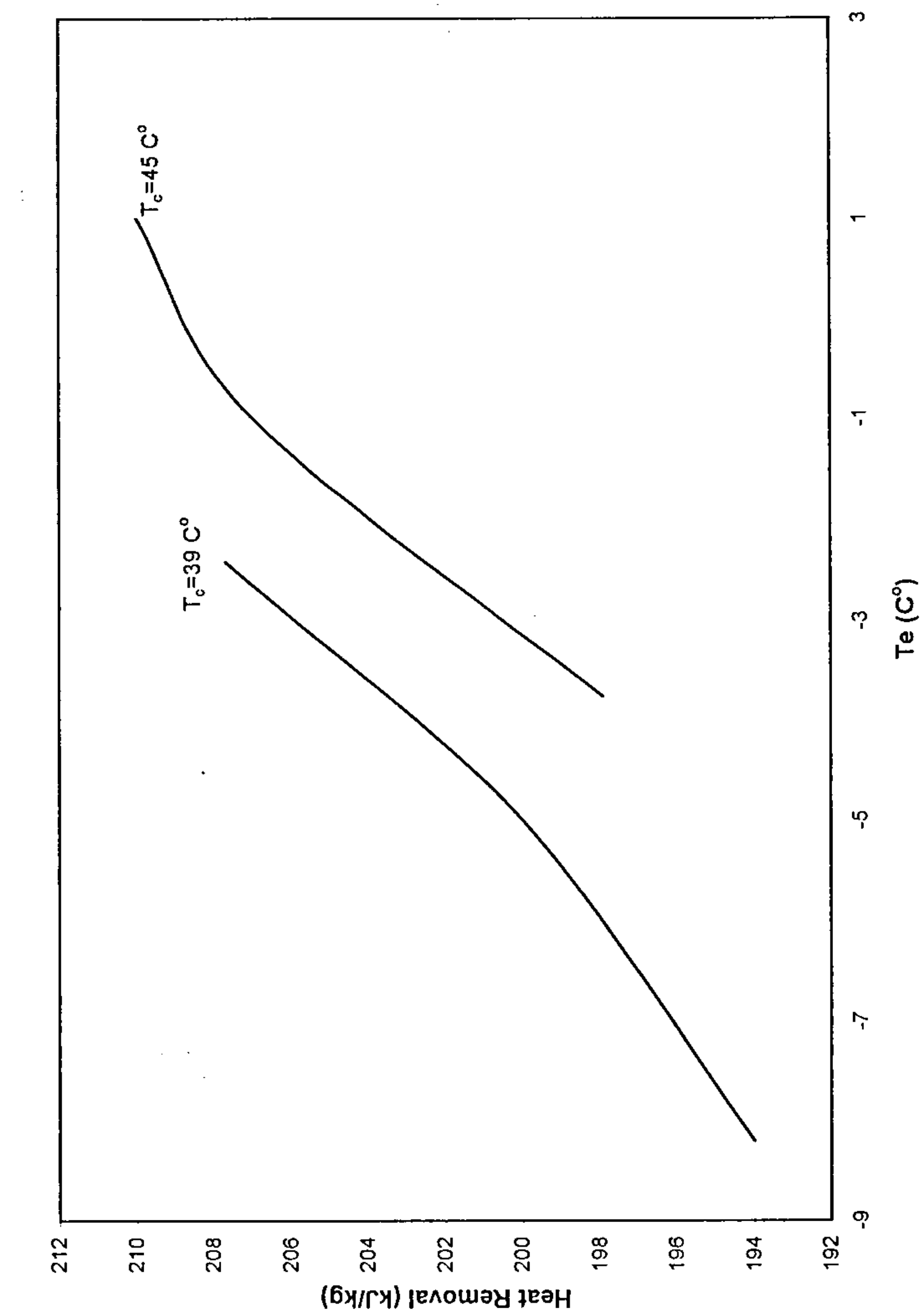


Figure (6.6): Heat Removal Vs Te



Figiure (6.7): Compressor Current Vs Te

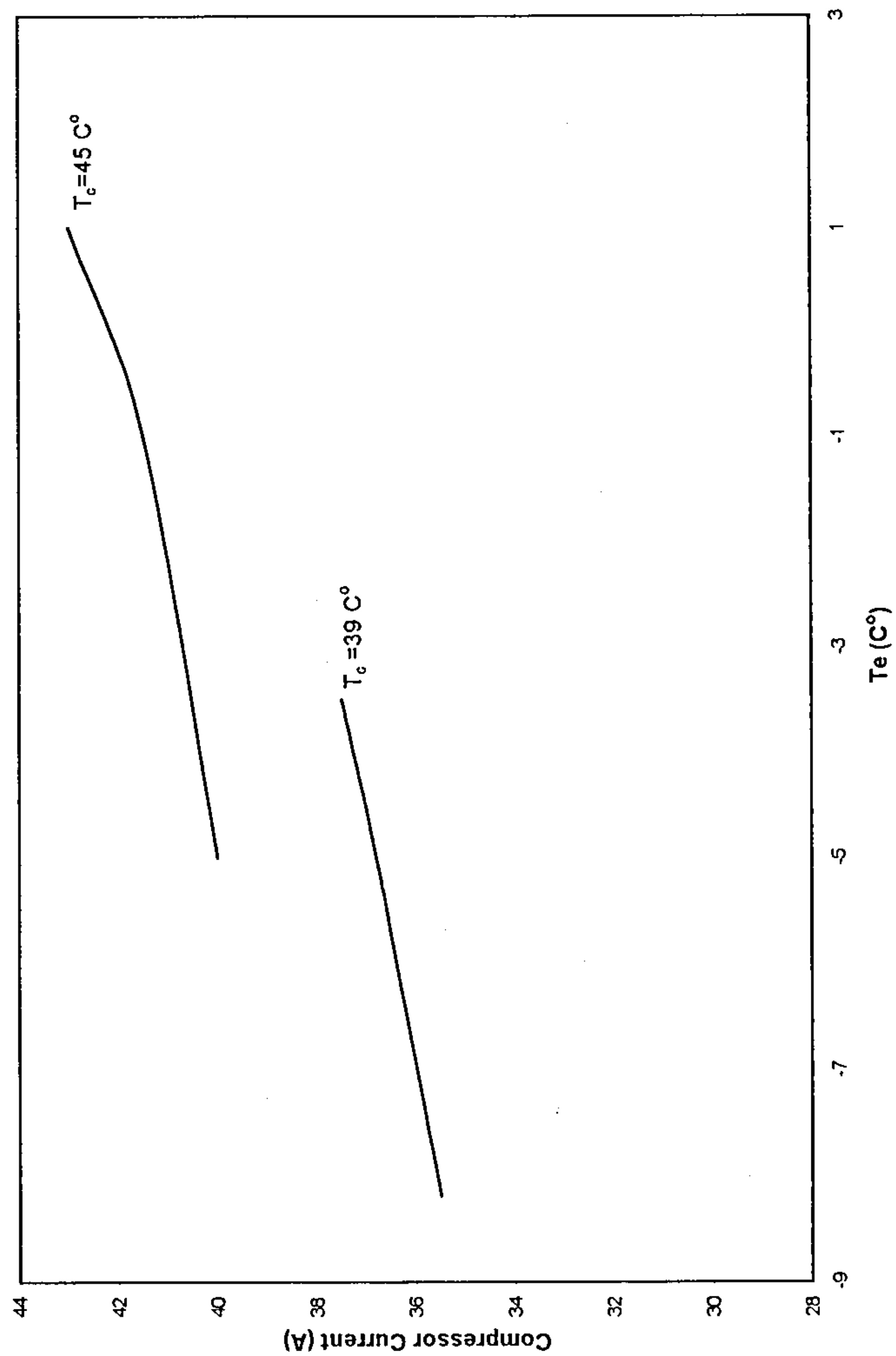


Figure (6.8): Refrigeration Effect Vs Tc

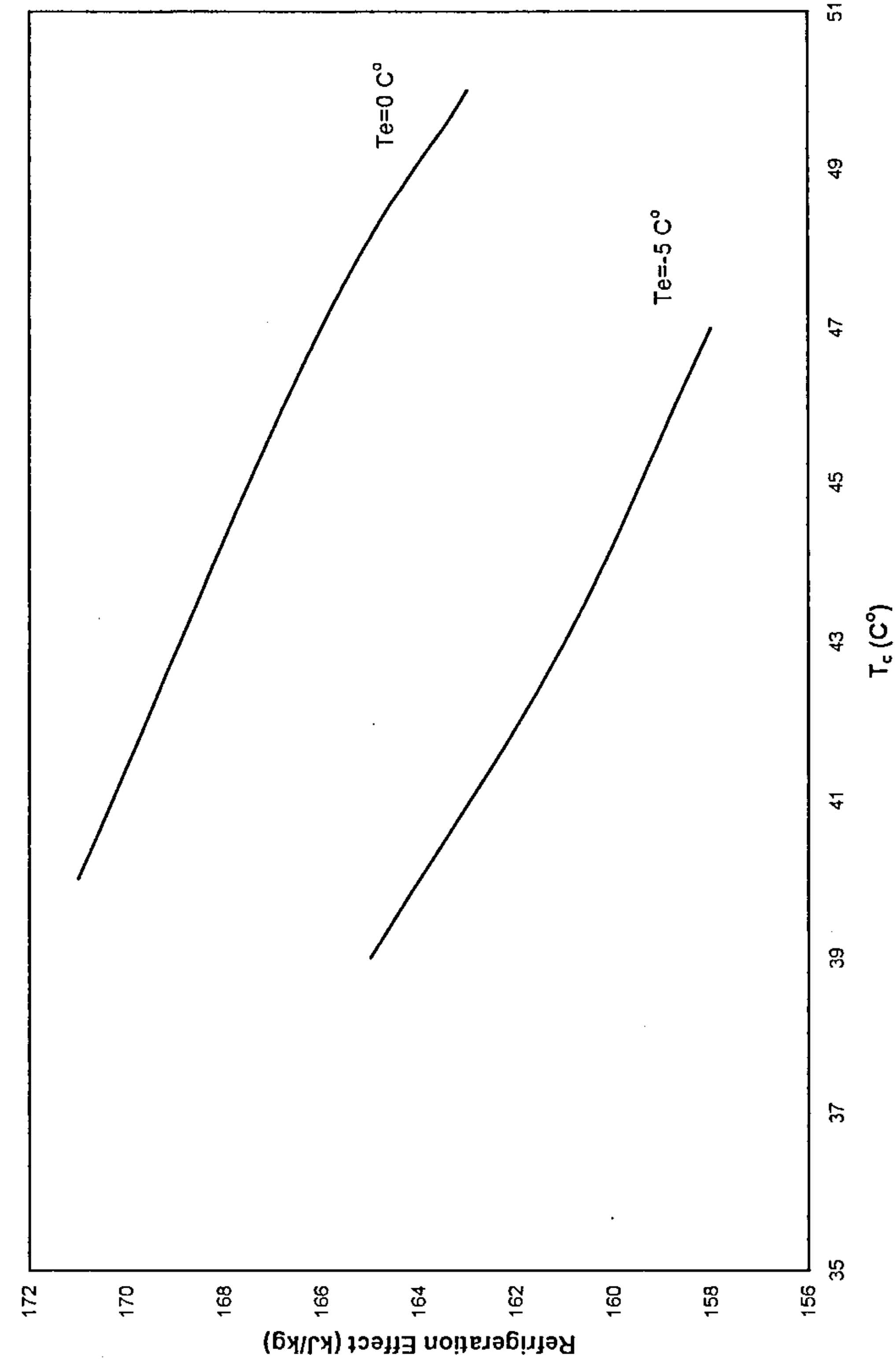


Figure (6.9): Compression Work Vs Tc

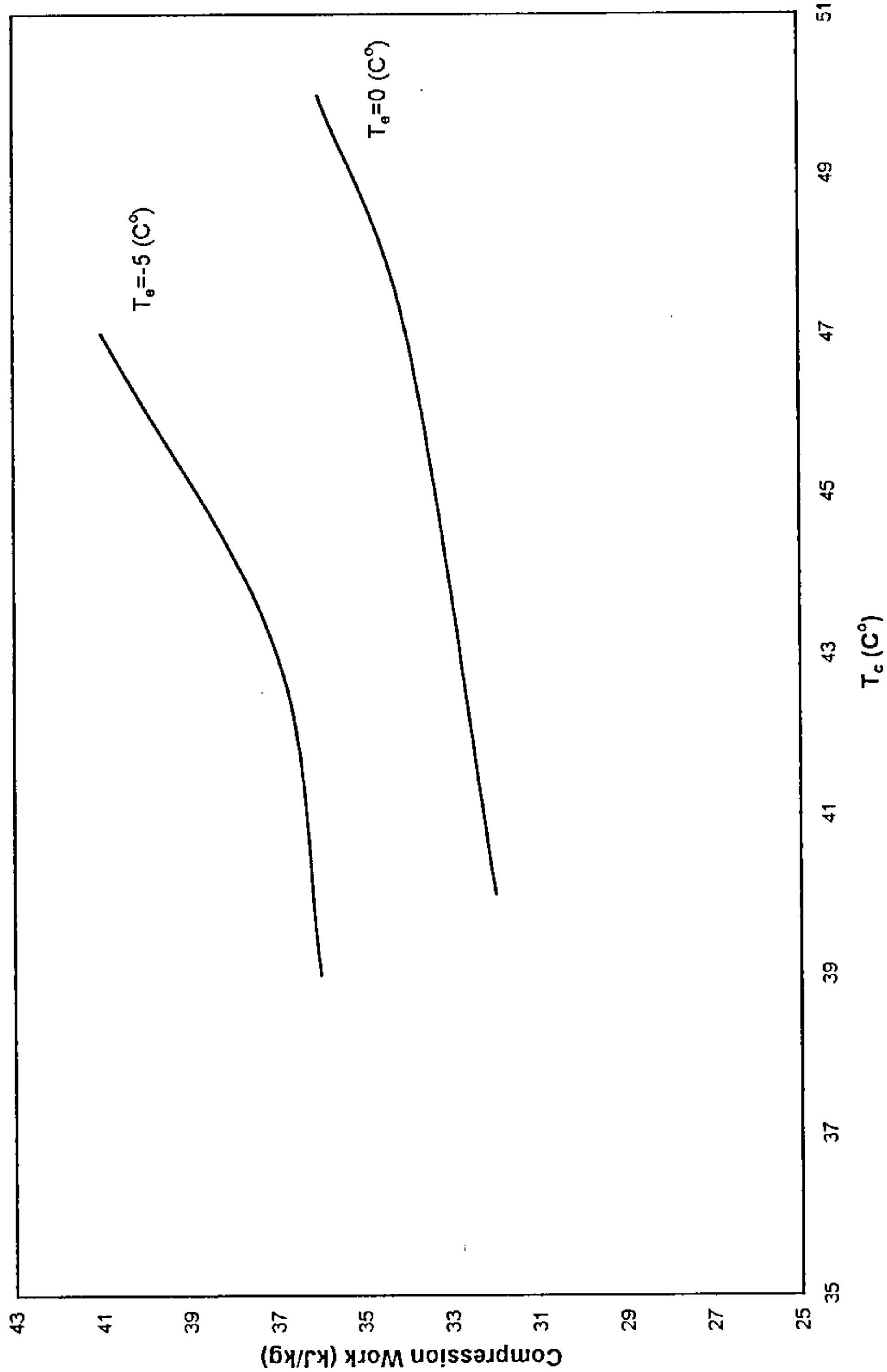


Figure (6.10): Coefficient of Performance Vs Tc

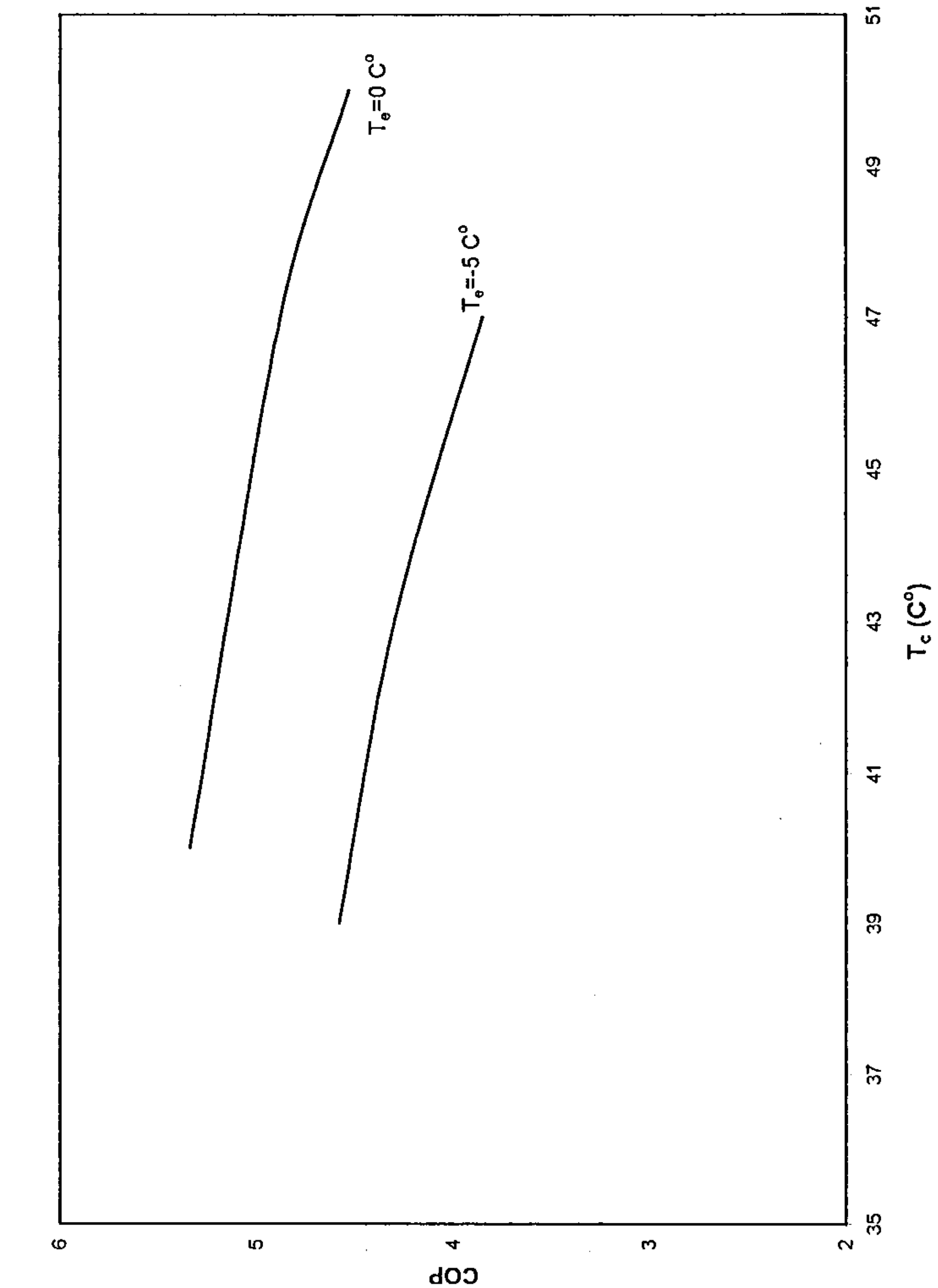
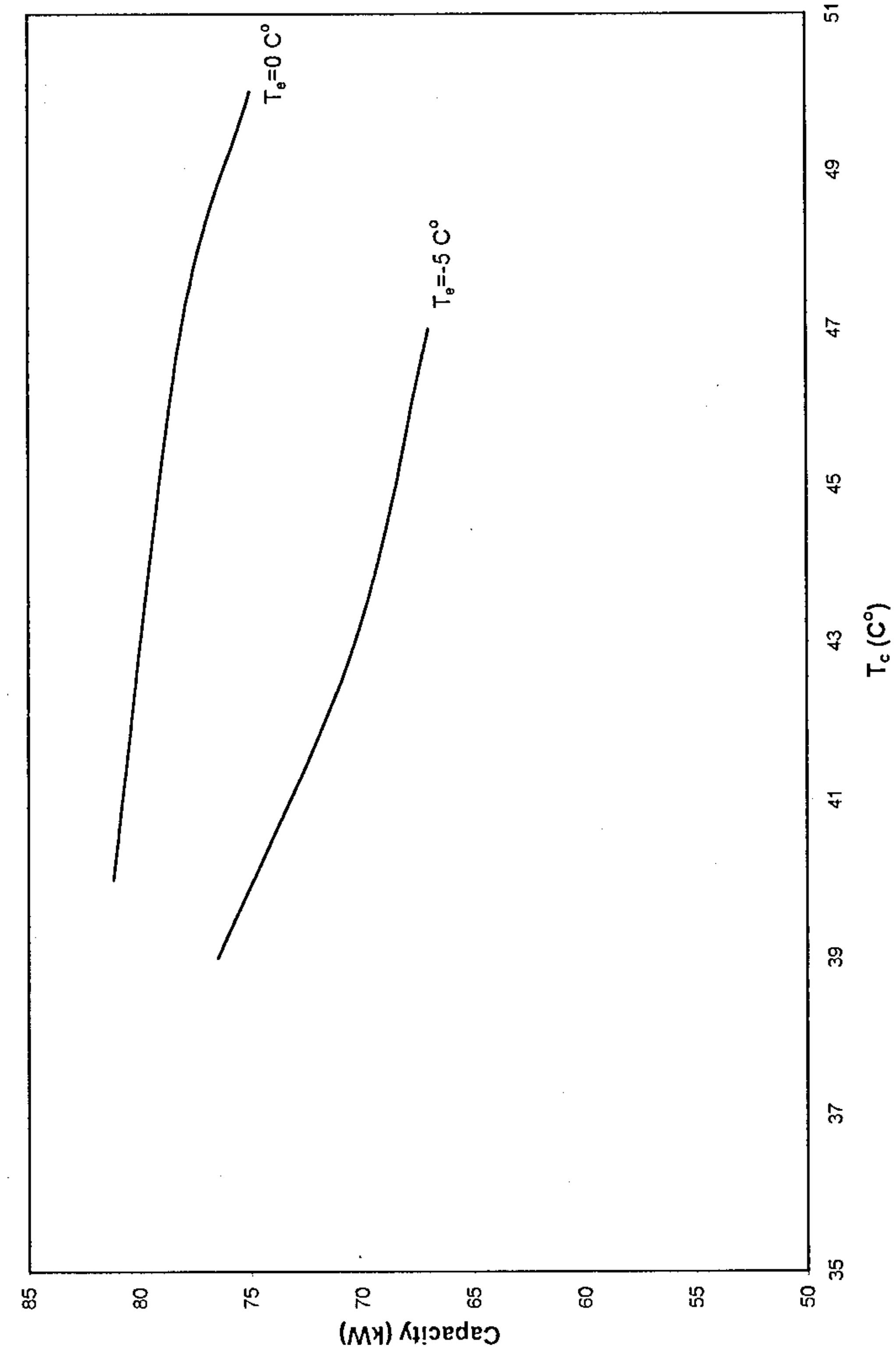


Figure (6.11): Refrigeration Capacity Vs Tc



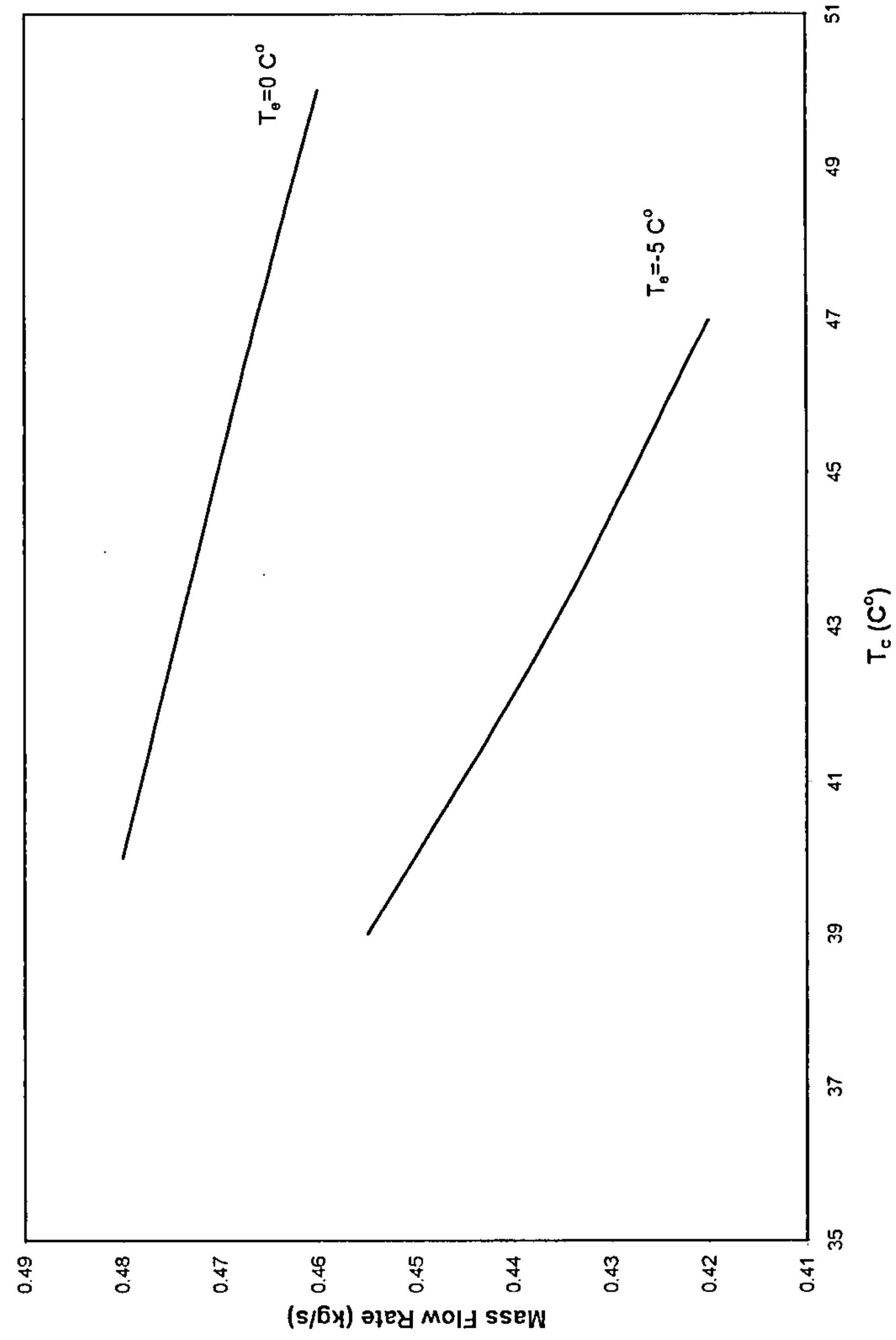


Figure (6.12): Mass Flow Rate Vs Tc

Figure (6.13): Heat Removal Vs Tc

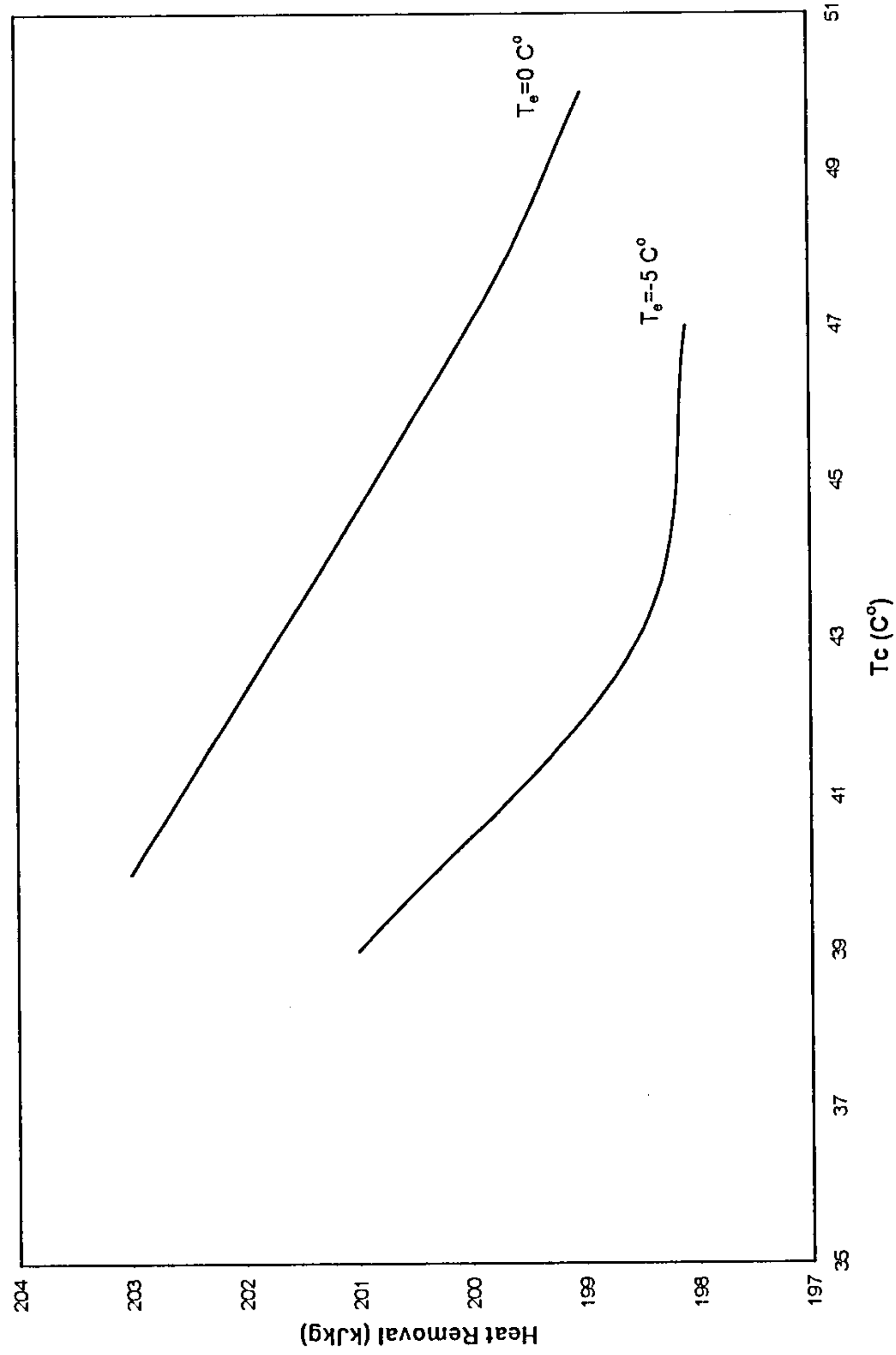
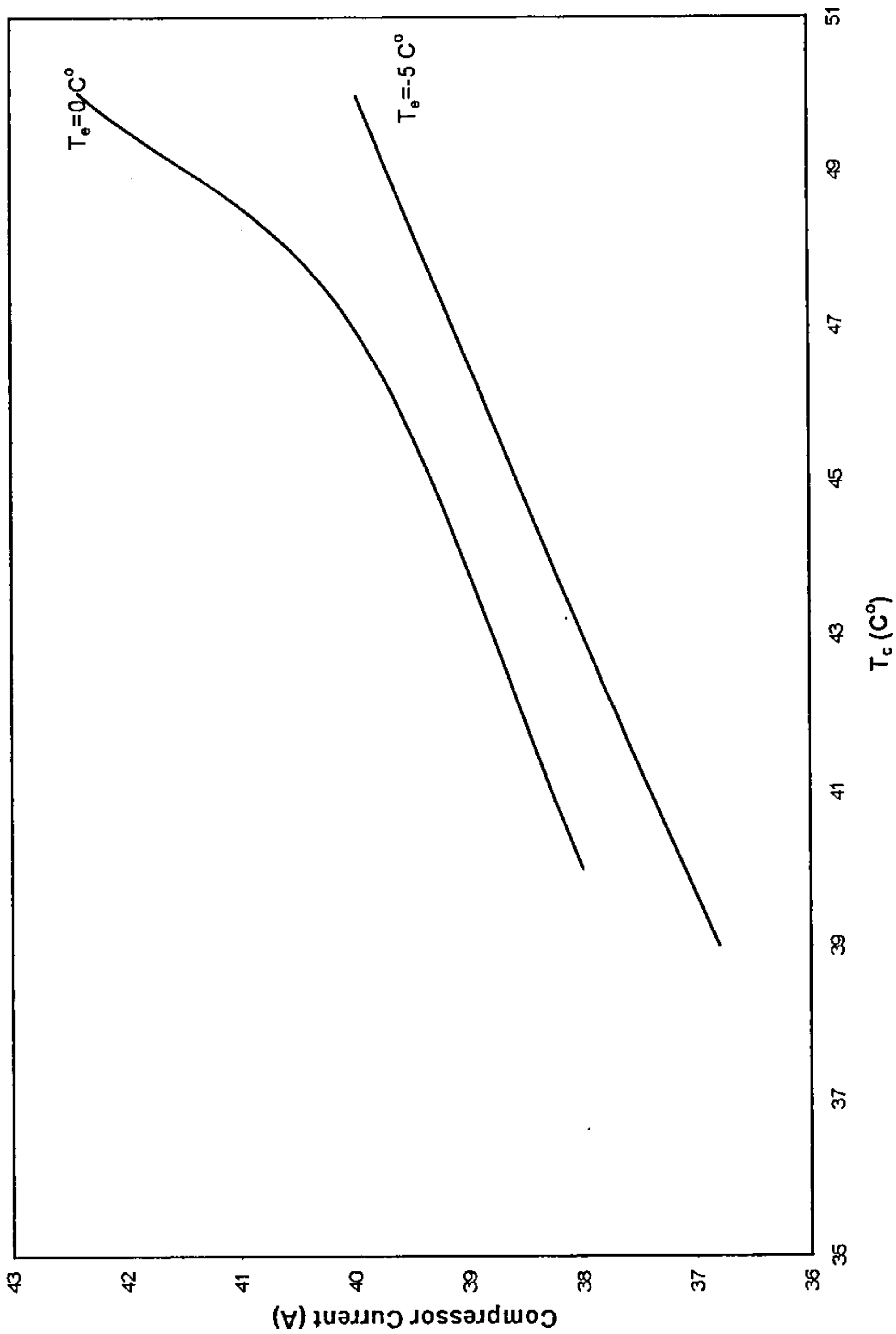


Figure (6.14): Compressor Current Vs Tc



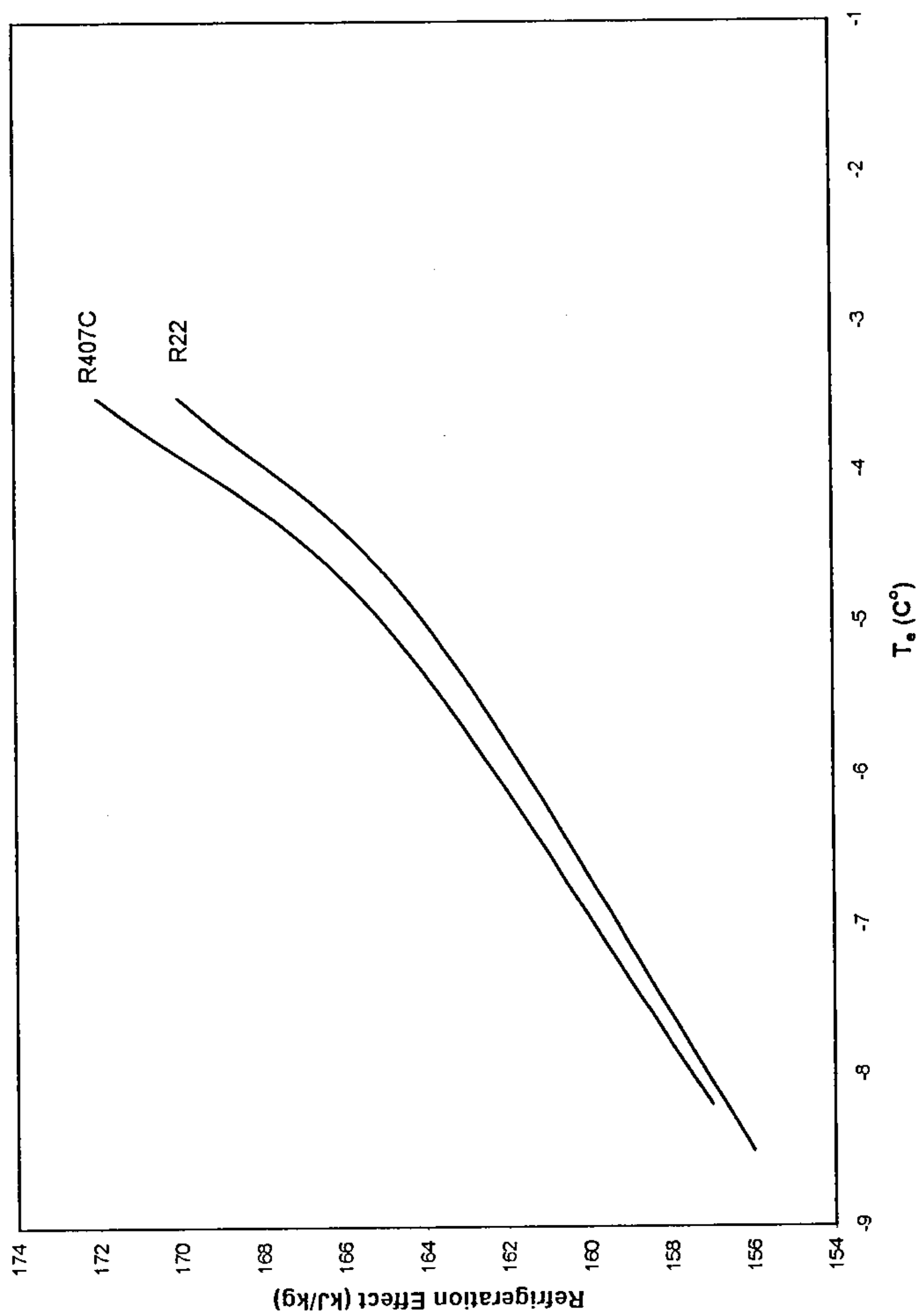


Figure (6.15): Refrigeration Effect Vs Te for R407C and R22

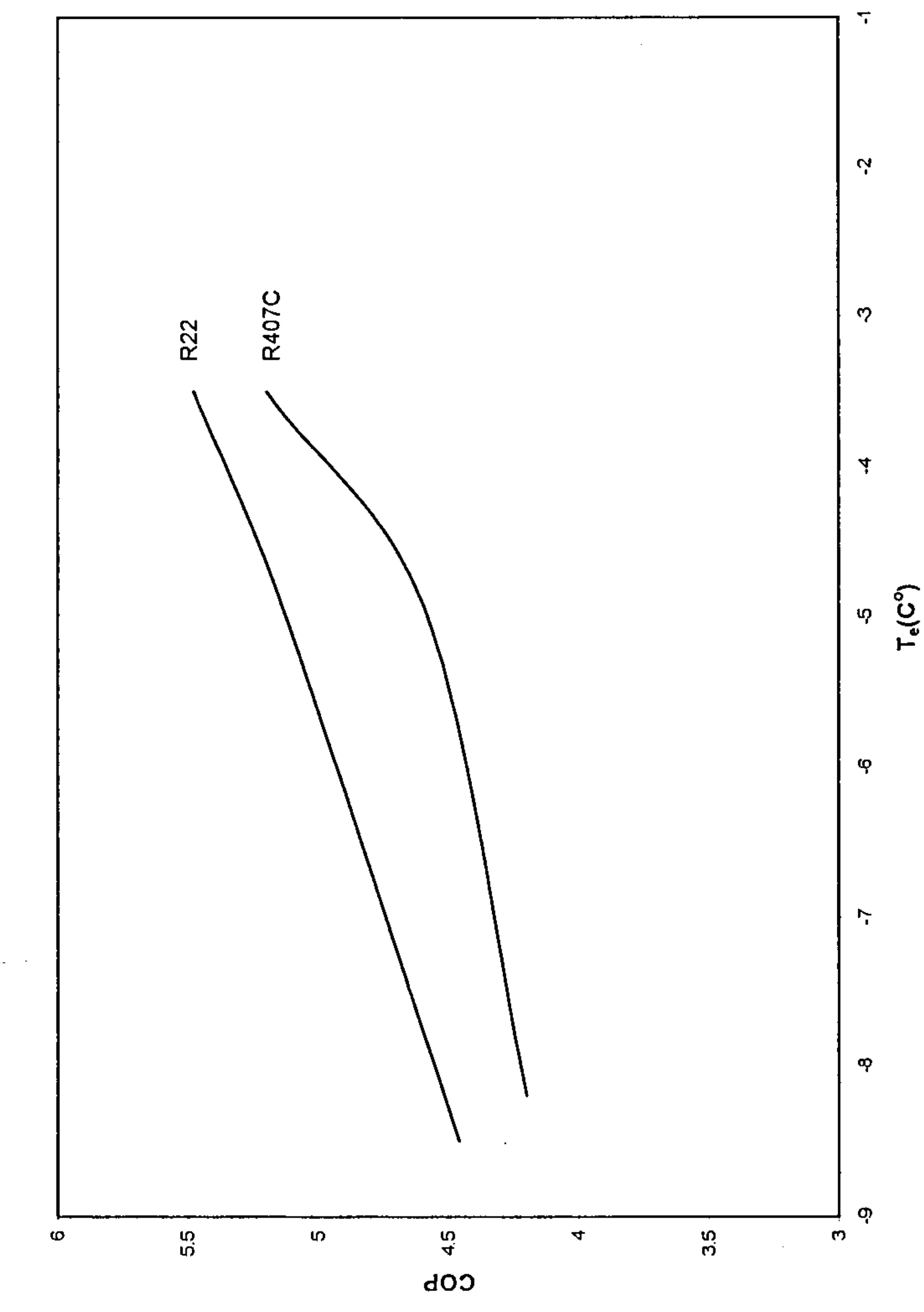


Figure (6.16): Coefficient of Performance Vs Te for R407C and R22

Figure (6.17): Heat Removal Vs Te for R407C and R22

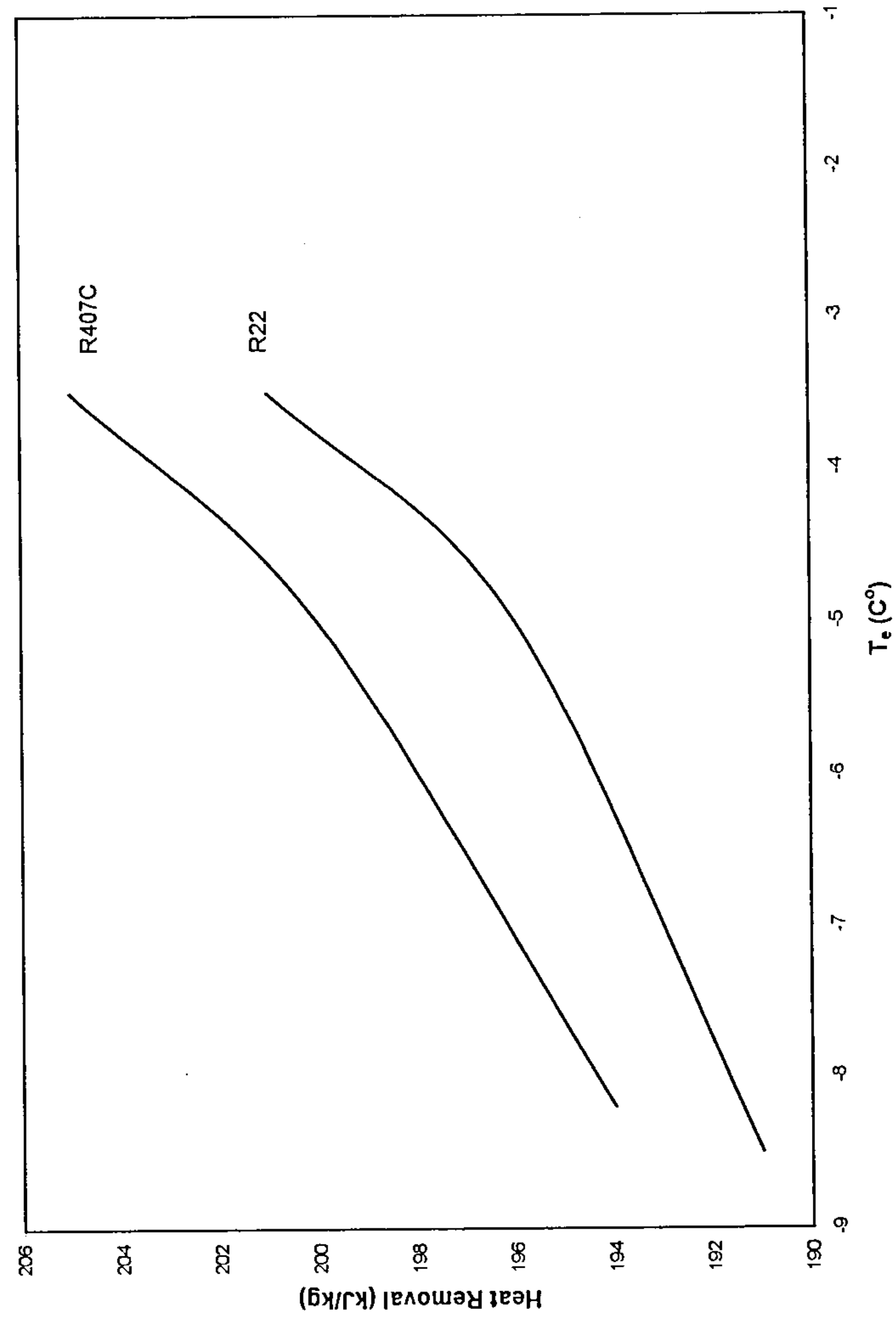
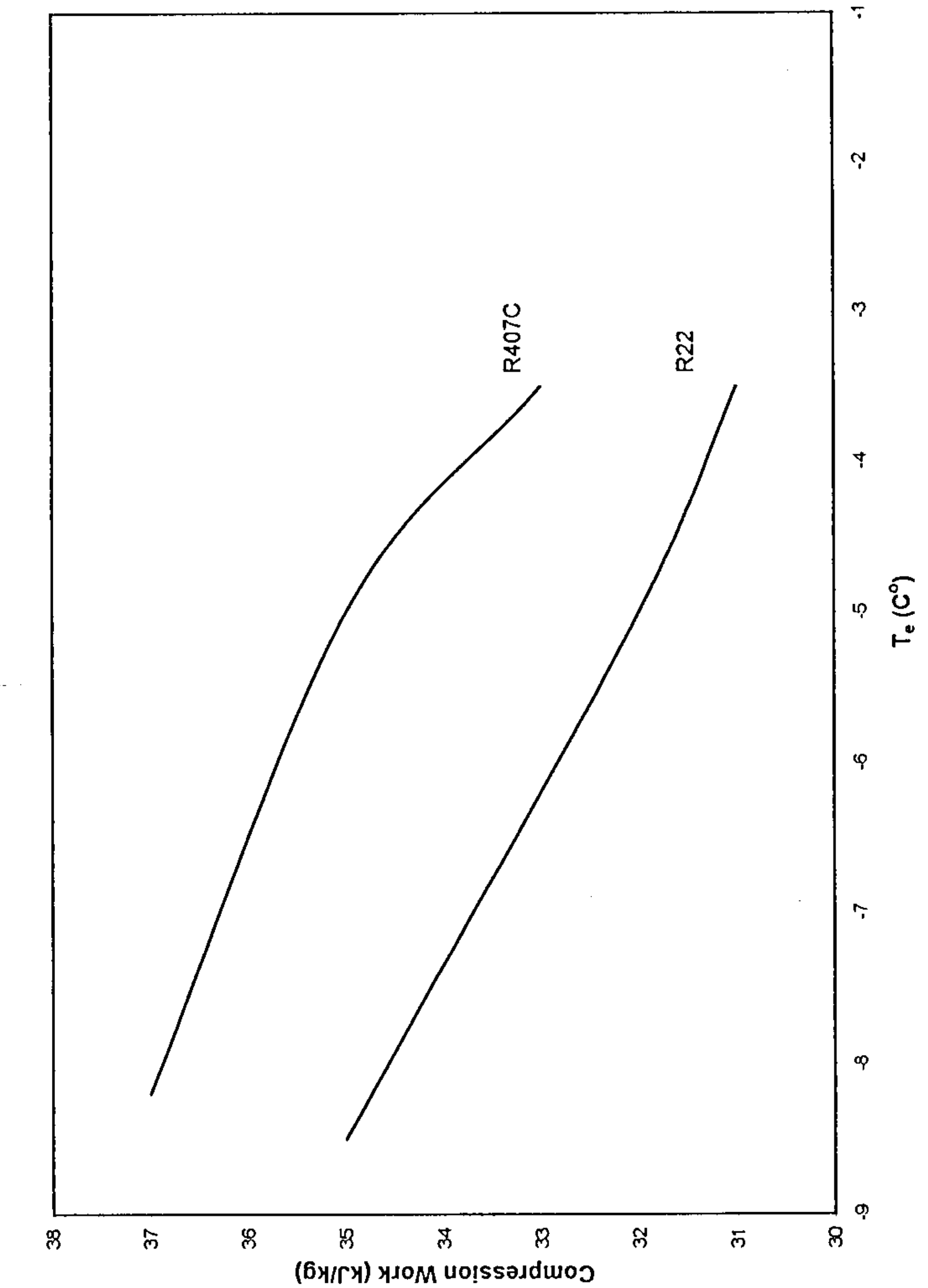
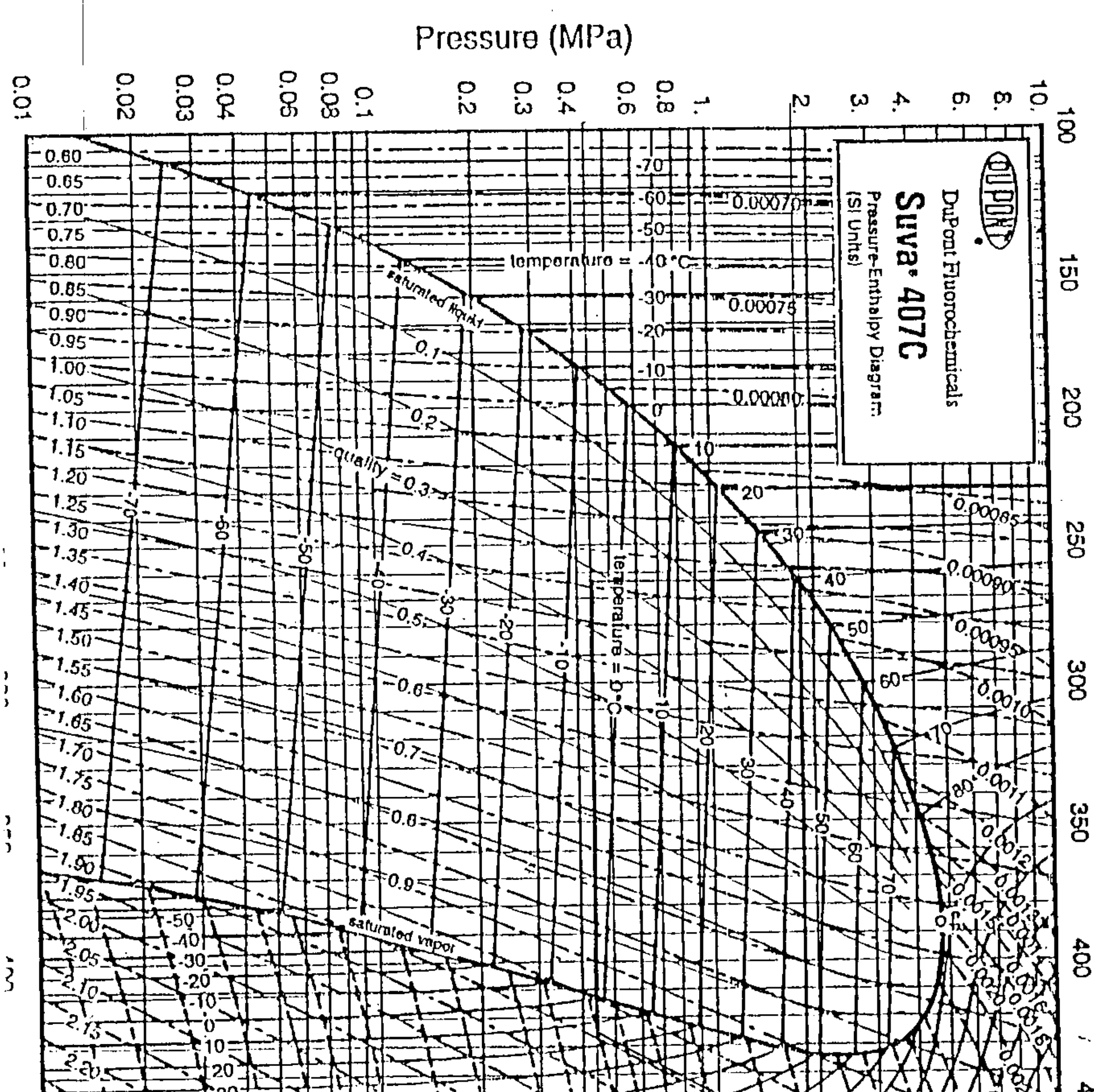
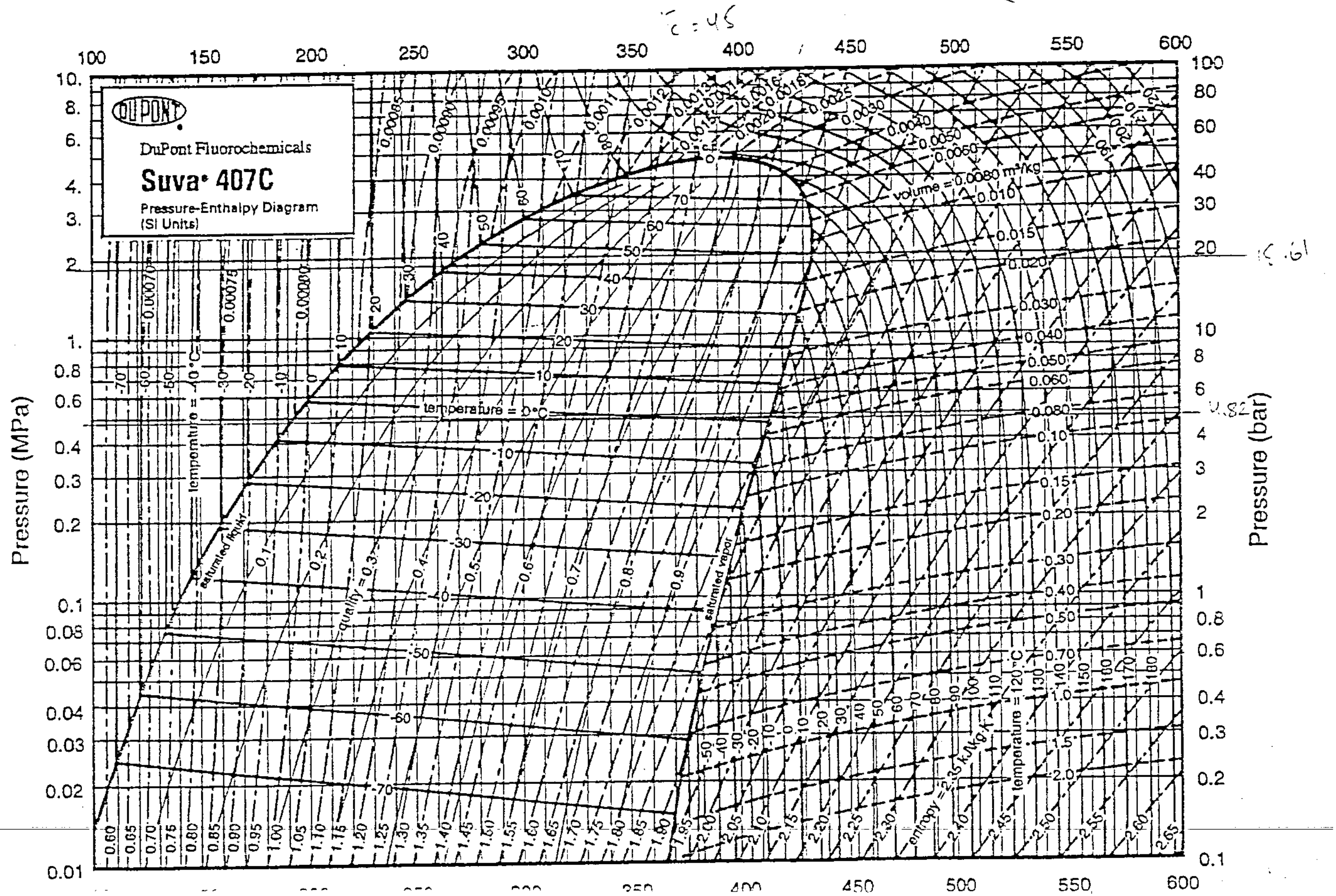
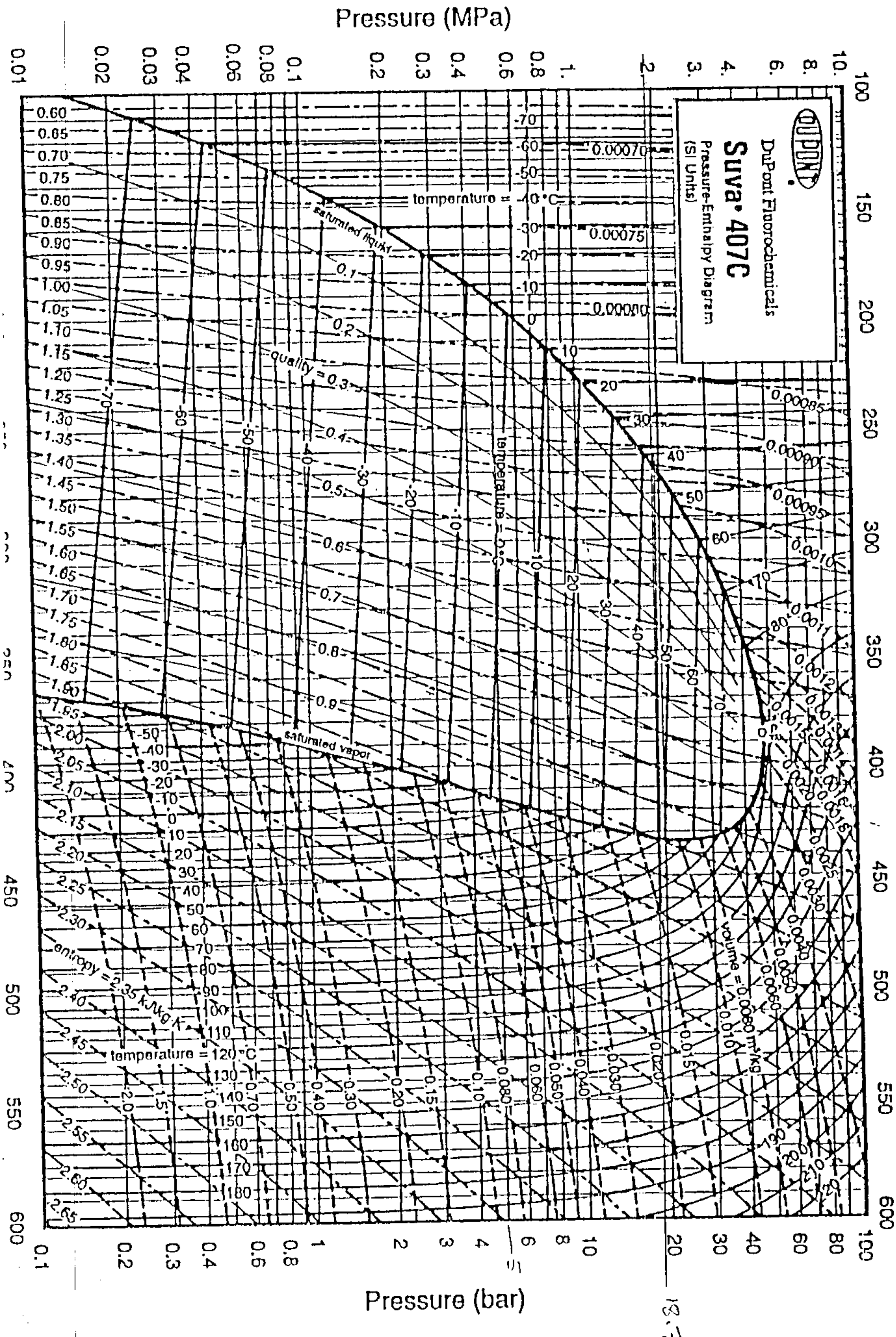


Figure (6.18): Compression Work Vs Te for R407C and R22

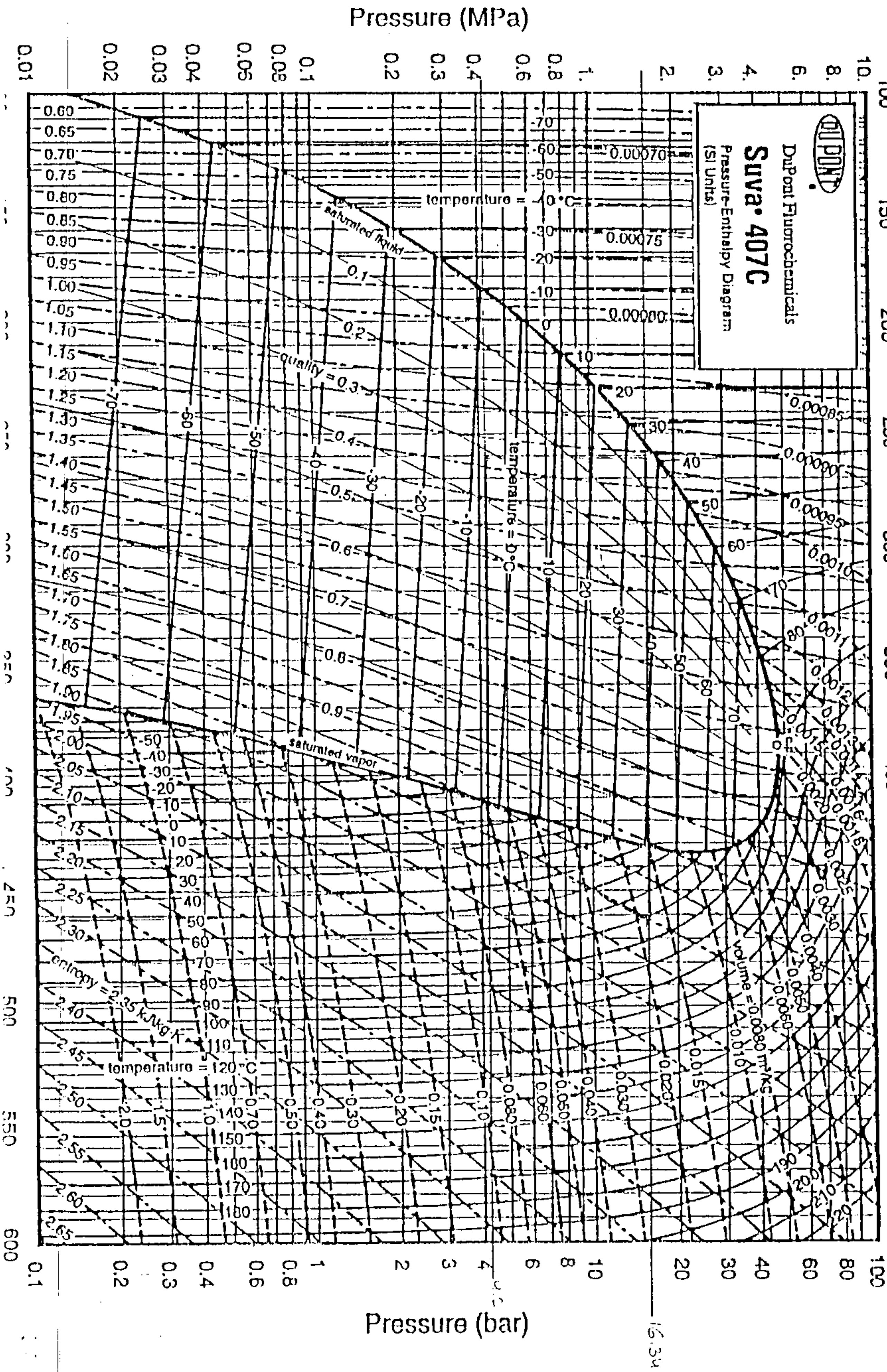



Pressure (MPa)
DuPont Fluorochemicals
Suva® 407C
Pressure-Enthalpy Diagram
(SI Units)
saturated liquid
saturated vapor
quality = 0.3
temperature = -40 °C
temperature = 0 °C
temperature = 120 °C
entropy = 2.35 kJ/kg K
volume = 0.0080 m³/kg
Pressure (bar)


DuPont Fluorochemicals
Suva® 407C
Pressure-Enthalpy Diagram
(SI Units)
Pressure (MPa)
Pressure (bar)
saturated liquid
saturated vapor
quality = 0.3
temperature = 0 °C
temperature = -40 °C
temperature = 120 °C
volume = 0.0080 m³/kg
entropy = 2.35 kJ/kg·K
T4 = 40
T6 = 18.1
Tc = 45
(Te variation test)
19.61
4.82

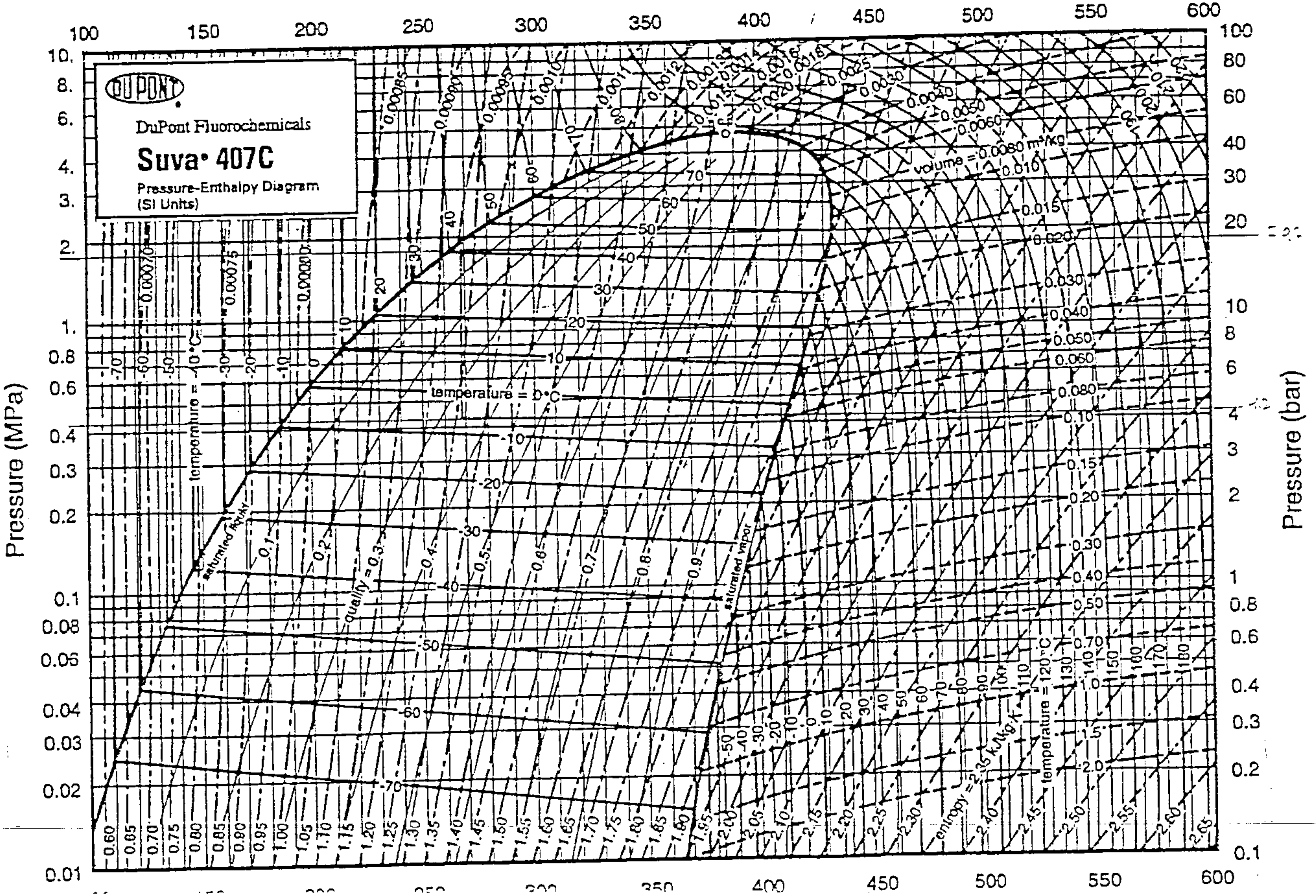


Pressure (MPa)
DuPont Fluorochemicals
Suva® 407C
Pressure-Enthalpy Diagram
(SI Units)
saturated liquid
saturated vapor
quality = 0.3
temperature = -40°C
temperature = 0°C
temperature = 120°C
entropy = 2.35 kJ/kg·K
volume = 0.0080 m³/kg
Pressure (bar)

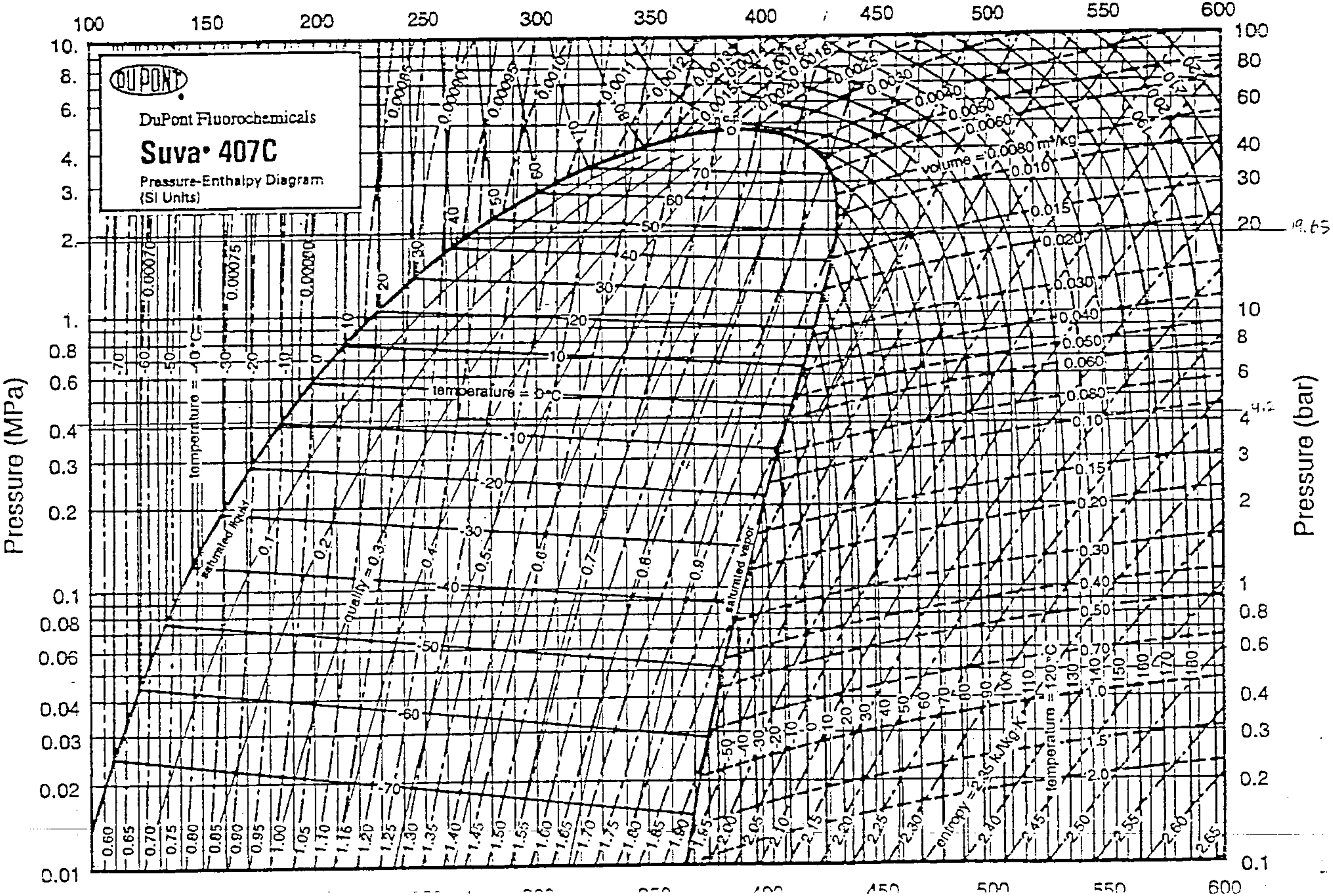


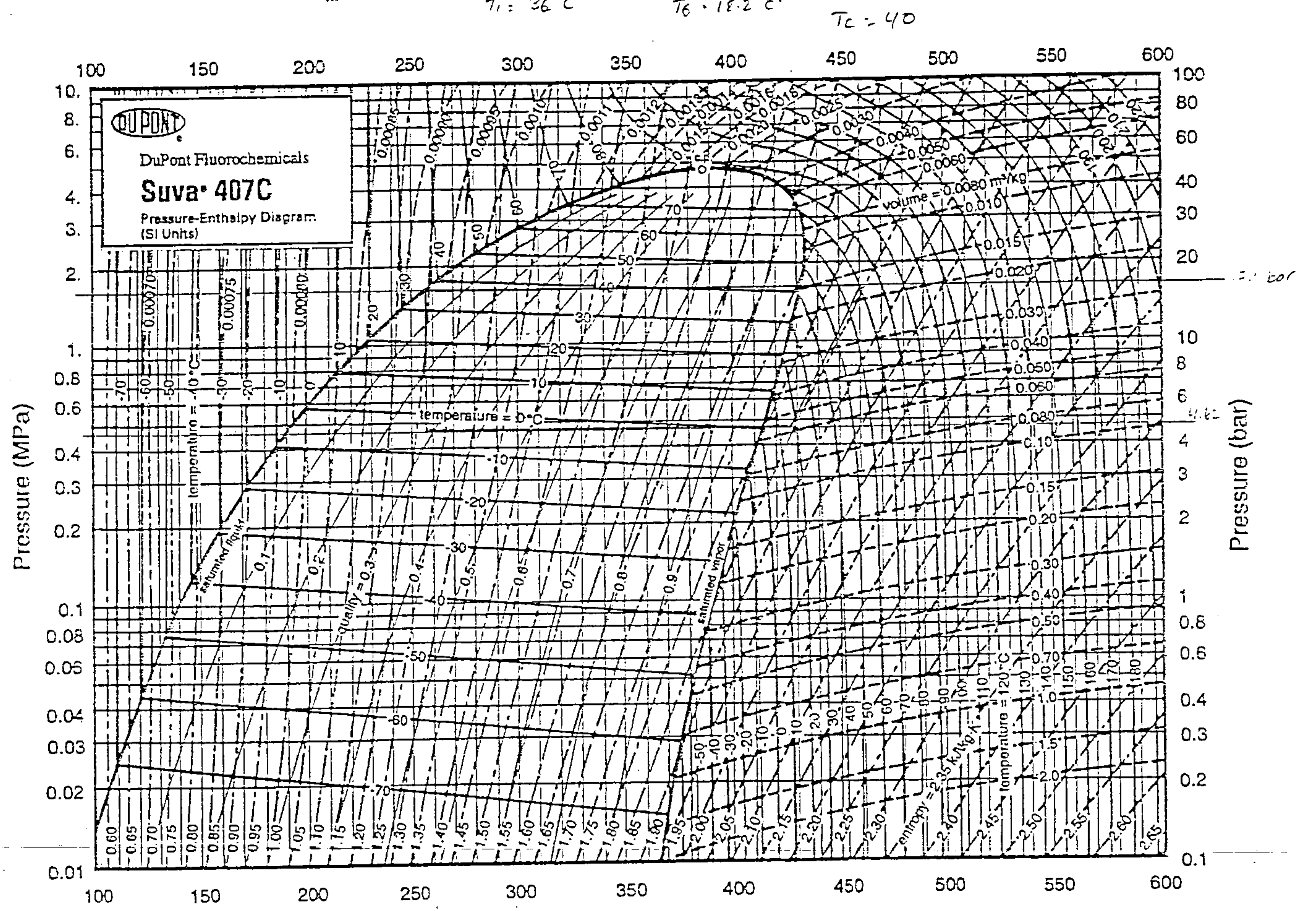
Pressure (MPa)
DuPont Fluorochemicals
Suva® 407C
Pressure-Enthalpy Diagram
(SI Units)
saturated liquid
saturated vapor
temperature = 0 °C
temperature = 120 °C
quality = 0.3
entropy = 2.35 kJ/kg·K
volume = 0.0080 m³/kg
Pressure (bar)

T_{cond} : 34C° T_1 = 40 T_c : 43 C° T_e = −5 C°

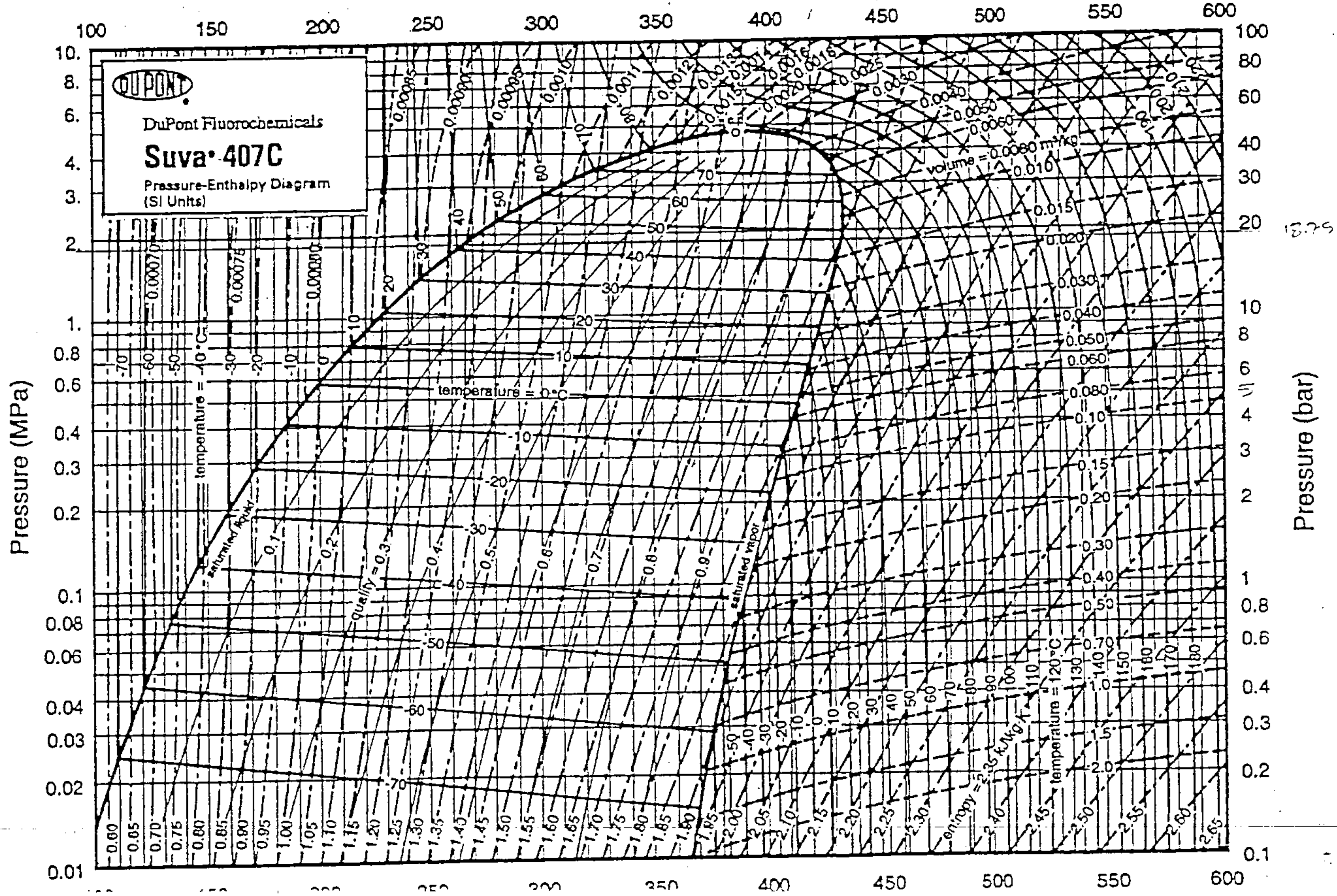


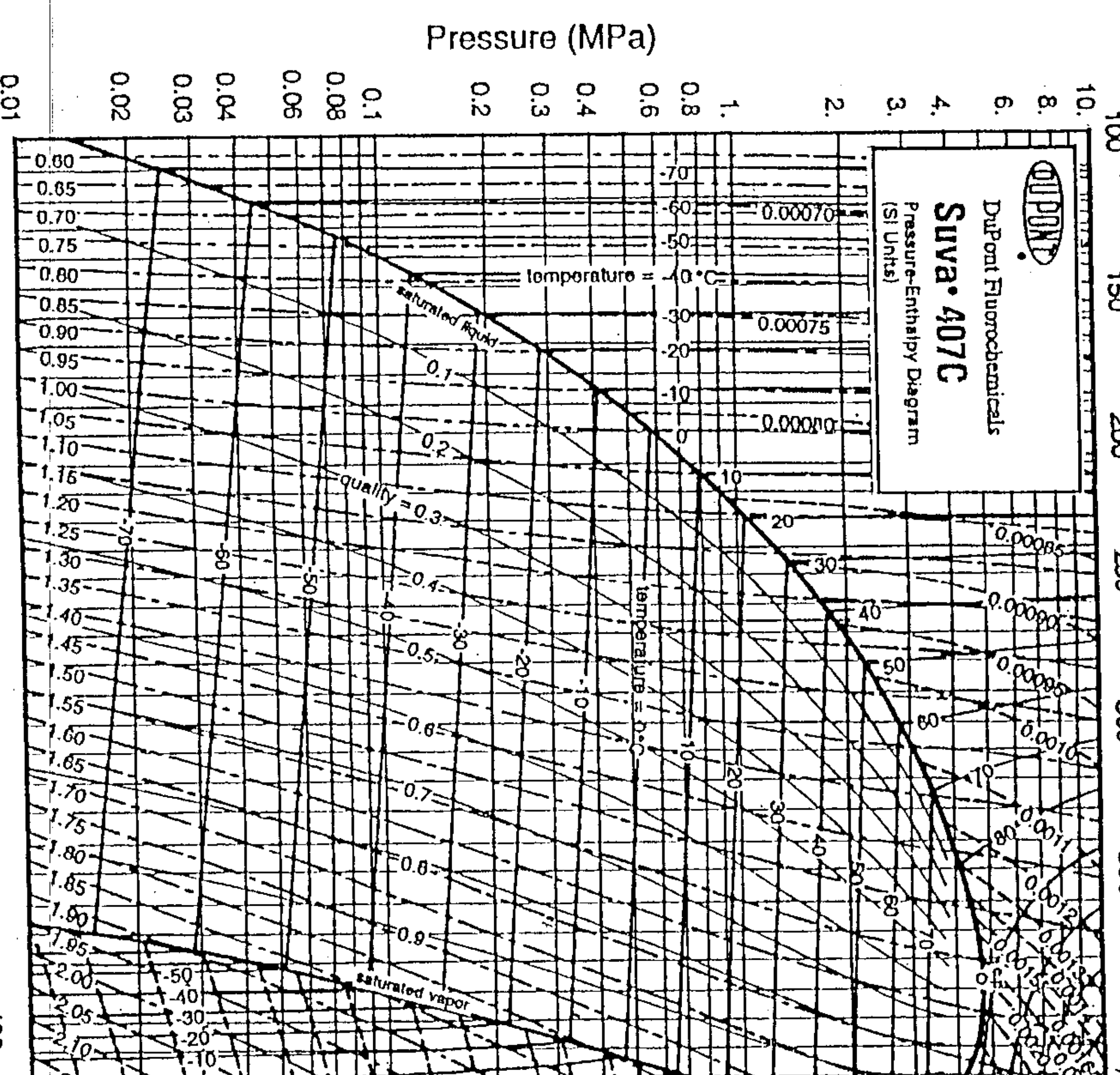
Tcond in = 37   T1 = 43   ⇒ Tc = 47C°   Tc = -5C   Tc Variation Test

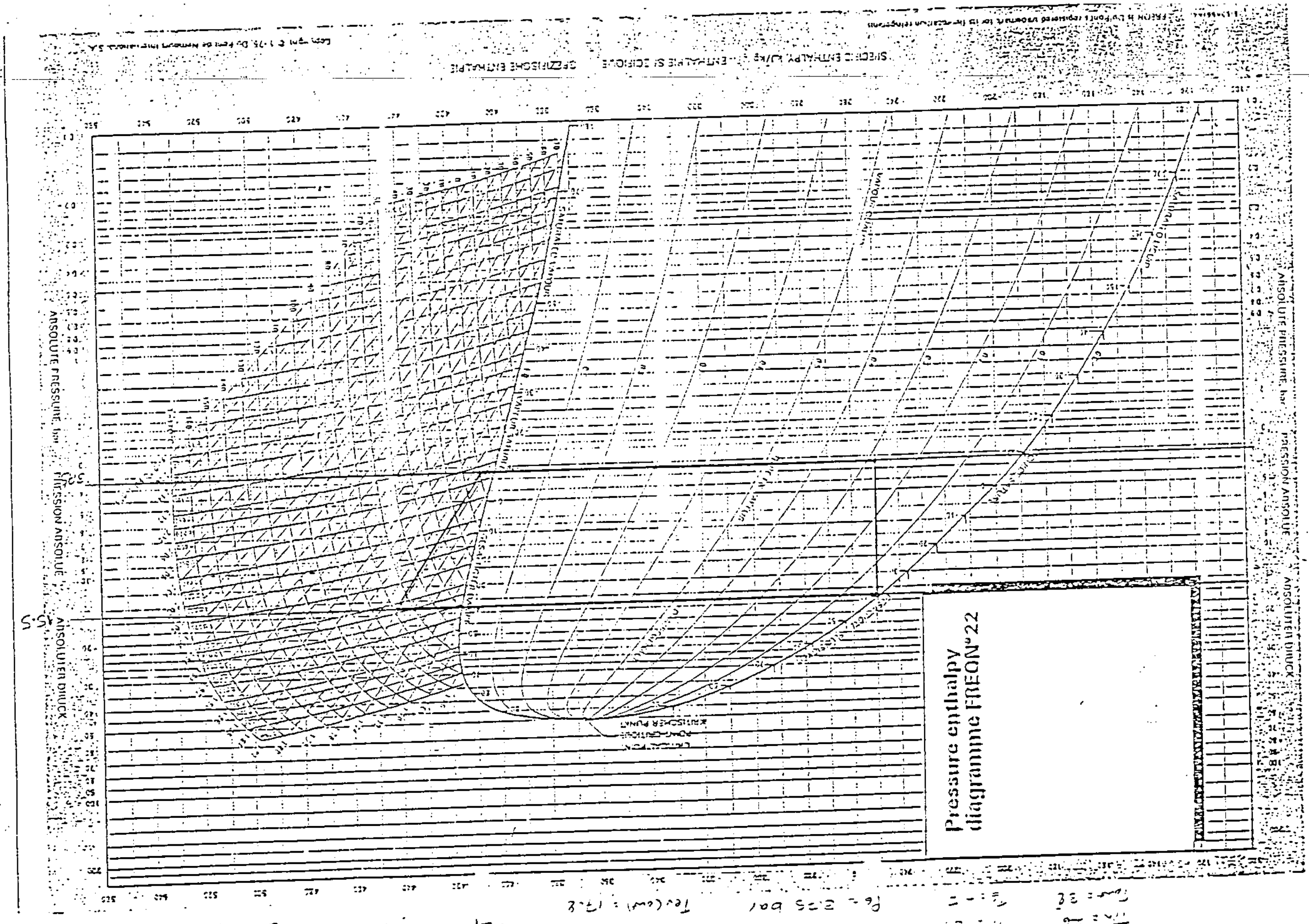


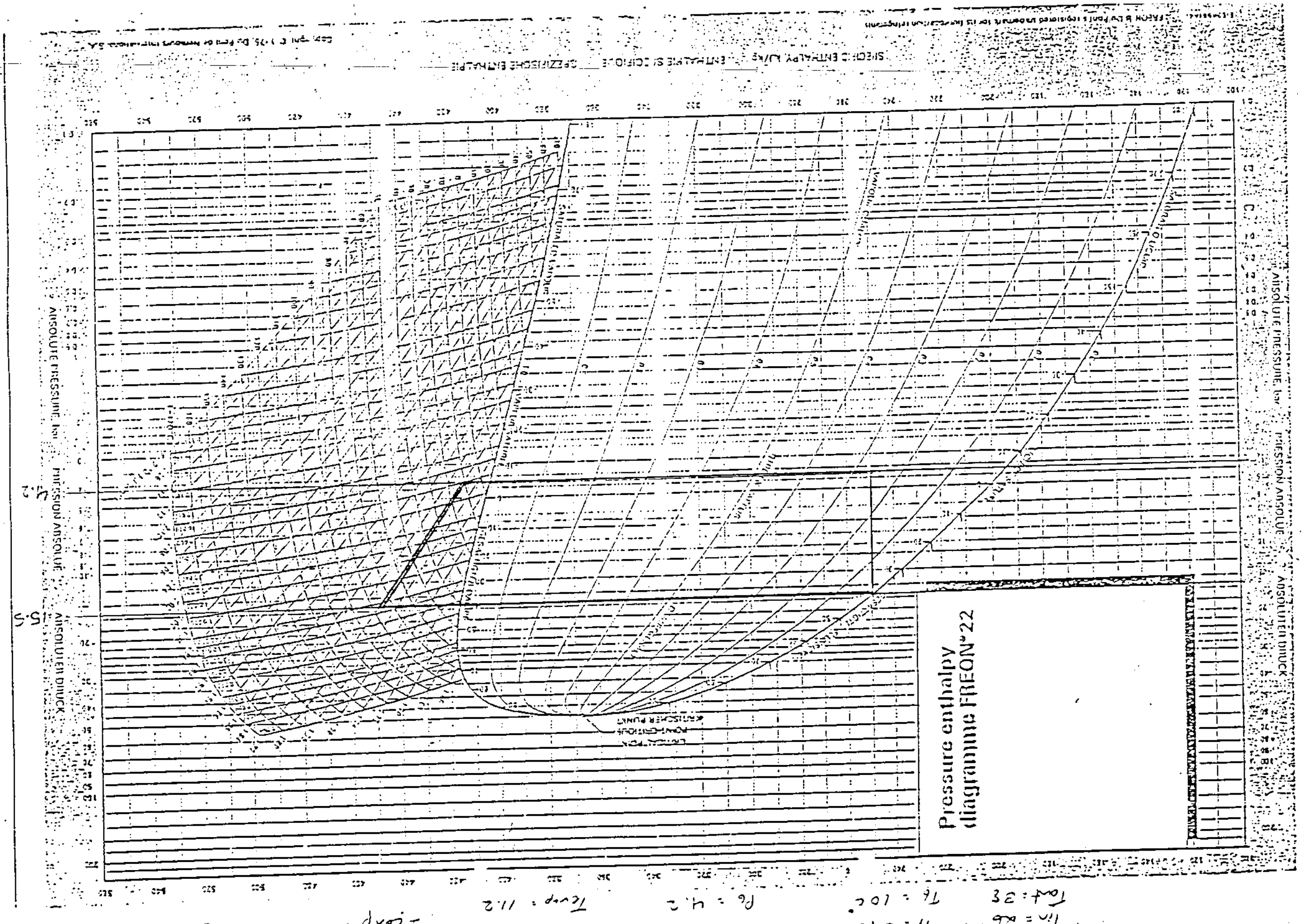

DuPont Fluorochemicals
Suva® 407C
Pressure-Enthalpy Diagram
(SI Units)
Pressure (MPa)
Pressure (bar)
saturated liquid
saturated vapor
quality = 0.3
temperature = 0 °C
temperature = -40 °C
temperature = 120 °C
entropy = 2.35 kJ/kg·K
volume = 0.0080 m³/kg

Tcd = 33 . P1 = 18.75 P6 = 5.00 Tc = 47
T1 = 40 Te = 20

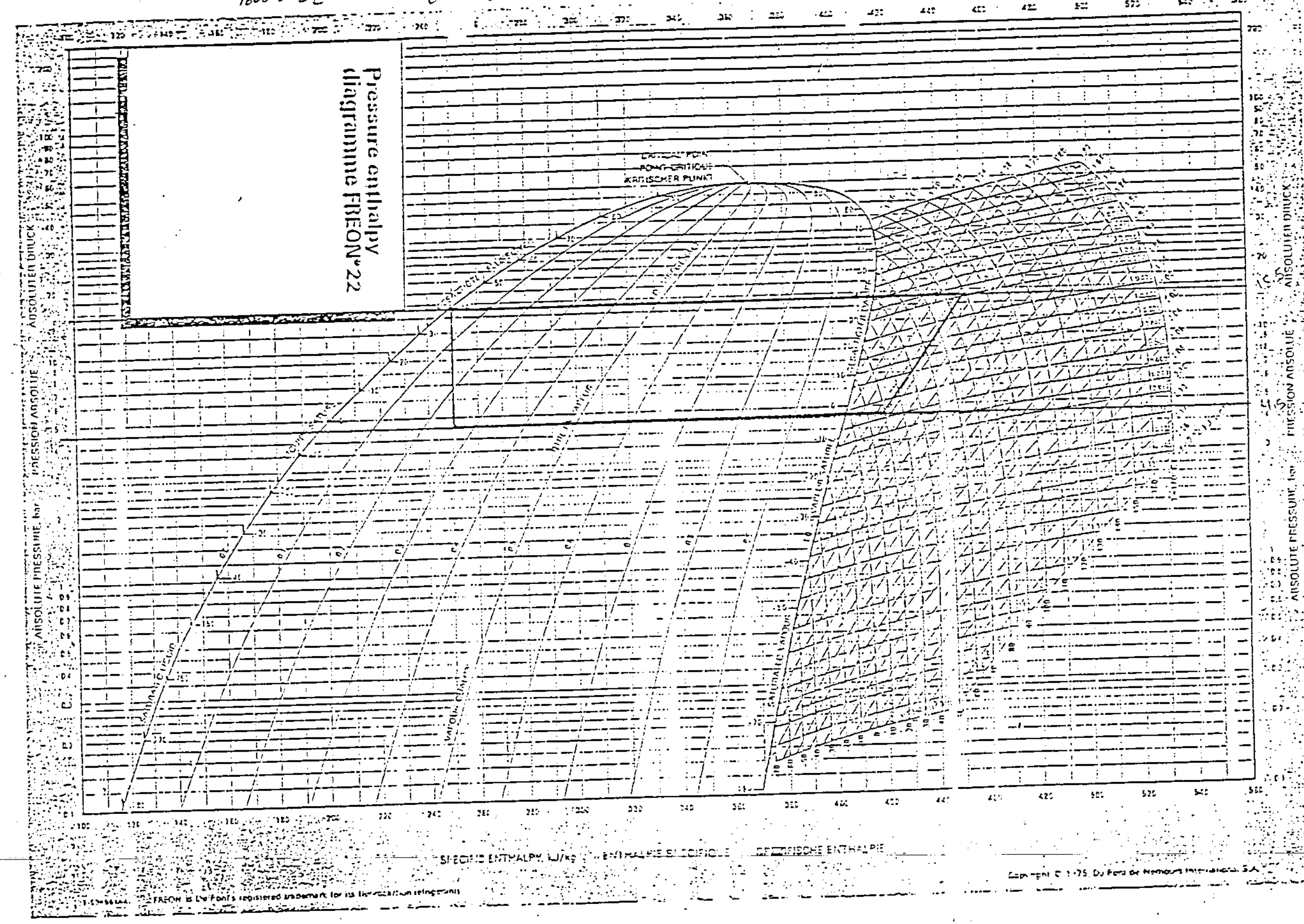



Pressure (MPa)
DuPont Fluorochemicals
Suva® 407C
Pressure-Enthalpy Diagram
(SI Units)
saturated liquid
saturated vapor
quality = 0.3
temperature = -40 °C
temperature = 0 °C
temperature = 120 °C
entropy = 2.35 kJ/kg·K
volume = 0.0080 m³/kg
Pressure (bar)


Pressure enthalpy
diagramme FREON°22
ABSOLUTE PRESSURE, bar
PRESSION ABSOLUE
ABSOLUTER DRUCK
SATURATED LIQUID
SATURATED VAPOUR
VAPOUR QUALITY
SPECIFIC ENTHALPY, kJ/kg
SPEZIFISCHE ENTHALPIE
KRITISCHER PUNKT
15.5


Pressure enthalpy
diagramme FREON*22
ABSOLUTE PRESSURE, bar
PRESSION ABSOLUE
ABSOLUTER DRUCK
SPECIFIC ENTHALPY, kJ/kg
ENTHALPIE SPECIFIQUE
SPEZIFISCHE ENTHALPIE
SATURATED LIQUID
SATURATED VAPOUR
VAPEUR SATUREE
CRITICAL POINT
POINT CRITIQUE
KRITISCHER PUNKT
4.2
15.5
T_{out} = 23
T_{in} = 26
T_6 = 10c°
T_1 = 39c°
P_6 = 4.2
P_1 = 15.5
T_{evap} = 11.2
T_{evap} = 16
I_{comp} = 25.2
T_c = 39c°

Tout = 38 T6 = 18 P6 = 4.5 bar Tev(out) = 20.4



APPENDIX (C): Refrigerant R407C, thermodynamic tables

TABLE 1
Suva® 407C Saturation Properties—Temperature Table

TEMP. °C	PRESSURE kPa LIQUID pf	PRESSURE kPa VAPOR pg	VOLUME m3/kg LIQUID vf	VOLUME m3/kg VAPOR vg	DENSITY kg/m3 LIQUID 1/vf	DENSITY kg/m3 VAPOR 1/vg	ENTHALPY kJ/kg LIQUID hf	ENTHALPY kJ/kg LATENT hfg	ENTHALPY kJ/kg VAPOR hg	ENTROPY kJ/(kg)(K) LIQUID sf	ENTROPY kJ/(kg)(K) VAPOR sg	TEMP. °C
-100	2.5	1.2	0.0006	14.1643	1583.8	0.071	75.8	275.4	351.3	0.4409	2.0690	-100
-99	2.7	1.3	0.0006	12.8066	1580.4	0.078	76.9	274.9	351.9	0.4473	2.0629	-99
-98	3.0	1.4	0.0006	11.7371	1577.1	0.085	78.1	274.4	352.5	0.4537	2.0568	-98
-97	3.2	1.6	0.0006	10.7066	1573.7	0.093	79.2	273.9	353.1	0.4601	2.0509	-97
-96	3.5	1.7	0.0006	9.7752	1570.4	0.102	80.3	273.4	353.7	0.4664	2.0451	-96
-95	3.8	1.9	0.0006	8.9445	1567.1	0.112	81.4	272.9	354.3	0.4727	2.0394	-95
-94	4.2	2.1	0.0006	8.1833	1563.7	0.122	82.6	272.4	355.0	0.4790	2.0339	-94
-93	4.5	2.3	0.0006	7.5019	1560.4	0.133	83.7	271.9	355.6	0.4853	2.0284	-93
-92	4.9	2.5	0.0006	6.8823	1557.0	0.145	84.8	271.4	356.2	0.4915	2.0230	-92
-91	5.4	2.8	0.0006	6.3251	1553.7	0.158	85.9	270.9	356.8	0.4977	2.0178	-91
-90	5.8	3.0	0.0006	5.8173	1550.3	0.172	87.1	270.4	357.4	0.5039	2.0126	-90
-89	6.3	3.3	0.0006	5.3533	1546.9	0.187	88.2	269.9	358.1	0.5101	2.0075	-89
-88	6.8	3.6	0.0006	4.9358	1543.6	0.203	89.3	269.4	358.7	0.5162	2.0026	-88
-87	7.3	3.9	0.0006	4.5537	1540.2	0.220	90.5	268.8	359.3	0.5224	1.9977	-87
-86	7.9	4.3	0.0007	4.2052	1536.9	0.238	91.6	268.3	359.9	0.5285	1.9929	-86
-85	8.5	4.7	0.0007	3.8880	1533.5	0.257	92.8	267.8	360.6	0.5346	1.9882	-85
-84	9.2	5.1	0.0007	3.5984	1530.1	0.278	93.9	267.3	361.2	0.5406	1.9836	-84
-83	9.9	5.5	0.0007	3.3344	1526.8	0.300	95.0	266.8	361.8	0.5467	1.9791	-83
-82	10.6	5.9	0.0007	3.0921	1523.4	0.323	96.2	266.3	362.5	0.5527	1.9747	-82
-81	11.4	6.4	0.0007	2.8703	1520.0	0.348	97.3	265.8	363.1	0.5587	1.9703	-81
-80	12.3	7.0	0.0007	2.6667	1516.6	0.375	98.5	265.2	363.7	0.5646	1.9661	-80
-79	13.2	7.5	0.0007	2.4795	1513.2	0.403	99.6	264.7	364.4	0.5706	1.9619	-79
-78	14.1	8.1	0.0007	2.3079	1509.9	0.433	100.8	264.2	365.0	0.5765	1.9578	-78
-77	15.1	8.8	0.0007	2.1501	1506.5	0.465	102.0	263.7	365.6	0.5824	1.9538	-77
-76	16.2	9.4	0.0007	2.0048	1503.1	0.499	103.1	263.2	366.3	0.5883	1.9498	-76
-75	17.3	10.2	0.0007	1.8709	1499.7	0.535	104.3	262.6	366.9	0.5942	1.9460	-75
-74	18.5	10.9	0.0007	1.7473	1496.3	0.572	105.4	262.1	367.6	0.6001	1.9422	-74
-73	19.7	11.8	0.0007	1.6335	1492.9	0.612	106.6	261.6	368.2	0.6059	1.9385	-73
-72	21.0	12.6	0.0007	1.5281	1489.5	0.654	107.8	261.1	368.8	0.6117	1.9348	-72
-71	22.4	13.5	0.0007	1.4306	1486.1	0.699	109.0	260.5	369.5	0.6175	1.9313	-71
-70	23.9	14.5	0.0007	1.3405	1482.7	0.746	110.1	260.0	370.1	0.6233	1.9277	-70
-69	25.4	15.6	0.0007	1.2571	1479.3	0.796	111.3	259.5	370.8	0.6291	1.9243	-69
-68	27.0	16.7	0.0007	1.1797	1475.9	0.848	112.5	258.9	371.4	0.6349	1.9209	-68
-67	28.7	17.8	0.0007	1.1078	1472.5	0.903	113.7	258.4	372.1	0.6406	1.9176	-67
-66	30.5	19.0	0.0007	1.0411	1469.0	0.961	114.9	257.9	372.7	0.6463	1.9144	-66
-65	32.4	20.3	0.0007	0.9791	1465.6	1.021	116.0	257.3	373.3	0.6520	1.9112	-65
-64	34.4	21.7	0.0007	0.9215	1462.2	1.085	117.2	256.8	374.0	0.6577	1.9081	-64
-63	36.4	23.1	0.0007	0.8678	1458.8	1.152	118.4	256.2	374.6	0.6634	1.9050	-63
-62	38.6	24.7	0.0007	0.8179	1455.3	1.223	119.6	255.7	375.3	0.6691	1.9020	-62
-61	40.9	26.3	0.0007	0.7713	1451.9	1.297	120.8	255.1	375.9	0.6747	1.8991	-61
-60	43.3	27.9	0.0007	0.7279	1448.5	1.374	122.0	254.6	376.6	0.6803	1.8962	-60
-59	45.7	29.7	0.0007	0.6873	1445.0	1.455	123.2	254.0	377.2	0.6859	1.8933	-59
-58	48.4	31.6	0.0007	0.6494	1441.6	1.540	124.4	253.5	377.9	0.6916	1.8906	-58
-57	51.1	33.5	0.0007	0.6140	1438.1	1.629	125.6	252.9	378.5	0.6971	1.8878	-57
-56	53.9	35.6	0.0007	0.5809	1434.7	1.722	126.8	252.3	379.2	0.7027	1.8852	-56
-55	56.9	37.7	0.0007	0.5499	1431.2	1.819	128.0	251.8	379.8	0.7083	1.8825	-55
-54	60.0	40.0	0.0007	0.5208	1427.8	1.920	129.3	251.2	380.5	0.7138	1.8800	-54
-53	63.3	42.4	0.0007	0.4936	1424.3	2.026	130.5	250.6	381.1	0.7194	1.8775	-53
-52	66.6	44.9	0.0007	0.4681	1420.8	2.137	131.7	250.1	381.8	0.7249	1.8750	-52
-51	70.2	47.5	0.0007	0.4441	1417.4	2.252	132.9	249.5	382.4	0.7304	1.8726	-51
-50	73.8	50.2	0.0007	0.4216	1413.9	2.372	134.2	248.9	383.1	0.7359	1.8702	-50
-49	77.7	53.0	0.0007	0.4004	1410.4	2.497	135.4	248.3	383.7	0.7414	1.8678	-49
-48	81.6	56.0	0.0007	0.3805	1406.9	2.628	136.6	247.7	384.4	0.7469	1.8655	-48
-47	85.8	59.1	0.0007	0.3618	1403.5	2.764	137.9	247.1	385.0	0.7523	1.8633	-47
-46	90.1	62.4	0.0007	0.3442	1400.0	2.905	139.1	246.6	385.6	0.7578	1.8611	-46
-45	94.6	65.8	0.0007	0.3276	1396.5	3.053	140.3	246.0	386.3	0.7632	1.8589	-45
-44	99.2	69.3	0.0007	0.3120	1393.0	3.206	141.6	245.4	386.9	0.7687	1.8568	-44
-43	104.0	73.0	0.0007	0.2972	1389.5	3.365	142.8	244.7	387.6	0.7741	1.8547	-43
-42	109.1	76.8	0.0007	0.2833	1386.0	3.530	144.1	244.1	388.2	0.7795	1.8527	-42
-41	114.3	80.8	0.0007	0.2701	1382.4	3.702	145.3	243.5	388.9	0.7849	1.8507	-41

TABLE 1 (continued)

Suva® 407C Saturation Properties—Temperature Table

TEMP. °C	PRESSURE kPa LIQUID pf	PRESSURE kPa VAPOR pg	VOLUME m3/kg LIQUID vf	VOLUME m3/kg VAPOR vg	DENSITY kg/m3 LIQUID 1/vf	DENSITY kg/m3 VAPOR 1/vg	ENTHALPY kJ/kg LIQUID hf	ENTHALPY kJ/kg LATENT hfg	ENTHALPY kJ/kg VAPOR hg	ENTROPY kJ/(kg)(K) LIQUID sf	ENTROPY kJ/(kg)(K) VAPOR sg	TEMP. °C
-40	119.7	85.0	0.0007	0.2577	1378.9	3.880	146.6	242.9	389.5	0.7903	1.8487	-40
-39	125.3	89.3	0.0007	0.2460	1375.4	4.065	147.9	242.3	390.2	0.7957	1.8468	-39
-38	131.1	93.8	0.0007	0.2349	1371.9	4.257	149.1	241.7	390.8	0.8011	1.8449	-38
-37	137.1	98.5	0.0007	0.2244	1368.3	4.456	150.4	241.0	391.4	0.8064	1.8430	-37
-36	143.3	103.4	0.0007	0.2145	1364.8	4.662	151.7	240.4	392.1	0.8118	1.8412	36
-35	149.8	108.5	0.0007	0.2051	1361.3	4.876	153.2	239.5	392.7	0.8184	1.8394	-35
-34	156.4	113.8	0.0007	0.1962	1357.7	5.098	154.5	238.8	393.4	0.8237	1.8377	-34
-33	163.3	119.2	0.0007	0.1877	1354.2	5.327	155.8	238.2	394.0	0.8290	1.8360	-33
-32	170.5	124.9	0.0007	0.1797	1350.6	5.564	157.1	237.6	394.6	0.8343	1.8343	-32
-31	177.8	130.8	0.0007	0.1721	1347.1	5.810	158.3	236.9	395.3	0.8396	1.8326	-31
-30	185.5	136.9	0.0007	0.1649	1343.5	6.064	159.6	236.3	395.9	0.8448	1.8310	-30
-29	193.3	143.2	0.0007	0.1580	1339.9	6.327	160.9	235.6	396.5	0.8501	1.8294	-29
-28	201.5	149.8	0.0007	0.1515	1336.3	6.599	162.2	234.9	397.2	0.8554	1.8278	-28
-27	209.9	156.5	0.0008	0.1453	1332.7	6.880	163.3	234.5	397.8	0.8596	1.8263	-27
-26	218.6	163.6	0.0008	0.1394	1329.2	7.171	164.4	234.0	398.4	0.8643	1.8248	-26
-25	227.6	170.9	0.0008	0.1338	1325.6	7.472	165.7	233.3	399.0	0.8696	1.8233	-25
-24	236.8	178.4	0.0008	0.1285	1322.0	7.782	167.1	232.6	399.7	0.8748	1.8218	-24
-23	246.3	186.2	0.0008	0.1234	1318.3	8.102	168.4	231.9	400.3	0.8801	1.8204	-23
-22	256.2	194.2	0.0008	0.1186	1314.7	8.433	169.7	231.2	400.9	0.8854	1.8189	-22
-21	266.3	202.6	0.0008	0.1140	1311.1	8.775	171.0	230.5	401.5	0.8907	1.8176	-21
-20	276.8	211.2	0.0008	0.1096	1307.5	9.127	172.4	229.7	402.1	0.8959	1.8162	-20
-19	287.5	220.1	0.0008	0.1054	1303.8	9.491	173.7	229.0	402.7	0.9012	1.8148	-19
-18	298.6	229.2	0.0008	0.1014	1300.2	9.866	175.1	228.3	403.4	0.9064	1.8135	-18
-17	310.0	238.7	0.0008	0.0975	1296.5	10.253	176.4	227.5	404.0	0.9117	1.8122	-17
-16	321.8	248.5	0.0008	0.0939	1292.9	10.651	177.8	226.8	404.6	0.9169	1.8109	-16
-15	333.8	258.6	0.0008	0.0904	1289.2	11.062	179.1	226.0	405.2	0.9221	1.8097	-15
-14	346.3	269.0	0.0008	0.0871	1285.5	11.486	180.5	225.3	405.8	0.9274	1.8084	-14
-13	359.0	279.7	0.0008	0.0839	1281.9	11.923	181.9	224.5	406.4	0.9326	1.8072	-13
-12	372.2	290.8	0.0008	0.0808	1278.2	12.372	183.2	223.7	407.0	0.9378	1.8060	-12
-11	385.7	302.2	0.0008	0.0779	1274.5	12.835	184.5	223.1	407.6	0.9425	1.8048	-11
-10	399.6	313.9	0.0008	0.0751	1270.8	13.313	185.9	222.3	408.2	0.9478	1.8037	-10
-9	413.8	326.0	0.0008	0.0724	1267.1	13.804	187.3	221.5	408.8	0.9530	1.8025	-9
-8	428.5	338.5	0.0008	0.0699	1263.3	14.311	188.7	220.7	409.3	0.9582	1.8014	-8
-7	443.5	351.3	0.0008	0.0674	1259.6	14.831	190.1	219.9	409.9	0.9635	1.8003	-7
-6	458.9	364.5	0.0008	0.0651	1255.9	15.368	191.5	219.0	410.5	0.9687	1.7992	-6
-5	474.8	378.1	0.0008	0.0628	1252.1	15.919	192.9	218.2	411.1	0.9739	1.7981	-5
-4	491.0	392.1	0.0008	0.0607	1248.4	16.487	194.3	217.4	411.7	0.9791	1.7970	-4
-3	507.7	406.5	0.0008	0.0586	1244.6	17.071	195.7	216.5	412.2	0.9843	1.7959	-3
-2	524.8	421.2	0.0008	0.0566	1240.8	17.671	197.1	215.7	412.8	0.9896	1.7949	-2
-1	542.3	436.4	0.0008	0.0547	1237.0	18.289	198.6	214.8	413.4	0.9948	1.7938	-1
0	560.3	452.0	0.0008	0.0528	1233.2	18.924	200.0	213.9	413.9	1.0000	1.7928	0
1	578.7	468.0	0.0008	0.0511	1229.4	19.577	201.4	213.0	414.5	1.0052	1.7918	1
2	597.6	484.5	0.0008	0.0494	1225.6	20.249	202.9	212.1	415.0	1.0104	1.7908	2
3	616.9	501.4	0.0008	0.0478	1221.8	20.939	204.3	211.2	415.6	1.0156	1.7898	3
4	636.7	518.7	0.0008	0.0462	1217.9	21.649	205.8	210.3	416.1	1.0209	1.7888	4
5	657.0	536.6	0.0008	0.0447	1214.1	22.378	207.3	209.4	416.6	1.0261	1.7879	5
6	677.8	554.8	0.0008	0.0432	1210.2	23.127	208.7	208.4	417.2	1.0313	1.7869	6
7	699.0	573.6	0.0008	0.0418	1206.3	23.898	210.2	207.5	417.7	1.0365	1.7859	7
8	720.8	592.8	0.0008	0.0405	1202.4	24.689	211.7	206.5	418.2	1.0418	1.7850	8
9	743.0	612.5	0.0008	0.0392	1198.5	25.502	213.2	205.6	418.8	1.0470	1.7841	9
10	765.8	632.8	0.0008	0.0380	1194.6	26.338	214.7	204.6	419.3	1.0522	1.7831	10
11	789.1	653.5	0.0008	0.0368	1190.7	27.196	216.2	203.6	419.8	1.0574	1.7822	11
12	812.9	674.7	0.0008	0.0356	1186.8	28.078	217.7	202.6	420.3	1.0627	1.7813	12
13	837.3	696.5	0.0008	0.0345	1182.8	28.984	219.2	201.6	420.8	1.0679	1.7804	13
14	862.2	718.8	0.0008	0.0334	1178.8	29.914	220.8	200.5	421.3	1.0732	1.7794	14
15	887.6	741.7	0.0009	0.0324	1174.8	30.870	222.3	199.5	421.8	1.0784	1.7785	15
16	913.6	765.1	0.0009	0.0314	1170.8	31.852	223.8	198.4	422.3	1.0837	1.7776	16
17	940.2	789.1	0.0009	0.0304	1166.8	32.860	225.4	197.4	422.7	1.0889	1.7767	17
18	967.3	813.6	0.0009	0.0295	1162.8	33.896	226.9	196.3	423.2	1.0942	1.7758	18
19	995.1	838.7	0.0009	0.0286	1158.7	34.960	228.5	195.2	423.7	1.0995	1.7749	19

TABLE 1 (continued)
Suva® 407C Saturation Properties—Temperature Table

TEMP.	PRESSURE kPa		VOLUME m3/kg		DENSITY kg/m3		ENTHALPY kJ/kg			ENTROPY kJ/(kg)(K)		TEMP.
°C	LIQUID pf	VAPOR pg	LIQUID vf	VAPOR vg	LIQUID 1/vf	VAPOR 1/vg	LIQUID hf	LATENT hfg	VAPOR hg	LIQUID sf	VAPOR sg	°C
20	1023.4	864.4	0.0009	0.0277	1154.7	36.052	230.1	194.1	424.1	1.1047	1.7740	20
21	1052.3	890.7	0.0009	0.0269	1150.6	37.175	231.6	193.0	424.6	1.1100	1.7731	21
22	1081.8	917.6	0.0009	0.0261	1146.5	38.328	233.2	191.8	425.1	1.1153	1.7722	22
23	1112.0	945.1	0.0009	0.0253	1142.3	39.512	234.8	190.7	425.5	1.1206	1.7713	23
24	1142.7	973.3	0.0009	0.0246	1138.2	40.728	236.4	189.5	425.9	1.1259	1.7704	24
25	1174.1	1002.1	0.0009	0.0238	1134.0	41.977	238.0	188.3	426.4	1.1312	1.7695	25
26	1206.1	1031.5	0.0009	0.0231	1129.9	43.261	239.7	187.1	426.8	1.1366	1.7686	26
27	1238.8	1061.6	0.0009	0.0224	1125.6	44.579	241.3	185.9	427.2	1.1419	1.7677	27
28	1272.1	1092.3	0.0009	0.0218	1121.4	45.934	242.9	184.7	427.6	1.1473	1.7668	28
29	1306.0	1123.7	0.0009	0.0211	1117.2	47.325	244.6	183.4	428.0	1.1526	1.7659	29
30	1340.7	1155.9	0.0009	0.0205	1112.9	48.755	246.2	182.1	428.4	1.1580	1.7649	30
31	1376.0	1188.7	0.0009	0.0199	1108.6	50.225	247.9	180.8	428.7	1.1634	1.7640	31
32	1412.0	1222.2	0.0009	0.0193	1104.3	51.735	249.6	179.5	429.1	1.1688	1.7630	32
33	1448.7	1256.4	0.0009	0.0188	1099.9	53.287	251.3	178.2	429.5	1.1742	1.7621	33
34	1486.1	1291.4	0.0009	0.0182	1095.5	54.883	253.0	176.9	429.8	1.1796	1.7611	34
35	1524.2	1327.1	0.0009	0.0177	1091.1	56.523	254.7	175.5	430.2	1.1850	1.7602	35
36	1563.0	1363.5	0.0009	0.0172	1086.7	58.209	256.4	174.1	430.5	1.1905	1.7592	36
37	1602.5	1400.7	0.0009	0.0167	1082.2	59.943	258.1	172.7	430.8	1.1959	1.7582	37
38	1642.8	1438.7	0.0009	0.0162	1077.7	61.726	259.9	171.3	431.1	1.2014	1.7572	38
39	1683.8	1477.5	0.0009	0.0157	1073.2	63.561	261.6	169.8	431.4	1.2069	1.7562	39
40	1725.5	1517.0	0.0009	0.0153	1068.6	65.448	263.4	168.3	431.7	1.2125	1.7551	40
41	1768.0	1557.4	0.0009	0.0148	1064.0	67.390	265.2	166.8	432.0	1.2180	1.7541	41
42	1811.3	1598.6	0.0009	0.0144	1059.4	69.388	267.0	165.3	432.3	1.2236	1.7530	42
43	1855.3	1640.6	0.0009	0.0140	1054.7	71.446	268.8	163.7	432.5	1.2292	1.7519	43
44	1900.2	1683.5	0.0010	0.0136	1050.0	73.565	270.6	162.2	432.8	1.2348	1.7508	44
45	1945.8	1727.2	0.0010	0.0132	1045.2	75.747	272.5	160.5	433.0	1.2404	1.7497	45
46	1992.2	1771.7	0.0010	0.0128	1040.4	77.994	274.3	158.9	433.2	1.2461	1.7485	46
47	2039.4	1817.2	0.0010	0.0125	1035.5	80.311	276.2	157.2	433.4	1.2517	1.7474	47
48	2007.4	1863.5	0.0010	0.0121	1030.6	82.699	278.1	155.5	433.6	1.2575	1.7462	48
49	2136.2	1910.8	0.0010	0.0117	1025.7	85.161	280.0	153.8	433.8	1.2632	1.7449	49
50	2185.9	1959.0	0.0010	0.0114	1020.7	87.701	281.9	152.0	433.9	1.2690	1.7437	50
51	2236.4	2008.1	0.0010	0.0111	1015.6	90.321	283.8	150.2	434.1	1.2748	1.7424	51
52	2287.7	2058.1	0.0010	0.0107	1010.5	93.027	285.8	148.4	434.2	1.2806	1.7411	52
53	2339.9	2109.1	0.0010	0.0104	1005.3	95.820	287.7	146.5	434.3	1.2865	1.7397	53
54	2392.9	2161.1	0.0010	0.0101	1000.0	98.707	289.7	144.6	434.4	1.2924	1.7384	54
55	2446.8	2214.1	0.0010	0.0098	994.7	101.691	291.7	142.7	434.4	1.2984	1.7369	55
56	2501.6	2268.1	0.0010	0.0095	989.3	104.777	293.8	140.7	434.5	1.3044	1.7355	56
57	2557.3	2323.1	0.0010	0.0093	983.8	107.970	295.8	138.6	434.5	1.3105	1.7340	57
58	2613.8	2379.1	0.0010	0.0090	978.2	111.277	297.9	136.6	434.5	1.3166	1.7324	58
59	2671.2	2436.2	0.0010	0.0087	972.6	114.703	300.0	134.4	434.4	1.3227	1.7308	59
60	2729.5	2494.4	0.0010	0.0085	966.8	118.255	302.2	132.2	434.4	1.3289	1.7291	60
61	2788.7	2553.6	0.0010	0.0082	961.0	121.941	304.3	130.0	434.3	1.3352	1.7274	61
62	2848.8	2614.0	0.0010	0.0080	955.0	125.768	306.5	127.7	434.2	1.3415	1.7256	62
63	2909.9	2675.4	0.0011	0.0077	948.9	129.746	308.7	125.3	434.1	1.3479	1.7238	63
64	2971.8	2738.0	0.0011	0.0075	942.7	133.884	311.0	122.9	433.9	1.3544	1.7219	64
65	3034.7	2801.8	0.0011	0.0072	936.3	138.194	313.3	120.4	433.7	1.3609	1.7199	65
66	3098.5	2866.8	0.0011	0.0070	929.8	142.687	315.6	117.9	433.5	1.3675	1.7178	66
67	3163.2	2932.9	0.0011	0.0068	923.2	147.378	318.0	115.2	433.2	1.3743	1.7157	67
68	3228.8	3000.3	0.0011	0.0066	916.3	152.282	320.4	112.5	432.9	1.3811	1.7134	68
69	3295.4	3068.9	0.0011	0.0064	909.3	157.416	322.8	109.7	432.5	1.3880	1.7111	69
70	3362.9	3138.8	0.0011	0.0061	902.0	162.800	325.3	106.8	432.1	1.3950	1.7086	70
71	3431.3	3210.1	0.0011	0.0059	894.5	168.458	327.9	103.8	431.6	1.4022	1.7060	71
72	3500.6	3282.6	0.0011	0.0057	886.7	174.415	330.5	100.6	431.1	1.4095	1.7033	72
73	3570.8	3356.5	0.0011	0.0055	878.6	180.703	333.1	97.4	430.5	1.4169	1.7004	73
74	3642.0	3431.8	0.0011	0.0053	870.1	187.358	335.9	94.0	429.9	1.4246	1.6973	74
75	3714.0	3508.6	0.0012	0.0051	861.3	194.425	338.7	90.4	429.2	1.4324	1.6941	75
76	3786.9	3586.9	0.0012	0.0050	852.0	201.958	341.6	86.7	428.3	1.4404	1.6906	76
77	3060.6	3666.7	0.0012	0.0048	842.1	210.021	344.6	82.8	427.4	1.4487	1.6869	77
78	3935.2	3748.1	0.0012	0.0046	831.6	218.698	347.8	78.6	426.4	1.4573	1.6829	78
79	4010.5	3831.1	0.0012	0.0044	820.3	228.096	351.0	74.2	425.2	1.4663	1.6785	79

TABLE 2
Suva® 407C Superheated Vapor—Constant Pressure Tables

V = Volume in m³/kg   H = Enthalpy in kJ/kg   S = Entropy in kJ/(kg) (K)   (Saturation Properties in parentheses)

ABSOLUTE PRESSURE, kPa

TEMP. °C	10.0 (-75.20°C)			20.0 (-65.30°C)			30.0 (-58.80°C)			40.0 (-54.00°C)			TEMP. °C
	V	H	S	V	H	S	V	H	S	V	H	S	
	(1.9002)	(366.8)	(1.9469)	(0.9944)	(373.2)	(1.9120)	(0.6812)	(377.3)	(1.8929)	(0.5209)	(380.5)	(1.8800)	
-70	1.9509	370.2	1.9641	—	—	—	—	—	—	—	—	—	-70
-65	1.9995	373.6	1.9003	0.9956	373.4	1.9120	—	—	—	—	—	—	-65
-60	2.0400	377.0	1.9964	1.0201	376.7	1.9289	—	—	—	—	—	—	-60
-55	2.0965	380.4	2.0123	1.0445	380.2	1.9448	0.6938	380.0	1.9052	—	—	—	-55
-50	2.1450	383.8	2.0280	1.0609	383.7	1.9606	0.7101	383.5	1.9209	0.5308	383.3	1.8926	-50
-45	2.1935	387.4	2.0435	1.0933	387.2	1.9762	0.7265	387.0	1.9365	0.5431	386.8	1.9003	-45
-40	2.2420	390.9	2.0509	1.1176	390.7	1.9916	0.7428	390.5	1.9520	0.5554	390.4	1.9237	-40
-35	2.2905	394.5	2.0742	1.1420	394.3	2.0069	0.7591	394.1	1.9673	0.5677	394.0	1.9391	-35
-30	2.3309	398.1	2.0893	1.1663	398.0	2.0220	0.7755	397.8	1.9824	0.5800	397.6	1.9542	-30
-25	2.3874	401.8	2.1043	1.1907	401.6	2.0370	0.7917	401.5	1.9974	0.5923	401.3	1.9692	-25
-20	2.4358	405.5	2.1191	1.2150	405.4	2.0518	0.8080	405.2	2.0123	0.6046	405.0	1.9841	-20
-15	2.4842	409.3	2.1338	1.2393	409.1	2.0666	0.8243	409.0	2.0271	0.6168	408.8	1.9989	-15
-10	2.5327	413.1	2.1484	1.2636	412.9	2.0812	0.8406	412.8	2.0417	0.6291	412.6	2.0136	-10
-5	2.5811	416.9	2.1629	1.2879	416.8	2.0957	0.8568	416.6	2.0562	0.6413	416.5	2.0281	-5
0	2.6295	420.8	2.1772	1.3122	420.7	2.1100	0.8731	420.5	2.0706	0.6535	420.4	2.0425	0
5	2.6779	424.8	2.1915	1.3365	424.6	2.1243	0.8893	424.5	2.0849	0.6658	424.3	2.0568	5
10	2.7262	428.7	2.2056	1.3607	428.6	2.1385	0.9056	428.4	2.0990	0.6780	428.3	2.0710	10
15	2.7746	432.7	2.2197	1.3850	432.6	2.1525	0.9218	432.5	2.1131	0.6902	432.3	2.0850	15
20	2.8230	436.8	2.2336	1.4093	436.7	2.1665	0.9380	436.5	2.1271	0.7024	436.4	2.0990	20
25	2.8714	440.9	2.2475	1.4335	440.8	2.1803	0.9542	440.6	2.1409	0.7146	440.5	2.1129	25
30	2.9197	445.0	2.2612	1.4578	444.9	2.1941	0.9705	444.8	2.1547	0.7268	444.7	2.1267	30
35	2.9681	449.2	2.2749	1.4820	449.1	2.2078	0.9867	449.0	2.1684	0.7390	448.8	2.1404	35
40	3.0164	453.4	2.2885	1.5063	453.3	2.2214	1.0029	453.2	2.1820	0.7512	453.1	2.1540	40
45	3.0648	457.7	2.3020	1.5305	457.6	2.2349	1.0191	457.4	2.1955	0.7634	457.3	2.1675	45
50	3.1131	462.0	2.3154	1.5547	461.9	2.2483	1.0353	461.8	2.2090	0.7755	461.6	2.1810	50
55	3.1615	466.3	2.3287	1.5790	466.2	2.2616	1.0514	466.1	2.2223	0.7877	466.0	2.1943	55
60	3.2098	470.7	2.3420	1.6032	470.6	2.2749	1.0676	470.5	2.2356	0.7999	470.4	2.2076	60
65	3.2581	475.1	2.3551	1.6274	475.0	2.2881	1.0838	474.9	2.2488	0.8120	474.8	2.2208	65
70	3.3064	479.6	2.3682	1.6516	479.5	2.3012	1.1000	479.4	2.2619	0.8242	479.3	2.2339	70
75	3.3548	484.1	2.3813	1.6758	484.0	2.3142	1.1162	483.9	2.2749	0.8363	483.8	2.2470	75
80	3.4031	488.6	2.3942	1.7000	488.5	2.3272	1.1323	488.4	2.2879	0.8485	488.3	2.2599	80
85	1.7242	493.1	2.3400	1.1405	493.0	2.3008	0.8606	492.9	2.2728	—	—	—	85
90	—	—	—	—	—	—	1.1647	497.6	2.3136	0.8728	497.5	2.2857	90
95	—	—	—	—	—	—	1.1808	502.3	2.3263	0.8849	502.2	2.2984	95
100	—	—	—	—	—	—	—	—	—	0.8971	506.9	2.3111	100

TEMP. °C	50.0 (-50.10°C)			60.0 (-46.70°C)			70.0 (-43.80°C)			80.0 (-41.20°C)			TEMP. °C
	V	H	S	V	H	S	V	H	S	V	H	S	
	(0.4230)	(383.0)	(1.8703)	(0.3568)	(385.2)	(1.8627)	(0.3090)	(387.1)	(1.8564)	(0.2727)	(388.7)	(1.8511)	
-50	0.4231	383.1	1.8705	—	—	—	—	—	—	—	—	—	-50
-45	0.4331	386.6	1.8862	0.3597	386.4	1.8681	—	—	—	—	—	—	-45
-40	0.4430	390.2	1.9017	0.3680	390.0	1.8836	0.3144	389.8	1.8682	0.2743	389.6	1.8540	-40
-35	0.4529	393.8	1.9170	0.3763	393.6	1.8990	0.3216	393.4	1.8836	0.2805	393.2	1.8703	-35
-30	0.4627	397.4	1.9322	0.3845	397.3	1.9142	0.3287	397.1	1.8989	0.2868	396.9	1.8855	-30
-25	0.4726	401.1	1.9473	0.3928	401.0	1.9293	0.3358	400.8	1.9140	0.2931	400.6	1.9006	-25
-20	0.4825	404.9	1.9622	0.4011	404.7	1.9442	0.3429	404.5	1.9289	0.2993	404.4	1.9156	-20
-15	0.4923	408.7	1.9770	0.4093	408.5	1.9590	0.3500	408.3	1.9437	0.3055	408.2	1.9305	-15
-10	0.5022	412.5	1.9916	0.4175	412.3	1.9737	0.3571	412.2	1.9584	0.3118	412.0	1.9452	-10
-5	0.5120	416.3	2.0062	0.4258	416.2	1.9882	0.3642	416.0	1.9730	0.3180	415.9	1.9598	-5
0	0.5218	420.2	2.0206	0.4340	420.1	2.0027	0.3712	419.9	1.9875	0.3242	419.8	1.9742	0
5	0.5316	424.2	2.0349	0.4422	424.0	2.0170	0.3783	423.9	2.0018	0.3304	423.8	1.9886	5
10	0.5414	428.2	2.0491	0.4504	428.0	2.0312	0.3854	427.9	2.0160	0.3366	427.8	2.0028	10
15	0.5512	432.2	2.0632	0.4586	432.1	2.0453	0.3924	431.9	2.0302	0.3428	431.8	2.0170	15
20	0.5610	436.3	2.0772	0.4668	436.1	2.0593	0.3995	436.0	2.0442	0.3490	435.9	2.0310	20
25	0.5708	440.4	2.0911	0.4750	440.2	2.0732	0.4065	440.1	2.0581	0.3551	440.0	2.0449	25
30	0.5806	444.5	2.1049	0.4831	444.4	2.0871	0.4135	444.3	2.0719	0.3613	444.2	2.0588	30
35	0.5904	448.7	2.1186	0.4913	448.6	2.1008	0.4205	448.5	2.0856	0.3675	448.4	2.0725	35
40	0.6002	452.9	2.1322	0.4995	452.8	2.1144	0.4276	452.7	2.0993	0.3736	452.6	2.0862	40
45	0.6099	457.2	2.1458	0.5076	457.1	2.1280	0.4346	457.0	2.1128	0.3798	456.9	2.0997	45
50	0.6197	461.5	2.1592	0.5158	461.4	2.1414	0.4416	461.3	2.1263	0.3859	461.2	2.1132	50
55	0.6294	465.9	2.1726	0.5239	465.8	2.1548	0.4486	465.7	2.1397	0.3921	465.6	2.1266	55
60	0.6392	470.3	2.1859	0.5321	470.2	2.1681	0.4556	470.1	2.1530	0.3982	470.0	2.1399	60
65	0.6490	474.7	2.1991	0.5402	474.6	2.1813	0.4626	474.5	2.1662	0.4043	474.4	2.1531	65
70	0.6587	479.2	2.2122	0.5484	479.1	2.1944	0.4696	479.0	2.1793	0.4105	478.9	2.1663	70
75	0.6684	483.7	2.2253	0.5565	483.6	2.2075	0.4766	483.5	2.1924	0.4166	483.4	2.1793	75
80	0.6782	488.2	2.2382	0.5646	488.1	2.2205	0.4835	488.0	2.2054	0.4227	487.9	2.1923	80
85	0.6879	492.8	2.2511	0.5728	492.7	2.2334	0.4905	492.6	2.2183	0.4288	492.5	2.2053	85
90	0.6977	497.5	2.2640	0.5809	497.4	2.2462	0.4975	497.3	2.2312	0.4350	497.2	2.2181	90
95	0.7074	502.1	2.2767	0.5890	502.0	2.2590	0.5045	501.9	2.2439	0.4411	501.8	2.2309	95
100	0.7171	506.8	2.2894	0.5971	506.7	2.2717	0.5115	506.6	2.2566	0.4472	506.6	2.2436	100
105	0.6053	511.5	2.2843	0.5104	511.4	2.2693	0.4533	511.3	2.2562	—	—	—	105
110	—	—	—	—	—	—	0.5254	516.2	2.2818	0.4594	516.1	2.2680	110

TABLE 2 (continued)
Suva® 407C Superheated Vapor—Constant Pressure Tables

V = Volume in m^3/kg H = Enthalpy in kJ/kg S = Entropy in kJ/(kg) (K) (Saturation Properties in parentheses)

ABSOLUTE PRESSURE, kPa

TEMP. °C	90.0 (-38.90°C)			100.0 (-36.70°C)			101.325 (-36.40°C)			110.0 (-34.70°C)			TEMP. °C
	V	H	S	V	H	S	V	H	S	V	H	S	
	(0.2443)	(390.2)	(1.8465)	(0.2214)	(391.6)	(1.8425)	(0.2186)	(391.8)	(1.8420)	(0.2025)	(392.9)	(1.8389)	
-35	0.2406	393.1	1.8504	0.2231	392.9	1.8477	0.2201	392.8	1.8464	—	—	—	-35
-30	0.2542	396.7	1.8737	0.2281	396.6	1.8631	0.2251	396.5	1.8617	0.2060	396.4	1.8534	-30
-25	0.2598	400.5	1.8888	0.2332	400.3	1.8782	0.2301	400.3	1.8769	0.2114	400.1	1.8686	-25
-20	0.2654	404.2	1.9038	0.2382	404.0	1.8932	0.2351	404.0	1.8919	0.2160	403.9	1.8836	-20
-15	0.2710	408.0	1.9187	0.2433	407.9	1.9081	0.2400	407.8	1.9068	0.2206	407.7	1.8985	-15
-10	0.2765	411.9	1.9334	0.2483	411.7	1.9229	0.2450	411.7	1.9215	0.2252	411.5	1.9133	-10
-5	0.2821	415.7	1.9480	0.2533	415.6	1.9375	0.2499	415.6	1.9362	0.2298	415.4	1.9279	-5
0	0.2876	419.7	1.9625	0.2583	419.5	1.9520	0.2549	419.5	1.9507	0.2344	419.4	1.9424	0
5	0.2931	423.6	1.9769	0.2633	423.5	1.9664	0.2598	423.5	1.9651	0.2389	423.3	1.9568	5
10	0.2987	427.6	1.9911	0.2683	427.5	1.9807	0.2647	427.5	1.9793	0.2435	427.3	1.9711	10
15	0.3042	431.7	2.0053	0.2733	431.5	1.9948	0.2697	431.5	1.9935	0.2480	431.4	1.9853	15
20	0.3097	435.7	2.0193	0.2783	435.6	2.0089	0.2746	435.6	2.0076	0.2526	435.5	1.9994	20
25	0.3152	439.9	2.0333	0.2832	439.7	2.0228	0.2795	439.7	2.0215	0.2571	439.6	2.0134	25
30	0.3207	444.0	2.0471	0.2882	443.9	2.0367	0.2844	443.9	2.0354	0.2616	443.8	2.0272	30
35	0.3262	448.2	2.0609	0.2932	448.1	2.0505	0.2893	448.1	2.0492	0.2661	448.0	2.0410	35
40	0.3317	452.5	2.0745	0.2981	452.4	2.0641	0.2942	452.3	2.0628	0.2706	452.2	2.0547	40
45	0.3371	456.8	2.0881	0.3031	456.6	2.0777	0.2990	456.6	2.0764	0.2752	456.5	2.0683	45
50	0.3426	461.1	2.1016	0.3080	461.0	2.0912	0.3039	461.0	2.0899	0.2797	460.9	2.0818	50
55	0.3481	465.4	2.1150	0.3129	465.3	2.1046	0.3088	465.3	2.1033	0.2842	465.2	2.0952	55
60	0.3536	469.8	2.1283	0.3179	469.7	2.1179	0.3137	469.7	2.1166	0.2887	469.6	2.1085	60
65	0.3590	474.3	2.1415	0.3228	474.2	2.1312	0.3185	474.2	2.1299	0.2931	474.1	2.1218	65
70	0.3645	478.8	2.1547	0.3277	478.7	2.1443	0.3234	478.7	2.1430	0.2976	478.6	2.1349	70
75	0.3700	483.3	2.1678	0.3326	483.2	2.1574	0.3283	483.2	2.1561	0.3021	483.1	2.1480	75
80	0.3754	487.8	2.1808	0.3376	487.8	2.1704	0.3331	487.7	2.1691	0.3066	487.7	2.1610	80
85	0.3809	492.4	2.1937	0.3425	492.4	2.1834	0.3380	492.3	2.1821	0.3111	492.3	2.1740	85
90	0.3863	497.1	2.2066	0.3474	497.0	2.1962	0.3428	497.0	2.1949	0.3155	496.9	2.1869	90
95	0.3918	501.8	2.2193	0.3523	501.7	2.2090	0.3477	501.7	2.2077	0.3200	501.6	2.1996	95
100	0.3972	506.5	2.2321	0.3572	506.4	2.2217	0.3525	506.4	2.2204	0.3245	506.3	2.2124	100
105	0.4026	511.2	2.2447	0.3621	511.1	2.2344	0.3573	511.1	2.2331	0.3290	511.0	2.2250	105
110	0.4081	516.0	2.2573	0.3670	515.9	2.2470	0.3622	515.9	2.2457	0.3334	515.8	2.2376	110
115	0.4135	520.8	2.2698	0.3719	520.7	2.2595	0.3670	520.7	2.2582	0.3379	520.7	2.2501	115
120	—	—	—	—	—	—	—	—	—	0.3423	525.5	2.2626	120

TEMP. °C	120.0 (-32.9°C)			130.0 (-31.1°C)			140.0 (-29.5°C)			150.0 (-28.0°C)			TEMP. °C
	V	H	S	V	H	S	V	H	S	V	H	S	
	(0.1866)	(394.1)	(1.8357)	(0.1731)	(395.2)	(1.8328)	(0.1615)	(396.2)	(1.8302)	(0.1513)	(397.2)	(1.8278)	
-30	0.1890	396.2	1.8445	0.1740	396.0	1.8363	—	—	—	—	—	—	-30
-25	0.1933	399.9	1.8597	0.1779	399.8	1.8515	0.1648	399.6	1.8439	0.1534	399.4	1.8368	-25
-20	0.1975	403.7	1.8748	0.1819	403.5	1.8666	0.1684	403.4	1.8590	0.1568	403.2	1.8519	-20
-15	0.2018	407.5	1.8897	0.1858	407.4	1.8816	0.1721	407.2	1.8740	0.1602	407.0	1.8669	-15
-10	0.2060	411.4	1.9045	0.1897	411.2	1.8964	0.1757	411.1	1.8888	0.1637	410.9	1.8818	-10
-5	0.2102	415.3	1.9192	0.1936	415.1	1.9111	0.1794	415.0	1.9035	0.1671	414.8	1.8965	-5
0	0.2144	419.2	1.9337	0.1975	419.1	1.9256	0.1830	418.9	1.9181	0.1705	418.8	1.9111	0
5	0.2186	423.2	1.9481	0.2014	423.0	1.9400	0.1866	422.9	1.9326	0.1739	422.7	1.9256	5
10	0.2228	427.2	1.9624	0.2053	427.1	1.9544	0.1903	426.9	1.9469	0.1772	426.8	1.9399	10
15	0.2270	431.2	1.9766	0.2091	431.1	1.9686	0.1939	431.0	1.9611	0.1806	430.8	1.9541	15
20	0.2311	435.3	1.9907	0.2130	435.2	1.9827	0.1975	435.1	1.9752	0.1840	434.9	1.9683	20
25	0.2353	439.5	2.0047	0.2169	439.3	1.9967	0.2011	439.2	1.9892	0.1874	439.1	1.9823	25
30	0.2395	443.7	2.0186	0.2207	443.5	2.0106	0.2046	443.4	2.0031	0.1907	443.3	1.9962	30
35	0.2436	447.9	2.0323	0.2246	447.7	2.0244	0.2082	447.6	2.0169	0.1941	447.5	2.0100	35
40	0.2478	452.1	2.0460	0.2284	452.0	2.0381	0.2118	451.9	2.0307	0.1974	451.8	2.0237	40
45	0.2519	456.4	2.0596	0.2322	456.3	2.0517	0.2154	456.2	2.0443	0.2008	456.1	2.0374	45
50	0.2560	460.7	2.0731	0.2361	460.6	2.0652	0.2189	460.5	2.0578	0.2041	460.4	2.0509	50
55	0.2602	465.1	2.0866	0.2399	465.0	2.0786	0.2225	464.9	2.0712	0.2074	464.8	2.0644	55
60	0.2643	469.5	2.0999	0.2437	469.4	2.0920	0.2261	469.3	2.0846	0.2107	469.2	2.0777	60
65	0.2684	474.0	2.1132	0.2475	473.9	2.1052	0.2296	473.8	2.0979	0.2141	473.7	2.0910	65
70	0.2726	478.5	2.1263	0.2513	478.4	2.1184	0.2332	478.3	2.1111	0.2174	478.2	2.1042	70
75	0.2767	483.0	2.1394	0.2551	482.9	2.1315	0.2367	482.8	2.1242	0.2207	482.7	2.1173	75
80	0.2808	487.6	2.1525	0.2590	487.5	2.1446	0.2402	487.4	2.1372	0.2240	487.3	2.1304	80
85	0.2849	492.2	2.1654	0.2628	492.1	2.1575	0.2438	492.0	2.1502	0.2273	491.9	2.1433	85
90	0.2890	496.8	2.1783	0.2666	496.7	2.1704	0.2473	496.6	2.1631	0.2306	496.5	2.1562	90
95	0.2931	501.5	2.1911	0.2704	501.4	2.1832	0.2508	501.3	2.1759	0.2339	501.2	2.1690	95
100	0.2972	506.2	2.2038	0.2741	506.1	2.1959	0.2544	506.0	2.1886	0.2372	505.9	2.1818	100
105	0.3013	511.0	2.2165	0.2779	510.9	2.2086	0.2579	510.8	2.2013	0.2405	510.7	2.1945	105
110	0.3054	515.8	2.2291	0.2817	515.7	2.2212	0.2614	515.6	2.2139	0.2438	515.5	2.2071	110
115	0.3095	520.6	2.2416	0.2855	520.5	2.2337	0.2649	520.4	2.2264	0.2471	520.3	2.2196	115
120	0.3136	525.4	2.2540	0.2893	525.4	2.2462	0.2685	525.3	2.2389	0.2504	525.2	2.2321	120
125	—	—	—	—	—	—	0.2720	530.2	2.2513	0.2537	530.1	2.2445	125

TABLE 2 (continued)
Suva® 407C Superheated Vapor—Constant Pressure Tables

V = Volume in m^3/kg H = Enthalpy in kJ/kg S = Entropy in kJ/(kg) (K) (Saturation Properties in parentheses)

ABSOLUTE PRESSURE, kPa

TEMP. °C	160.0 (-26.50 °C)			170.0 (-25.10 °C)			180.0 (-23.80 °C)			190.0 (-22.50 °C)			TEMP. °C
	V	H	S	V	H	S	V	H	S	V	H	S	
	(0.1424)	(398.1)	(1.8255)	(0.1345)	(399.0)	(1.8234)	(0.1274)	(399.8)	(1.8215)	(0.1211)	(400.6)	(1.8197)	
-25	0.1434	399.2	1.8301	0.1346	399.0	1.8238	—	—	—	—	—	—	-25
-20	0.1466	403.0	1.8453	0.1376	402.9	1.8390	0.1296	402.7	1.8330	0.1225	402.5	1.8274	-20
-15	0.1498	406.9	1.8603	0.1407	406.7	1.8540	0.1325	406.5	1.8481	0.1252	406.4	1.8424	-15
-10	0.1531	410.7	1.8752	0.1437	410.6	1.8689	0.1354	410.4	1.8630	0.1280	410.2	1.8574	-10
-5	0.1563	414.7	1.8899	0.1468	414.5	1.8837	0.1383	414.3	1.8778	0.1307	414.2	1.8722	-5
0	0.1595	418.6	1.9045	0.1498	418.5	1.8983	0.1412	418.3	1.8924	0.1335	418.1	1.8868	0
5	0.1627	422.6	1.9190	0.1528	422.4	1.9128	0.1440	422.3	1.9069	0.1362	422.2	1.9013	5
10	0.1659	426.6	1.9333	0.1558	426.5	1.9272	0.1469	426.3	1.9213	0.1389	426.2	1.9158	10
15	0.1690	430.7	1.9476	0.1588	430.6	1.9414	0.1497	430.4	1.9356	0.1416	430.3	1.9301	15
20	0.1722	434.8	1.9617	0.1618	434.7	1.9556	0.1526	434.5	1.9498	0.1443	434.4	1.9442	20
25	0.1754	439.0	1.9758	0.1648	438.8	1.9696	0.1554	438.7	1.9638	0.1470	438.6	1.9583	25
30	0.1785	443.1	1.9897	0.1678	443.0	1.9836	0.1582	442.9	1.9778	0.1497	442.8	1.9723	30
35	0.1817	447.4	2.0035	0.1707	447.2	1.9974	0.1610	447.1	1.9916	0.1523	447.0	1.9861	35
40	0.1848	451.6	2.0173	0.1737	451.5	2.0111	0.1638	451.4	2.0054	0.1550	451.3	1.9999	40
45	0.1880	455.9	2.0309	0.1767	455.8	2.0248	0.1666	455.7	2.0190	0.1577	455.6	2.0136	45
50	0.1911	460.3	2.0444	0.1796	460.2	2.0384	0.1694	460.1	2.0326	0.1603	459.9	2.0271	50
55	0.1942	464.7	2.0579	0.1826	464.6	2.0518	0.1722	464.4	2.0461	0.1630	464.3	2.0406	55
60	0.1974	469.1	2.0713	0.1855	469.0	2.0652	0.1750	468.9	2.0595	0.1656	468.8	2.0540	60
65	0.2005	473.6	2.0846	0.1885	473.4	2.0785	0.1778	473.3	2.0728	0.1683	473.2	2.0674	65
70	0.2036	478.1	2.0978	0.1914	477.9	2.0917	0.1806	477.8	2.0860	0.1709	477.7	2.0806	70
75	0.2067	482.6	2.1109	0.1944	482.5	2.1049	0.1834	482.4	2.0991	0.1736	482.3	2.0937	75
80	0.2098	487.2	2.1240	0.1973	487.1	2.1179	0.1862	487.0	2.1122	0.1762	486.9	2.1068	80
85	0.2129	491.8	2.1369	0.2002	491.7	2.1309	0.1889	491.6	2.1252	0.1788	491.5	2.1198	85
90	0.2160	496.4	2.1498	0.2032	496.3	2.1438	0.1917	496.2	2.1381	0.1815	496.2	2.1327	90
95	0.2191	501.1	2.1627	0.2061	501.0	2.1566	0.1945	500.9	2.1509	0.1841	500.8	2.1456	95
100	0.2222	505.8	2.1754	0.2090	505.8	2.1694	0.1972	505.7	2.1637	0.1867	505.6	2.1583	100
105	0.2253	510.6	2.1881	0.2119	510.5	2.1821	0.2000	510.4	2.1764	0.1893	510.3	2.1710	105
110	0.2284	515.4	2.2007	0.2148	515.3	2.1947	0.2028	515.2	2.1890	0.1920	515.2	2.1837	110
115	0.2315	520.2	2.2132	0.2178	520.2	2.2072	0.2055	520.1	2.2016	0.1946	520.0	2.1962	115
120	0.2346	525.1	2.2257	0.2207	525.0	2.2197	0.2083	525.0	2.2141	0.1972	524.9	2.2087	120
125	0.2377	530.0	2.2381	0.2236	530.0	2.2321	0.2110	529.9	2.2265	0.1998	529.8	2.2211	125
130	—	—	—	—	—	—	0.2138	534.8	2.2388	0.2024	534.7	2.2335	130

TEMP. °C	200.0 (-21.30 °C)			210.0 (-20.10 °C)			220.0 (-19.00 °C)			230.0 (-17.90 °C)			TEMP. °C
	V	H	S	V	H	S	V	H	S	V	H	S	
	(0.1154)	(401.3)	(1.8180)	(0.1101)	(402.0)	(1.8164)	(0.1054)	(402.7)	(1.8149)	(0.1010)	(403.4)	(1.8134)	
-20	0.1160	402.3	1.8220	0.1102	402.2	1.8168	—	—	—	—	—	—	-20
-15	0.1187	406.2	1.8371	0.1127	406.0	1.8319	0.1073	405.8	1.8270	0.1024	405.7	1.8223	-15
-10	0.1213	410.1	1.8520	0.1152	409.9	1.8469	0.1097	409.8	1.8420	0.1047	409.6	1.8373	-10
-5	0.1239	414.0	1.8668	0.1177	413.9	1.8617	0.1121	413.7	1.8568	0.1070	413.5	1.8522	-5
0	0.1265	418.0	1.8815	0.1202	417.8	1.8764	0.1145	417.7	1.8716	0.1093	417.5	1.8669	0
5	0.1291	422.0	1.8960	0.1227	421.9	1.8910	0.1169	421.7	1.8861	0.1116	421.6	1.8815	5
10	0.1317	426.1	1.9105	0.1252	425.9	1.9054	0.1193	425.8	1.9006	0.1139	425.6	1.8960	10
15	0.1343	430.1	1.9248	0.1276	430.0	1.9198	0.1216	429.9	1.9149	0.1161	429.7	1.9103	15
20	0.1368	434.3	1.9390	0.1301	434.1	1.9340	0.1240	434.0	1.9292	0.1184	433.9	1.9246	20
25	0.1394	438.4	1.9531	0.1326	438.3	1.9481	0.1263	438.2	1.9433	0.1206	438.0	1.9387	25
30	0.1420	442.6	1.9670	0.1350	442.5	1.9620	0.1287	442.4	1.9573	0.1229	442.2	1.9527	30
35	0.1445	446.9	1.9809	0.1374	446.7	1.9759	0.1310	446.6	1.9712	0.1251	446.5	1.9666	35
40	0.1471	451.2	1.9947	0.1399	451.0	1.9897	0.1333	450.9	1.9850	0.1273	450.8	1.9804	40
45	0.1496	455.5	2.0084	0.1423	455.4	2.0034	0.1356	455.2	1.9987	0.1296	455.1	1.9941	45
50	0.1521	459.8	2.0220	0.1447	459.7	2.0170	0.1380	459.6	2.0123	0.1318	459.5	2.0078	50
55	0.1547	464.2	2.0355	0.1471	464.1	2.0305	0.1403	464.0	2.0258	0.1340	463.9	2.0213	55
60	0.1572	468.7	2.0489	0.1495	468.5	2.0439	0.1426	468.4	2.0392	0.1362	468.3	2.0347	60
65	0.1597	473.1	2.0622	0.1519	473.0	2.0573	0.1449	472.9	2.0526	0.1384	472.8	2.0481	65
70	0.1622	477.6	2.0754	0.1543	477.5	2.0705	0.1472	477.4	2.0658	0.1406	477.3	2.0613	70
75	0.1647	482.2	2.0886	0.1567	482.1	2.0837	0.1495	482.0	2.0790	0.1428	481.9	2.0745	75
80	0.1672	486.8	2.1017	0.1591	486.7	2.0968	0.1518	486.6	2.0921	0.1450	486.5	2.0876	80
85	0.1697	491.4	2.1147	0.1615	491.3	2.1098	0.1540	491.2	2.1051	0.1472	491.1	2.1006	85
90	0.1723	496.1	2.1276	0.1639	496.0	2.1227	0.1563	495.9	2.1180	0.1494	495.8	2.1136	90
95	0.1748	500.8	2.1404	0.1663	500.7	2.1356	0.1586	500.6	2.1309	0.1516	500.5	2.1264	95
100	0.1772	505.5	2.1532	0.1687	505.4	2.1483	0.1609	505.3	2.1437	0.1538	505.2	2.1392	100
105	0.1797	510.3	2.1659	0.1711	510.2	2.1611	0.1632	510.1	2.1564	0.1560	510.0	2.1520	105
110	0.1822	515.1	2.1786	0.1734	515.0	2.1737	0.1654	514.9	2.1690	0.1581	514.8	2.1646	110
115	0.1847	519.9	2.1911	0.1758	519.8	2.1863	0.1677	519.7	2.1816	0.1603	519.7	2.1772	115
120	0.1872	524.8	2.2036	0.1782	524.7	2.1988	0.1700	524.6	2.1941	0.1625	524.6	2.1897	120
125	0.1897	529.7	2.2160	0.1805	529.6	2.2112	0.1722	529.6	2.2066	0.1646	529.5	2.2021	125
130	0.1922	534.7	2.2284	0.1829	534.6	2.2236	0.1745	534.5	2.2189	0.1668	534.4	2.2145	130
135	—	—	—	—	—	—	0.1768	539.5	2.2312	0.1690	539.4	2.2268	135

TABLE 2 (continued)
Suva® 407C Superheated Vapor—Constant Pressure Tables

V = Volume in m³/kg H = Enthalpy in kJ/kg S = Entropy in kJ/(kg) (K) (Saturation Properties in parentheses)

ABSOLUTE PRESSURE, kPa

TEMP. °C	240.0 (-16.90°C) V	H	S	250.0 (-15.90°C) V	H	S	260.0 (-14.90°C) V	H	S	270.0 (-13.90°C) V	H	S	TEMP. °C
	(0.0970)	(404.0)	(1.8121)	(0.0934)	(404.7)	(1.8108)	(0.0899)	(405.3)	(1.8095)	(0.0868)	(405.8)	(1.8083)	
-15	0.0979	405.5	1.8177	0.0937	405.3	1.8133	—	—	—	—	—	—	-15
-10	0.1001	409.4	1.8328	0.0959	409.3	1.8284	0.0920	409.1	1.8242	0.0883	408.9	1.8201	-10
-5	0.1023	413.4	1.8476	0.0980	413.2	1.8433	0.0940	413.1	1.8391	0.0903	412.9	1.8351	-5
0	0.1045	417.4	1.8624	0.1001	417.2	1.8581	0.0961	417.1	1.8539	0.0923	416.9	1.8499	0
5	0.1067	421.4	1.8770	0.1022	421.2	1.8727	0.0981	421.1	1.8686	0.0943	420.9	1.8646	5
10	0.1089	425.5	1.8915	0.1043	425.3	1.8872	0.1001	425.2	1.8831	0.0962	425.0	1.8791	10
15	0.1111	429.6	1.9059	0.1064	429.4	1.9016	0.1022	429.3	1.8975	0.0982	429.1	1.8935	15
20	0.1133	433.7	1.9201	0.1085	433.6	1.9159	0.1042	433.4	1.9118	0.1002	433.3	1.9078	20
25	0.1154	437.9	1.9343	0.1106	437.8	1.9300	0.1062	437.6	1.9260	0.1021	437.5	1.9220	25
30	0.1176	442.1	1.9483	0.1127	442.0	1.9441	0.1082	441.9	1.9400	0.1040	441.7	1.9361	30
35	0.1197	446.4	1.9622	0.1148	446.2	1.9580	0.1102	446.1	1.9540	0.1060	446.0	1.9500	35
40	0.1219	450.7	1.9761	0.1168	450.5	1.9719	0.1122	450.4	1.9678	0.1079	450.3	1.9639	40
45	0.1240	455.0	1.9898	0.1189	454.9	1.9856	0.1142	454.8	1.9815	0.1098	454.6	1.9777	45
50	0.1261	459.4	2.0034	0.1209	459.2	1.9992	0.1161	459.1	1.9952	0.1117	459.0	1.9913	50
55	0.1283	463.8	2.0169	0.1230	463.7	2.0128	0.1181	463.5	2.0088	0.1136	463.4	2.0049	55
60	0.1304	468.2	2.0304	0.1250	468.1	2.0262	0.1201	468.0	2.0222	0.1155	467.9	2.0183	60
65	0.1325	472.7	2.0437	0.1271	472.6	2.0396	0.1221	472.5	2.0356	0.1174	472.4	2.0317	65
70	0.1346	477.2	2.0570	0.1291	477.1	2.0529	0.1240	477.0	2.0489	0.1193	476.9	2.0450	70
75	0.1367	481.8	2.0702	0.1311	481.7	2.0661	0.1260	481.6	2.0621	0.1212	481.5	2.0582	75
80	0.1389	486.4	2.0833	0.1332	486.3	2.0792	0.1279	486.2	2.0752	0.1231	486.1	2.0714	80
85	0.1410	491.0	2.0963	0.1352	490.9	2.0922	0.1299	490.8	2.0882	0.1250	490.7	2.0844	85
90	0.1431	495.7	2.1093	0.1372	495.6	2.1052	0.1318	495.5	2.1012	0.1268	495.4	2.0974	90
95	0.1452	500.4	2.1222	0.1392	500.3	2.1180	0.1338	500.2	2.1141	0.1287	500.1	2.1103	95
100	0.1473	505.1	2.1350	0.1413	505.0	2.1309	0.1357	505.0	2.1269	0.1306	504.9	2.1231	100
105	0.1493	509.9	2.1477	0.1433	509.8	2.1436	0.1377	509.7	2.1396	0.1325	509.6	2.1358	105
110	0.1514	514.7	2.1603	0.1453	514.6	2.1562	0.1396	514.6	2.1523	0.1343	514.5	2.1485	110
115	0.1535	519.6	2.1729	0.1473	519.5	2.1688	0.1415	519.4	2.1649	0.1362	519.3	2.1611	115
120	0.1556	524.5	2.1854	0.1493	524.4	2.1814	0.1434	524.3	2.1774	0.1380	524.2	2.1736	120
125	0.1577	529.4	2.1979	0.1513	529.3	2.1938	0.1454	529.2	2.1899	0.1399	529.2	2.1861	125
130	0.1598	534.4	2.2103	0.1533	534.3	2.2062	0.1473	534.2	2.2023	0.1418	534.1	2.1985	130
135	0.1618	539.4	2.2226	0.1553	539.3	2.2185	0.1492	539.2	2.2146	0.1436	539.1	2.2108	135
140	—	—	—	—	—	—	0.1511	544.2	2.2269	0.1455	544.2	2.2231	140

TEMP. °C	280.0 (-13.00°C) V	H	S	290.0 (-12.10°C) V	H	S	300.0 (-11.20°C) V	H	S	310.0 (-10.30°C) V	H	S	TEMP. °C
	(0.0838)	(406.4)	(1.8072)	(0.0810)	(406.9)	(1.8061)	(0.0785)	(407.5)	(1.8051)	(0.0760)	(408.0)	(1.8041)	
-10	0.0850	408.7	1.8162	0.0818	408.6	1.8124	0.0789	408.4	1.8087	0.0762	408.2	1.8051	-10
-5	0.0869	412.7	1.8312	0.0837	412.6	1.8274	0.0807	412.4	1.8237	0.0779	412.2	1.8201	-5
0	0.0888	416.7	1.8460	0.0856	416.6	1.8422	0.0825	416.4	1.8386	0.0797	416.3	1.8350	0
5	0.0907	420.8	1.8607	0.0874	420.6	1.8569	0.0843	420.5	1.8533	0.0814	420.3	1.8498	5
10	0.0926	424.9	1.8753	0.0893	424.7	1.8715	0.0861	424.6	1.8679	0.0832	424.4	1.8644	10
15	0.0945	429.0	1.8897	0.0911	428.9	1.8860	0.0879	428.7	1.8824	0.0849	428.6	1.8789	15
20	0.0964	433.2	1.9040	0.0929	433.0	1.9003	0.0897	432.9	1.8967	0.0866	432.7	1.8932	20
25	0.0983	437.4	1.9182	0.0947	437.2	1.9145	0.0914	437.1	1.9109	0.0883	437.0	1.9075	25
30	0.1002	441.6	1.9323	0.0965	441.5	1.9286	0.0932	441.3	1.9250	0.0900	441.2	1.9216	30
35	0.1020	445.9	1.9463	0.0984	445.7	1.9426	0.0949	445.6	1.9390	0.0917	445.5	1.9356	35
40	0.1039	450.2	1.9601	0.1002	450.0	1.9565	0.0967	449.9	1.9529	0.0934	449.8	1.9495	40
45	0.1057	454.5	1.9739	0.1020	454.4	1.9702	0.0984	454.3	1.9667	0.0951	454.2	1.9633	45
50	0.1076	458.9	1.9876	0.1037	458.8	1.9839	0.1002	458.7	1.9804	0.0968	458.5	1.9770	50
55	0.1094	463.3	2.0011	0.1055	463.2	1.9975	0.1019	463.1	1.9940	0.0985	463.0	1.9906	55
60	0.1113	467.8	2.0146	0.1073	467.7	2.0110	0.1036	467.6	2.0075	0.1001	467.4	2.0041	60
65	0.1131	472.3	2.0280	0.1091	472.2	2.0244	0.1053	472.1	2.0209	0.1018	471.9	2.0175	65
70	0.1149	476.8	2.0413	0.1108	476.7	2.0377	0.1070	476.6	2.0342	0.1035	476.5	2.0309	70
75	0.1168	481.4	2.0545	0.1126	481.3	2.0509	0.1088	481.2	2.0475	0.1051	481.1	2.0441	75
80	0.1186	486.0	2.0677	0.1144	485.9	2.0641	0.1105	485.8	2.0606	0.1068	485.7	2.0573	80
85	0.1204	490.6	2.0807	0.1161	490.5	2.0771	0.1122	490.4	2.0737	0.1084	490.3	2.0703	85
90	0.1222	495.3	2.0937	0.1179	495.2	2.0901	0.1139	495.1	2.0867	0.1101	495.0	2.0833	90
95	0.1240	500.0	2.1066	0.1196	499.9	2.1030	0.1156	499.8	2.0996	0.1117	499.7	2.0962	95
100	0.1258	504.8	2.1194	0.1214	504.7	2.1159	0.1173	504.6	2.1124	0.1134	504.5	2.1091	100
105	0.1276	509.6	2.1322	0.1231	509.5	2.1286	0.1189	509.4	2.1252	0.1150	509.3	2.1219	105
110	0.1294	514.4	2.1448	0.1249	514.3	2.1413	0.1206	514.2	2.1379	0.1167	514.1	2.1345	110
115	0.1312	519.2	2.1574	0.1266	519.2	2.1539	0.1223	519.1	2.1505	0.1183	519.0	2.1472	115
120	0.1330	524.1	2.1700	0.1284	524.1	2.1664	0.1240	524.0	2.1630	0.1199	523.9	2.1597	120
125	0.1348	529.1	2.1824	0.1301	529.0	2.1789	0.1257	528.9	2.1755	0.1216	528.8	2.1722	125
130	0.1366	534.0	2.1948	0.1318	534.0	2.1913	0.1274	533.9	2.1879	0.1232	533.8	2.1846	130
135	0.1384	539.0	2.2072	0.1336	539.0	2.2037	0.1290	538.9	2.2003	0.1248	538.8	2.1970	135
140	0.1402	544.1	2.2194	0.1353	544.0	2.2159	0.1307	543.9	2.2125	0.1264	543.9	2.2092	140

TABLE 2 (continued)

Suva® 407C Superheated Vapor—Constant Pressure Tables

V = Volume in m^3/kg H = Enthalpy in kJ/kg S = Entropy in kJ/(kg) (K) (Saturation Properties in parentheses)

ABSOLUTE PRESSURE, kPa

TEMP. °C	320.0 (-9.50°C) V	H	S	330.0 (-8.70°C) V	H	S	340.0 (-7.90°C) V	H	S	350.0 (-7.10°C) V	H	S	TEMP. °C
	(0.0738)	(408.5)	(1.8031)	(0.0716)	(408.9)	(1.8021)	(0.0696)	(409.4)	(1.8012)	(0.0677)	(409.9)	(1.8004)	
-5	0.0753	412.1	1.8166	0.0728	411.9	1.8132	0.0705	411.7	1.8099	0.0683	411.6	1.8067	-5
0	0.0770	416.1	1.8316	0.0745	415.9	1.8282	0.0722	415.8	1.8249	0.0699	415.6	1.8217	0
5	0.0787	420.2	1.8463	0.0762	420.0	1.8430	0.0738	419.9	1.8397	0.0715	419.7	1.8365	5
10	0.0804	424.3	1.8610	0.0778	424.1	1.8576	0.0754	424.0	1.8544	0.0731	423.8	1.8512	10
15	0.0821	428.4	1.8755	0.0794	428.3	1.8722	0.0770	428.1	1.8689	0.0746	428.0	1.8658	15
20	0.0838	432.6	1.8898	0.0811	432.5	1.8865	0.0786	432.3	1.8833	0.0762	432.2	1.8802	20
25	0.0854	436.8	1.9041	0.0827	436.7	1.9008	0.0801	436.5	1.8976	0.0777	436.4	1.8945	25
30	0.0871	441.1	1.9182	0.0843	440.9	1.9150	0.0817	440.8	1.9118	0.0792	440.7	1.9087	30
35	0.0887	445.4	1.9323	0.0859	445.2	1.9290	0.0833	445.1	1.9258	0.0808	445.0	1.9228	35
40	0.0904	449.7	1.9462	0.0875	449.5	1.9429	0.0848	449.4	1.9398	0.0823	449.3	1.9367	40
45	0.0920	454.0	1.9600	0.0891	453.9	1.9568	0.0864	453.8	1.9536	0.0838	453.7	1.9506	45
50	0.0937	458.4	1.9737	0.0907	458.3	1.9705	0.0879	458.2	1.9673	0.0853	458.1	1.9643	50
55	0.0953	462.9	1.9873	0.0923	462.7	1.9841	0.0895	462.6	1.9810	0.0868	462.5	1.9779	55
60	0.0969	467.3	2.0008	0.0939	467.2	1.9976	0.0910	467.1	1.9945	0.0883	467.0	1.9915	60
65	0.0985	471.8	2.0142	0.0954	471.7	2.0111	0.0925	471.6	2.0080	0.0898	471.5	2.0049	65
70	0.1001	476.4	2.0276	0.0970	476.3	2.0244	0.0941	476.2	2.0213	0.0913	476.1	2.0183	70
75	0.1018	481.0	2.0408	0.0986	480.9	2.0377	0.0956	480.8	2.0346	0.0928	480.7	2.0316	75
80	0.1034	485.6	2.0540	0.1001	485.5	2.0508	0.0971	485.4	2.0478	0.0942	485.3	2.0448	80
85	0.1050	490.2	2.0671	0.1017	490.1	2.0639	0.0986	490.0	2.0609	0.0957	489.9	2.0579	85
90	0.1066	494.9	2.0801	0.1032	494.8	2.0769	0.1001	494.7	2.0739	0.0972	494.6	2.0709	90
95	0.1082	499.6	2.0930	0.1048	499.6	2.0899	0.1016	499.5	2.0868	0.0986	499.4	2.0838	95
100	0.1098	504.4	2.1059	0.1063	504.3	2.1027	0.1031	504.2	2.0997	0.1001	504.1	2.0967	100
105	0.1113	509.2	2.1186	0.1079	509.1	2.1155	0.1046	509.0	2.1125	0.1016	508.9	2.1095	105
110	0.1129	514.0	2.1313	0.1094	514.0	2.1282	0.1061	513.9	2.1252	0.1030	513.8	2.1222	110
115	0.1145	518.9	2.1440	0.1110	518.8	2.1408	0.1076	518.7	2.1378	0.1045	518.7	2.1349	115
120	0.1161	523.8	2.1565	0.1125	523.7	2.1534	0.1091	523.6	2.1504	0.1059	523.6	2.1474	120
125	0.1177	528.8	2.1690	0.1140	528.7	2.1659	0.1106	528.6	2.1629	0.1074	528.5	2.1599	125
130	0.1193	533.7	2.1814	0.1156	533.6	2.1783	0.1121	533.6	2.1753	0.1088	533.5	2.1724	130
135	0.1208	538.7	2.1938	0.1171	538.7	2.1907	0.1136	538.6	2.1876	0.1103	538.5	2.1847	135
140	0.1224	543.8	2.2060	0.1186	543.7	2.2029	0.1151	543.6	2.1999	0.1117	543.6	2.1970	140
145	0.1240	548.9	2.2183	0.1202	548.8	2.2152	0.1166	548.7	2.2122	0.1132	548.6	2.2092	145

TEMP. °C	360.0 (-6.30°C) V	H	S	370.0 (-5.60°C) V	H	S	380.0 (-4.90°C) V	H	S	390.0 (-4.20°C) V	H	S	TEMP. °C
	(0.0659)	(410.3)	(1.7995)	(0.0642)	(410.7)	(1.7987)	(0.0625)	(411.2)	(1.7979)	(0.0610)	(411.6)	(1.7971)	
-5	0.0663	411.4	1.8036	0.0643	411.2	1.8005	—	—	—	—	—	—	-5
0	0.0678	415.4	1.8186	0.0658	415.3	1.8155	0.0640	415.1	1.8126	0.0622	415.0	1.8096	0
5	0.0694	419.5	1.8334	0.0673	419.4	1.8304	0.0654	419.2	1.8275	0.0636	419.1	1.8246	5
10	0.0709	423.7	1.8482	0.0688	423.5	1.8452	0.0669	423.4	1.8422	0.0650	423.2	1.8393	10
15	0.0724	427.8	1.8627	0.0703	427.7	1.8597	0.0683	427.5	1.8568	0.0665	427.4	1.8540	15
20	0.0739	432.0	1.8772	0.0718	431.9	1.8742	0.0698	431.7	1.8713	0.0679	431.6	1.8685	20
25	0.0754	436.3	1.8915	0.0733	436.1	1.8885	0.0712	436.0	1.8856	0.0693	435.8	1.8828	25
30	0.0769	440.5	1.9057	0.0747	440.4	1.9027	0.0726	440.3	1.8999	0.0707	440.1	1.8971	30
35	0.0784	444.8	1.9198	0.0762	444.7	1.9168	0.0740	444.6	1.9140	0.0720	444.4	1.9112	35
40	0.0799	449.2	1.9337	0.0776	449.0	1.9308	0.0755	448.9	1.9280	0.0734	448.8	1.9252	40
45	0.0814	453.5	1.9476	0.0790	453.4	1.9447	0.0769	453.3	1.9418	0.0748	453.2	1.9391	45
50	0.0828	458.0	1.9613	0.0805	457.8	1.9584	0.0783	457.7	1.9556	0.0762	457.6	1.9528	50
55	0.0843	462.4	1.9750	0.0819	462.3	1.9721	0.0797	462.2	1.9693	0.0775	462.1	1.9665	55
60	0.0857	466.9	1.9885	0.0833	466.8	1.9857	0.0810	466.7	1.9829	0.0789	466.5	1.9801	60
65	0.0872	471.4	2.0020	0.0847	471.3	1.9991	0.0824	471.2	1.9963	0.0802	471.1	1.9936	65
70	0.0886	476.0	2.0154	0.0862	475.9	2.0125	0.0838	475.7	2.0097	0.0816	475.6	2.0070	70
75	0.0901	480.5	2.0287	0.0876	480.4	2.0258	0.0852	480.3	2.0230	0.0829	480.2	2.0203	75
80	0.0915	485.2	2.0418	0.0890	485.1	2.0390	0.0865	485.0	2.0362	0.0842	484.9	2.0335	80
85	0.0930	489.8	2.0550	0.0904	489.7	2.0521	0.0879	489.6	2.0494	0.0856	489.5	2.0467	85
90	0.0944	494.5	2.0680	0.0918	494.4	2.0652	0.0893	494.3	2.0624	0.0869	494.3	2.0597	90
95	0.0958	499.3	2.0809	0.0932	499.2	2.0781	0.0906	499.1	2.0754	0.0882	499.0	2.0727	95
100	0.0973	504.0	2.0938	0.0946	504.0	2.0910	0.0920	503.9	2.0883	0.0896	503.8	2.0856	100
105	0.0987	508.9	2.1066	0.0959	508.8	2.1038	0.0933	508.7	2.1011	0.0909	508.6	2.0984	105
110	0.1001	513.7	2.1193	0.0973	513.6	2.1165	0.0947	513.5	2.1138	0.0922	513.4	2.1111	110
115	0.1015	518.6	2.1320	0.0987	518.5	2.1292	0.0960	518.4	2.1265	0.0935	518.3	2.1238	115
120	0.1029	523.5	2.1446	0.1001	523.4	2.1418	0.0974	523.3	2.1390	0.0948	523.2	2.1364	120
125	0.1043	528.4	2.1571	0.1015	528.4	2.1543	0.0987	528.3	2.1516	0.0961	528.2	2.1489	125
130	0.1058	533.4	2.1695	0.1028	533.3	2.1667	0.1001	533.3	2.1640	0.0974	533.2	2.1614	130
135	0.1072	538.4	2.1819	0.1042	538.4	2.1791	0.1014	538.3	2.1764	0.0988	538.2	2.1737	135
140	0.1086	543.5	2.1942	0.1056	543.4	2.1914	0.1027	543.3	2.1887	0.1001	543.3	2.1860	140
145	0.1100	548.6	2.2064	0.1069	548.5	2.2036	0.1041	548.4	2.2009	0.1014	548.3	2.1983	145
150	—	—	—	—	—	—	0.1054	553.5	2.2131	0.1027	553.5	2.2105	150

TABLE 2 (continued)

Suva® 407C Superheated Vapor—Constant Pressure Tables

V = Volume in m^3/kg H = Enthalpy in kJ/kg S = Entropy in kJ/(kg) (K) (Saturation Properties in parentheses)

ABSOLUTE PRESSURE, kPa

TEMP. °C	400.0 (-3.50°C) V	H	S	430.0 (-1.80°C) V	H	S	450.0 (-0.10°C) V	H	S	480.0 (1.40°C) V	H	S	TEMP. °C
	(0.0595)	(412.0)	(1.7964)	(0.0561)	(412.9)	(1.7946)	(0.0531)	(413.8)	(1.7930)	(0.0504)	(414.7)	(1.7914)	
0	0.0605	414.8	1.8068	0.0566	414.4	1.7999	0.0531	413.9	1.7933	0.0000	0.0	0.0000	0
5	0.0619	418.9	1.8217	0.0579	418.5	1.8149	0.0544	418.1	1.8084	0.0512	417.7	1.8022	5
10	0.0633	423.1	1.8365	0.0592	422.7	1.8297	0.0557	422.3	1.8233	0.0524	421.9	1.8171	10
15	0.0647	427.2	1.8512	0.0606	426.9	1.8444	0.0569	426.5	1.8380	0.0536	426.1	1.8319	15
20	0.0660	431.5	1.8657	0.0619	431.1	1.8590	0.0582	430.7	1.8526	0.0548	430.4	1.8466	20
25	0.0674	435.7	1.8801	0.0632	435.4	1.8734	0.0594	435.0	1.8671	0.0560	434.6	1.8611	25
30	0.0688	440.0	1.8943	0.0645	439.7	1.8877	0.0606	439.3	1.8814	0.0572	439.0	1.8754	30
35	0.0701	444.3	1.9084	0.0657	444.0	1.9019	0.0619	443.7	1.8956	0.0584	443.3	1.8897	35
40	0.0715	448.7	1.9225	0.0670	448.3	1.9159	0.0631	448.0	1.9097	0.0595	447.7	1.9038	40
45	0.0728	453.1	1.9364	0.0683	452.7	1.9298	0.0643	452.4	1.9237	0.0607	452.1	1.9178	45
50	0.0742	457.5	1.9502	0.0696	457.2	1.9437	0.0655	456.9	1.9375	0.0618	456.6	1.9317	50
55	0.0755	461.9	1.9638	0.0708	461.6	1.9574	0.0667	461.4	1.9513	0.0630	461.1	1.9454	55
60	0.0768	466.4	1.9774	0.0721	466.1	1.9710	0.0679	465.9	1.9649	0.0641	465.6	1.9591	60
65	0.0781	471.0	1.9909	0.0733	470.7	1.9845	0.0691	470.4	1.9785	0.0652	470.1	1.9727	65
70	0.0794	475.5	2.0044	0.0746	475.3	1.9980	0.0702	475.0	1.9919	0.0664	474.7	1.9861	70
75	0.0808	480.1	2.0177	0.0758	479.9	2.0113	0.0714	479.6	2.0053	0.0675	479.3	1.9995	75
80	0.0821	484.8	2.0309	0.0770	484.5	2.0245	0.0726	484.3	2.0185	0.0686	484.0	2.0128	80
85	0.0834	489.4	2.0440	0.0783	489.2	2.0377	0.0738	488.9	2.0317	0.0697	488.7	2.0260	85
90	0.0847	494.2	2.0571	0.0795	493.9	2.0508	0.0749	493.7	2.0448	0.0708	493.4	2.0391	90
95	0.0860	498.9	2.0701	0.0807	498.7	2.0638	0.0761	498.4	2.0578	0.0719	498.2	2.0521	95
100	0.0873	503.7	2.0830	0.0820	503.5	2.0767	0.0773	503.2	2.0707	0.0730	503.0	2.0651	100
105	0.0885	508.5	2.0958	0.0832	508.3	2.0895	0.0784	508.0	2.0836	0.0741	507.8	2.0780	105
110	0.0898	513.3	2.1085	0.0844	513.1	2.1023	0.0796	512.9	2.0964	0.0752	512.7	2.0907	110
115	0.0911	518.2	2.1212	0.0856	518.0	2.1150	0.0807	517.8	2.1091	0.0763	517.6	2.1035	115
120	0.0924	523.2	2.1338	0.0868	522.9	2.1276	0.0819	522.7	2.1217	0.0774	522.5	2.1161	120
125	0.0937	528.1	2.1463	0.0880	527.9	2.1401	0.0830	527.7	2.1342	0.0785	527.5	2.1287	125
130	0.0950	533.1	2.1588	0.0892	532.9	2.1526	0.0842	532.7	2.1467	0.0796	532.5	2.1411	130
135	0.0962	538.1	2.1712	0.0904	537.9	2.1650	0.0853	537.7	2.1591	0.0807	537.5	2.1536	135
140	0.0975	543.2	2.1835	0.0916	543.0	2.1773	0.0864	542.8	2.1715	0.0818	542.6	2.1659	140
145	0.0988	548.3	2.1957	0.0928	548.1	2.1896	0.0876	547.9	2.1837	0.0828	547.7	2.1782	145
150	0.1000	553.4	2.2079	0.0940	553.2	2.2018	0.0887	553.0	2.1959	0.0839	552.9	2.1904	150
155	—	—	—	—	—	—	—	—	—	0.0850	558.0	2.2026	155

TEMP. °C	500.0 (2.90°C) V	H	S	530.0 (4.40°C) V	H	S	550.0 (5.70°C) V	H	S	580.0 (7.10°C) V	H	S	TEMP. °C
	(0.0479)	(415.5)	(1.7899)	(0.0457)	(416.3)	(1.7885)	(0.0436)	(417.0)	(1.7872)	(0.0417)	(417.8)	(1.7859)	
5	0.0484	417.3	1.7962	0.0458	416.8	1.7905	—	—	—	—	—	—	5
10	0.0495	421.5	1.8112	0.0469	421.1	1.8055	0.0445	420.7	1.8000	0.0424	420.3	1.7947	10
15	0.0507	425.7	1.8260	0.0480	425.3	1.8204	0.0456	424.9	1.8150	0.0434	424.5	1.8098	15
20	0.0518	430.0	1.8407	0.0491	429.6	1.8352	0.0467	429.2	1.8298	0.0444	428.9	1.8246	20
25	0.0530	434.3	1.8553	0.0502	433.9	1.8497	0.0477	433.6	1.8444	0.0454	433.2	1.8393	25
30	0.0541	438.6	1.8697	0.0513	438.3	1.8642	0.0488	437.9	1.8589	0.0464	437.6	1.8538	30
35	0.0552	443.0	1.8840	0.0524	442.6	1.8785	0.0498	442.3	1.8733	0.0474	442.0	1.8682	35
40	0.0563	447.4	1.8981	0.0534	447.0	1.8927	0.0508	446.7	1.8875	0.0484	446.4	1.8825	40
45	0.0574	451.8	1.9121	0.0545	451.5	1.9067	0.0518	451.2	1.9016	0.0494	450.8	1.8966	45
50	0.0585	456.3	1.9261	0.0556	456.0	1.9207	0.0529	455.7	1.9155	0.0504	455.3	1.9106	50
55	0.0596	460.8	1.9399	0.0566	460.5	1.9345	0.0539	460.2	1.9294	0.0514	459.9	1.9245	55
60	0.0607	465.3	1.9536	0.0577	465.0	1.9483	0.0549	464.7	1.9432	0.0523	464.4	1.9383	60
65	0.0618	469.9	1.9672	0.0587	469.6	1.9619	0.0559	469.3	1.9568	0.0533	469.0	1.9519	65
70	0.0629	474.5	1.9806	0.0597	474.2	1.9754	0.0568	473.9	1.9704	0.0542	473.6	1.9655	70
75	0.0639	479.1	1.9941	0.0607	478.8	1.9888	0.0578	478.6	1.9838	0.0552	478.3	1.9790	75
80	0.0650	483.8	2.0074	0.0618	483.5	2.0021	0.0588	483.2	1.9971	0.0561	483.0	1.9923	80
85	0.0661	488.5	2.0206	0.0628	488.2	2.0154	0.0598	487.9	2.0104	0.0571	487.7	2.0056	85
90	0.0671	493.2	2.0337	0.0638	492.9	2.0285	0.0608	492.7	2.0236	0.0580	492.5	2.0188	90
95	0.0682	498.0	2.0468	0.0648	497.7	2.0416	0.0617	497.5	2.0366	0.0589	497.2	2.0319	95
100	0.0693	502.8	2.0597	0.0658	502.5	2.0546	0.0627	502.3	2.0496	0.0599	502.1	2.0449	100
105	0.0703	507.6	2.0726	0.0668	507.4	2.0675	0.0637	507.1	2.0626	0.0608	506.9	2.0578	105
110	0.0713	512.5	2.0854	0.0678	512.3	2.0803	0.0646	512.0	2.0754	0.0617	511.8	2.0707	110
115	0.0724	517.4	2.0981	0.0688	517.2	2.0930	0.0656	516.9	2.0881	0.0626	516.7	2.0835	115
120	0.0734	522.3	2.1108	0.0698	522.1	2.1057	0.0665	521.9	2.1008	0.0635	521.7	2.0961	120
125	0.0745	527.3	2.1233	0.0708	527.1	2.1183	0.0675	526.9	2.1134	0.0645	526.7	2.1088	125
130	0.0755	532.3	2.1358	0.0718	532.1	2.1308	0.0684	531.9	2.1259	0.0654	531.7	2.1213	130
135	0.0765	537.3	2.1483	0.0728	537.2	2.1432	0.0694	537.0	2.1384	0.0663	536.8	2.1338	135
140	0.0776	542.4	2.1606	0.0738	542.2	2.1556	0.0703	542.0	2.1508	0.0672	541.9	2.1462	140
145	0.0786	547.5	2.1729	0.0748	547.3	2.1679	0.0713	547.2	2.1631	0.0681	547.0	2.1585	145
150	0.0796	552.7	2.1851	0.0757	552.5	2.1801	0.0722	552.3	2.1753	0.0690	552.1	2.1707	150
155	0.0807	557.8	2.1973	0.0767	557.7	2.1923	0.0731	557.5	2.1875	0.0699	557.3	2.1829	155
160	—	—	—	—	—	—	0.0741	562.7	2.1996	0.0708	562.5	2.1950	160

TABLE 2 (continued)
Suva® 407C Superheated Vapor—Constant Pressure Tables

V = Volume in m³/kg   H = Enthalpy in kJ/kg   S = Entropy in kJ/(kg) (K)   (Saturation Properties in parentheses)

ABSOLUTE PRESSURE, kPa

TEMP. °C	600.0 (8.40°C) V	H	S	630.0 (9.60°C) V	H	S	650.0 (10.80°C) V	H	S	680.0 (12.00°C) V	H	S	TEMP. °C
	(0.0400)	(418.4)	(1.7847)	(0.0384)	(419.1)	(1.7835)	(0.0370)	(419.7)	(1.7824)	(0.0356)	(420.3)	(1.7813)	
10	0.0404	419.8	1.7896	0.0385	419.4	1.7846	—	—	—	—	—	—	10
15	0.0414	424.1	1.8047	0.0395	423.7	1.7998	0.0378	423.3	1.7950	0.0362	422.9	1.7904	15
20	0.0424	428.5	1.8196	0.0405	428.1	1.8147	0.0387	427.7	1.8100	0.0371	427.3	1.8054	20
25	0.0433	432.8	1.8343	0.0414	432.4	1.8295	0.0396	432.1	1.8248	0.0380	431.7	1.8203	25
30	0.0443	437.2	1.8489	0.0423	436.8	1.8441	0.0405	436.5	1.8395	0.0389	436.1	1.8350	30
35	0.0453	441.6	1.8633	0.0433	441.3	1.8586	0.0414	440.9	1.8540	0.0397	440.6	1.8496	35
40	0.0462	446.1	1.8776	0.0442	445.7	1.8729	0.0423	445.4	1.8684	0.0406	445.0	1.8640	40
45	0.0472	450.5	1.8918	0.0451	450.2	1.8871	0.0432	449.9	1.8826	0.0415	449.5	1.8783	45
50	0.0481	455.0	1.9058	0.0460	454.7	1.9012	0.0441	454.4	1.8967	0.0423	454.1	1.8924	50
55	0.0491	459.6	1.9197	0.0469	459.3	1.9152	0.0450	459.0	1.9107	0.0432	458.6	1.9064	55
60	0.0500	464.1	1.9335	0.0478	463.8	1.9290	0.0458	463.5	1.9246	0.0440	463.2	1.9203	60
65	0.0509	468.7	1.9472	0.0487	468.4	1.9427	0.0467	468.2	1.9383	0.0448	467.9	1.9341	65
70	0.0518	473.4	1.9608	0.0496	473.1	1.9563	0.0476	472.8	1.9520	0.0457	472.5	1.9478	70
75	0.0527	478.0	1.9743	0.0505	477.7	1.9699	0.0484	477.5	1.9655	0.0465	477.2	1.9613	75
80	0.0536	482.7	1.9877	0.0514	482.5	1.9833	0.0493	482.2	1.9790	0.0473	481.9	1.9748	80
85	0.0546	487.4	2.0010	0.0522	487.2	1.9966	0.0501	486.9	1.9923	0.0481	486.7	1.9882	85
90	0.0555	492.2	2.0142	0.0531	492.0	2.0098	0.0510	491.7	2.0055	0.0490	491.5	2.0014	90
95	0.0564	497.0	2.0273	0.0540	496.8	2.0229	0.0518	496.5	2.0187	0.0498	496.3	2.0146	95
100	0.0572	501.8	2.0404	0.0548	501.6	2.0360	0.0526	501.4	2.0318	0.0506	501.1	2.0277	100
105	0.0581	506.7	2.0533	0.0557	506.5	2.0489	0.0535	506.2	2.0447	0.0514	506.0	2.0407	105
110	0.0590	511.6	2.0662	0.0566	511.4	2.0618	0.0543	511.1	2.0576	0.0522	510.9	2.0536	110
115	0.0599	516.5	2.0790	0.0574	516.3	2.0746	0.0551	516.1	2.0704	0.0530	515.9	2.0664	115
120	0.0608	521.5	2.0917	0.0583	521.3	2.0873	0.0559	521.1	2.0832	0.0538	520.8	2.0791	120
125	0.0617	526.5	2.1043	0.0591	526.3	2.1000	0.0567	526.1	2.0958	0.0546	525.9	2.0918	125
130	0.0625	531.5	2.1168	0.0600	531.3	2.1125	0.0576	531.1	2.1084	0.0553	530.9	2.1044	130
135	0.0634	536.6	2.1293	0.0608	536.4	2.1250	0.0584	536.2	2.1209	0.0561	536.0	2.1169	135
140	0.0643	541.7	2.1417	0.0616	541.5	2.1374	0.0592	541.3	2.1333	0.0569	541.1	2.1294	140
145	0.0652	546.8	2.1541	0.0625	546.6	2.1498	0.0600	546.4	2.1457	0.0577	546.2	2.1417	145
150	0.0660	551.9	2.1663	0.0633	551.8	2.1621	0.0608	551.6	2.1580	0.0585	551.4	2.1540	150
155	0.0669	557.1	2.1785	0.0641	557.0	2.1743	0.0616	556.8	2.1702	0.0592	556.6	2.1662	155
160	0.0678	562.4	2.1906	0.0650	562.2	2.1864	0.0624	562.0	2.1823	0.0600	561.8	2.1784	160
165	—	—	—	—	—	—	0.0632	567.3	2.1944	0.0608	567.1	2.1905	165

TEMP. °C	700.0 (13.20°C) V	H	S	730.0 (14.30°C) V	H	S	750.0 (15.40°C) V	H	S	800.0 (17.50°C) V	H	S	TEMP. °C
	(0.0343)	(420.9)	(1.7802)	(0.0331)	(421.4)	(1.7792)	(0.0320)	(422.0)	(1.7782)	(0.0300)	(423.0)	(1.7763)	
15	0.0347	422.5	1.7858	0.0333	422.1	1.7814	—	—	—	—	—	—	15
20	0.0356	426.9	1.8010	0.0341	426.5	1.7966	0.0328	426.1	1.7924	0.0304	425.2	1.7841	20
25	0.0364	431.3	1.8159	0.0350	430.9	1.8116	0.0337	430.5	1.8074	0.0312	429.7	1.7993	25
30	0.0373	435.7	1.8307	0.0358	435.4	1.8264	0.0345	435.0	1.8223	0.0320	434.2	1.8143	30
35	0.0381	440.2	1.8453	0.0367	439.8	1.8411	0.0353	439.5	1.8370	0.0328	438.8	1.8291	35
40	0.0390	444.7	1.8597	0.0375	444.4	1.8556	0.0361	444.0	1.8515	0.0336	443.3	1.8437	40
45	0.0398	449.2	1.8740	0.0383	448.9	1.8699	0.0369	448.5	1.8659	0.0343	447.9	1.8582	45
50	0.0407	453.8	1.8882	0.0391	453.4	1.8841	0.0377	453.1	1.8802	0.0351	452.5	1.8725	50
55	0.0415	458.3	1.9023	0.0399	458.0	1.8982	0.0385	457.7	1.8943	0.0358	457.1	1.8867	55
60	0.0423	462.9	1.9162	0.0407	462.6	1.9122	0.0392	462.3	1.9083	0.0365	461.7	1.9008	60
65	0.0431	467.6	1.9300	0.0415	467.3	1.9260	0.0400	467.0	1.9221	0.0373	466.4	1.9147	65
70	0.0439	472.2	1.9437	0.0423	472.0	1.9397	0.0408	471.7	1.9359	0.0380	471.1	1.9285	70
75	0.0447	476.9	1.9573	0.0431	476.7	1.9533	0.0415	476.4	1.9495	0.0387	475.8	1.9422	75
80	0.0455	481.7	1.9708	0.0438	481.4	1.9669	0.0423	481.1	1.9631	0.0394	480.6	1.9558	80
85	0.0463	486.4	1.9841	0.0446	486.2	1.9803	0.0430	485.9	1.9765	0.0401	485.4	1.9692	85
90	0.0471	491.2	1.9974	0.0454	491.0	1.9936	0.0438	490.7	1.9898	0.0408	490.2	1.9826	90
95	0.0479	496.0	2.0106	0.0461	495.8	2.0068	0.0445	495.5	2.0030	0.0415	495.1	1.9959	95
100	0.0487	500.9	2.0237	0.0469	500.7	2.0199	0.0452	500.4	2.0162	0.0422	499.9	2.0090	100
105	0.0494	505.8	2.0367	0.0476	505.5	2.0329	0.0460	505.3	2.0292	0.0429	504.9	2.0221	105
110	0.0502	510.7	2.0497	0.0484	510.5	2.0459	0.0467	510.2	2.0422	0.0436	509.8	2.0351	110
115	0.0510	515.6	2.0625	0.0491	515.4	2.0587	0.0474	515.2	2.0550	0.0443	514.8	2.0480	115
120	0.0518	520.6	2.0753	0.0499	520.4	2.0715	0.0481	520.2	2.0678	0.0450	519.8	2.0608	120
125	0.0525	525.6	2.0879	0.0506	525.4	2.0842	0.0489	525.2	2.0805	0.0457	524.8	2.0736	125
130	0.0533	530.7	2.1005	0.0514	530.5	2.0968	0.0496	530.3	2.0932	0.0463	529.9	2.0862	130
135	0.0540	535.8	2.1131	0.0521	535.6	2.1093	0.0503	535.4	2.1057	0.0470	535.0	2.0988	135
140	0.0548	540.9	2.1255	0.0528	540.7	2.1218	0.0510	540.5	2.1182	0.0477	540.1	2.1113	140
145	0.0556	546.0	2.1379	0.0536	545.8	2.1342	0.0517	545.7	2.1306	0.0484	545.3	2.1237	145
150	0.0563	551.2	2.1502	0.0543	551.0	2.1465	0.0524	550.8	2.1429	0.0490	550.5	2.1360	150
155	0.0571	556.4	2.1624	0.0550	556.2	2.1587	0.0531	556.1	2.1552	0.0497	555.7	2.1483	155
160	0.0578	561.7	2.1746	0.0557	561.5	2.1709	0.0538	561.3	2.1673	0.0503	561.0	2.1605	160
165	0.0586	566.9	2.1867	0.0565	566.8	2.1830	0.0545	566.6	2.1795	0.0510	566.2	2.1727	165
170	—	—	—	—	—	—	0.0552	571.9	2.1915	0.0517	571.6	2.1847	170

TABLE 2 (continued)
Suva® 407C Superheated Vapor—Constant Pressure Tables

V = Volume in m³/kg H = Enthalpy in kJ/kg S = Entropy in kJ/(kg) (K) (Saturation Properties in parentheses)

ABSOLUTE PRESSURE, kPa

TEMP. °C	850.0 (19.40°C) V	H	S	900.0 (21.40°C) V	H	S	950.0 (23.20°C) V	H	S	1000.0 (24.90°C) V	H	S	TEMP. °C
	(0.0282)	(423.9)	(1.7745)	(0.0266)	(424.8)	(1.7728)	(0.0252)	(425.6)	(1.7712)	(0.0239)	(426.3)	(1.7696)	
20	0.0283	424.4	1.7763	—	—	—	—	—	—	—	—	—	20
25	0.0291	428.9	1.7916	0.0272	428.1	1.7841	0.0254	427.3	1.7768	0.0239	426.4	1.7698	25
30	0.0298	433.5	1.8067	0.0279	432.7	1.7993	0.0261	431.9	1.7922	0.0246	431.0	1.7853	30
35	0.0306	438.0	1.8216	0.0286	437.3	1.8143	0.0268	436.5	1.8073	0.0252	435.7	1.8006	35
40	0.0313	442.6	1.8363	0.0293	441.9	1.8291	0.0275	441.1	1.8223	0.0259	440.4	1.8156	40
45	0.0320	447.2	1.8508	0.0300	446.5	1.8438	0.0282	445.8	1.8370	0.0266	445.1	1.8304	45
50	0.0328	451.8	1.8652	0.0307	451.1	1.8583	0.0289	450.5	1.8516	0.0272	449.8	1.8451	50
55	0.0335	456.4	1.8795	0.0314	455.8	1.8726	0.0295	455.1	1.8660	0.0278	454.5	1.8596	55
60	0.0342	461.1	1.8936	0.0320	460.5	1.8868	0.0302	459.9	1.8802	0.0284	459.2	1.8739	60
65	0.0349	465.8	1.9076	0.0327	465.2	1.9008	0.0308	464.6	1.8943	0.0291	464.0	1.8881	65
70	0.0355	470.5	1.9215	0.0334	469.9	1.9148	0.0314	469.4	1.9083	0.0297	468.8	1.9021	70
75	0.0362	475.3	1.9352	0.0340	474.7	1.9285	0.0321	474.1	1.9222	0.0303	473.6	1.9161	75
80	0.0369	480.1	1.9488	0.0347	479.5	1.9422	0.0327	479.0	1.9359	0.0309	478.4	1.9298	80
85	0.0376	484.9	1.9623	0.0353	484.3	1.9558	0.0333	483.8	1.9495	0.0315	483.3	1.9435	85
90	0.0383	489.7	1.9758	0.0360	489.2	1.9692	0.0339	488.7	1.9630	0.0321	488.2	1.9570	90
95	0.0389	494.6	1.9891	0.0366	494.1	1.9826	0.0345	493.6	1.9764	0.0326	493.1	1.9705	95
100	0.0396	499.5	2.0023	0.0372	499.0	1.9958	0.0351	498.5	1.9897	0.0332	498.0	1.9838	100
105	0.0402	504.4	2.0154	0.0378	503.9	2.0090	0.0357	503.4	2.0029	0.0338	503.0	1.9970	105
110	0.0409	509.3	2.0284	0.0385	508.9	2.0220	0.0363	508.4	2.0160	0.0344	508.0	2.0102	110
115	0.0415	514.3	2.0413	0.0391	513.9	2.0350	0.0369	513.4	2.0290	0.0349	513.0	2.0232	115
120	0.0422	519.3	2.0542	0.0397	518.9	2.0479	0.0375	518.5	2.0419	0.0355	518.0	2.0361	120
125	0.0428	524.4	2.0669	0.0403	524.0	2.0607	0.0381	523.6	2.0547	0.0360	523.1	2.0490	125
130	0.0435	529.5	2.0796	0.0409	529.1	2.0734	0.0387	528.7	2.0674	0.0366	528.2	2.0617	130
135	0.0441	534.6	2.0922	0.0415	534.2	2.0860	0.0392	533.8	2.0801	0.0372	533.4	2.0744	135
140	0.0448	539.7	2.1048	0.0421	539.3	2.0986	0.0398	539.0	2.0927	0.0377	538.6	2.0870	140
145	0.0454	544.9	2.1172	0.0427	544.5	2.1110	0.0404	544.1	2.1051	0.0383	543.8	2.0995	145
150	0.0460	550.1	2.1296	0.0433	549.7	2.1234	0.0410	549.4	2.1176	0.0388	549.0	2.1120	150
155	0.0466	555.3	2.1419	0.0439	555.0	2.1357	0.0415	554.6	2.1299	0.0394	554.3	2.1243	155
160	0.0473	560.6	2.1541	0.0445	560.3	2.1480	0.0421	559.9	2.1422	0.0399	559.5	2.1366	160
165	0.0479	565.9	2.1662	0.0451	565.6	2.1602	0.0427	565.2	2.1544	0.0404	564.9	2.1488	165
170	0.0485	571.2	2.1783	0.0457	570.9	2.1723	0.0432	570.6	2.1665	0.0410	570.2	2.1610	170
175	—	—	—	0.0463	576.3	2.1843	0.0438	575.9	2.1785	0.0415	575.6	2.1730	175

TEMP. °C	1100.0 (28.30°C) V	H	S	1200.0 (31.30°C) V	H	S	1300.0 (34.20°C) V	H	S	1400.0 (37.00°C) V	H	S	TEMP. °C
	(0.0216)	(427.7)	(1.7666)	(0.0197)	(428.9)	(1.7637)	(0.0181)	(429.9)	(1.7609)	(0.0167)	(430.8)	(1.7582)	
30	0.0218	429.4	1.7721	—	—	—	—	—	—	—	—	—	30
35	0.0225	434.1	1.7876	0.0202	432.4	1.7752	0.0182	430.7	1.7633	—	—	—	35
40	0.0231	438.8	1.8029	0.0208	437.3	1.7908	0.0188	435.6	1.7792	0.0170	433.9	1.7680	40
45	0.0237	443.6	1.8179	0.0213	442.1	1.8061	0.0193	440.5	1.7948	0.0176	438.9	1.7839	45
50	0.0243	448.4	1.8328	0.0219	446.9	1.8212	0.0199	445.4	1.8101	0.0181	443.9	1.7994	50
55	0.0249	453.1	1.8475	0.0225	451.8	1.8360	0.0204	450.3	1.8252	0.0186	448.9	1.8147	55
60	0.0255	457.9	1.8620	0.0230	456.6	1.8507	0.0209	455.2	1.8400	0.0191	453.8	1.8298	60
65	0.0261	462.7	1.8763	0.0236	461.5	1.8652	0.0215	460.2	1.8547	0.0196	458.8	1.8446	65
70	0.0266	467.6	1.8905	0.0241	466.3	1.8795	0.0220	465.1	1.8691	0.0201	463.8	1.8593	70
75	0.0272	472.4	1.9045	0.0246	471.2	1.8937	0.0225	470.0	1.8834	0.0206	468.8	1.8737	75
80	0.0278	477.3	1.9184	0.0252	476.1	1.9077	0.0230	475.0	1.8976	0.0211	473.8	1.8880	80
85	0.0283	482.2	1.9321	0.0257	481.1	1.9215	0.0234	480.0	1.9116	0.0215	478.8	1.9021	85
90	0.0289	487.1	1.9458	0.0262	486.0	1.9353	0.0239	485.0	1.9254	0.0220	483.9	1.9161	90
95	0.0294	492.0	1.9593	0.0267	491.0	1.9489	0.0244	490.0	1.9391	0.0224	488.9	1.9299	95
100	0.0299	497.0	1.9727	0.0272	496.0	1.9624	0.0249	495.0	1.9527	0.0229	494.0	1.9436	100
105	0.0305	502.0	1.9860	0.0277	501.0	1.9758	0.0253	500.1	1.9662	0.0233	499.1	1.9571	105
110	0.0310	507.0	1.9992	0.0282	506.1	1.9891	0.0258	505.2	1.9795	0.0238	504.2	1.9706	110
115	0.0315	512.1	2.0123	0.0287	511.2	2.0022	0.0263	510.3	1.9928	0.0242	509.3	1.9839	115
120	0.0320	517.2	2.0253	0.0292	516.3	2.0153	0.0267	515.4	2.0059	0.0246	514.5	1.9971	120
125	0.0326	522.3	2.0382	0.0296	521.4	2.0283	0.0272	520.6	2.0190	0.0251	519.7	2.0102	125
130	0.0331	527.4	2.0511	0.0301	526.6	2.0412	0.0276	525.7	2.0319	0.0255	524.9	2.0232	130
135	0.0336	532.6	2.0638	0.0306	531.8	2.0539	0.0281	530.9	2.0448	0.0259	530.1	2.0361	135
140	0.0341	537.8	2.0764	0.0311	537.0	2.0666	0.0285	536.2	2.0575	0.0263	535.4	2.0489	140
145	0.0346	543.0	2.0890	0.0315	542.2	2.0793	0.0290	541.4	2.0702	0.0267	540.7	2.0617	145
150	0.0351	548.2	2.1015	0.0320	547.5	2.0918	0.0294	546.7	2.0828	0.0271	546.0	2.0743	150
155	0.0356	553.5	2.1139	0.0325	552.8	2.1042	0.0298	552.1	2.0952	0.0276	551.3	2.0868	155
160	0.0361	558.8	2.1262	0.0329	558.1	2.1166	0.0303	557.4	2.1077	0.0280	556.7	2.0993	160
165	0.0366	564.2	2.1385	0.0334	563.5	2.1289	0.0307	562.8	2.1200	0.0284	562.1	2.1117	165
170	0.0371	569.5	2.1506	0.0339	568.9	2.1411	0.0311	568.2	2.1323	0.0288	567.5	2.1240	170
175	0.0376	574.9	2.1627	0.0343	574.3	2.1533	0.0315	573.6	2.1444	0.0292	572.9	2.1362	175
180	0.0381	580.4	2.1748	0.0348	579.7	2.1653	0.0320	579.1	2.1565	0.0296	578.4	2.1483	180
185	—	—	—	0.0352	585.2	2.1773	0.0324	584.5	2.1686	0.0300	583.9	2.1604	185
190	—	—	—	—	—	—	—	—	—	0.0304	589.4	2.1724	190

TABLE 2 (continued)

Suva® 407C Superheated Vapor—Constant Pressure Tables

V = Volume in m^3/kg H = Enthalpy in kJ/kg S = Entropy in kJ/(kg) (K) (Saturation Properties in parentheses)

TEMP. °C	1500.0 (39.60°C) V	H	S	1600.0 (42.00°C) V	H	S	1700.0 (44.40°C) V	H	S	1800.0 (46.60°C) V	H	S	TEMP. °C
	(0.0155)	(431.6)	(1.7556)	(0.0144)	(432.3)	(1.7530)	(0.0134)	(432.9)	(1.7504)	(0.0126)	(433.3)	(1.7478)	
40	0.0155	432.0	1.7570	—	—	—	—	—	—	—	—	—	40
45	0.0161	437.2	1.7732	0.0147	435.4	1.7628	0.0135	433.5	1.7525	—	—	—	45
50	0.0166	442.3	1.7091	0.0152	440.6	1.7790	0.0140	438.9	1.7091	0.0129	437.0	1.7593	50
55	0.0171	447.3	1.0047	0.0157	445.8	1.7949	0.0145	444.1	1.7053	0.0134	442.4	1.7759	55
60	0.0176	452.4	1.8200	0.0162	450.9	1.8104	0.0150	449.4	1.8012	0.0139	447.8	1.7920	60
65	0.0180	457.4	1.8350	0.0167	456.0	1.8257	0.0154	454.6	1.8167	0.0143	453.1	1.8078	65
70	0.0185	462.5	1.8498	0.0171	461.1	1.8407	0.0159	459.8	1.8319	0.0147	458.3	1.8233	70
75	0.0190	467.5	1.8644	0.0175	466.3	1.8555	0.0163	464.9	1.8469	0.0152	463.6	1.8385	75
80	0.0194	472.6	1.8789	0.0180	471.4	1.8701	0.0167	470.1	1.8616	0.0156	468.8	1.8534	80
85	0.0199	477.7	1.8931	0.0184	476.5	1.8845	0.0171	475.3	1.8761	0.0160	474.0	1.8681	85
90	0.0203	482.7	1.9072	0.0188	481.6	1.8987	0.0175	480.4	1.8905	0.0164	479.3	1.8826	90
95	0.0207	487.8	1.9211	0.0192	486.7	1.9127	0.0179	485.6	1.9047	0.0168	484.5	1.8969	95
100	0.0212	492.9	1.9349	0.0197	491.9	1.9266	0.0183	490.8	1.9187	0.0171	489.7	1.9110	100
105	0.0216	498.1	1.9486	0.0201	497.1	1.9404	0.0187	496.0	1.9325	0.0175	495.0	1.9250	105
110	0.0220	503.2	1.9621	0.0205	502.2	1.9540	0.0191	501.2	1.9462	0.0179	500.2	1.9388	110
115	0.0224	508.4	1.9755	0.0208	507.4	1.9675	0.0195	506.5	1.9598	0.0182	505.5	1.9525	115
120	0.0228	513.6	1.9888	0.0212	512.7	1.9808	0.0198	511.7	1.9733	0.0186	510.8	1.9660	120
125	0.0232	518.8	2.0019	0.0216	517.9	1.9941	0.0202	517.0	1.9866	0.0189	516.1	1.9794	125
130	0.0236	524.0	2.0150	0.0220	523.2	2.0072	0.0206	522.3	1.9998	0.0193	521.4	1.9927	130
135	0.0240	529.3	2.0280	0.0224	528.4	2.0202	0.0209	527.6	2.0129	0.0196	526.8	2.0058	135
140	0.0244	534.6	2.0408	0.0228	533.8	2.0332	0.0213	532.9	2.0259	0.0200	532.1	2.0189	140
145	0.0248	539.9	2.0536	0.0231	539.1	2.0460	0.0216	538.3	2.0387	0.0203	537.5	2.0318	145
150	0.0252	545.2	2.0663	0.0235	544.4	2.0587	0.0220	543.7	2.0515	0.0207	542.9	2.0447	150
155	0.0256	550.6	2.0789	0.0239	549.8	2.0714	0.0224	549.1	2.0642	0.0210	548.3	2.0574	155
160	0.0260	556.0	2.0914	0.0242	555.2	2.0839	0.0227	554.5	2.0768	0.0213	553.8	2.0700	160
165	0.0264	561.4	2.1038	0.0246	560.7	2.0964	0.0230	559.9	2.0093	0.0217	559.2	2.0826	165
170	0.0267	566.8	2.1161	0.0250	566.1	2.1008	0.0234	565.4	2.1017	0.0220	564.7	2.0951	170
175	0.0271	572.3	2.1284	0.0253	571.6	2.1211	0.0237	570.9	2.1141	0.0223	570.2	2.1074	175
180	0.0275	577.8	2.1406	0.0257	577.1	2.1333	0.0241	576.4	2.1263	0.0226	575.8	2.1197	180
185	0.0279	583.3	2.1527	0.0260	582.6	2.1454	0.0244	582.0	2.1385	0.0230	581.3	2.1319	185
190	0.0282	588.8	2.1647	0.0264	588.2	2.1575	0.0247	587.6	2.1506	0.0233	586.9	2.1441	190
195	—	—	—	0.0267	593.8	2.1694	0.0251	593.1	2.1626	0.0236	592.5	2.1561	195
200	—	—	—	—	—	—	—	—	—	0.0239	598.2	2.1681	200

TEMP. °C	1900.0 (48.80°C) V	H	S	2000.0 (50.80°C) V	H	S	2200.0 (54.70°C) V	H	S	2400.0 (58.40°C) V	H	S	TEMP. °C
	(0.0118)	(433.7)	(1.7452)	(0.0111)	(434.0)	(1.7426)	(0.0099)	(434.4)	(1.7373)	(0.0089)	(434.5)	(1.7318)	
50	0.0119	435.1	1.7495	—	—	—	—	—	—	—	—	—	50
55	0.0124	440.7	1.7665	0.0115	438.8	1.7572	0.0099	434.7	1.7383	—	—	—	55
60	0.0129	446.1	1.7831	0.0120	444.4	1.7742	0.0104	440.7	1.7563	0.0090	436.6	1.7381	60
65	0.0133	451.5	1.7992	0.0124	449.9	1.7906	0.0108	446.5	1.7736	0.0095	442.8	1.7566	65
70	0.0137	456.9	1.8149	0.0128	455.4	1.8066	0.0113	452.2	1.7904	0.0099	448.8	1.7742	70
75	0.0142	462.2	1.8303	0.0132	460.8	1.8223	0.0117	457.8	1.8066	0.0103	454.6	1.7912	75
80	0.0146	467.5	1.8454	0.0136	466.2	1.8376	0.0120	463.4	1.8224	0.0107	460.4	1.8076	80
85	0.0149	472.8	1.8603	0.0140	471.5	1.8527	0.0124	468.9	1.8379	0.0110	466.1	1.8236	85
90	0.0153	478.1	1.8749	0.0144	476.9	1.8675	0.0128	474.3	1.8531	0.0114	471.7	1.8392	90
95	0.0157	483.4	1.8894	0.0147	482.2	1.8821	0.0131	479.8	1.8680	0.0117	477.3	1.8545	95
100	0.0161	488.6	1.9036	0.0151	487.5	1.8965	0.0134	485.2	1.8827	0.0121	482.9	1.8695	100
105	0.0164	493.9	1.9177	0.0155	492.9	1.9106	0.0138	490.7	1.8971	0.0124	488.4	1.8843	105
110	0.0168	499.2	1.9316	0.0158	498.2	1.9247	0.0141	496.1	1.9114	0.0127	493.9	1.8988	110
115	0.0171	504.5	1.9454	0.0161	503.5	1.9385	0.0144	501.5	1.9255	0.0130	499.4	1.9131	115
120	0.0175	509.8	1.9590	0.0165	508.9	1.9522	0.0147	506.9	1.9394	0.0133	504.9	1.9272	120
125	0.0178	515.2	1.9725	0.0168	514.3	1.9658	0.0150	512.4	1.9531	0.0136	510.5	1.9411	125
130	0.0182	520.5	1.9858	0.0171	519.6	1.9792	0.0154	517.8	1.9667	0.0139	516.0	1.9549	130
135	0.0185	525.9	1.9990	0.0175	525.0	1.9925	0.0157	523.3	1.9801	0.0142	521.5	1.9685	135
140	0.0188	531.3	2.0122	0.0178	530.4	2.0057	0.0160	528.7	1.9935	0.0144	527.0	1.9820	140
145	0.0191	536.7	2.0252	0.0181	535.9	2.0188	0.0162	534.2	2.0067	0.0147	532.6	1.9953	145
150	0.0195	542.1	2.0381	0.0184	541.3	2.0317	0.0165	539.7	2.0197	0.0150	538.1	2.0085	150
155	0.0198	547.6	2.0509	0.0187	546.8	2.0446	0.0168	545.2	2.0327	0.0153	543.7	2.0216	155
160	0.0201	553.0	2.0635	0.0190	552.3	2.0573	0.0171	550.8	2.0455	0.0155	549.3	2.0345	160
165	0.0204	558.5	2.0761	0.0193	557.8	2.0700	0.0174	556.3	2.0583	0.0158	554.9	2.0474	165
170	0.0207	564.0	2.0887	0.0196	563.3	2.0825	0.0177	561.9	2.0709	0.0161	560.5	2.0601	170
175	0.0211	569.6	2.1011	0.0199	568.9	2.0950	0.0180	567.5	2.0835	0.0163	566.1	2.0728	175
180	0.0214	575.1	2.1134	0.0202	574.4	2.1074	0.0182	573.1	2.0959	0.0166	571.8	2.0853	180
185	0.0217	580.7	2.1257	0.0205	580.0	2.1196	0.0185	578.7	2.1083	0.0168	577.4	2.0977	185
190	0.0220	586.3	2.1378	0.0208	585.7	2.1318	0.0188	584.4	2.1206	0.0171	583.1	2.1101	190
195	0.0223	591.9	2.1499	0.0211	591.3	2.1440	0.0190	590.1	2.1328	0.0173	588.8	2.1223	195
200	0.0226	597.6	2.1619	0.0214	597.0	2.1560	0.0193	595.8	2.1449	0.0176	594.6	2.1345	200
205	—	—	—	0.0217	602.7	2.1680	0.0196	601.5	2.1569	0.0178	600.3	2.1466	205
210	—	—	—	—	—	—	—	—	—	0.0181	606.1	2.1586	210

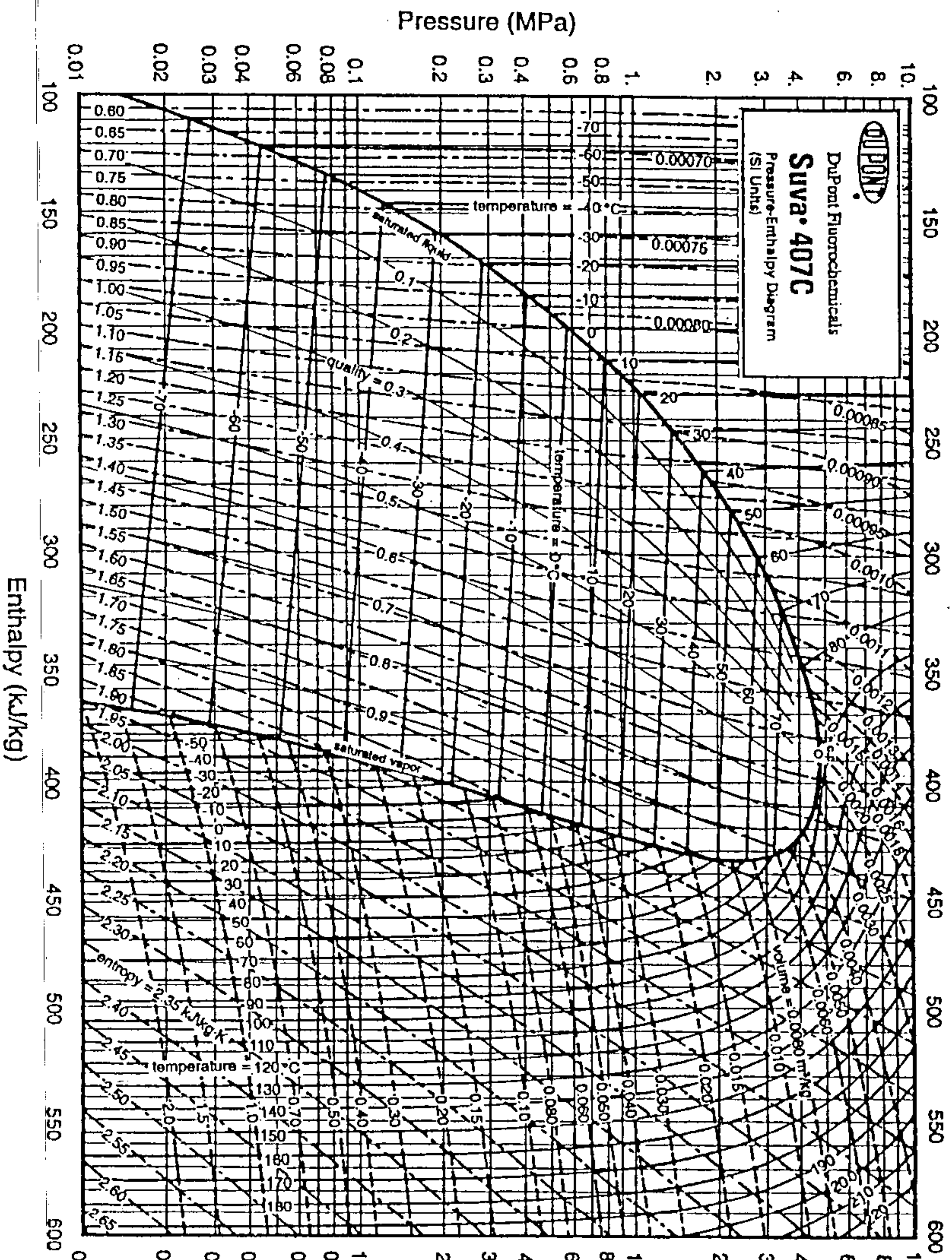
TABLE 2 (continued)
Suva® 407C Superheated Vapor—Constant Pressure Tables

V = Volume in m^3/kg H = Enthalpy in kJ/kg S = Entropy in kJ/(kg) (K) (Saturation Properties in parentheses)

ABSOLUTE PRESSURE, kPa

TEMP. ℃	2600.0 (61.80℃) V	H	S	2800.0 (65.00℃) V	H	S	3000.0 (68.00℃) V	H	S	3200.0 (70.90℃) V	H	S	TEMP. ℃
	(0.0080)	(434.2)	(1.7261)	(0.0072)	(433.7)	(1.7200)	(0.0066)	(432.9)	(1.7134)	(0.0060)	(431.7)	(1.7064)	
65	0.0083	438.6	1.7390	0.0073	433.8	1.7201	—	—	—	—	—	—	65
70	0.0087	445.0	1.7578	0.0077	440.8	1.7409	0.0068	436.0	1.7226	—	—	—	70
75	0.0091	451.2	1.7758	0.0081	447.5	1.7601	0.0072	443.3	1.7438	0.0064	438.6	1.7262	75
80	0.0095	457.2	1.7930	0.0085	453.8	1.7782	0.0076	450.1	1.7632	0.0068	446.1	1.7476	80
85	0.0099	463.1	1.8096	0.0089	460.0	1.7956	0.0080	456.7	1.7816	0.0072	453.0	1.7672	85
90	0.0102	469.0	1.8257	0.0092	466.0	1.8124	0.0083	463.0	1.7991	0.0075	459.7	1.7857	90
95	0.0106	474.7	1.8414	0.0095	472.0	1.8286	0.0087	469.1	1.8159	0.0079	466.1	1.8033	95
100	0.0109	480.4	1.8568	0.0099	477.8	1.8444	0.0090	475.2	1.8322	0.0082	472.4	1.8202	100
105	0.0112	486.1	1.8719	0.0102	483.6	1.8598	0.0093	481.1	1.8481	0.0085	478.5	1.8365	105
110	0.0115	491.7	1.8867	0.0104	489.4	1.8750	0.0095	487.0	1.8636	0.0088	484.6	1.8524	110
115	0.0118	497.3	1.9012	0.0107	495.1	1.8898	0.0098	492.9	1.8787	0.0090	490.6	1.8679	115
120	0.0121	502.9	1.9156	0.0110	500.8	1.9044	0.0101	498.7	1.8936	0.0093	496.5	1.8831	120
125	0.0123	508.5	1.9297	0.0113	506.5	1.9188	0.0104	504.5	1.9082	0.0095	502.4	1.8980	125
130	0.0126	514.1	1.9437	0.0115	512.2	1.9329	0.0106	510.2	1.9226	0.0098	508.2	1.9126	130
135	0.0129	519.7	1.9574	0.0118	517.8	1.9469	0.0109	516.0	1.9368	0.0100	514.1	1.9270	135
140	0.0132	525.3	1.9711	0.0121	523.5	1.9607	0.0111	521.7	1.9507	0.0103	519.9	1.9411	140
145	0.0134	530.9	1.9845	0.0123	529.2	1.9743	0.0114	527.4	1.9645	0.0105	525.7	1.9551	145
150	0.0137	536.5	1.9979	0.0126	534.8	1.9878	0.0116	533.2	1.9781	0.0107	531.5	1.9689	150
155	0.0139	542.1	2.0111	0.0128	540.5	2.0011	0.0118	538.9	1.9916	0.0110	537.3	1.9825	155
160	0.0142	547.7	2.0242	0.0130	546.2	2.0143	0.0121	544.6	2.0049	0.0112	543.1	1.9960	160
165	0.0144	553.4	2.0371	0.0133	551.9	2.0274	0.0123	550.4	2.0181	0.0114	548.9	2.0093	165
170	0.0147	559.0	2.0500	0.0135	557.6	2.0403	0.0125	556.1	2.0312	0.0116	554.7	2.0224	170
175	0.0149	564.7	2.0627	0.0138	563.3	2.0532	0.0127	561.9	2.0441	0.0118	560.5	2.0355	175
180	0.0152	570.4	2.0753	0.0140	569.1	2.0659	0.0129	567.7	2.0569	0.0120	566.3	2.0484	180
185	0.0154	576.1	2.0878	0.0142	574.8	2.0785	0.0132	573.5	2.0696	0.0122	572.1	2.0612	185
190	0.0157	581.8	2.1003	0.0144	580.6	2.0910	0.0134	579.3	2.0822	0.0125	578.0	2.0738	190
195	0.0159	587.6	2.1126	0.0147	586.3	2.1034	0.0136	585.1	2.0947	0.0127	583.8	2.0864	195
200	0.0161	593.3	2.1248	0.0149	592.1	2.1157	0.0138	590.9	2.1071	0.0129	589.7	2.0989	200
205	0.0164	599.1	2.1370	0.0151	597.9	2.1279	0.0140	596.8	2.1194	0.0131	595.6	2.1112	205
210	0.0166	604.9	2.1491	0.0153	603.8	2.1401	0.0142	602.6	2.1316	0.0133	601.5	2.1235	210
215	0.0168	610.7	2.1610	0.0155	609.6	2.1521	0.0144	608.5	2.1437	0.0135	607.4	2.1357	215
220	—	—	—	—	—	—	0.0146	614.4	2.1557	0.0136	613.3	2.1477	220
225	—	—	—	—	—	—	—	—	—	0.0138	619.2	2.1597	225

TEMP. ℃	3400.0 (73.60℃) V	H	S	3600.0 (76.20℃) V	H	S	3800.0 (71.70℃) V	H	S	4000.0 (81.00℃) V	H	S	TEMP. ℃
	(0.0054)	(430.2)	(1.6986)	(0.0049)	(428.2)	(1.6900)	(0.0013)	(327.0)	(1.3981)	(0.0040)	(422.4)	(1.6686)	
75	0.0056	432.9	1.7065	0.0035	407.3	1.6276	—	—	—	—	—	—	75
80	0.0061	441.5	1.7309	0.0054	436.0	1.7123	0.0046	429.2	1.6901	—	—	—	80
85	0.0065	449.1	1.7523	0.0058	444.6	1.7365	0.0052	439.5	1.7192	0.0046	433.4	1.6993	85
90	0.0068	456.2	1.7720	0.0062	452.3	1.7579	0.0056	448.1	1.7430	0.0050	443.4	1.7270	90
95	0.0072	462.9	1.7905	0.0065	459.5	1.7776	0.0060	455.9	1.7642	0.0054	451.9	1.7503	95
100	0.0075	469.5	1.8081	0.0068	466.4	1.7960	0.0063	463.1	1.7837	0.0058	459.6	1.7711	100
105	0.0078	475.8	1.8250	0.0071	473.0	1.8136	0.0066	470.0	1.8021	0.0061	466.9	1.7905	105
110	0.0081	482.1	1.8414	0.0074	479.4	1.8305	0.0069	476.7	1.8196	0.0063	473.8	1.8087	110
115	0.0083	488.2	1.8573	0.0077	485.7	1.8469	0.0071	483.2	1.8365	0.0066	480.5	1.8262	115
120	0.0086	494.2	1.8728	0.0079	491.9	1.8628	0.0074	489.5	1.8528	0.0069	487.1	1.8429	120
125	0.0088	500.2	1.8880	0.0082	498.1	1.8782	0.0076	495.8	1.8687	0.0071	493.5	1.8592	125
130	0.0091	506.2	1.9029	0.0084	504.1	1.8934	0.0079	502.0	1.8841	0.0073	499.8	1.8750	130
135	0.0093	512.1	1.9175	0.0087	510.2	1.9083	0.0081	508.1	1.8992	0.0076	506.1	1.8904	135
140	0.0095	518.0	1.9319	0.0089	516.1	1.9228	0.0083	514.2	1.9140	0.0078	512.3	1.9054	140
145	0.0098	523.9	1.9460	0.0091	522.1	1.9372	0.0085	520.3	1.9286	0.0080	518.4	1.9202	145
150	0.0100	529.8	1.9600	0.0093	528.0	1.9513	0.0087	526.3	1.9429	0.0082	524.5	1.9347	150
155	0.0102	535.6	1.9737	0.0095	534.0	1.9652	0.0089	532.3	1.9570	0.0084	530.6	1.9490	155
160	0.0104	541.5	1.9873	0.0097	539.9	1.9790	0.0091	538.3	1.9709	0.0086	536.6	1.9630	160
165	0.0106	547.3	2.0007	0.0099	545.8	1.9925	0.0093	544.2	1.9846	0.0088	542.7	1.9769	165
170	0.0108	553.2	2.0140	0.0101	551.7	2.0059	0.0095	550.2	1.9981	0.0090	548.7	1.9906	170
175	0.0110	559.1	2.0272	0.0103	557.6	2.0192	0.0097	556.2	2.0115	0.0091	554.7	2.0040	175
180	0.0112	564.9	2.0402	0.0105	563.5	2.0323	0.0099	562.1	2.0247	0.0093	560.7	2.0174	180
185	0.0114	570.8	2.0531	0.0107	569.4	2.0453	0.0101	568.1	2.0378	0.0095	566.7	2.0306	185
190	0.0116	576.7	2.0658	0.0109	575.4	2.0582	0.0103	574.1	2.0508	0.0097	572.7	2.0436	190
195	0.0118	582.6	2.0785	0.0111	581.3	2.0709	0.0104	580.0	2.0636	0.0099	578.7	2.0565	195
200	0.0120	588.5	2.0910	0.0113	587.2	2.0835	0.0106	586.0	2.0763	0.0100	584.8	2.0693	200
205	0.0122	594.4	2.1035	0.0115	593.2	2.0960	0.0108	592.0	2.0889	0.0102	590.8	2.0820	205
210	0.0124	600.3	2.1158	0.0117	599.1	2.1084	0.0110	598.0	2.1013	0.0104	596.8	2.0945	210
215	0.0126	606.2	2.1280	0.0118	605.1	2.1207	0.0111	604.0	2.1137	0.0105	602.9	2.1069	215
220	0.0128	612.2	2.1402	0.0120	611.1	2.1329	0.0113	610.0	2.1260	0.0107	608.9	2.1193	220
225	0.0130	618.2	2.1522	0.0122	617.1	2.1450	0.0115	616.0	2.1381	0.0109	615.0	2.1315	225
230	—	—	—	—	—	—	0.0124	623.1	2.1570	0.0110	621.0	2.1436	230
235	—	—	—	—	—	—	—	—	—	0.0112	627.1	2.1556	235


Pressure (MPa)
DuPont Fluorochemicals
Suva® 407C
Pressure-Enthalpy Diagram
(SI Units)
saturated liquid
saturated vapor
Enthalpy (kJ/kg)
Pressure (bar)

ملخص

دراسة أداء مبرد ماء بقدرة ٢٠ طن تبريد عندما يستخدم غاز تبريد (٤٠٧ج) بدلا من غاز التبريد (٢٢)

اعداد

وليد خالد داوود

اشراف

أ.د. محمود حماد

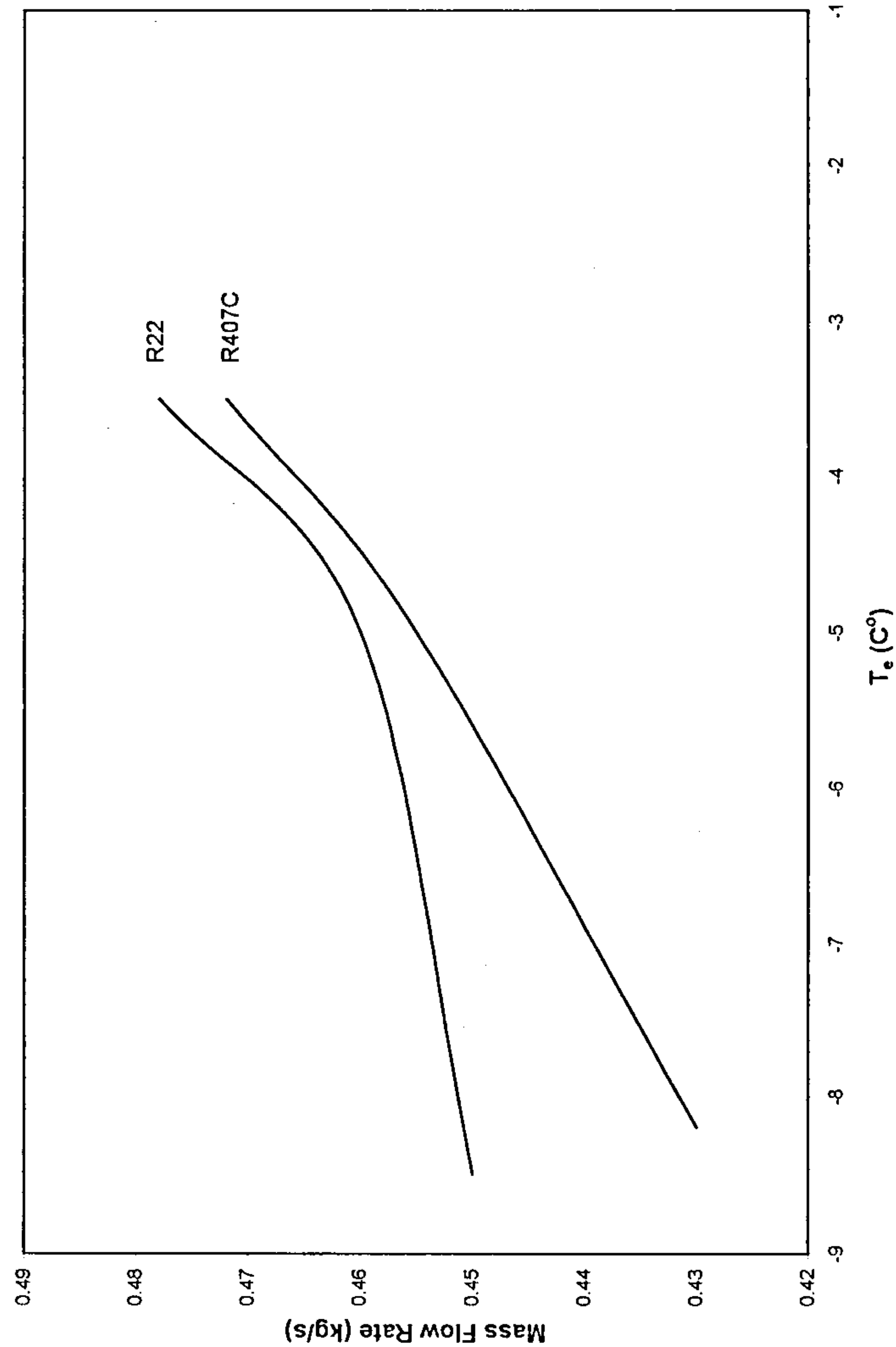
الهدف من هذا البحث هو فحص و دراسة أداء مبرد ماء مصنع محليا يعمل بغاز التبريد (٤٠٧ج) كبديل لغاز التبريد (٢٢).

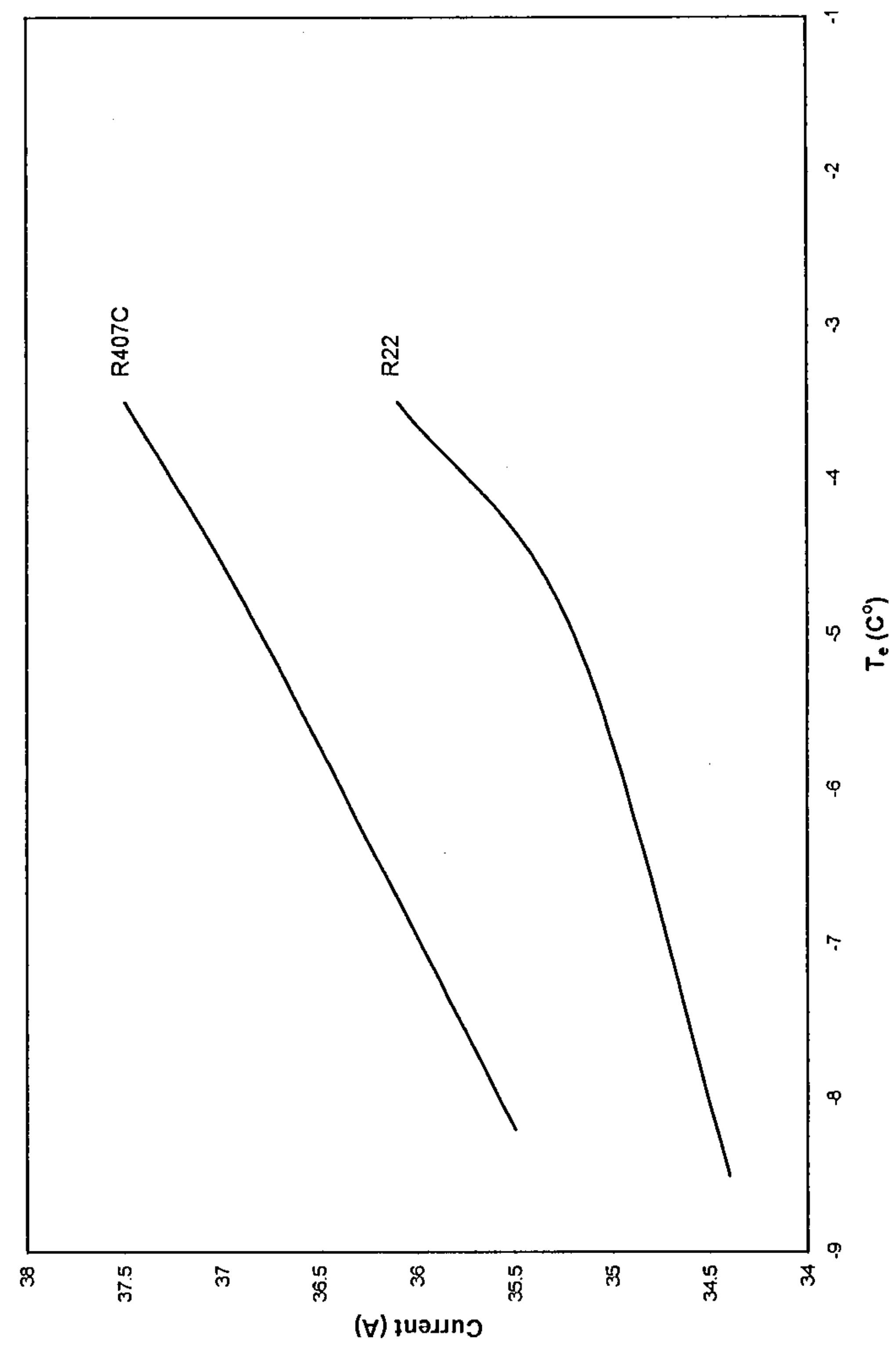
تم اجراء اختبارات الأداء عند درجات تكثيف و تبخير مختلفة ليتسنى دراسة العوامل المختلفة المؤثرة على المبرد مثل الضغوط الداخلية, درجة حرارة مخرج الضاغطة,أثر تسييل الغاز, معامل الأداء , القدرة و الطاقة المخرجة من المكثف لكلا الغازين.

تم استخدام نفس المبرد في كلا الحالتين, مع وجود بعض التغييرات البسيطة عند استخدام غاز (٤٠٧ج).

أظهرت النتائج ان غاز التبريد (٤٠٧ج) يعتبر بديل جيد لغاز التبريد (٢٢) حيث أنهما يشتركان بشكل كبير بكثير من الخصائص, ويحملان نفس الصفات الحرارية و الفيزيائية.

Figure (6.20): Mass Flow Rate Vs Te for R407c and R22





Figure(6.21): Compressor Current Vs Te for R407C and R22

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Appendices

APPENDIX (A): General performance data, condenser air inlet temperatures.

APPENDIX (B): Mullier charts results for Te, Tc variation tests, and R22 test.

APPENDIX (C): Refrigerant R407C, thermodynamic tables.

APPENDIX (A): General performance data, condenser air inlet temperatures.

Condenser in (C°)	Condenser out (C°)	Evaporator in (C°)	Evaporator out (C°)	Discaharge pr. (bar)	Suction pr. (bar)	P1 (bar)	P2 (bar)	P3 (bar)	P4 (bar)	P5 (bar)	P6 (bar)
27	37	19.9	14.8	16.89	4.34	15.86	15.86	15.86	15.72	4.68	4.34
27	37	18.6	13.4	16.55	4.34	15.86	15.86	15.86	15.86	4.68	4.34
27	37	17.4	12.3	16.89	4.34	15.86	15.86	15.86	15.86	4.68	4.34
27	37	16.5	11.4	16.89	4.27	15.86	15.86	15.86	15.86	4.62	4.27
27	37	15.5	10.4	16.89	4.14	15.86	15.86	15.86	15.86	4.55	4.12
27	36	12.6	7.9	16.68	4	15.86	15.86	15.86	16	4.34	3.93
27	37	16.8	11.7	16.89	4.24	15.86	15.86	15.86	15.86	4.6	4.23

T1 (C°)	T2 (C°)	T3 (C°)	T4 (C°)	T5 (C°)	T6 (C°)	Comp. amp. (A)
35	35	35	34	18.1	19.1	37
35	35	35	35	17.2	18.1	36.8
35	35	35	35	16.4	17.3	36.5
35	35	35	35	15.8	16.7	36.2
35	35	35	35	15	15.9	36
34	35	35	34	12.4	13.3	35
35	35	35	35	15.8	16.7	36

Table (A.1): General performance data (condenser air inlet temperature T=27C)

Condenser in (C°)	Condenser out (C°)	Evaporator in (C°)	Evaporator out (C°)	Discaharge pr. (bar)	Suction pr. (bar)	P1 (bar)	P2 (bar)	P3 (bar)	P4 (bar)	P5 (bar)	P6 (bar)
28	37	14.3	9.3	16.55	4	15.86	16.06	16	15.86	4.34	4
28	37	13.4	8.6	16.55	4	16	16	15.86	15.86	4.34	4
28	37	11.8	7.2	16.68	4	15.86	15.86	15.86	15.86	4.27	3.93
28	37	19.3	14.7	17.23	4.34	16	16	16	16	4.62	4.2
28	37	18.6	13.7	17.23	4.34	16.2	16.2	16.2	16.2	4.68	4.27
28	38	17.9	12.9	16.89	4.34	16.2	16.2	16.2	16.2	4.68	4.27
28	38	17	11.9	16.89	4.27	16.68	16.68	16.68	16.68	4.68	4.2
28	37	16	11.18	16.86	4.18	16.11	16.14	16.11	16.09	4.52	4.12

T1 (C°)	T2 (C°)	T3 (C°)	T4 (C°)	T5 (C°)	T6 (C°)	Comp. amp. (A)
35	35	35	35	13.8	14.7	35.6
35	35	35	35	13.2	14.1	35.2
35	35	35	34	11.8	12.6	34.8
35	35	36	35	17.5	18.6	36.7
35	35	36	35	17.4	18.5	36.3
36	36	37	36	17	17.9	36.2
36	36	37	36	16.3	17.3	36.2
35	35	36	35	15.28	16.24	35.86

Table (A.2): General performance data (condeser air inlet temperature, T=28C)

Condenser in (C°)	Condenser out (C°)	Evaporator in (C°)	Evaporator out (C°)	Discaharge pr. (bar)	Suction pr. (bar)	P1 (bar)	P2 (bar)	P3 (bar)	P4 (bar)	P5 (bar)	P6 (bar)
29	38	15.8	10.8	17.23	4.2	16.34	16.34	16.34	16.34	4.68	4.2
29	38	14.8	9.9	17.23	4.27	16.34	16.34	16.34	16.34	4.62	4.2
29	38	13.9	9	17.23	4.14	16.34	16.34	16.34	16.34	4.62	4.13
29	38	12.9	8.1	17.23	4	16.34	16.34	16.34	16.34	4.34	3.93
29	38	11.7	7.1	17.03	3.86	16.2	16.2	16.2	16.26	4.2	3.86
29	39	20	14.8	17.92	4.62	16.75	16.89	17.03	16.75	4.34	4.62
29	39	18.8	13.5	17.92	4.55	16.55	16.55	16.55	16.89	4.9	4.55
29	40	20	14.8	18.27	4.62	17.1	17.23	17.58	17.23	5.03	4.62
29	38	16	11.1	17.5	4.28	16.5	16.5	16.6	16.55	4.6	4.4

T1 (C°)	T2 (C°)	T3 (C°)	T4 (C°)	T5 (C°)	T6 (C°)	Comp. amp. (A)
36	36	37	36	15.4	16.4	36.2
36	36	36	36	14.6	15.5	36.8
36	36	37	36	13.7	14.7	36.3
36	36	37	36	12.2	13.7	36.1
36	36	36	35	11.8	12.6	35.5
36	37	35	36	17.2	18.2	37.5
36	37	35	36	16	17.1	37
36	38	35	36	17.4	18.2	38
36	36	36	36	14.8	15.8	36.6

Table (A.3): General performance data (condenser air inlet temperature, T=29C)

Condenser in (C^o)	Condenser out (C^o)	Evaporator in (C^o)	Evaporator out (C^o)	Discaharge pr. (bar)	Suction pr. (bar)	P1 (bar)	P2 (bar)	P3 (bar)	P4 (bar)	P5 (bar)	P6 (bar)
30	40	19.2	14.1	18.61	4.62	17.44	17.58	17.71	17.44	4.9	4.48
30	40	18.4	13.3	18.48	4.62	17.33	17.44	17.58	17.44	4.76	4.41
30	40	16.6	11.6	18.48	4.14	17.37	17.58	17.58	17.33	4.76	4.41
30	40	18.1	13	18.5	4.46	17.38	17.53	17.62	17.4	4.8	4.43

T1 (C^o)	T2 (C^o)	T3 (C^o)	T4 (C^o)	T5 (C^o)	T6 (C^o)	Comp. amp. (A)
37	38	36	37	16.3	17.5	38
37	38	36	37	15.2	16.5	38
37	39	36	37	14.1	15.3	37
37	38	36	37	15.2	16.43	38

Table (A.4): General performance data (condenser air inlet temperature, T=30C)

Condenser in (C^o)	Condenser out (C^o)	Evaporator in (C^o)	Evaporator out (C^o)	Discaharge pr. (bar)	Suction pr. (bar)	P1 (bar)	P2 (bar)	P3 (bar)	P4 (bar)	P5 (bar)	P6 (bar)
31	40	14.9	10.1	18.61	4.27	17.23	17.23	17.58	17.23	4.55	4.13
31	40	13.7	9	18.27	4.14	17.23	17.37	17.58	17.33	4.48	4.13
31	40	12.5	8	18.06	4	17.1	17.23	17.58	17.23	4.34	4
31	40	11.4	7.1	18.06	3.86	17.1	17.23	17.58	17.23	4.2	3.79
31	40	13.2	8.5	18.25	4.1	17.3	17.23	17.58	17.23	4.4	4

T1 (C^o)	T2 (C^o)	T3 (C^o)	T4 (C^o)	T5 (C^o)	T6 (C^o)	Comp. amp. (A)
37	39	36	37	12.3	13.8	37
37	38	36	37	11.1	12.7	37
37	38	36	37	9.9	11.7	36
37	38	36	36	8.9	10.7	36
37	38	36	37	10.6	12.2	36.5

Table (A.5): General performance data (condenser air inlet temperature, T=31C)

Condenser in (C°)	Condenser out (C°)	Evaporator in (C°)	Evaporator out (C°)	Discaharge pr. (bar)	Suction pr. (bar)	P1 (bar)	P2 (bar)	P3 (bar)	P4 (bar)	P5 (bar)	P6 (bar)
33	44	24	19	20	5.03	18.75	18.96	18.96	18.96	5.38	5.03
33	43	22	17.8	20	4.96	18.96	18.96	19.16	18.96	5.17	5.1
33	44	21	16.4	20	4.82	18.61	18.96	18.96	18.75	5.1	4.82
33	45	18.2	13.9	19.51	4.48	18.61	18.96	19.3	18.96	4.82	4.4
33	44	21.3	16.9	20	4.82	18.73	18.96	19.1	18.96	5.12	4.84

T1 (C°)	T2 (C°)	T3 (C°)	T4 (C°)	T5 (C°)	T6 (C°)	Comp. amp. (A)
40	41	39	40	19.3	20	40
41	43	40	41	18.1	19.2	40.8
40	42	39	40	17	18.1	41.5
40	41	39	39	13.4	14.9	40
40	42	39	40	17	18	41

Table (A.6): General performance data (condenser air inlet temperature, T=33C)

Condenser in (C°)	Condenser out (C°)	Evaporator in (C°)	Evaporator out (C°)	Discaharge pr. (bar)	Suction pr. (bar)	P1 (bar)	P2 (bar)	P3 (bar)	P4 (bar)	P5 (bar)	P6 (bar)
34	45	20	15.6	19.65	4.76	18.61	18.96	19.3	18.86	5.1	4.69
34	45	17.1	12.6	19.3	4.2	17.92	17.92	18.27	17.92	4.55	4.2
34	46	15.2	10.6	18.61	4	17.58	17.92	18.06	17.92	4.72	3.93
34	45	17.4	13	19.2	4.32	18	18.3	18.5	18.3	4.64	4.27

T1 (C°)	T2 (C°)	T3 (C°)	T4 (C°)	T5 (C°)	T6 (C°)	Comp. amp. (A)
41	42	40	40	15.6	17	41
40	41	39	39	11.8	13.5	38
40	41	39	39	9.6	11.4	37
40	41	39	39	12.3	14	38.7

Table (A.7): General performance data (condenser air inlet temperature, T=34C)

Condenser in (C^o)	Condenser out (C^o)	Evaporator in (C^o)	Evaporator out (C^o)	Discaharge pr. (bar)	Suction pr. (bar)	P1 (bar)	P2 (bar)	P3 (bar)	P4 (bar)	P5 (bar)	P6 (bar)
35	47	34	28	21.37	5.24	19.65	19.3	20.13	19.44	5.72	5.24
35	47	31	25.7	20.68	5.03	19.44	19.65	20	19.65	5.58	5.24
35	47	28	22.3	21.37	5.38	19.78	20	20.2	19.86	5.31	4.96
35	47	31	25.3	21.2	5.22	19.62	19.65	20.11	19.65	5.54	5.15

T1 (C^o)	T2 (C^o)	T3 (C^o)	T4 (C^o)	T5 (C^o)	T6 (C^o)	Comp. amp. (A)
43	45	42	43	29	30	43
43	44	42	43	27	28	42.4
43	45	42	43	24	25	41.5
43	45	42	43	27	28	42.3

Table (A.8): General performance data (condenser air inlet temperature, T=35C)

Condenser in (C°)	Condenser out (C°)	Evaporator in (C°)	Evaporator out (C°)	Discaharge pr. (bar)	Suction pr. (bar)	P1 (bar)	P2 (bar)	P3 (bar)	P4 (bar)	P5 (bar)	P6 (bar)
36	48	23	17.8	21.37	5.17	20	20.13	20.34	20	5.38	5.1
36	48	19.6	14.8	20.08	4.9	20	20.2	20.55	20.34	5.38	5.03
36	48	14.3	9.9	20.89	4.34	19.65	20	20.2	20	4.62	4.27
36	48	12.2	8.1	20.68	4.13	19.65	20	20.2	20.13	4.41	4
36	48	17.3	12.7	21	4.6	20	20.1	20.35	20.12	5	4.6

T1 (C°)	T2 (C°)	T3 (C°)	T4 (C°)	T5 (C°)	T6 (C°)	Comp. amp. (A)
43	45	43	44	20	21	42.3
43	45	43	43	17.4	18.7	42.4
43	45	42	43	12	13.8	39.1
43	44	42	42	9.9	11.9	39
43	45	42.5	43	14.8	16.4	40.7

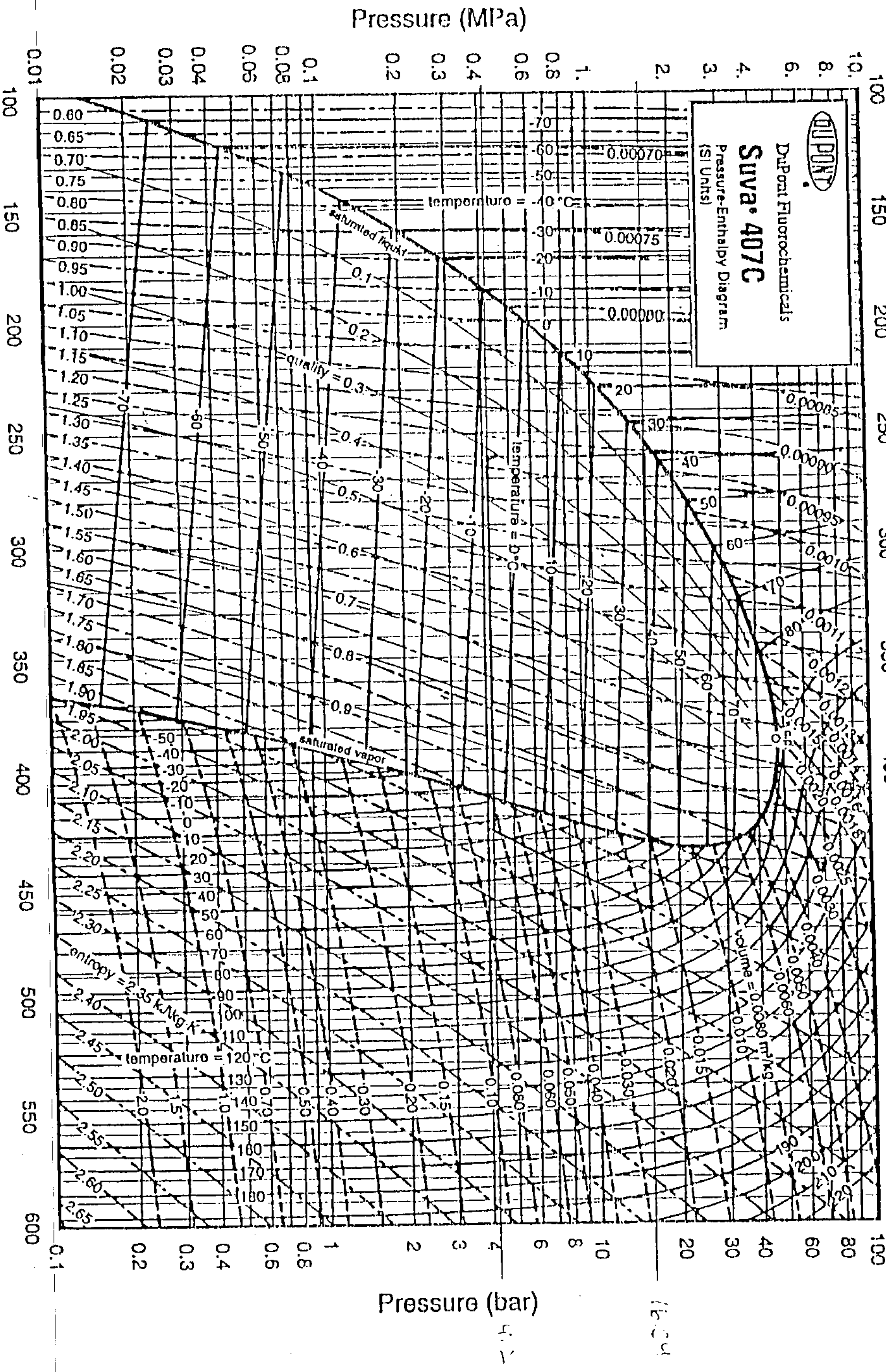
Table (A.9): General performance data (condenser air inlet temperature, T=36C)

Condenser in (C°)	Condenser out (C°)	Evaporator in (C°)	Evaporator out (C°)	Discaharge pr. (bar)	Suction pr. (bar)	P1 (bar)	P2 (bar)	P3 (bar)	P4 (bar)	P5 (bar)	P6 (bar)
37	49	16.5	11.9	21.51	4.68	20.34	20.48	20.68	19.78	4.82	4.41
37	48	13.2	8.9	20.82	4.29	19.65	20	20.13	20	4.55	4.2
37	49	14.9	10.4	21.2	4.44	20	20.25	20.4	19.9	4.7	4.3

T1 (C°)	T2 (C°)	T3 (C°)	T4 (C°)	T5 (C°)	T6 (C°)	Comp. amp. (A)
44	46	43	44	14.2	15.8	40.3
43	44	42	42	10.8	12.6	39.2
44	45	43	43	12.5	14.2	39.8

Table (A.10): General performance data (condenser air inlet temperature, T=37C)

APPENDIX (B): Mullier charts results for Te, Tc variation tests, and R22 test.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DuPont Fluorochemicals
Suva® 407C
Pressure-Enthalpy Diagram
(SI Units)
Pressure (MPa)
Pressure (bar)
Enthalpy (kJ/kg)
saturated liquid
saturated vapor
quality = 0.3
temperature = -40 °C
temperature = 0 °C
temperature = 120 °C
entropy = 2.35 kJ/kg·K
volume = 0.0080 m³/kg