MEASUREMENT OF THE VISCOSITY OF METHANE SATURATED ABSORPTION OILS AT LOW TEMPERATURES AND ELEVATED PRESSURES USING A CAPILLARY VISCOMETER

By

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MEASUREMENT OF THE VISCOSITY OF METHANE SATURATED ABSORPTION OILS AT LOW TEMPERATURES AND ELEVATED PRESSURES USING A CAPILLARY VISCOMETER

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PREFACE

The physical behavior of lean oils as they are saturated with light hydrocarbon gases is only partially understood. Of special importance to the absorber industry is the viscosity of gas-saturated lean oils for the study of mass transfer rates. The mass transfer rate in turn influences the effectiveness of absorber columns. The purpose of this dissertation is to aid in the understanding of the effect of temperature, pressure and composition on the viscosity of absorber oils as they are saturated with methane. The range of conditions studied were pressures from atmospheric to 1006.7 psia and temperatures from 77^oF to -26^oF. The basic instrument used in this investigation was the Zeitfuchs style capillary viscometer.

I would like to take this opportunity to extend my sincere thanks to Professor R. N. Maddox, my research adviser, for the advice and encouragement that he gave me during this study. I also wish to thank Professor J. H. Erbar for his time and assistance with the computer work involved in this study and Mr. Gene McCroskey for his invaluable assistance with the construction and maintainence of laboratory equipment.

Special thanks go to my parents for their encouragement and to my sister, Barbara, for her kindness and consideration.

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LIST OF SYMBOLS

$\overline{BP}$	- Average Boiling Point
cc	- Cubic centimeter
C-S	- Chao-Seader correlation
^{o}F	- Degree Fahrenheit
g	- Gram
HS No. 1	- Heavy Solvent No. 1
k	- Viscometer constant
MS 135	- Mineral Spirits 135
$\overline{MW}$	- Average molecular weight
Pc	- Critical pressure
S-RK	- Soave RK correlation
t	- Time
Tc	- Critical temperature
v	- Kinematic viscosity

CHAPTER I

INTRODUCTION

The need for viscosity data on absorber oils saturated with the lighter hydrocarbon gases, namely methane, ethane and propane, exists mostly in the natural gas industry. To date, no English literature data appear to be available in this area of work. A survey by Weber (9) pointed out that lean oil viscosities are important in the study of mass transfer rates in absorber columns. These rates, in turn, have a large influence on tray efficiencies.

For refrigerated absorber operations the temperature range of interest is between $40^{\circ}F$ and $-60^{\circ}F$ with a pressure range between 500 psia and 1500 psia. The primary purpose of this study was to collect viscosity data on several selected absorber oils saturated with methane. The equipment used was a Zeitfuchs style viscometer mounted inside the high pressure cell built by Bennett (10). Because of the lack of experimental data, the equilibrium behavior and the density of each system was predicted using equations of state.

CHAPTER II

EXPERIMENTAL PROCEDURE

This chapter is divided into two sections: High Pressure Viscometer Cell and Viscometer Calibration. This was done in order to point out the physical differences between the apparatus used. The high pressure viscometer cell was used in all work in which above ambient pressures were applied. Calibration of the three original viscometers was performed using a Neslab Instrument Co., model LTEV-70, constant temperature bath. The high pressure viscometer cell used in this study was built by Bennett (2) and was used unmodified. For details of the equipment one may refer to the published thesis by Bennett (2). Minor dimensioning errors were noted in the previous work and are corrected in McCoy (3).

High Pressure Viscometer Cell

Temperature Control

A compression type refrigeration unit circulating methanol as the coolant was used as the primary means of maintaining constant temperature. A pressure sensing device attached to the compressor unit was used to control bath temperature with the desired temperature being set by adjusting the compressor cut-in cut-out pressure difference.

In order for the pressure sensing device to function properly a pressure difference of no less than 5 psi had to be maintained while too large a pressure difference would allow large temperature oscillation between compressor cut-in and cut-out. The magnitude of the temperature oscillation at any given pressure difference was also a function of the desired operating temperature.

All temperatures and temperature fluctuations were observed using a copper-constantan thermocouple and a Leeds and Northrup, model 7555, type K-5, potentiometer.

While operating at ambient temperature, temperature control was achieved by removing the methanol from the cell bath and utilizing a stagnant water blanket around the cell.

In an attempt to operate with close temperature control at lower temperatures, two electrical heating tapes were employed by wrapping them around the one-half inch copper tubing leading to the pressure cell bath. The purpose in using heaters was to transfer enough energy into the methanol coolant system to balance the energy removal by the refrigeration unit and maintain a constant bath temperature. One heater was attached to a 120 volt Powerstat to supply a constant current while the other was attached to a Baley Instrument Co. Precision Temperature Controller to supply the additional energy required to maintain the desired energy equilibrium.

With 20°F as the desired bath temperature, the efficiency of the refrigeration unit was high enough that maximum heat flux through the one-half inch copper line was not sufficient to maintain an energy equilibrium. The pressure sensing device on the original equipment was then allowed to function and satisfactory temperature control was maintained. The temperature fluctuated very slowly within a few tenths of a degree Fahrenheit about the desired temperature.

With -4°F as the desired operating temperature, the pressure sensing device on the compressor unit provided very poor temperature control. The dual heater system was employed and the temperature showed very good stability.

Temperature control at the lower limit of the refrigeration unit, approximately -26°F, was no problem since the energy gained from the atmosphere by the methanol coolant cycle was sufficient to equalize the affect of the refrigeration cycle.

Assembly and Sample Preparation

With the pressure cell exhausted to atmospheric pressure, the compressor and circulating pump were turned off and the bath coolant level lowered to allow removal of the pressure cell cap and viscometer. After the old sample was drained from the viscometer reservoir, technical grade acetone was used to clean the viscometer. To remove the acetone from the viscometer, dry filtered air was allowed to flow through the viscometer capillaries until completely dry. After two milliliters of new oil sample was transferred to the viscometer reservoir, the viscometer was lowered and secured in the pressure cell. If ambient pressure viscosity data were desired, the sample was forced out of the reservoir into the capillary tubing of the viscometer and kept there until temperature equilibrium was reached. More rapid temperature equilibrium was reached. More rapid temperature equilibrium was achieved in this manner along with a decrease in the evaporative surface area of the oil sample in contact with the surrounding gas.

Purging and Pressurization

In order to rid the pressure cell of air after the installation of a new sample, the system was pruged by repreated pressurization and exhaustion. To initiate the purging operation all valves (Figure 1) were closed except valves A and B. A pressure of 200 psia was set on the Heise gauge by opening the methane supply via a pressure regulator. During the purging operation care was taken to maintain the oil sample in the viscometer reservoir without bubbling methane through it. As methane was allowed to flow through line N into the main cell, the pressure rise in the cell would force the sample out of the reservoir into the capillary tubing of the viscometer. To reestablish the sample in the viscometer reservoir, a compensating pressure was applied to the closed end of the viscometer, attached to line M, by allowing flow through valve E. When the pressure in the viscometer cell reached 200 psig the reverse process was performed. With valves D and A closed, valve C was opened to allow exhaustion of methane to a vent hood. Methane was allowed to flow very slowly through valve D with pressure equilibrium across the viscometer being maintained by allowing flow through valve E. Performing this procedure three times was sufficient to eliminate the majority of the air without wasting large amounts of methane. The oil samples were not subjected to pressures below that of atmospheric because of the possibility of boiling off significant quantities of the lighter components. In the manner of purging described, the samples were maintained as near the original

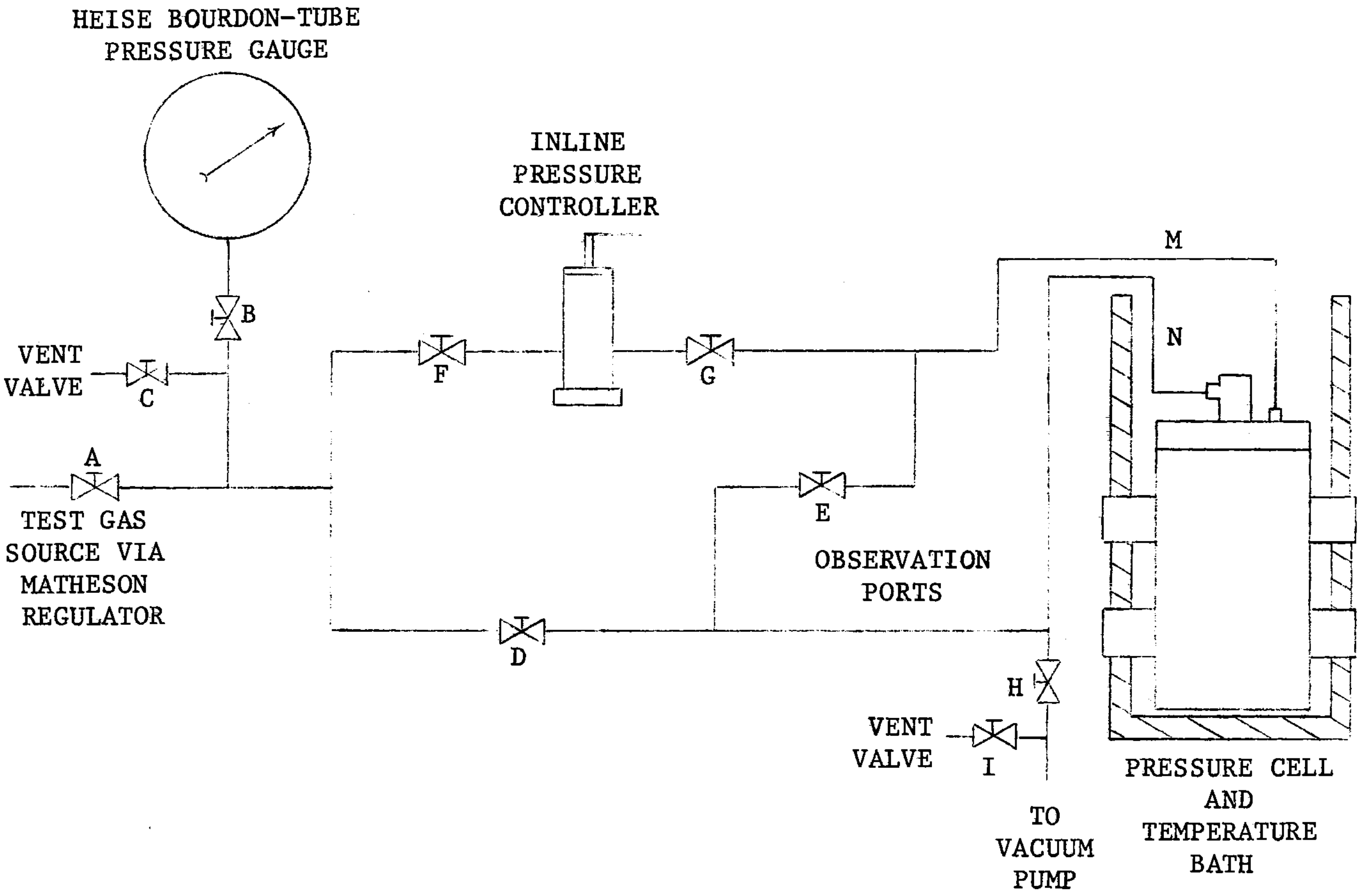

Figure 1. Schematic Diagram of the Experimental Apparatus

as possible and still allowed the removal of most of the air from the system.

While pressurizing to the final pressure, bubbling of methane through the sample was allowed when viscosity data were desired at ambient temperature. At bath temperatures below that of ambient, bubbling through the sample during pressurization was not allowed because of the temperature difference between the inflowing methane and the sample. Due to the high volatility of some of the experimental oils, flowing of a warm gas through a chilled sample may induce undesirable evaporation of some lighter components. After the pressurized system approached thermal equilibrium, bubbling methane through the oil sample was accomplished by using the inline pressure controller. Bubbling methane through the oil served to partially destroy concentration gradients in the sample. To further aid in achieving equilibrium, the sample was periodically forced through the capillary tubing of the viscometer and then back into the reservoir for further agitation.

Equilibrium and Data Collection

Measurement of the time required to fill the timing bulb on the viscometer was made during the saturation process in order to determine when equilibrium had been achieved. Until complete saturation was achieved, each succeeding run time was slightly shorter than the previous timing. Further agitation and more time was then allowed to permit the system to achieve equilibrium. When the time required to fill the timing bulb stabilized, final data runs were made and recorded.

Viscometer Calibration

Three model C-50 Zeitfuchs crossarm viscometers were initially used in this study which bore the identification numbers U-3502, U-3820, and U-2893. Distilled water was used in the calibration study to determine the viscometer constants. The calibration was done using a Neslab Instrument Co., model LTEV-70, constant temperature bath. After cleaning the viscometers with acetone, a two milliliter sample of distilled water was transferred to each of the three viscometers suspended in the bath. A piston type apparatus was attached to the capillary end of the viscometer for the purpose of initiating and reversing the flow of a sample. Passage of the fluid interface across the timing marks was observed using a 14 power cathetometer with the time required to fill the timing bulb being measured using two Standard clocks wired in series. After the bulb was filled, a slight pressure was applied to the sample forcing it back into the reservoir. When the interface of the back flowing sample reached about one-fourth of the way up the capillary tube, gravitational flow was reestablished and a new timed run started. The first run was in a dry bulb and was not recorded. The sample fluid was never allowed back into the reservoir during a set of runs because of the formation of a slug of fluid in the capillary ahead of the main stream. This would prematurely add fluid to the timing reservoir, thus inducing error among different oil systems because of surface tension differences among the oils.

Calibration data for the three crossarm viscometers are listed in Tables XIV, XV and XVI with the calculated viscometer constants in Table XVII.

CHAPTER III

EXPERIMENTAL RESULTS

This chapter is a graphical presentation of the behavior of kinematic and absolute viscosity as a function of temperature and pressure for each of the five lean oils under investigation. The absolute viscosity as presented were obtained from densities based on the equilibrium composition predicted by the Chao-Seader correlation.

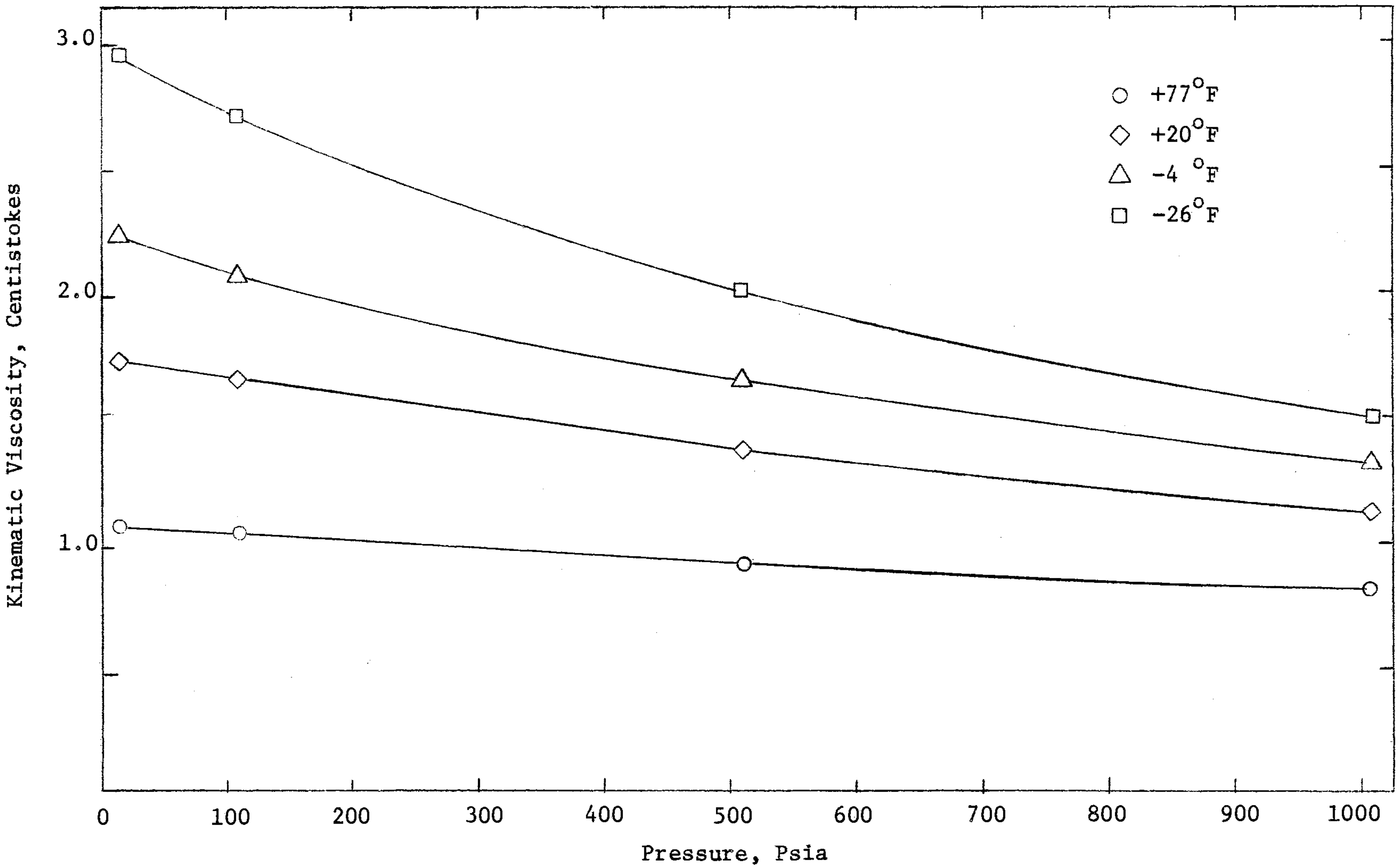

Figure 2. Kinematic Viscosity of Mineral Spirits 135 as a Function of Pressure

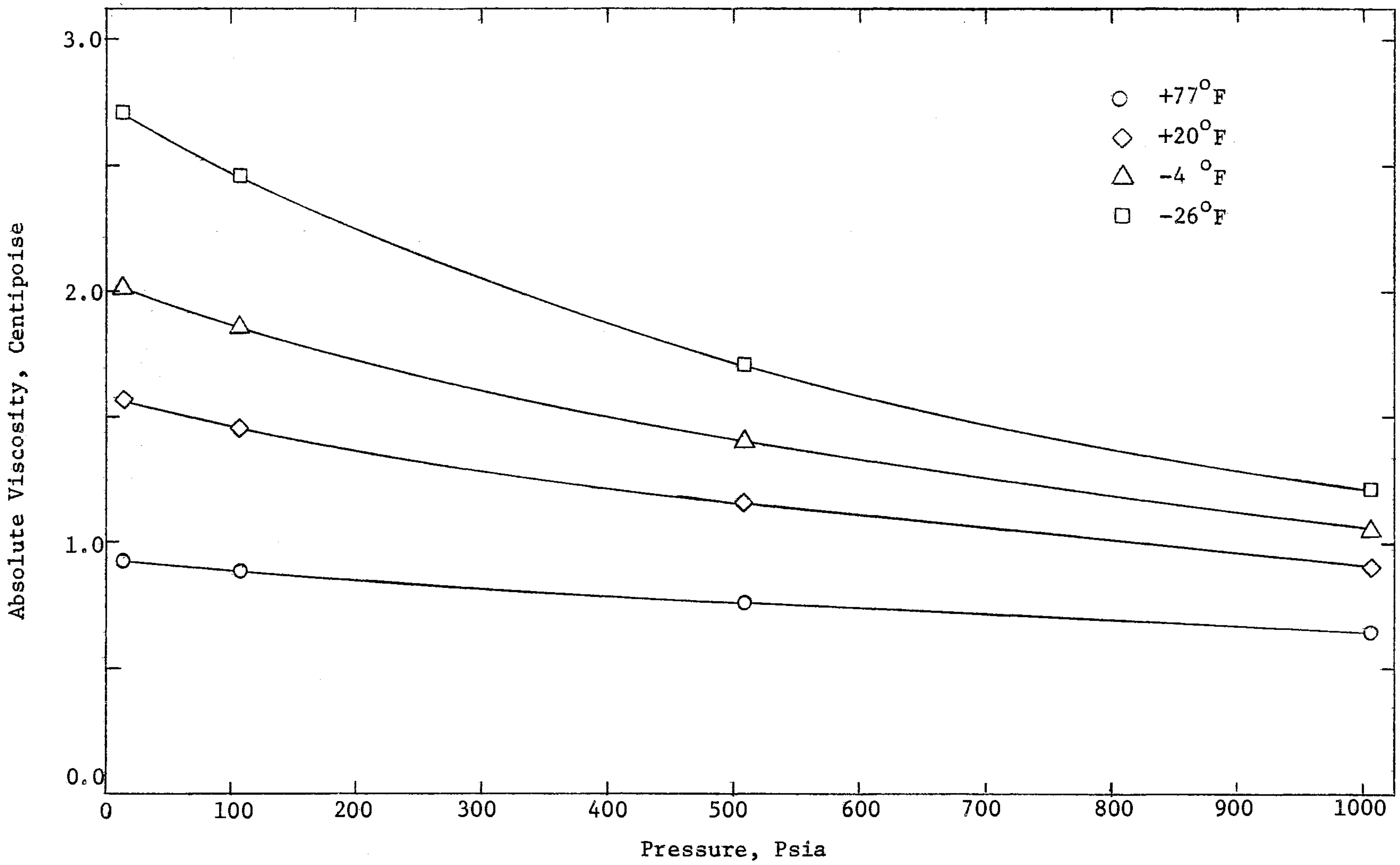

Figure 3. Absolute Viscosity of Mineral Spirits 135 as a Function of Pressure

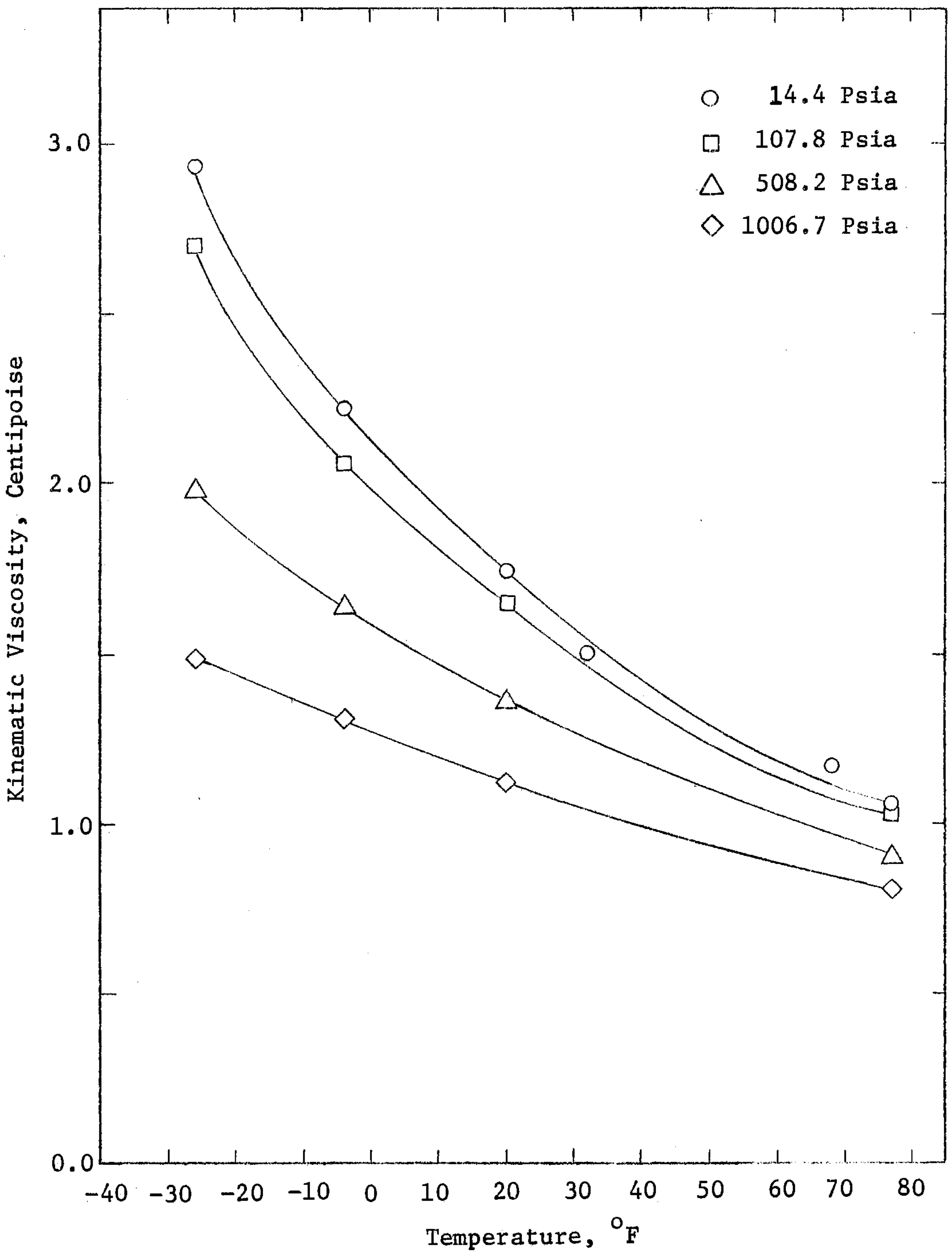

Figure 4. Kinematic Viscosity of Mineral Spirits 135 as a Function of Temperature

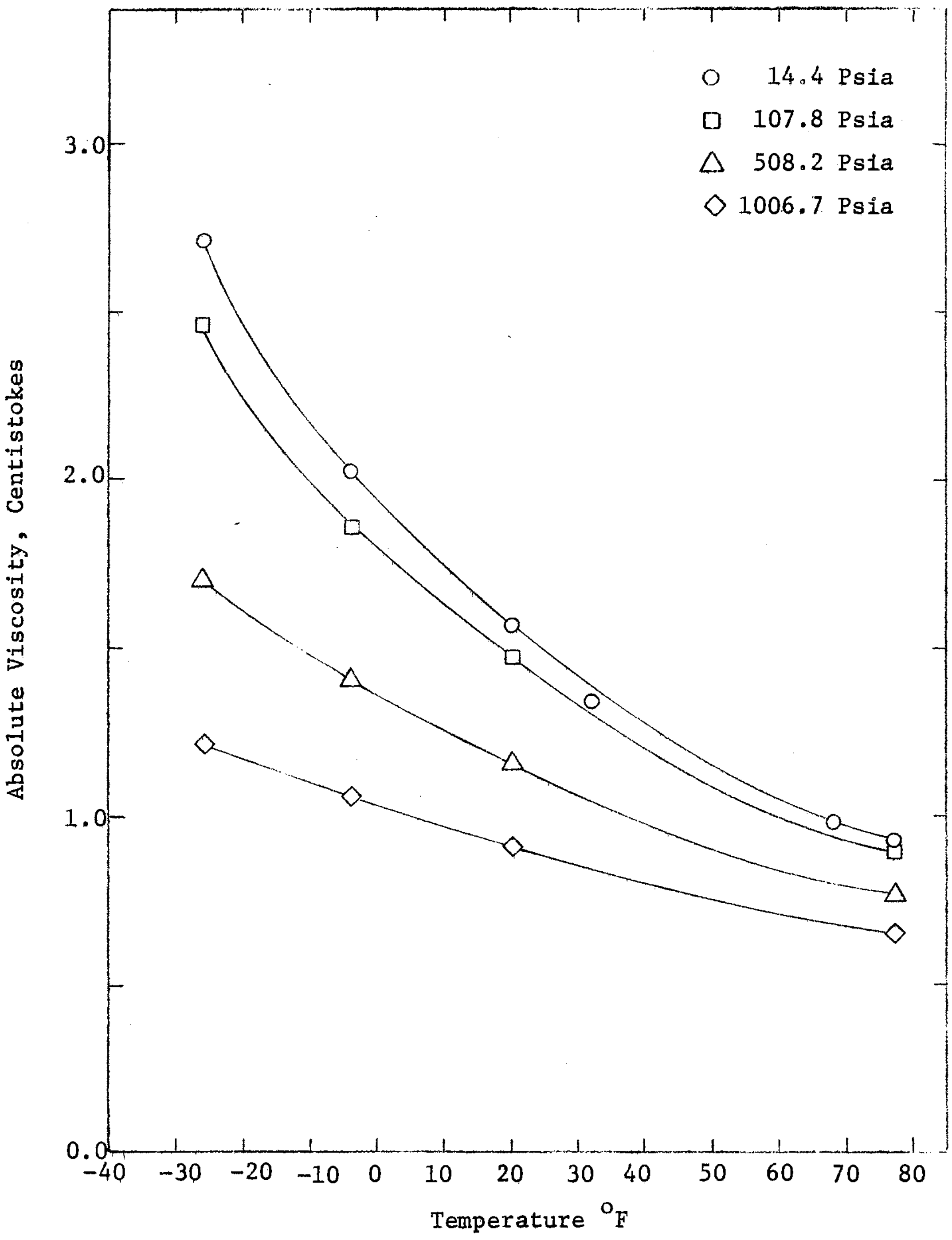

Figure 5. Absolute Viscosity of Mineral Spirits 135 as a Function of Temperature

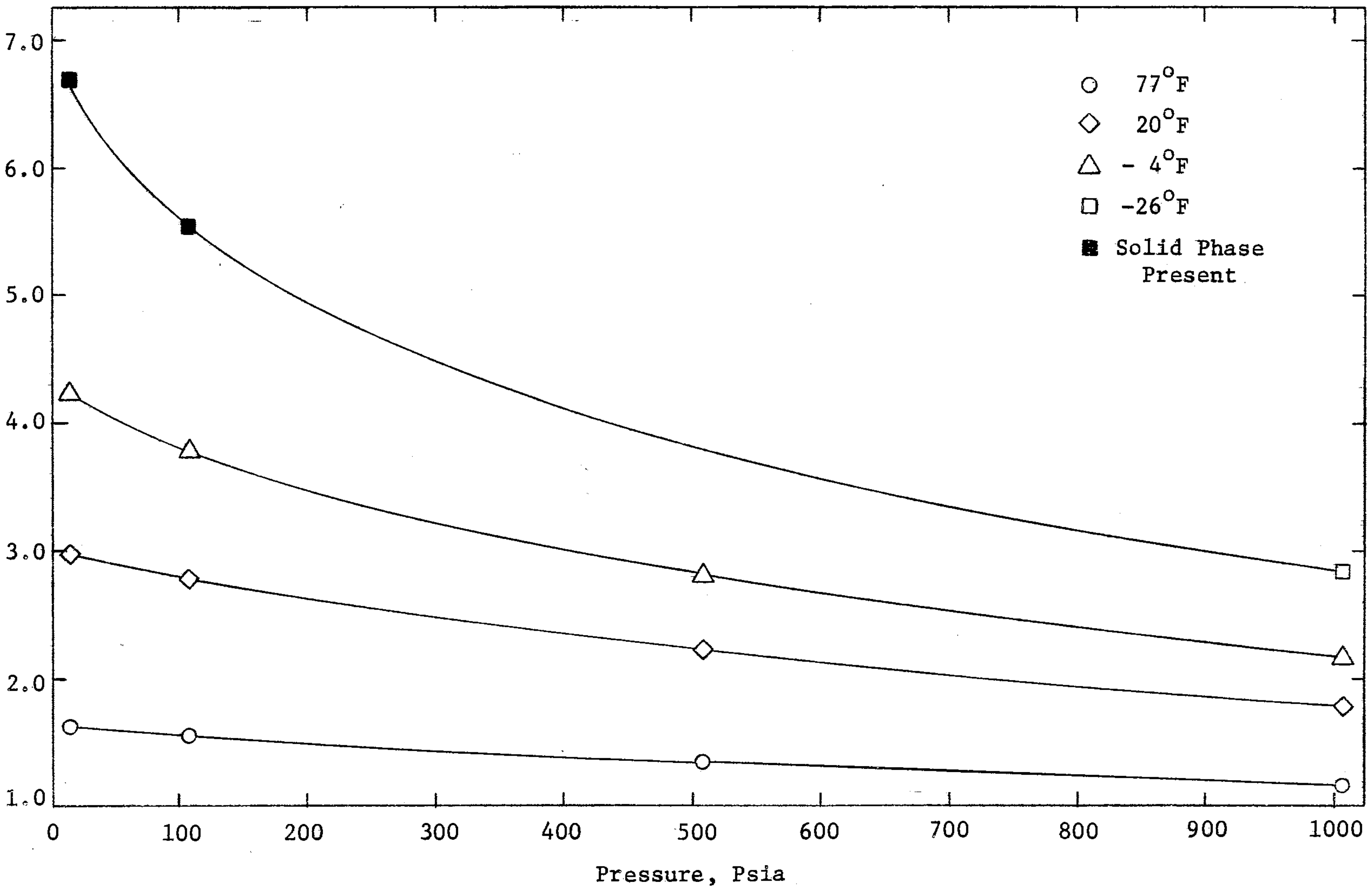

Figure 6. Kinematic Viscosity of a 50/50 Mixture of Mineral Spirits 135 / Heavy Solvent No. 1 as a Function of Pressure

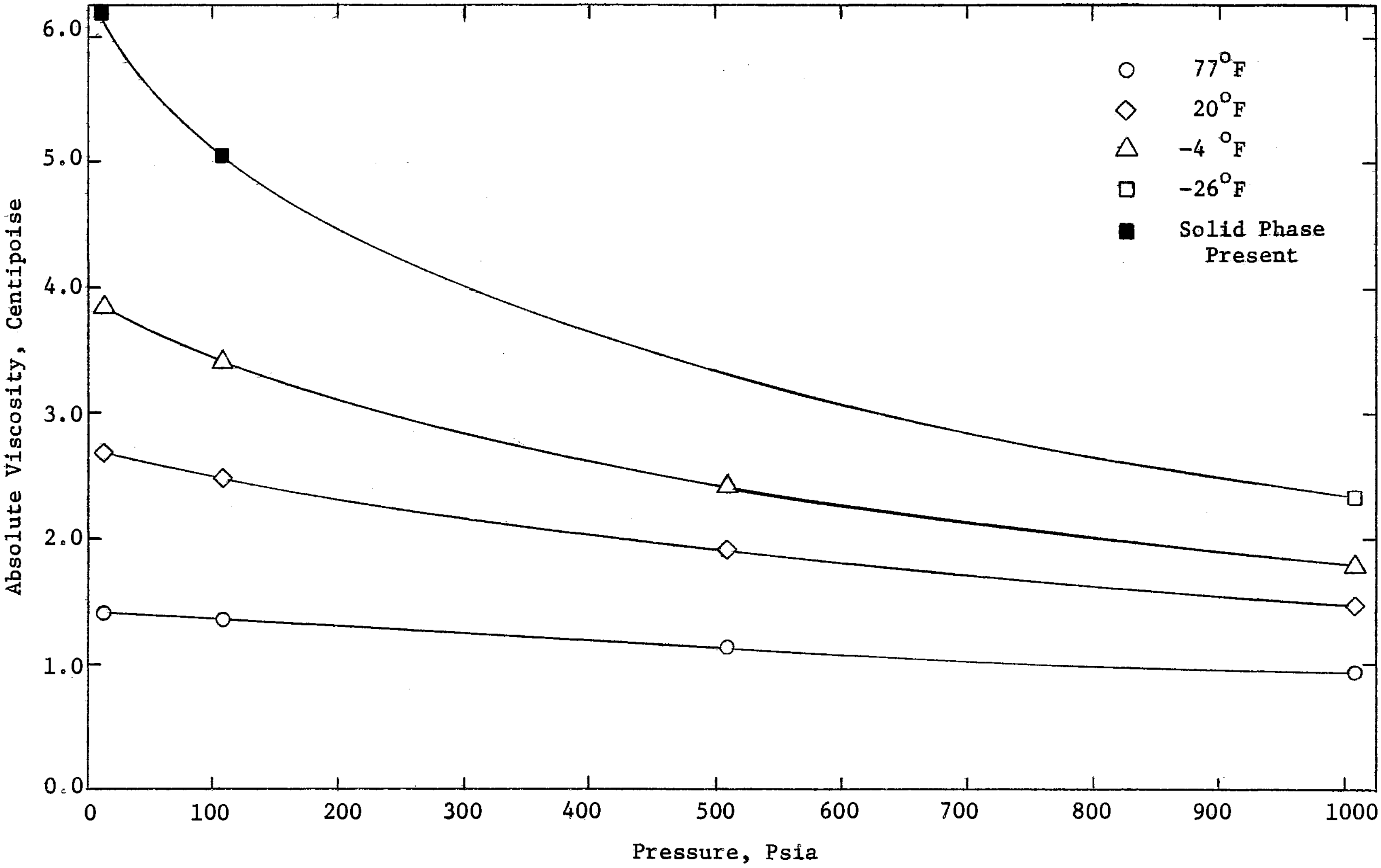

Figure 7. Absolute Viscosity of a 50/50 Mixture of Mineral Spirits 135 / Heavy Solvent No. 1 as a Function of Pressure

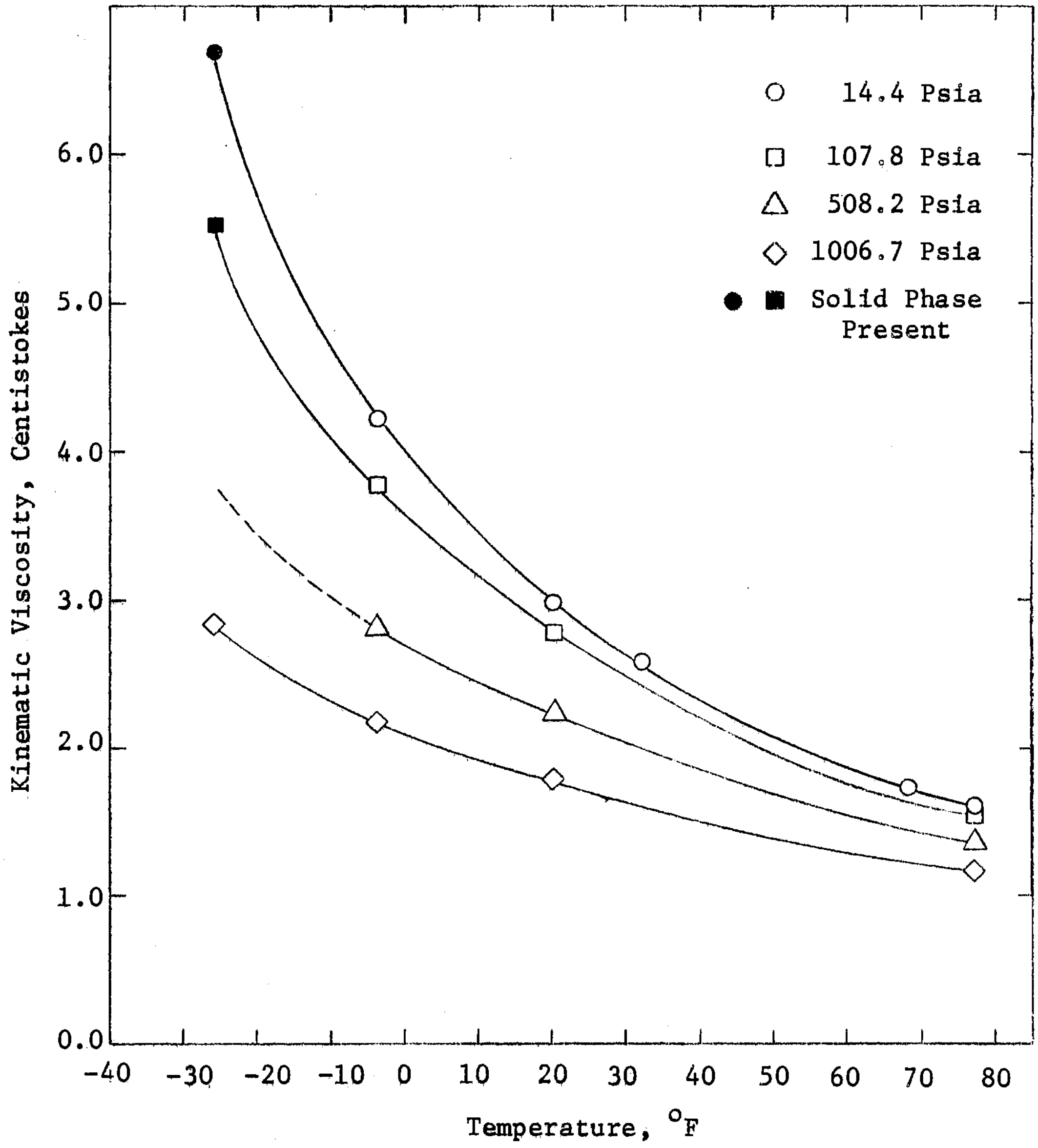

Figure 8. Kinematic Viscosity of a 50/50 Mixture of Mineral Spirits 135 / Heavy Solvent No. 1 as a Function of Temperature

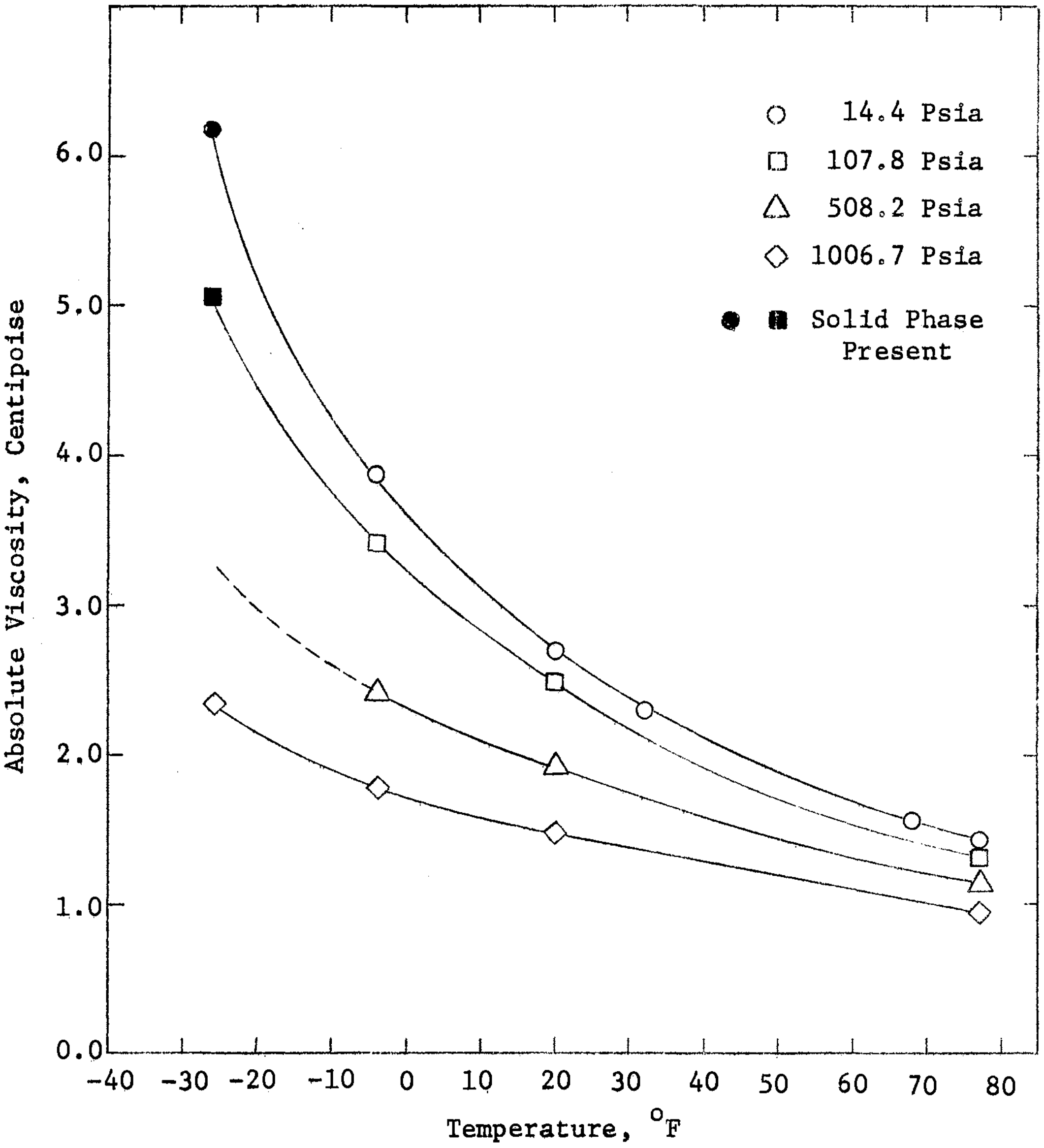

Figure 9. Absolute Viscosity of a 50/50 Mixture of Mineral Spirits 135 / Heavy Solvent No. 1 as a Function of Temperature

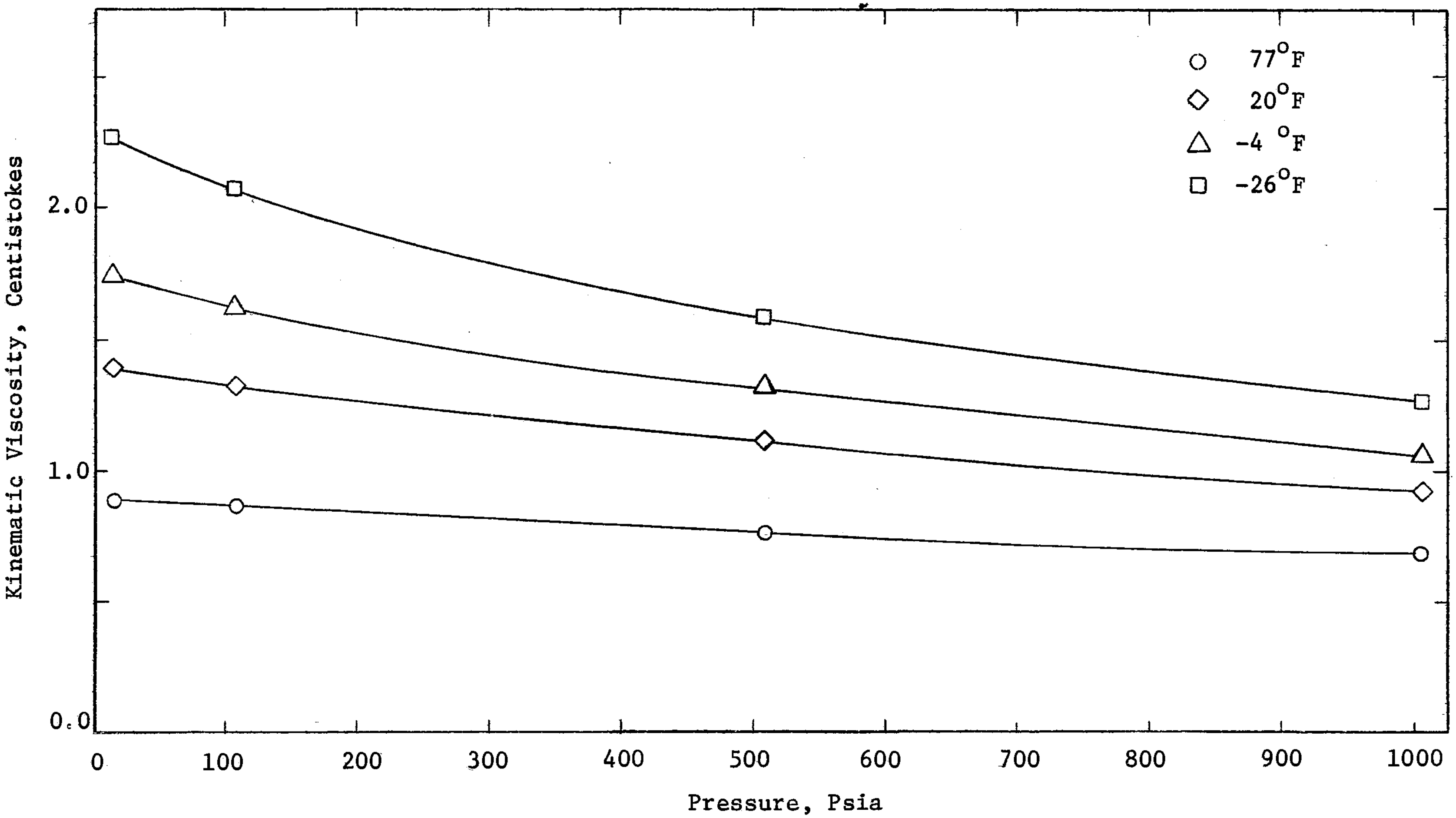

Figure 10. Kinematic Viscosity of a Highly Aromatic Absorption Oil as a Function of Pressure

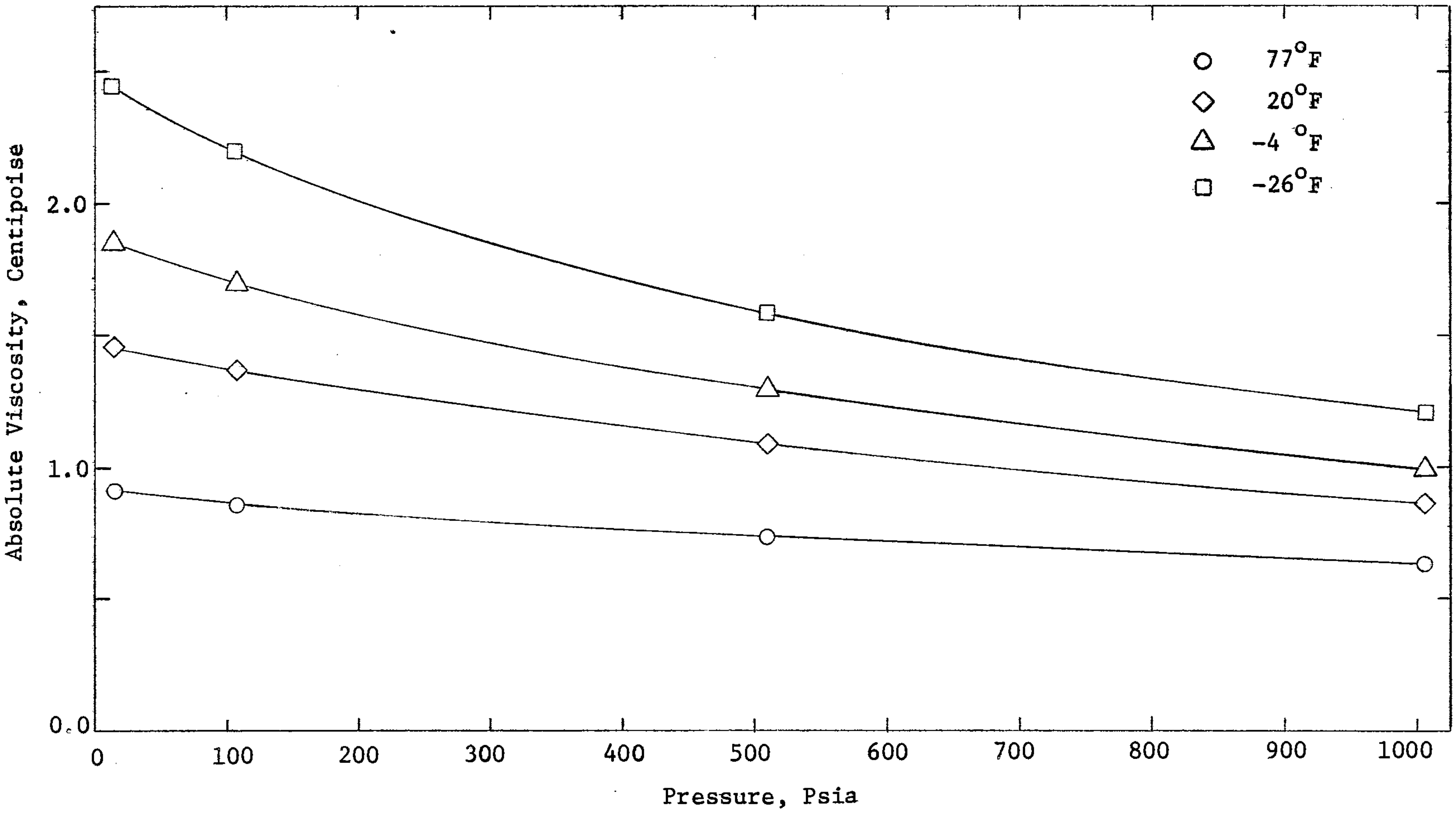

Figure 11. Absolute Viscosity of a Highly Aromatic Absorption as a Function of Pressure

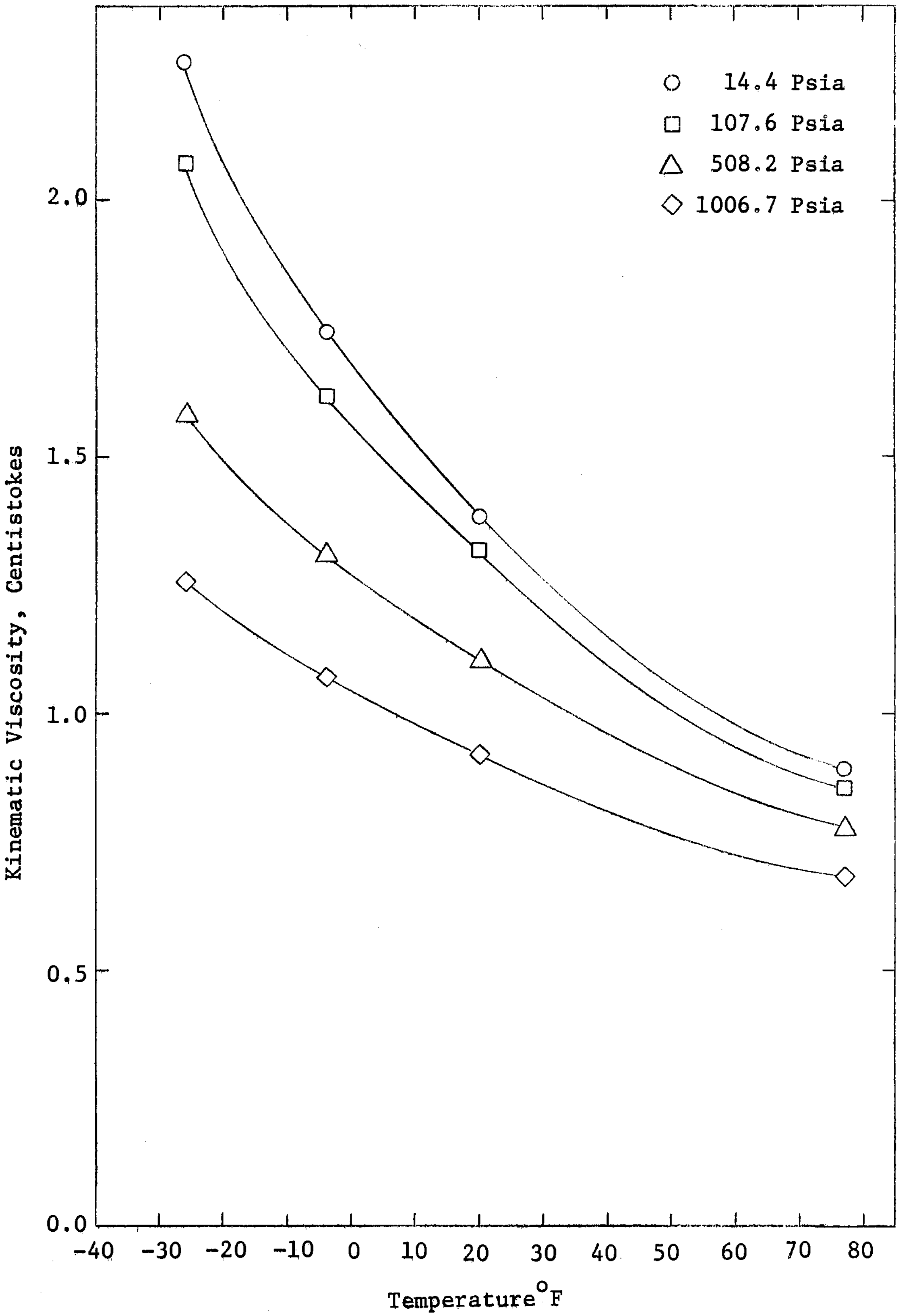

Figure 12. Kinematic Viscosity of a Highly Aromatic Absorption Oil as a Function of Temperature

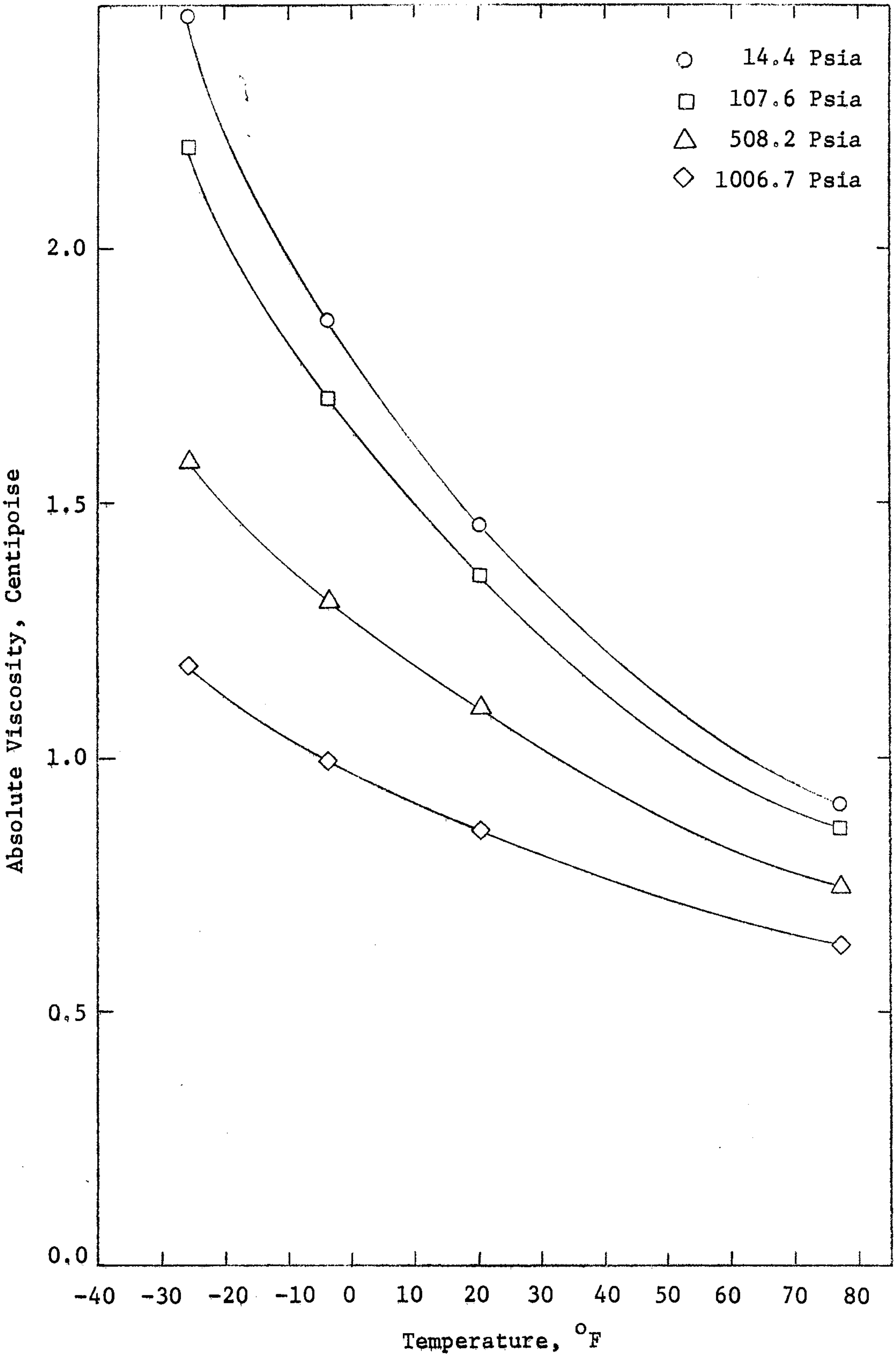

Figure 13. Absolute Viscosity of a Highly Aromatic Absorption Oil as a Function of Temperature

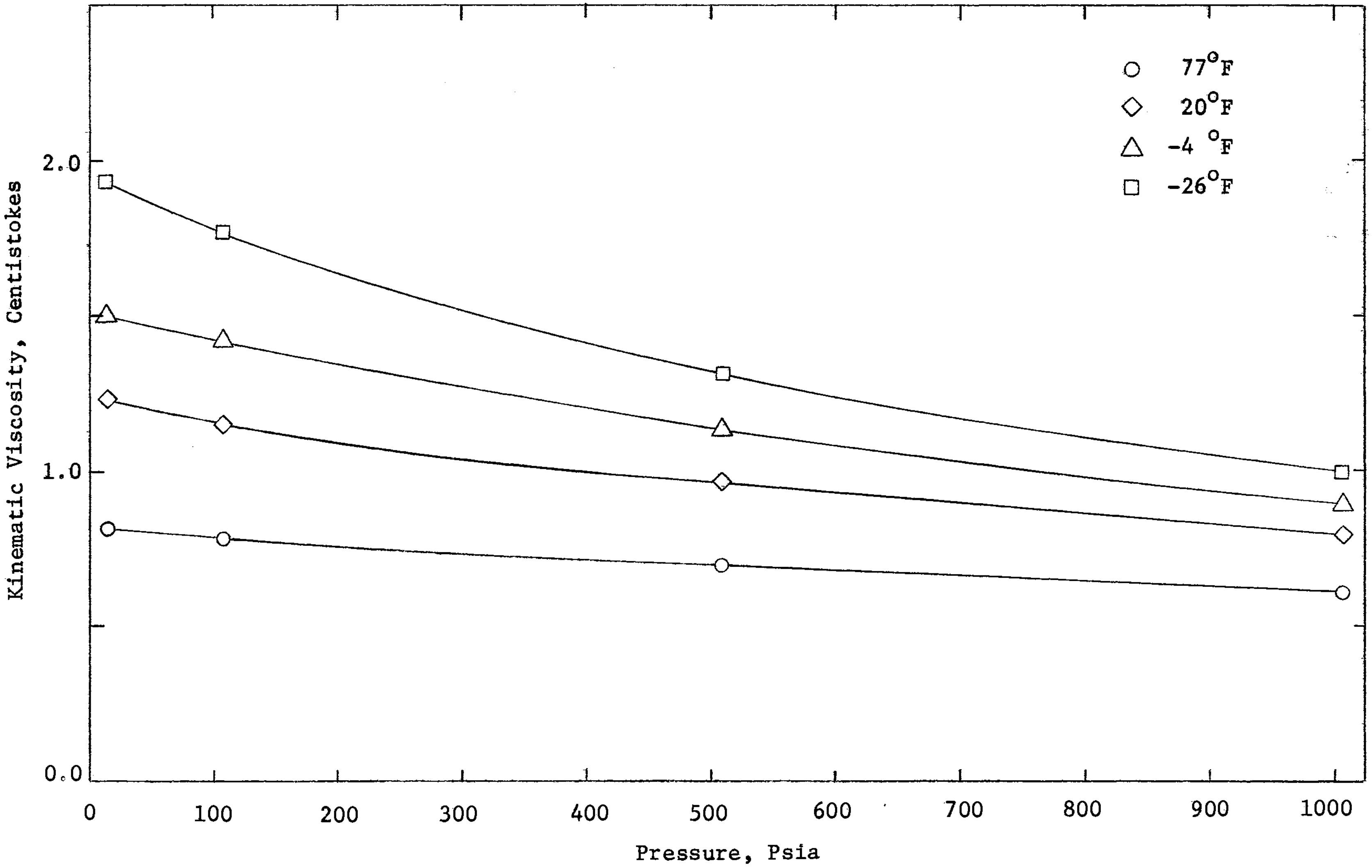

Figure 14. Kinematic Viscosity of a Highly Naphthenic Absorption Oil as a Function of Pressure

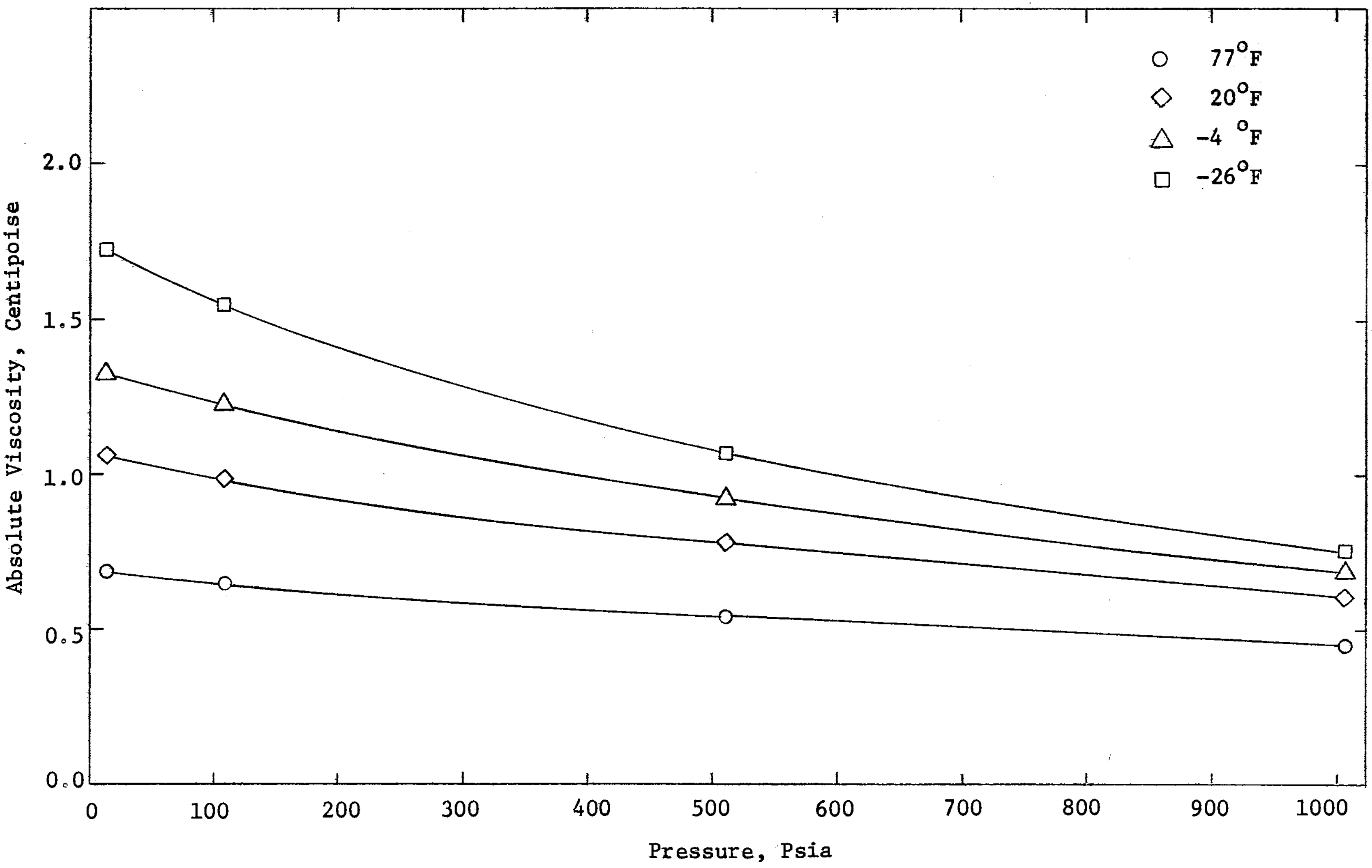

Figure 15. Absolute Viscosity of a Highly Naphthenic Absorption Oil as a Function of Pressure

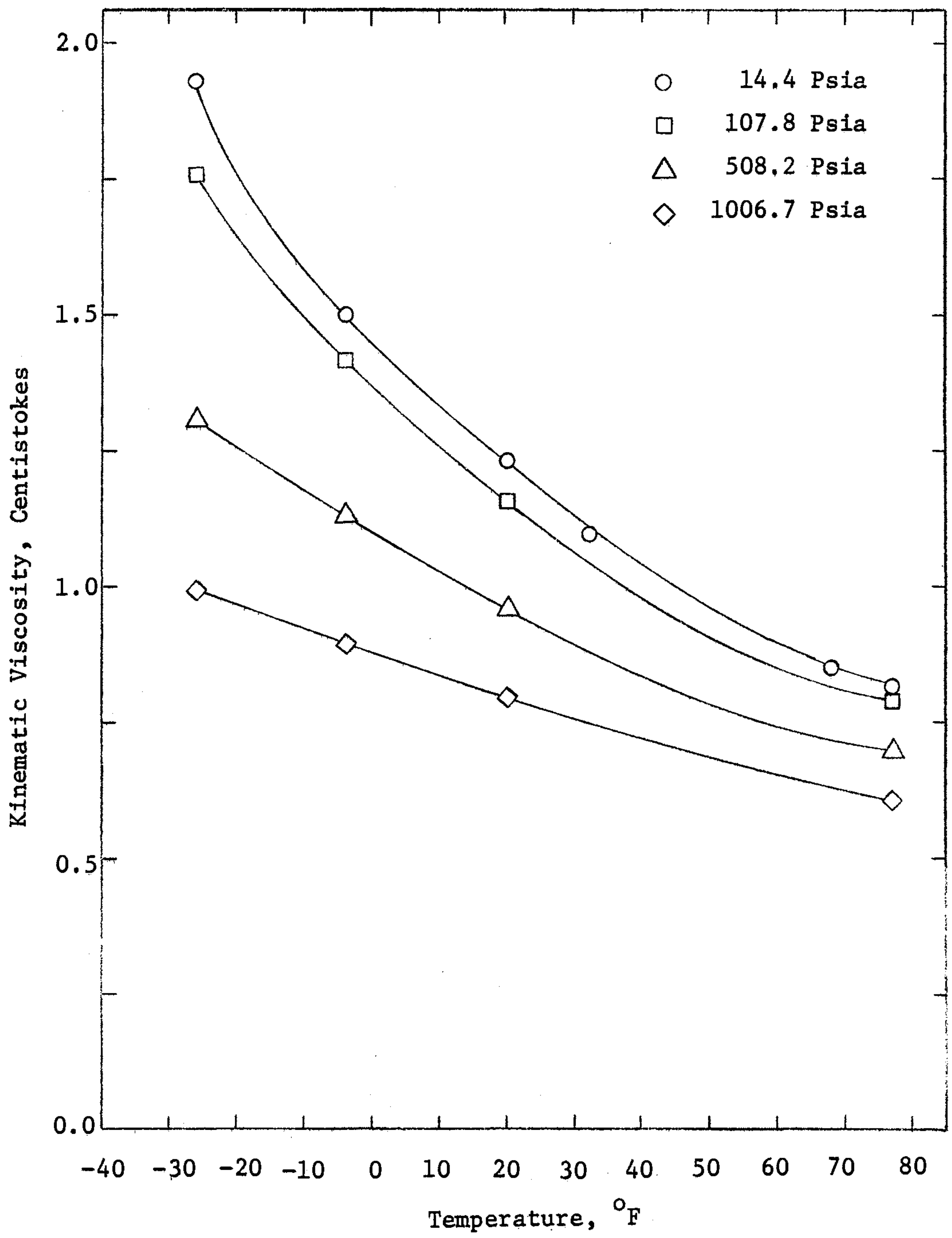

Figure 16. Kinematic Viscosity of Highly Naphthenic Absorption Oil as a Function of Temperature

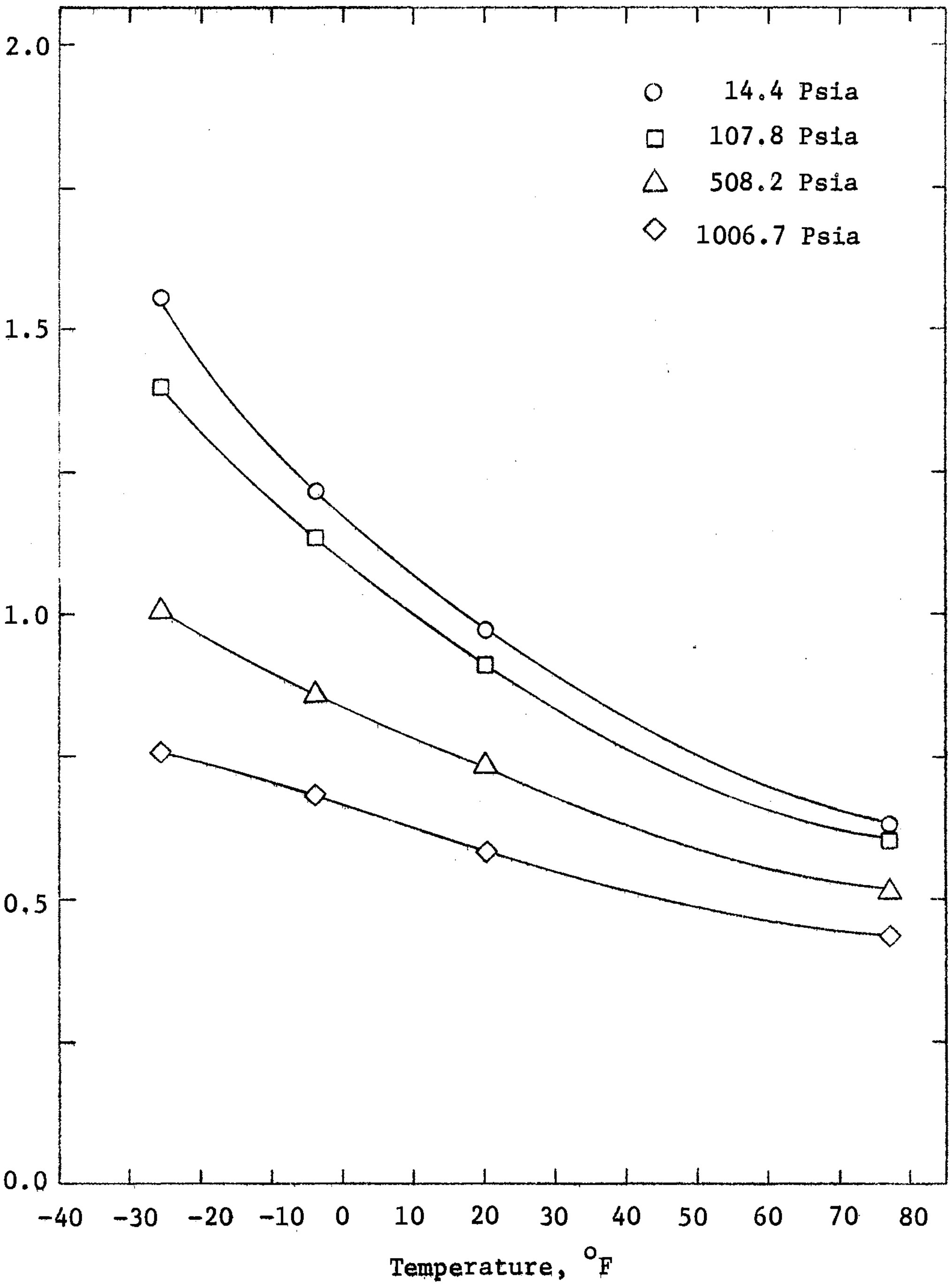

Figure 17. Absolute Viscosity of a Highly Naphthenic Absorption Oil as a Function of Temperature

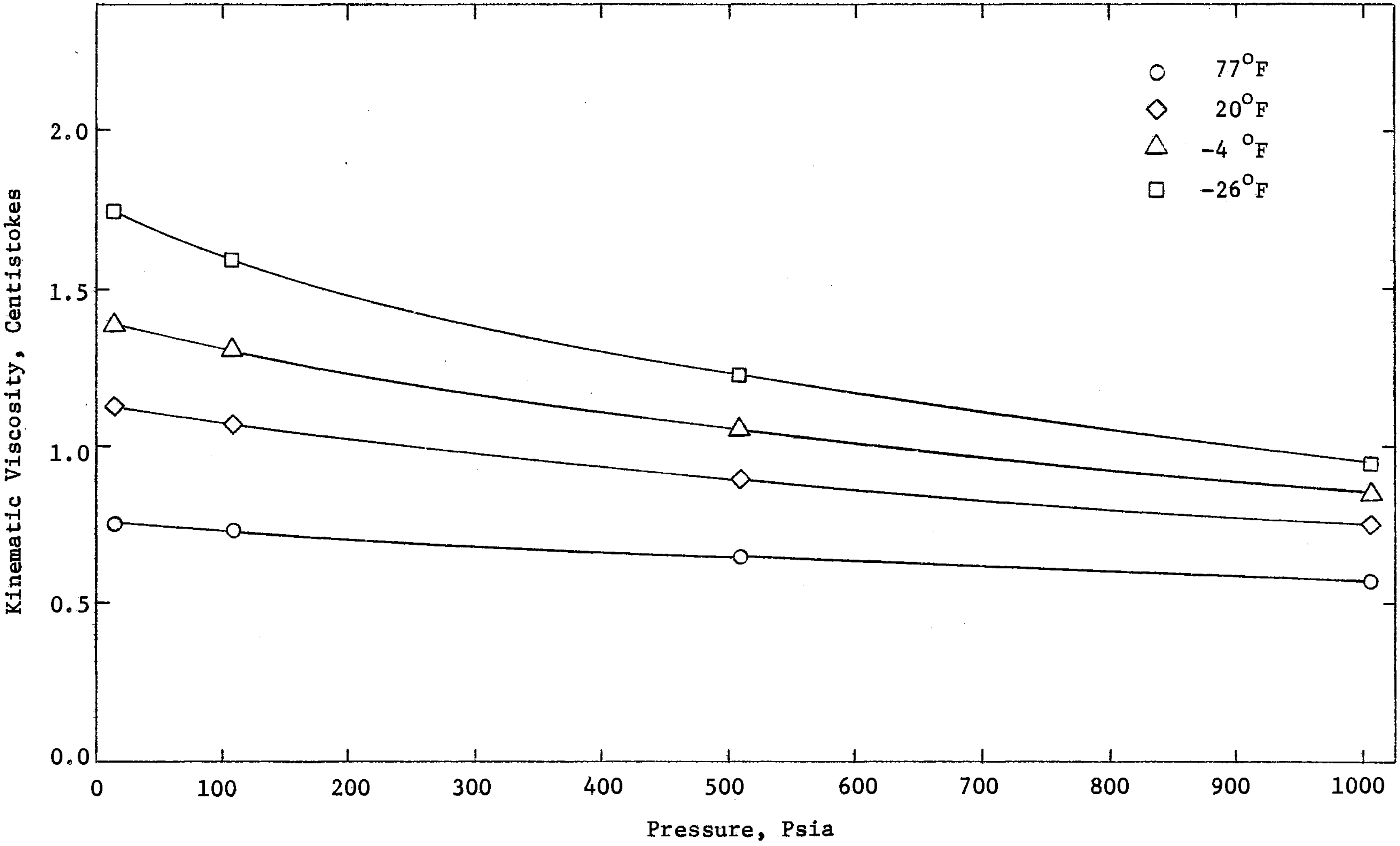

Figure 18. Kinematic Viscosity of Virgin Oil as a Function of Pressure

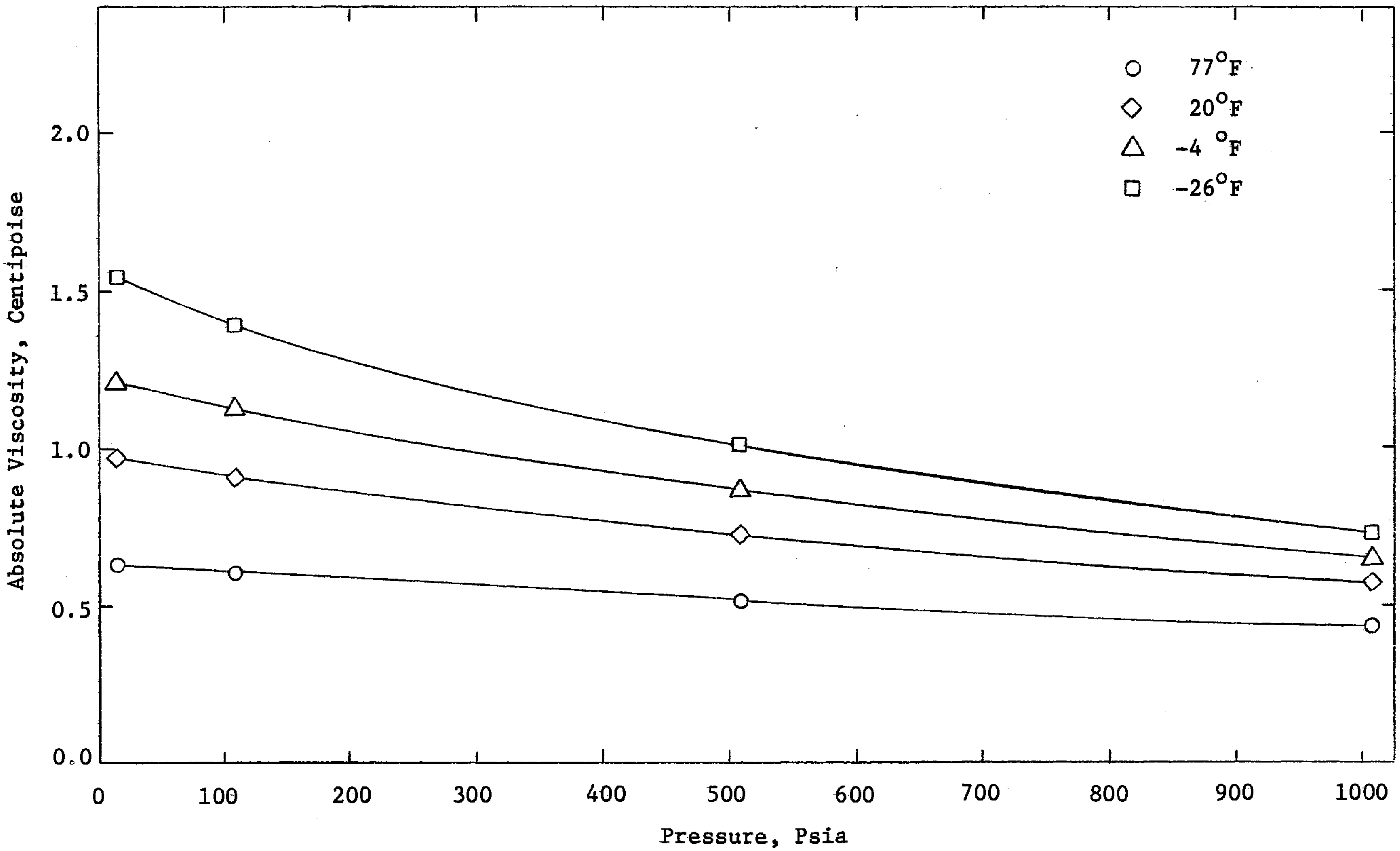

Figure 19. Absolute Viscosity of Virgin Oil as a Function of Pressure

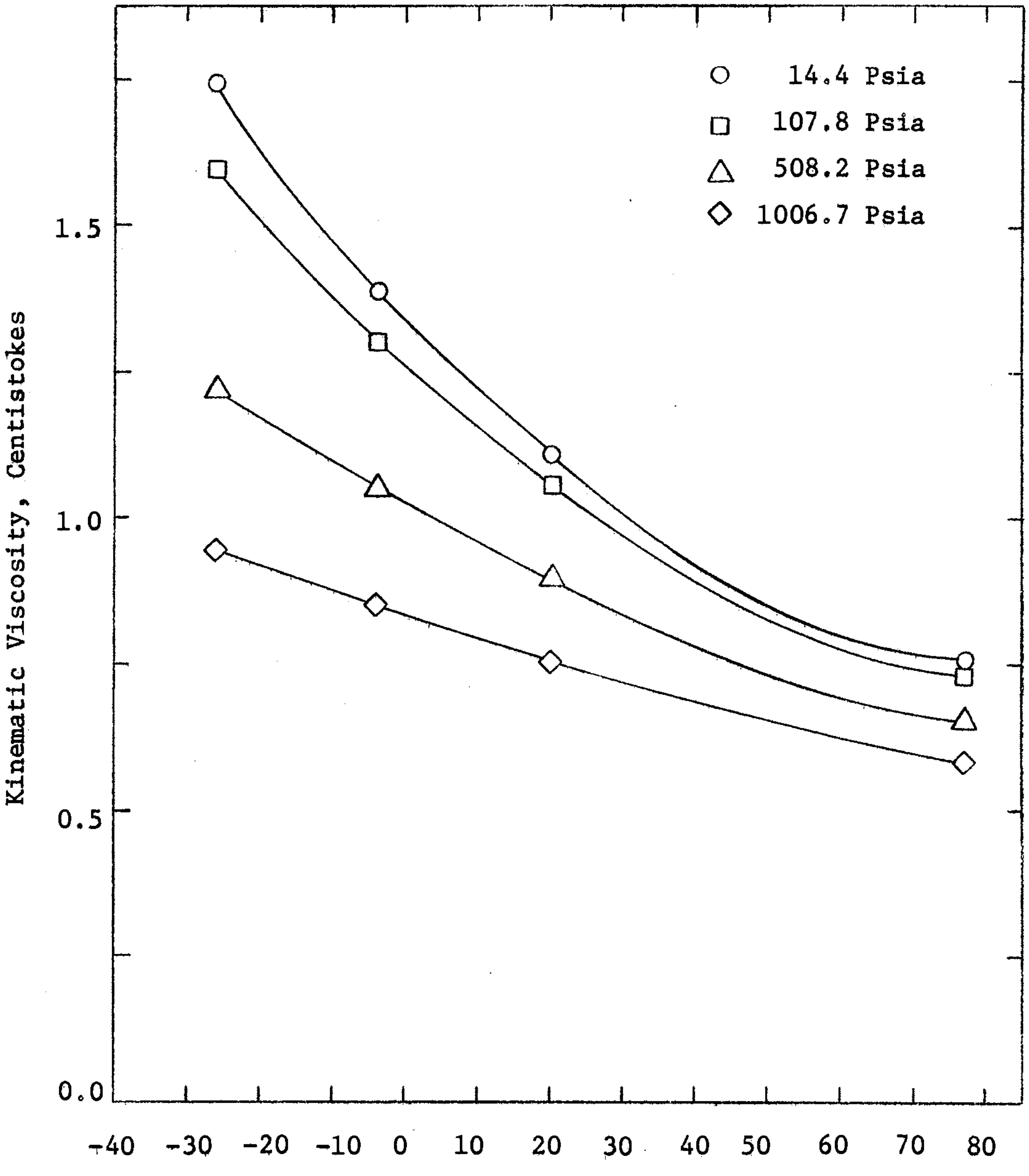

Figure 20. Kinematic Viscosity of Virgin Oil as a Function of Temperature

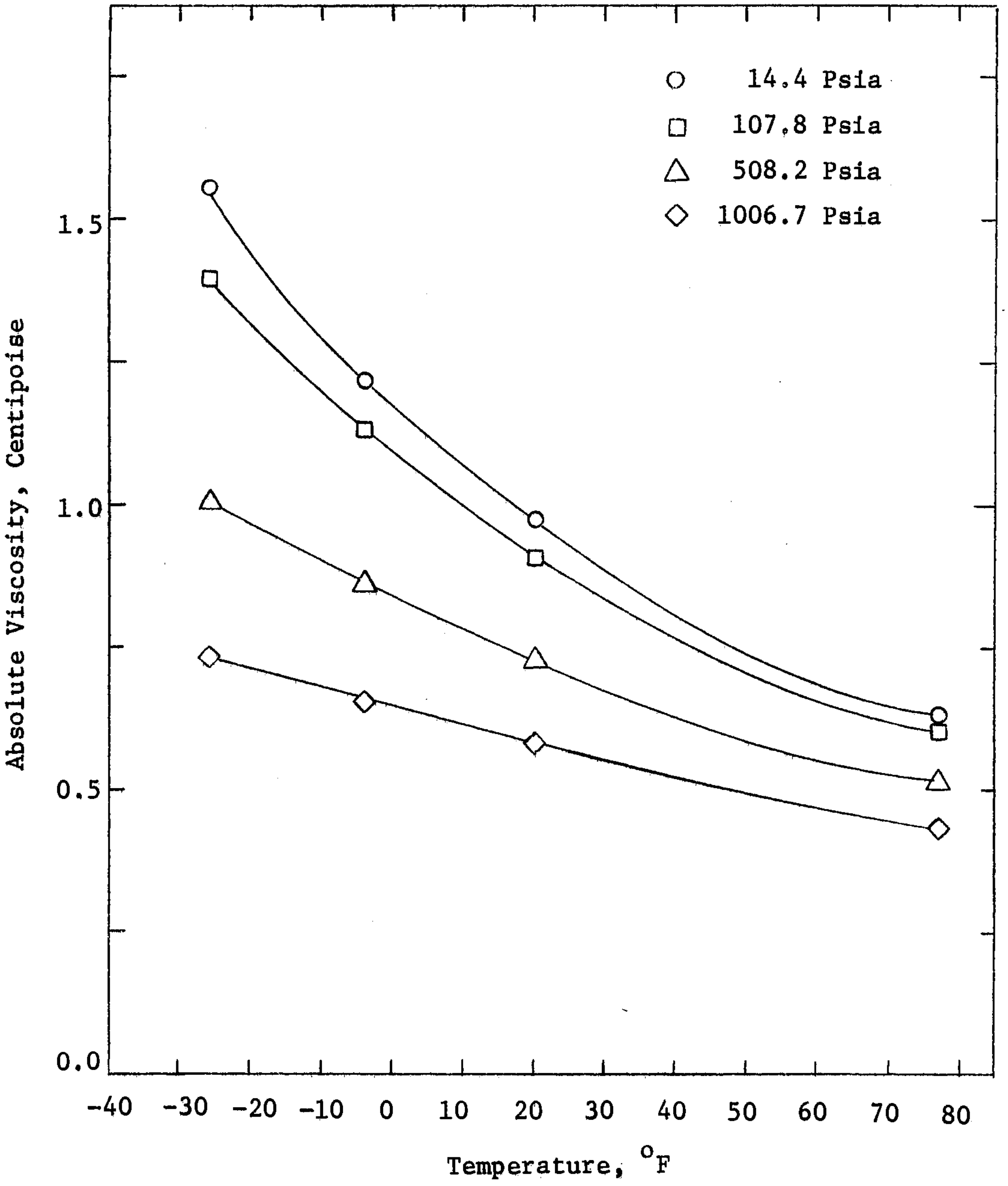

Figure 21. Absolute Viscosity of Virgin Oil as a Function of Temperature

CHAPTER IV

DISCUSSION OF RESULTS

The plots in this chapter represent only a small portion of the data obtained either experimentally or from equations of state but they are representative of the general behavior found throughout this study.

The equilibrium behavior of the lean oil systems was predicted using the correlation of Chao and Seader and the Soave RK correlation. The differences between the equilibrium compositions predicted by these two correlations were found to be relatively small. All data plotted are based on the equilibrium behavior predicted by the Chao-Seader correlation.

Before a comparison of the viscous behavior of the five lean oil systems is made, the predicted methane K-values should be examined on a common scale. Figure 22 presents plots on a log-log scale of methane K-values vs. the absolute pressure. The five lean oil systems studied may be broken into three groups based on composition; paraffinic, naphthenic, and aromatic. As depicted in Figure 22, the equilibrium behavior of the five oil systems is divided into three separate categories. Line 1 represents that oil system which consists largely of aromatic compounds and exhibits the largest methane K-values. Lines 2 and 3 represent the second category oil systems which are composed of about 80% paraffins and naphthenic compounds, divided equally, with

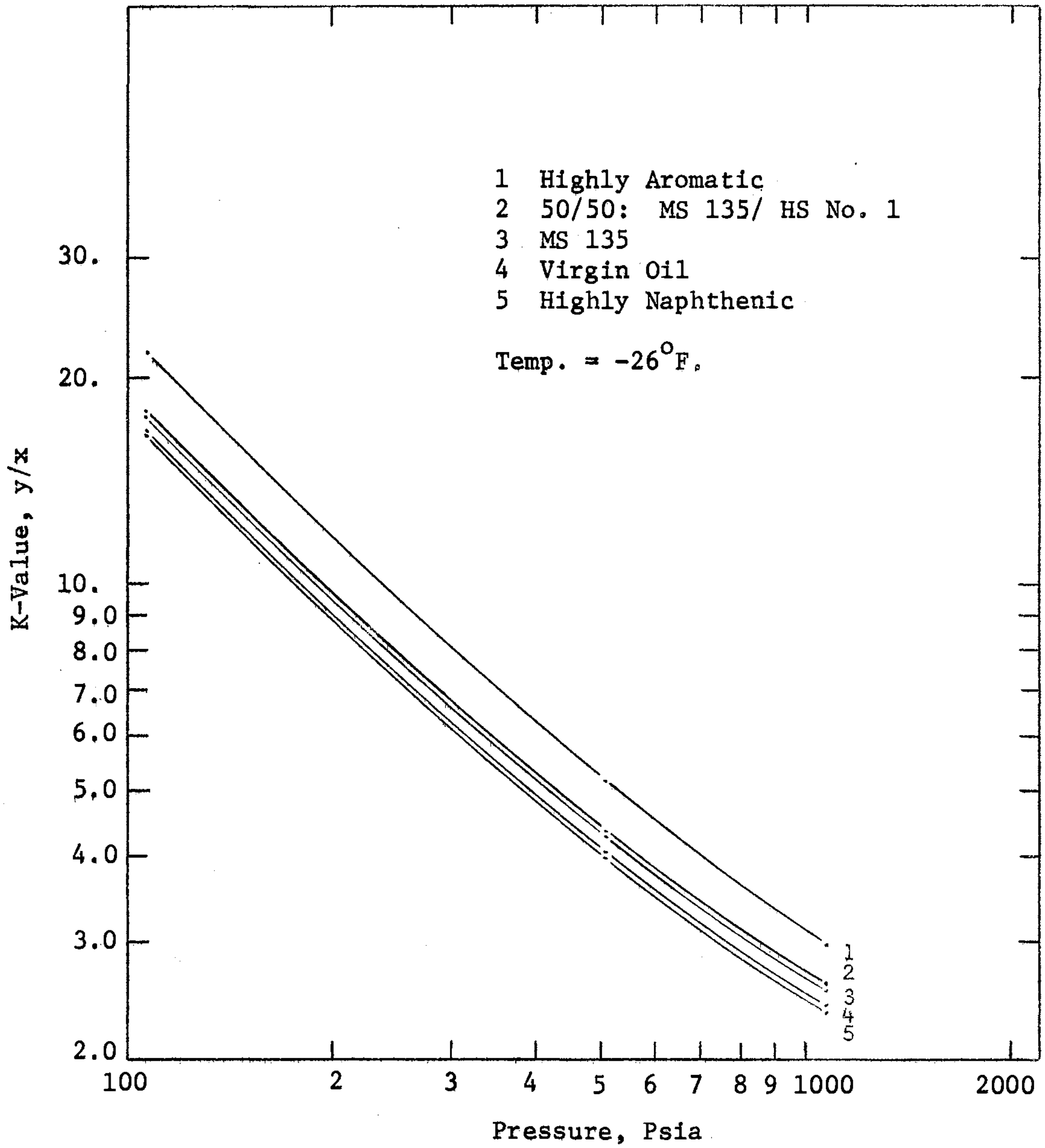

Figure 22. Comparison of Lean Oils; K-Value as a Function of Pressure

the remainder composed of aromatic compounds. The third category represented by lines 4 and 5 is composed of largely paraffins and largely naphthenic and paraffinic compounds but very little if any aromatic compounds. The methane K-values predicted in this study appear to compare qualitatively to those found experimentally by Kobayashi et. al. (4).

Figures 23, 24, 25 and 26 show a comparison of the absolute viscosity among the absorption oil systems. Viscosity profiles are shown to be separated into three categories; one containing a 50/50 mixture of Mineral Spirits 135 / Heavy Solvent No. 1, the second containing Mineral Spirits 135 and Highly Aromatic systems and the third containing Highly Naphthenic and Virgin Oil systems. Comparison on a molecular weight basis, Figure 27, the oils show a similar breakdown into the three categories. A quantitative comparison among the average molecular weights for the unsaturated lean oils in each category is: 50/50 MS 135 / HS No. 1, 153; MS 135 and Highly Aromatic Oil, 135 and 122 respectively and highly Naphthenic and Virgin Oil, 113 and 118 respectively.

Isotherms and isobars of absolute viscosity show a variation with pressure and temperature similar to that of kinematic viscosity. For this reason only absolute viscosity is referred to in this analysis.

Referring to Figures 23 and 24, at -26°F as the pressure is increased from atmospheric pressure to 1006.7 psia the absolute viscosity decreased by about 50% while at 77°F the absolute viscosity decreased by about 30%. Higher temperatures tend to decrease the dependence of viscosity on pressure. The viscosity dependence on

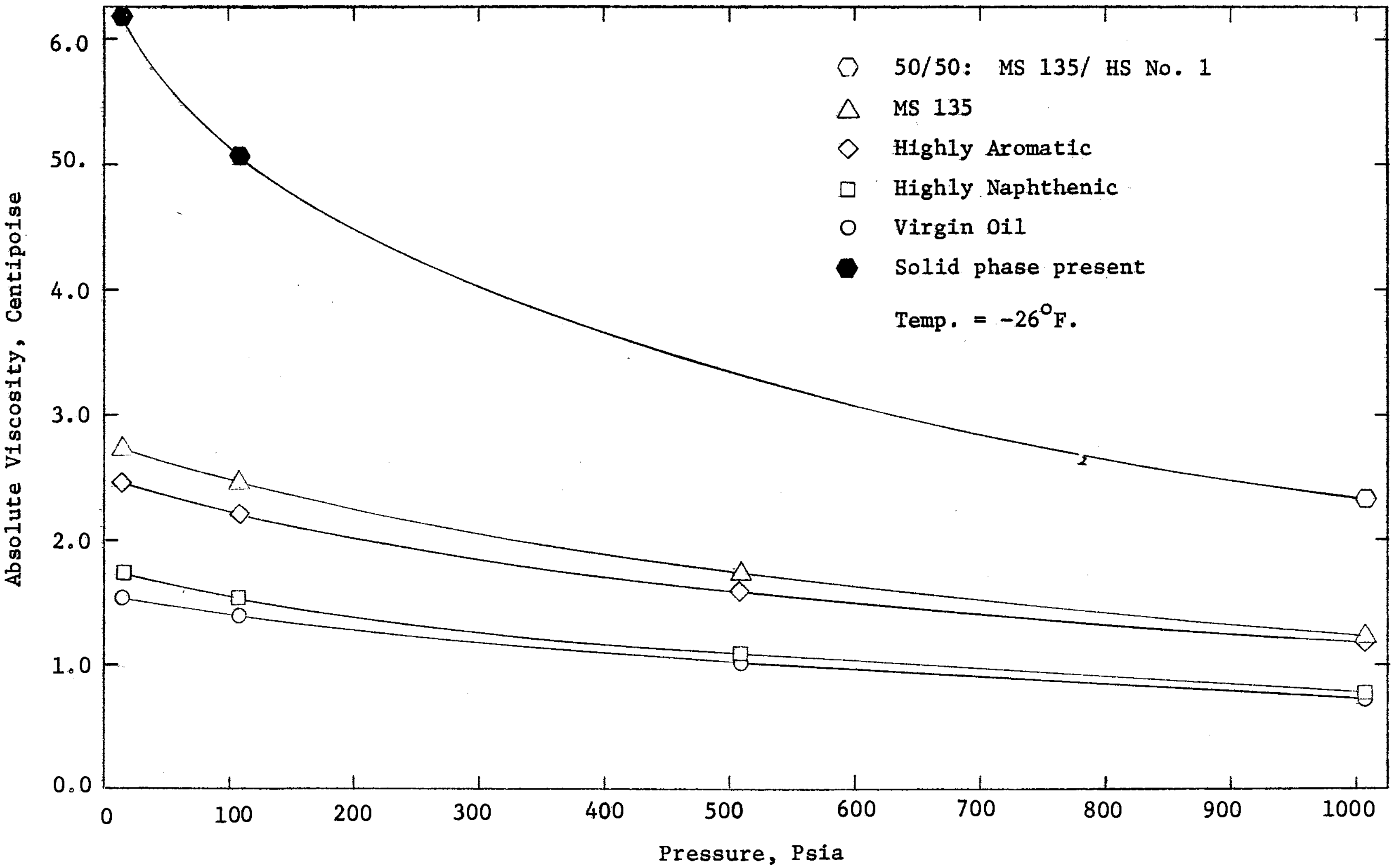

Figure 23. Comparison of Lean Oils; Absolute Viscosity as a Function of Pressure

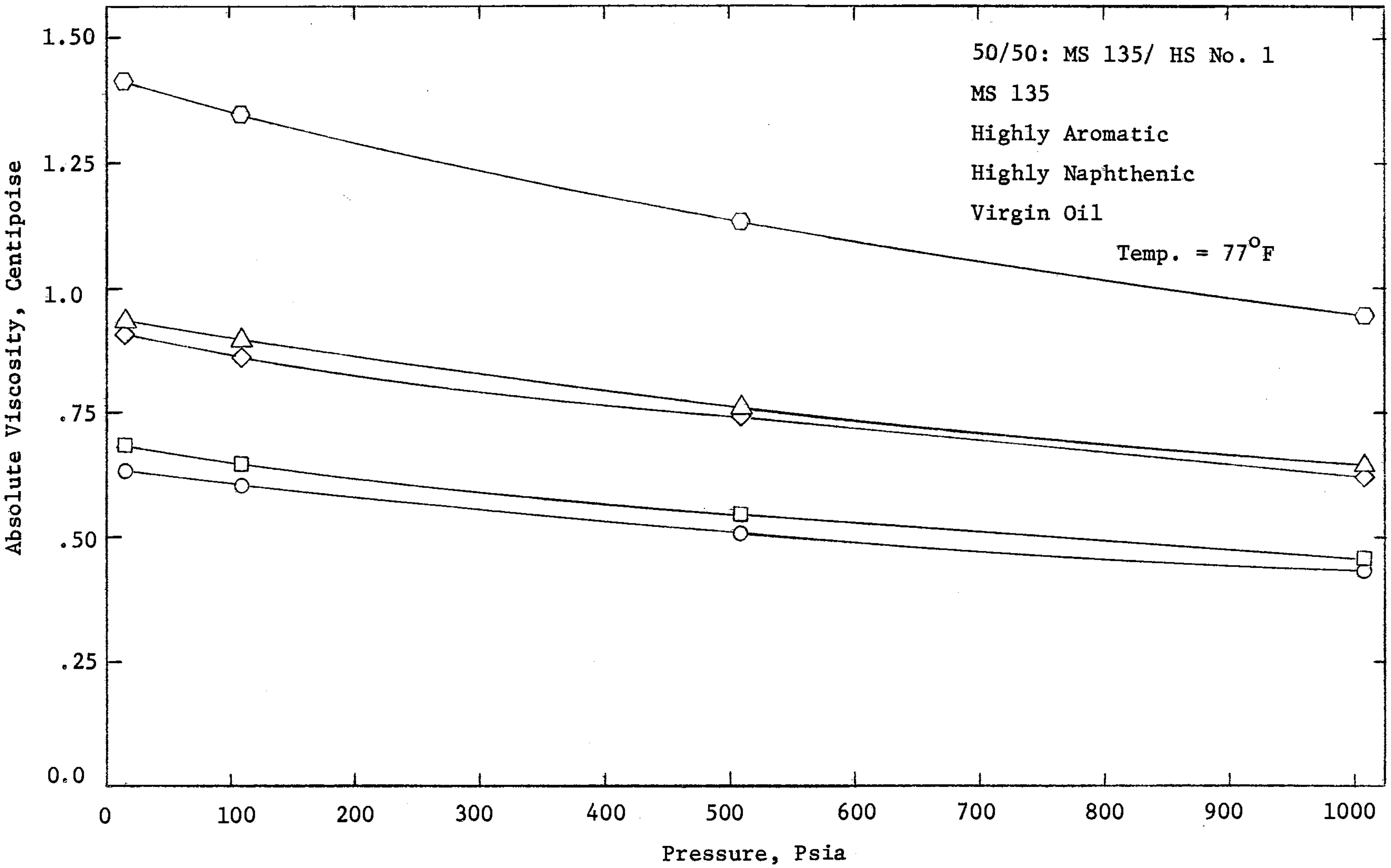

Figure 24. Comparison of Lean Oils; Absolute Viscosity as a Function of Pressure

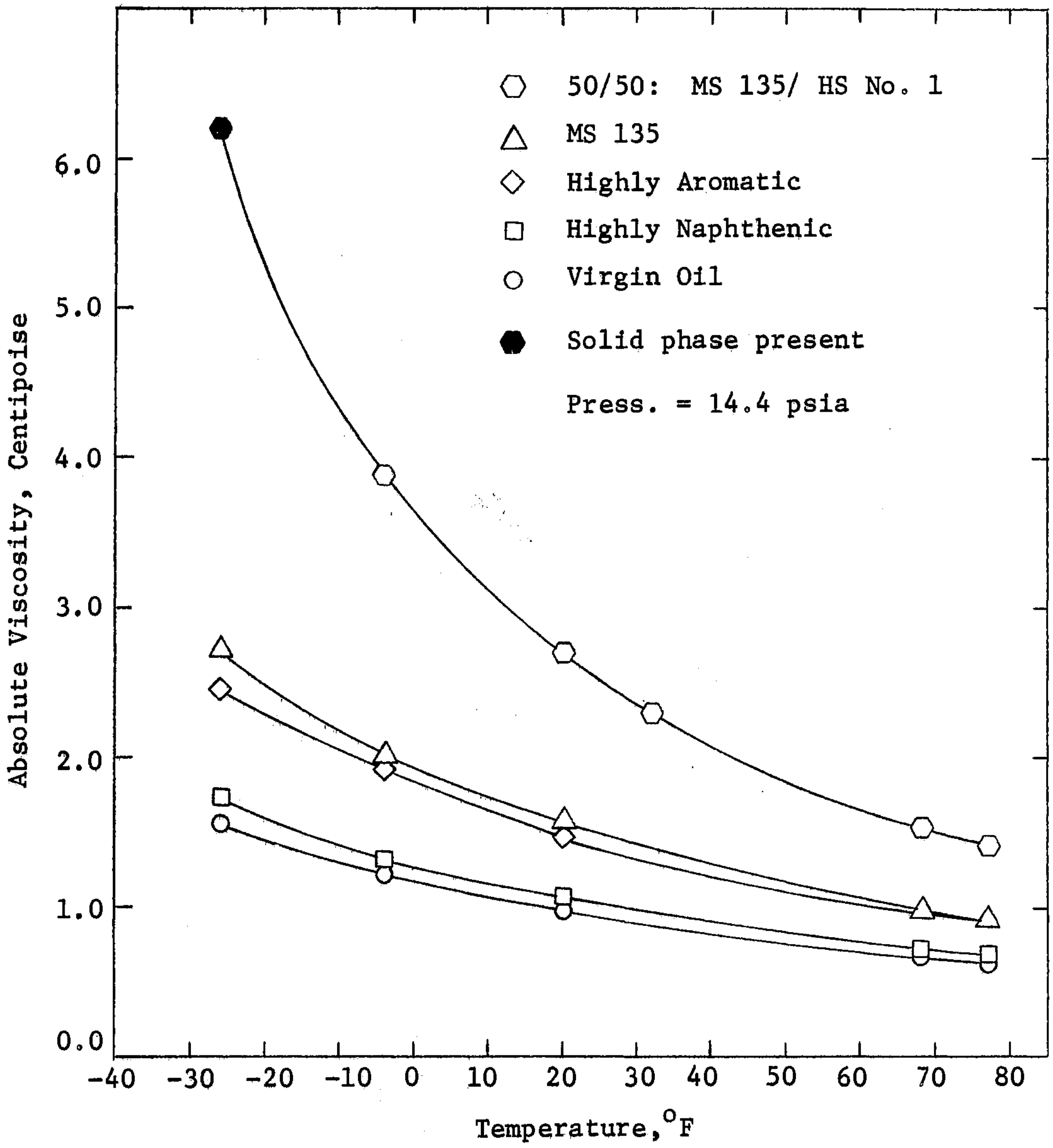

Figure 25. Comparison of Lean Oils; Absolute Viscosity as a Function of Temperature

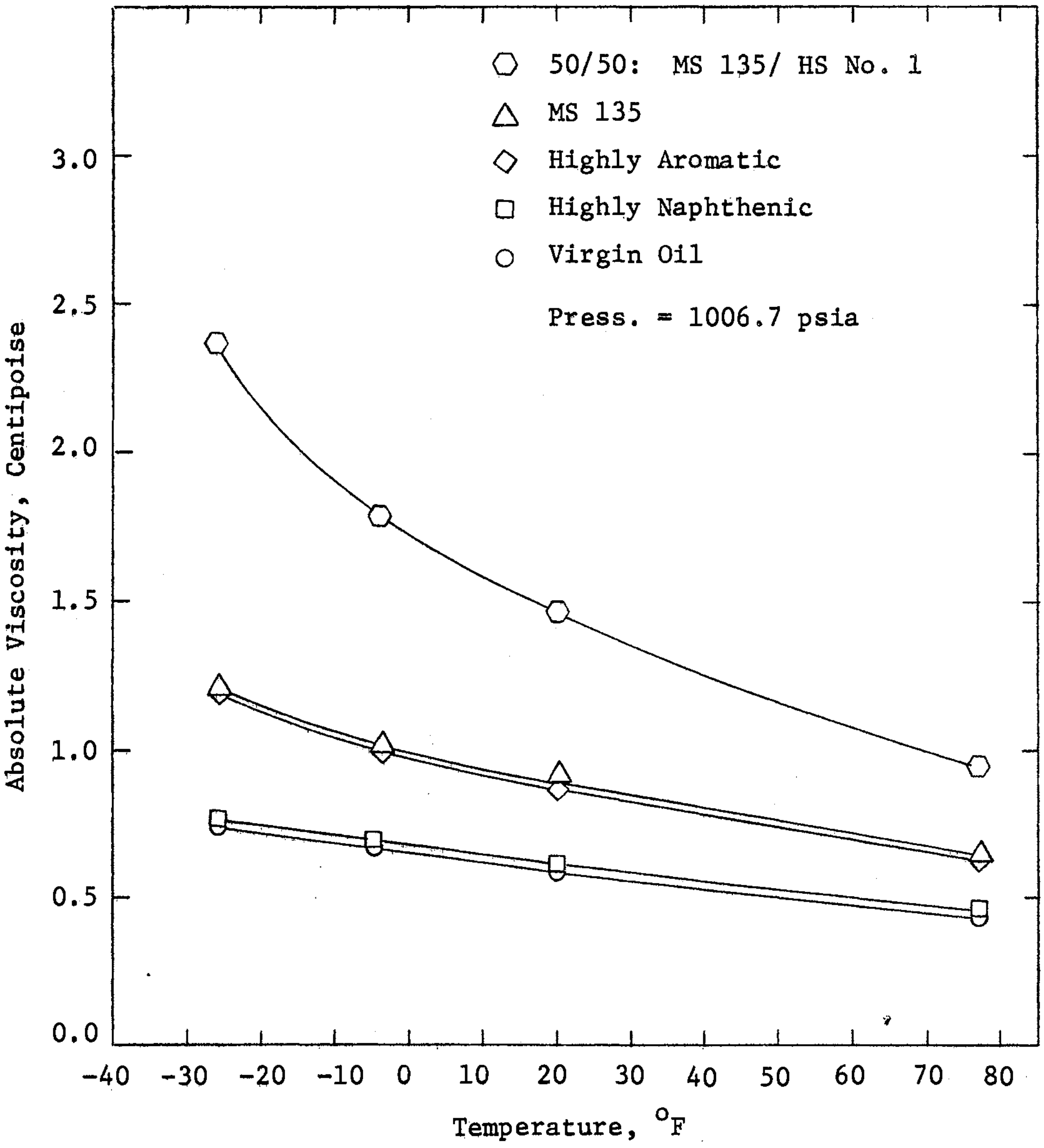

Figure 26. Comparison of Lean Oils; Absolute Viscosity as a Function of Temperature

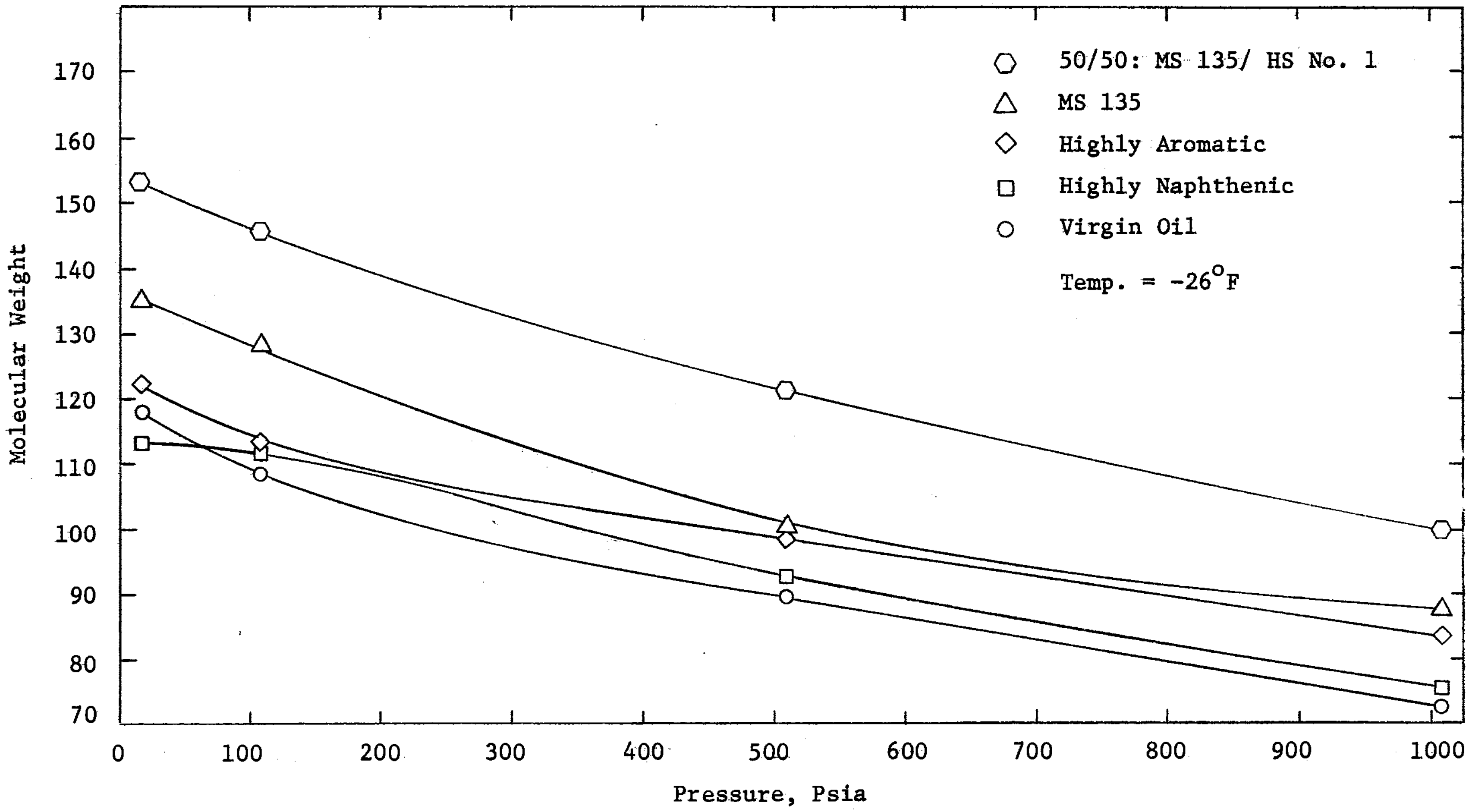

Figure 27. Comparison of Lean Oils; Molecular Weight as a Function of Pressure

temperature is shown in Figures 25 and 26 at constant pressures of 14.4 and 1006.7 psia respectively. Figure 25 shows the most dramatic change of viscosity with temperature with the 50/50 mixture of MS 135 / HS No. 1 showing a decrease in absolute viscosity by about 75% as the temperature was increased from -26°F to 77°F. In all other cases including those in Figure 26 a decrease in absolute viscosity by about 50% was noted. The large change in absolute viscosity with temperature in Figure 25 is due to the lack of methane in the system. In Figure 26, the direct effect of temperature on viscosity was depressed by the increase in methane solubility at low temperatures.

At a temperature of -26°F a solid phase was present in the 50/50, MS 135/HS No. 1 system. The concentration of the small crystal flakes was observed to decrease as the pressure increased at constant temperature. Total disappearance was noted at 1006.7 psia. The disappearance of the solid phase may be attributed to the decrease in molecular weight of the solution as the concentration of methane increased with increasing pressure.

Figures 28, 29 and 30 show the relation among the five variables, not necessarily independent; temperature, pressure, methane concentration, density and absolute viscosity, for an equilibrium system.

A. Figure 28: At constant temperature, an increase in liquid phase methane concentration is accompanied by a decrease in absolute viscosity. The increase in methane concentration is the result of an increase in pressure. A decrease in temperature along a low pressure isobar results in a relatively large increase in absolute viscosity and a small increase in methane concentration.

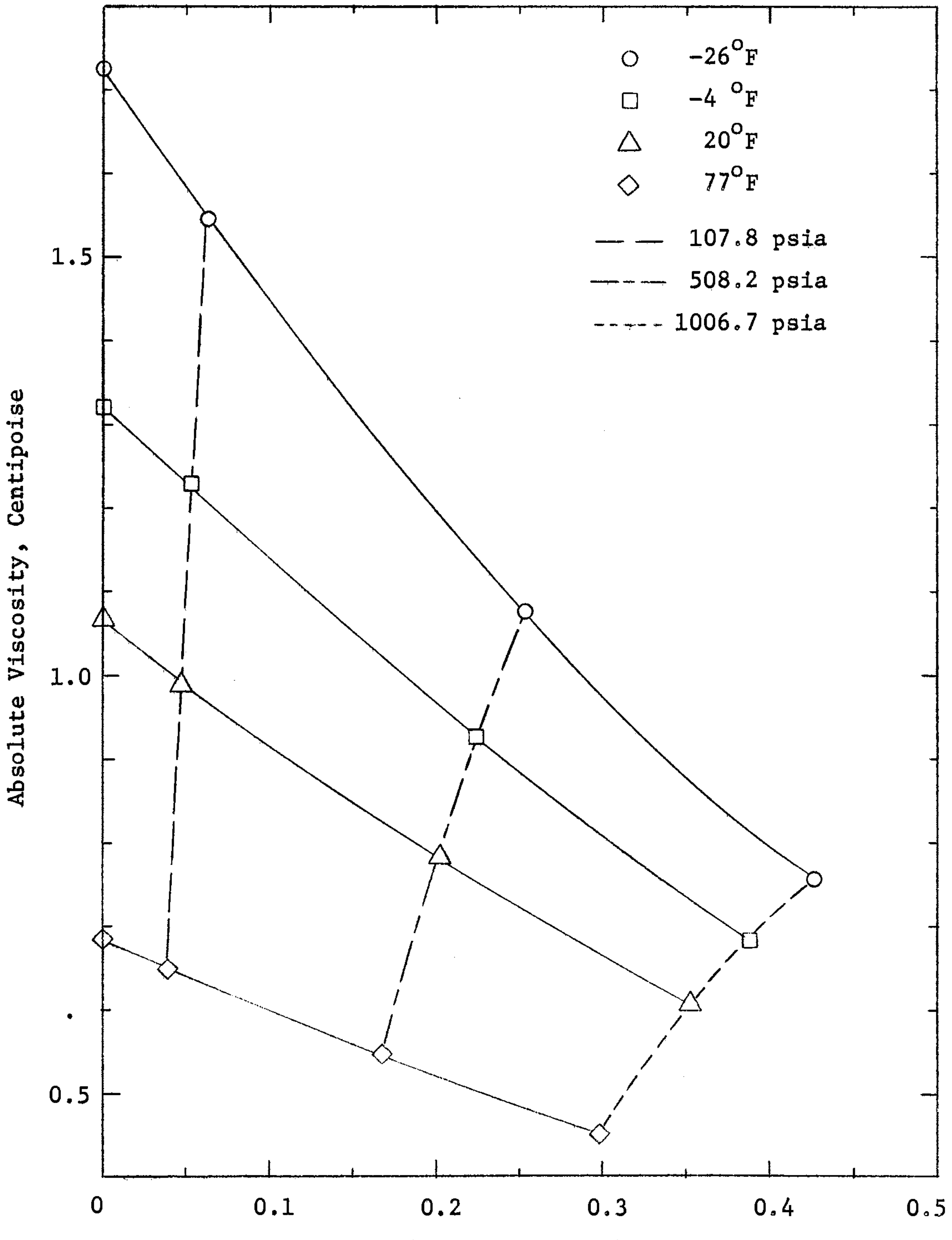

Figure 28. Absolute Viscosity of Methane-Highly Naphthenic Oil Equilibrium System as a Function of Methane Composition.

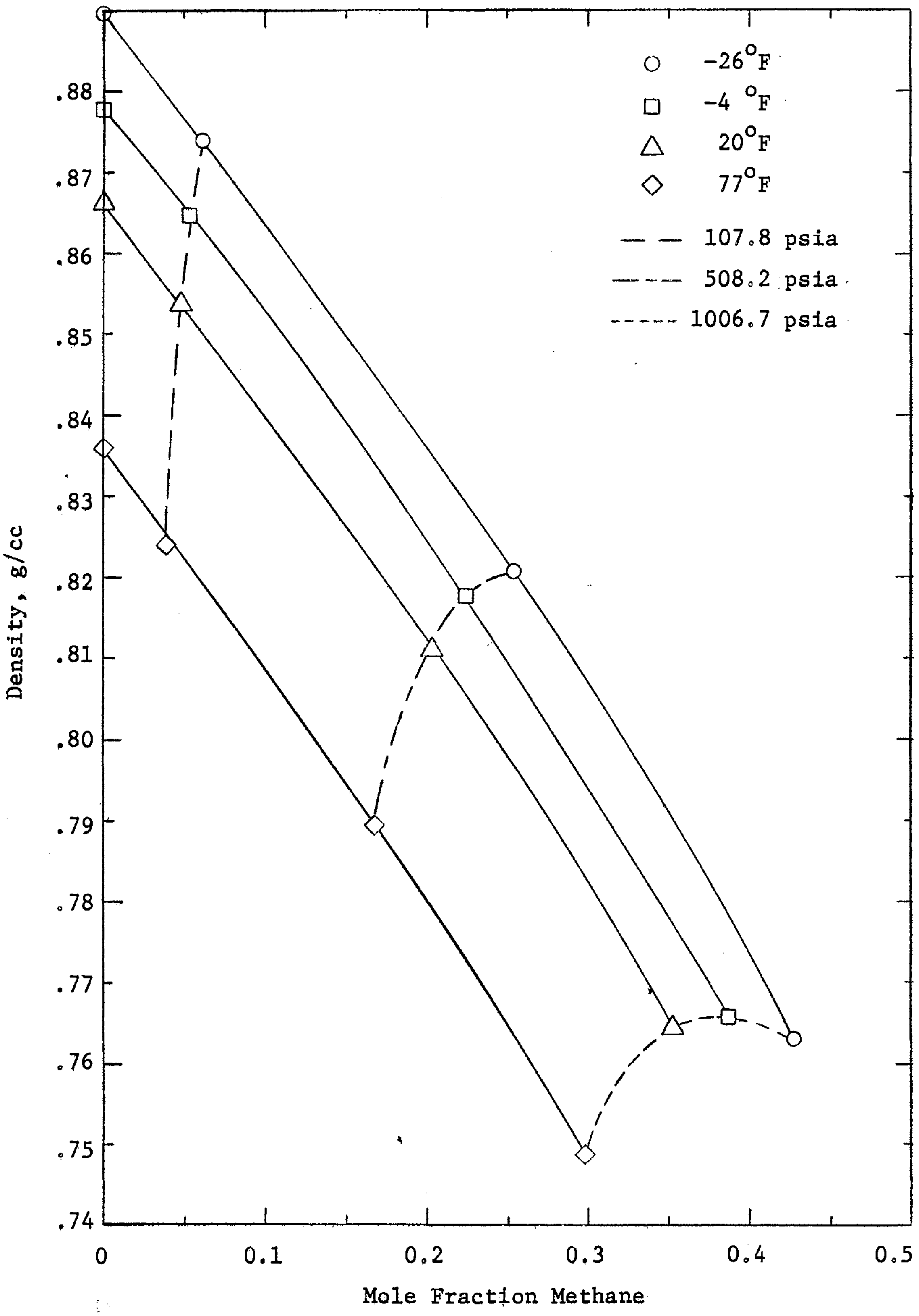

Figure 29. Density of Methane-Highly Naphthenic Oil Equilibrium System as a Function of Methane Composition

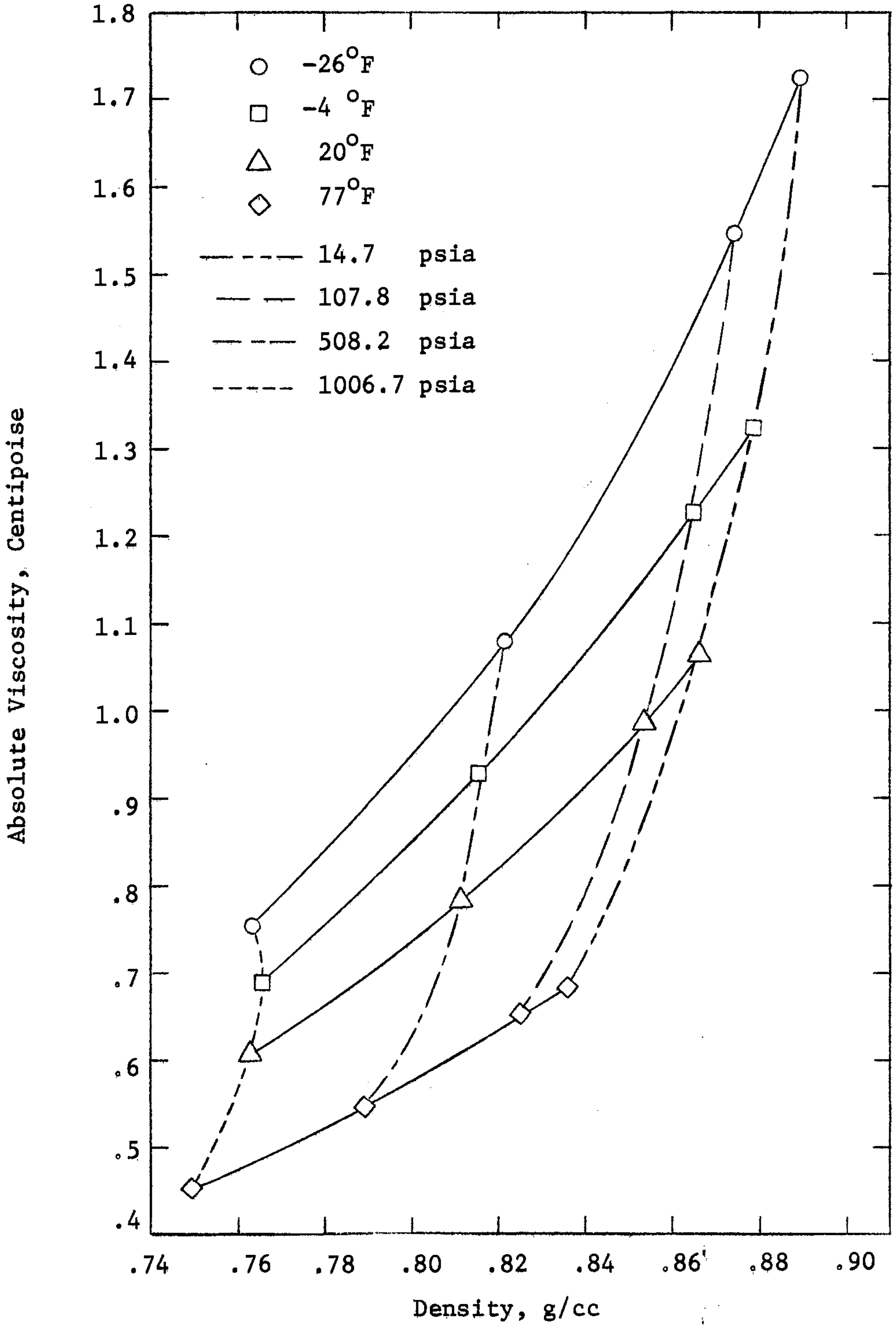

Figure 30. Absolute Viscosity of Methane-Highly Naphthenic Oil System as a Function of Density

B. Figure 29: As the methane concentration increases along an isotherm the density decreases at a rate independent of temperature. Along a low pressure isobar, a decrease in temperature effects a relatively large increase in density with a small increase in methane concentration. Along a high pressure isobar, a decrease in temperature results in an inversion in the density trend. The solubility of methane is large at these conditions with the increase in methane concentration overriding the temperature effect on density.

C. Figure 30: An increase in density at constant temperature results in an increase in absolute viscosity.

CHAPTER V

RECOMMENDATIONS

The equipment as designed provided a reasonable means by which to obtain kinematic viscosity. There are several modifications that would facilitate operation of the equipment and more accurate kinematic data.

Suggested modifications are:

1. During this work, materials were studied that were highly sensitive to temperature changes. Bath temperature control, depending on the technique used, ranged from excellent to inoperable. Modification or replacement of the present refrigeration system is recommended. Temperature fluctuations of the bath fluid made determining the actual temperature at which the oils were being studied very difficult.
2. In order to determine the damping effect of the gas in the cell upon temperature fluctuations of the bath fluid, a shielded thermocouple inserted into the cell would be valuable in determining the actual sample temperature.
3. Independent of the care that one exerted to clean the viscometer, foreign matter was observed suspended in the oil samples. A modification of the location of one of the inlet gas lines is suggested to eliminate the entrance of gas into the main cell through the brass tubing which extends down

into the viscometer reservoir. With this modification, foreign matter carried through the gas line would fall harmlessly to the bottom of the cell.

4. In this study specific oil samples were studied with several being highly volatile. For this reason, in order to maintain the oil samples as near the original as possible, purging of the cell was never performed using evacuation techniques. The installation of a bleed line in the bottom of the cell would make purging easier and more effective.
5. While working at high pressures, the application of a back-pressure to reverse the direction of flow of the test fluid by means of the inline pressure controller was very difficult. Since a large volume displacement is not required to induce a small pressure difference across the sample, a high pressure Ruska pump should be installed in parallel with the inline pressure controller.
6. During operation at high pressure and low temperatures, leaking around the windows and around the cell cap presented some problems. Replacing the Viton O-rings with energized Teflon coated stainless steel O-rings would solve most problems of this nature.

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APPENDIX A

ERROR ANALYSIS

ERROR ANALYSIS

Deam (8) presented a method for evaluating the most probable value of error as a result of uncertainties in experimental measurements. The equations used to calculate the kinematic and absolute viscosity are respectively,

$$v = kt \tag{1}$$

and,

$$\mu = kt\rho \tag{2}$$

Referring to equation (2), the errors associated with k and t for a specific set of viscosity data are independent and the total error is equivalent to the square root of the sum of the squares of each associated error.

$$\Delta v = \sqrt{(\Delta v_k)^2 + (\Delta v_t)^2} \tag{3}$$

The errors associated with each term in equation (1) are defined as follows:

$$\Delta v_k = \frac{\gamma v}{\gamma k}\,\delta k = t\delta_k \tag{4}$$

$$\Delta v_t = \frac{\gamma v}{\gamma t}\,\delta t = k\delta_t \tag{5}$$

where δ_k and δ_t are the uncertainties in the viscometer constant, k, and the time, t.

Rearranging
$$\Delta v_k = t\delta_k \qquad (6)$$

with
$$t = v/k \qquad (7)$$

$$\Delta v_k = v\,\frac{\delta_k}{k} \qquad (8)$$

$$\Delta v_t = v\,\frac{\delta_t}{t} \qquad (9)$$

Substituting equation (8) and (9) into equation (3) we have for the total error in the kinematic viscosity,

$$v = v\sqrt{\left(\frac{\delta_k}{k}\right)^2 + \left(\frac{\delta_t}{t}\right)^2} \qquad (10)$$

A typical set of data for the methane-Highly Naphthenic equilibrium system are

$k = .0109498$

$t = 119.99$ sec.

$\rho = .8205$ g/cc

$v = 1.3139$ centistokes

$\mu = 1.0781$ centipoise

The values of k and t were determined experimentally with the density being predicted from equations of state. The uncertainty associated with k was determined using the fastest and slowest run times of the calibration set. Viscometer constants were calculated for both times with one-half their difference being the uncertainty associated with k. The uncertainty in the time was calculated in a similar manner resulting in

$$\delta_k = .000044$$

$$\delta_t = .27$$

The density of each equilibrium system was predicted using the OSU Density Program (7) with the equilibrium composition being predicted by the NGPA K&H program (6) via the Chao-Seader correlation. The K-values as predicted by the Chao-Seader correlation have an average deviation from experimental data of 10%. Projecting graphically a 10% uncertainty in K-values to an uncertainty in methane composition and finally to an uncertainty in the density resulted in $\delta_\rho = .006$.

Using equation (10), the most probable value in kinematic viscosity is

$$\Delta v = .006$$

Then, $$v = 1.3139 \pm .006 \text{ centistokes}$$

Using an expanded form of equation (10), the most probable value of error in absolute viscosity is

$$\Delta\mu = .009$$

Then, $$\mu = 1.0781 \pm .009 \text{ centipoise}$$

APPENDIX B

CHEMICAL ANALYSIS OF ABSORPTION OILS

CHEMICAL ANALYSIS OF ABSORPTION OILS

The oil samples used in this investigation were received from various locations around the United States. To establish the origin of each sample, a brief history is presented in the following paragraph.

Mineral Spirits 135 and Heavy Solvent No. 1, Tables I and II respectively, are two of Shell Oil Company's absorption oils. Mineral Spirits 135 is used by Roberts Ranch with a 50/50 blend of Mineral Spirits 135 and Heavy Solvent No. 1 being used by Bluitt. The Highly Aromatic lean oil, Table III, IV and V, was received from Bitter Creek, Wyoming. The Highly Naphthenic lean oil, Table VI, VII and VIII, was received from Alvin, Texas. The Virgin Oil, Table X, was received from Cities Service Oil Company's Chico plant.

TABLE I

MINERAL SPIRITS 135

Gravity API	49.5
Gravity Spec. @ 60°F.	0.7818
Saybolt Color	Plus 28
Flash Tag CC	101
Doctor Test	Negative
KB No.	36.7
Aniline Pt.	132
Paraffins ,%	39.0
Olefins ,%	0.2
Naphthenes,%	45.6
Aromatics ,%	15.6
Distillation	Head Temp.°F
IBP	306
50%	324
90%	348
End Pt.	401
Recovery	98.0
Sulfur	0.008
Corrosion CU. Strip	Strip 1A (1)

---

(1) Not darker than

TABLE II

HEAVY SOLVENT NO. 1

Gravity API	42.0
Gravity Spec. @ 60°F.	0.8156
Saybolt Color	20
Flash Tag CC	135
Doctor Test	Positive
KB No.	-
Aniline Pt.	-
Paraffins ,%	37.0
Olefins ,%	00.0
Naphthenes,%	43.0
Aromatics ,%	20.0
Distillation	Head Temp. °F.
IBP	340
50%	427
90%	497
End Pt.	530
Recovery	-
Sulfur	0.06
Corrosion CU Strip	Strip 1 (1)

---

(1) Not darker than

TABLE III

HIGHLY AROMATIC LEAN OIL

Density (g/cc,60°F)	0.7892
Molecular Weight	122
Refractive Index, 68°F.	1.4460
Analysis:	
Paraffins ,%	34.6
Naphthenes ,%	26.3
Aromatics ,%	33.1
Dicyclo- Paraffins,%	05.9
Distillation:	Head Temp. °F.
IBP	280
5%	284
10	286
20	288
30	290
40	292
50	294
60	297
70	300
80	304
90	312
95	320
End Pt.	352
Residue,%	1.4

TABLE IV

CHEMICAL ANALYSIS OF HIGHLY AROMATIC LEAN OIL BY DISTILLATION FRACTION

Dist. Cut	Analysis			
	Paraffins	Naphthenes	Aromatics	Dicyclo-Paraffins
Original Sample	34.6	26.3	33.1	5.9
1	29.2	60.0	10.5	0.4
2	22.8	30.2	43.5	3.5
3	25.8	17.4	54.0	2.9
4	49.1	38.8	9.7	2.5
5	32.9	31.3	29.5	6.3
6	29.5	16.0	48.6	6.0
Residue	31.1	26.6	37.7	4.6

TABLE V

CHARACTERIZATION OF HIGHLY AROMATIC LEAN OIL BY DISTILLATION FRACTION

Dist. Cut	Head Temp, °F	Vol,% Dist.	Density g/cc,60°F	Mol. Wt.	Refractive Index,60°F
Original Sample	-	-	0.7892	122	1.4460
1	230-262	6.5	0.759	110	1.4225
2	262-277	19.3	0.798	113	1.4505
3	277-292	46.7	0.810	115	1.4585
4	292-308	72.5	0.760	111	1.4255
5	308-322	87.0	0.796	129	1.4453
6	322-326	92.2	0.811	128	1.4602
Residue	-	100.0	0.812	141	1.3570

TABLE VI

HIGHLY NAPHTHENIC LEAN OIL

Density (g/cc,60°F)	0.756
Molecular Weight	113
Refractive Index,68°F	1.4228
Analysis:	
Paraffins ,%	33.0
Naphthenes ,%	55.0
Aromatics ,%	09.4
Dicyclo-Paraffins,%	02.6
Distillation:	Head Temp.°F.
IBP	210
10%	237
20	241
30	245
40	249
50	252
60	256
70	260
80	266
90	278
95	297
End Pt.	330
Residue,%	1.4

TABLE VII

CHEMICAL ANALYSIS OF HIGH NAPHTHENIC LEAN OIL BY DISTILLATION FRACTION

Dist. Cut	Analysis			
	Paraffins	Naphthenes	Aromatics	Dicyclo-Paraffins
Original Sample	33.0	55.0	9.4	2.6
1	32.5	62.8	3.2	1.5
2	21.2	67.8	8.1	2.9
3	38.9	57.0	3.0	1.1
4	32.9	65.0	1.3	0.9
5	31.1	66.9	1.1	1.0
6	35.2	61.5	3.3	0.0
7	30.7	51.8	13.3	4.3
8	30.9	39.0	24.4	5.7
9	37.3	31.4	26.3	5.1
10	44.5	42.2	7.6	5.7
Residue	27.6	55.1	10.3	7.0

TABLE VIII

CHARACTERIZATION OF HIGHLY NAPHTHENIC LEAN OIL BY DISTILLATION FRACTIONS

Dist. Cut	Head Temp, °F	Vol,% Dist.	Density g/cc,60°F	Mol. Wt.	Refractive Index,60°F
Original Sample	-	-	0.756	113	1.4228
1	136-212	10	0.733	99	1.4080
2	212-230	20	0.752	105	1.4185
3	230-243	30	0.740	113	1.4138
4	243-248	40	0.744	115	1.4148
5	248-250	50	0.748	116	1.4160
6	250-261	60	0.749	115	1.4170
7	261-270	70	0.761	119	1.4280
8	270-275	80	0.785	118	1.4370
9	275-289	90	0.781	118	1.4382
10	289-295	92	0.760	129	1.4255
11	Residue	100	0.787	139	1.4382

TABLE IX

VIRGIN LEAN OIL

	Typical	Cities Distillation
Gravity, API	61.5	58.
Molecular Wt.	119	118
Doctor Test	Negative	-
Corrosion	1A	-
Paraffins,%	94.8	-
Aromatics,%	05.3	-
Distillation:	°F	°F
IBP	238	222
10%	248	253
20	-	256
30	-	258
50	267	265
70	-	274
90	284	290
End Pt.	330	336
Recovery,%	99.0	96.5
Residue,%	-	0.6
Loss,%	-	2.9

APPENDIX C

CHARACTERIZATION OF ABSORPTION OILS

CHARACTERIZATION OF ABSORPTION OILS

Absolute viscosity is the product of kinematic viscosity and density. In order to predict the density of an equilibrium system one must be able to predict its equilibrium behavior. In this study, the NGPA K&H program (6) was used to predict the equilibrium behavior of each system. The data required to characterize a system for use in the NGPA K&H program (6) were: mean average boiling point, critical temperature, critical pressure, ^{o}API Gravity and the average molecular weight of each system component.

Figures 31 and 32 show the True Boiling Point curves for the Highly Aromatic and for the Highly Naphthenic lean oils respectively. The Highly Aromatic and the Highly Naphthenic absorption oils were divided into ten fractions as illustrated in these figures. Each fraction represented a hypothetical component in order that the oils may be more accurately defined for use in the equations of state. The other three oils: MS 135, 50/50, MS 135/HS No. 1 and Virgin Oil, were considered as a single hypothetical component due to the lack of detailed distillation analysis.

Figures 33 and 34 present the behavior of molecular weight and density as a function of % volume overhead for Highly Aromatic lean oil. Figures 35 and 36 show the behavior of molecular weight and density as a function of % volume overhead for Highly Naphthenic lean oil. The division of the oil into fractions as shown in the TBP

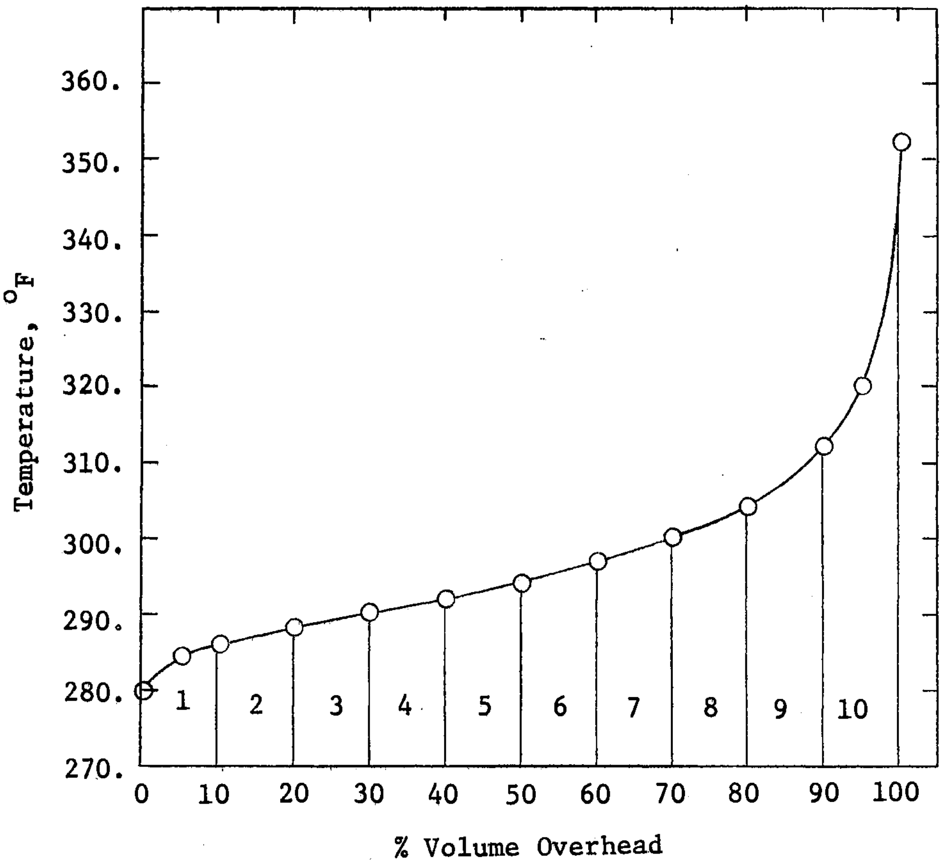

Figure 31. True Boiling Point Profile for Highly Aromatic Lean Oil Divided into Fractions

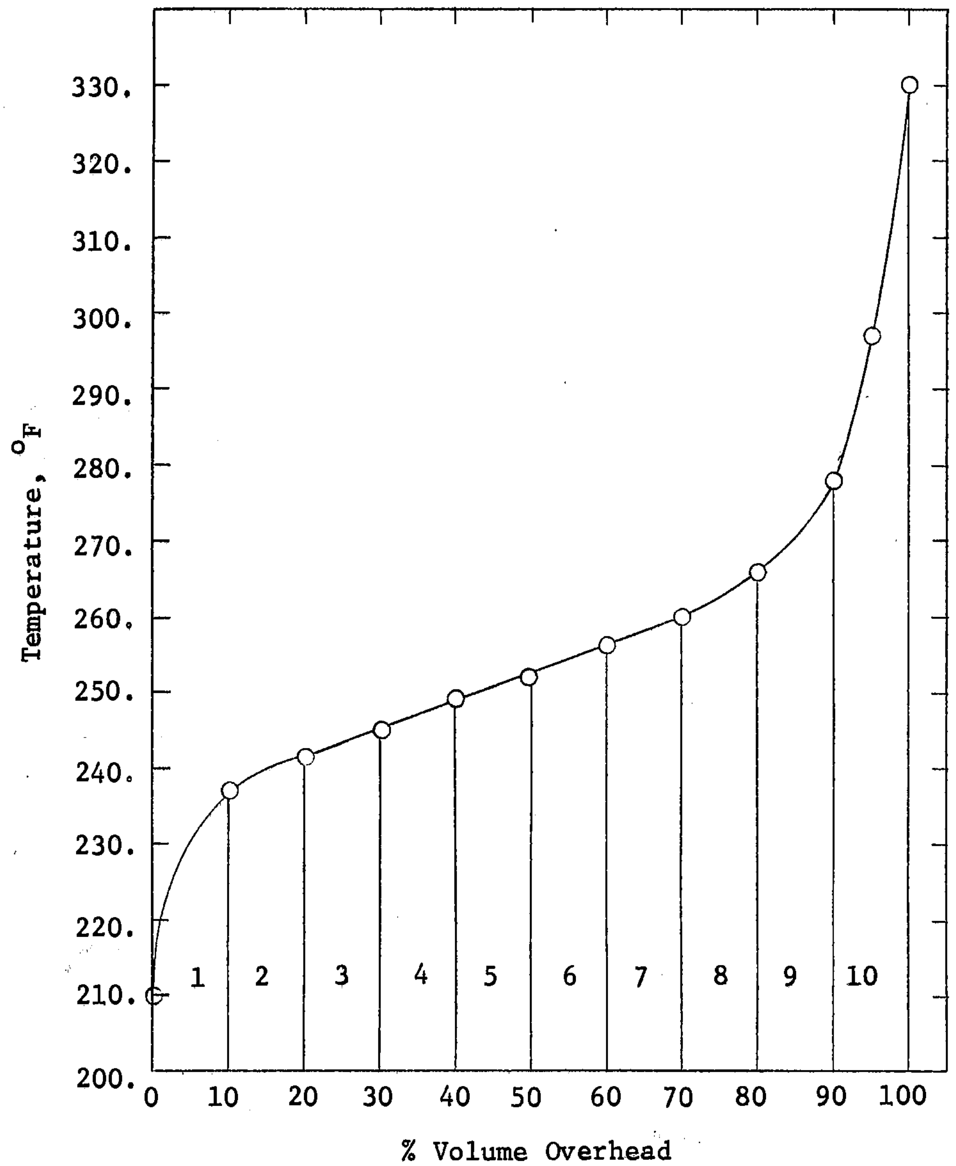

Figure 32. True Boiling Point Profile for Highly Naphthenic Lean Oil

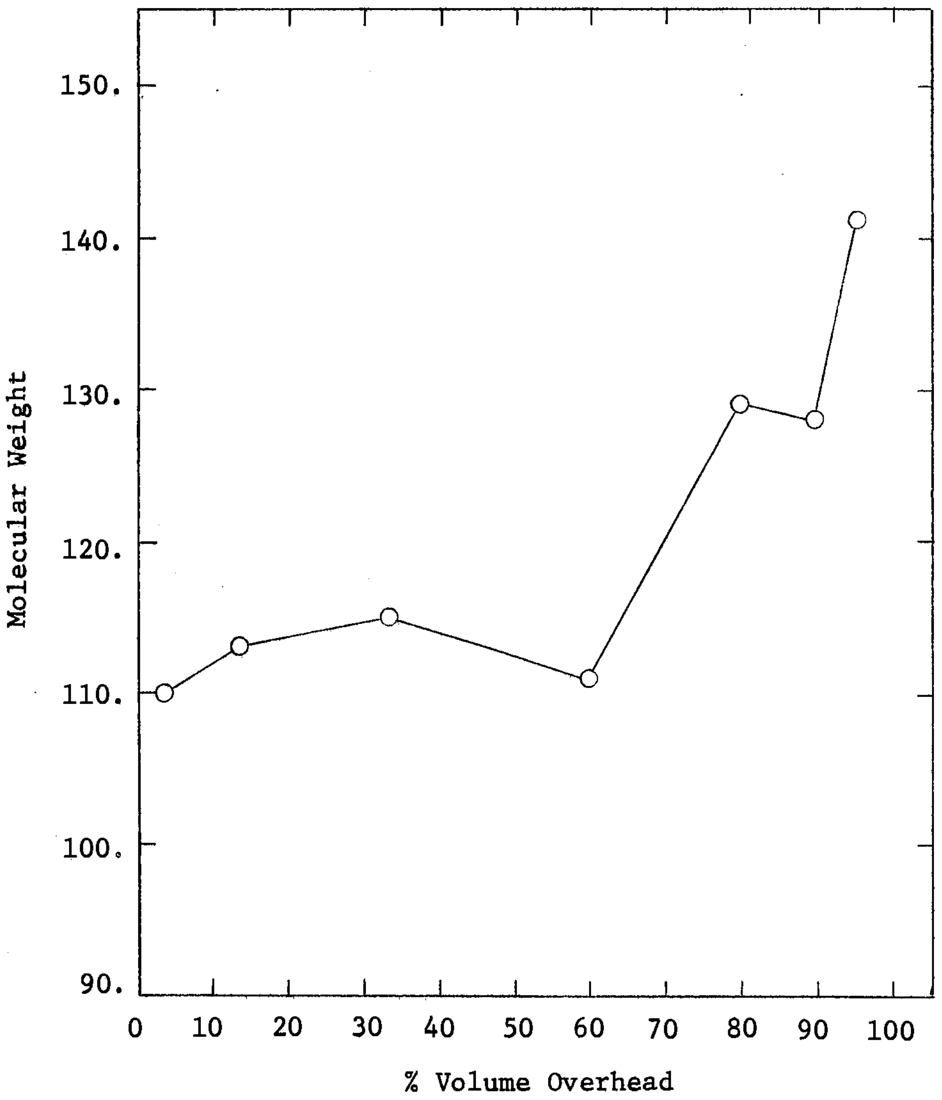

Figure 33. Molecular Weight as a Function of % Volume Overhead for Highly Aromatic Lean Oil

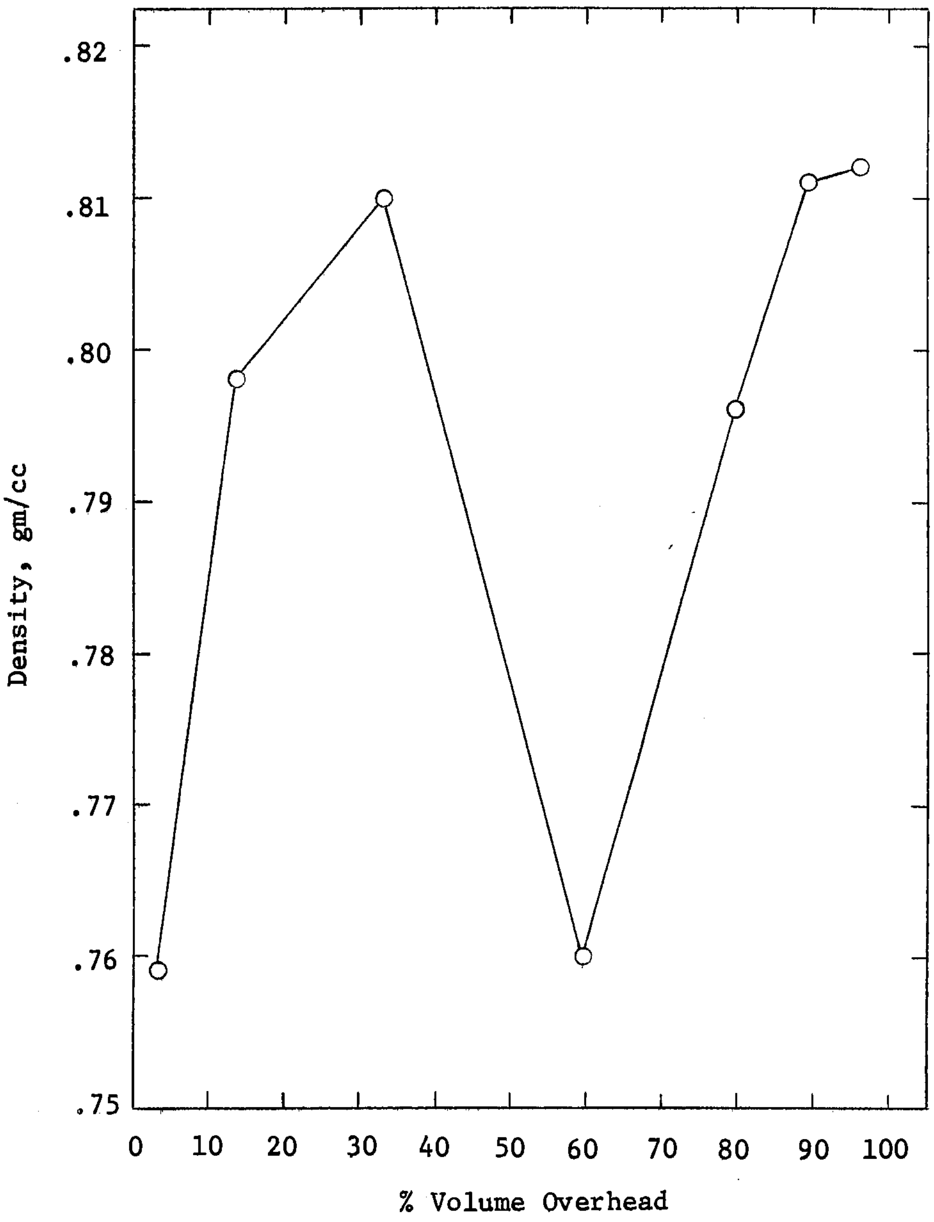

Figure 34. Density as a Function of % Volume Overhead for Highly Aromatic Lean Oil

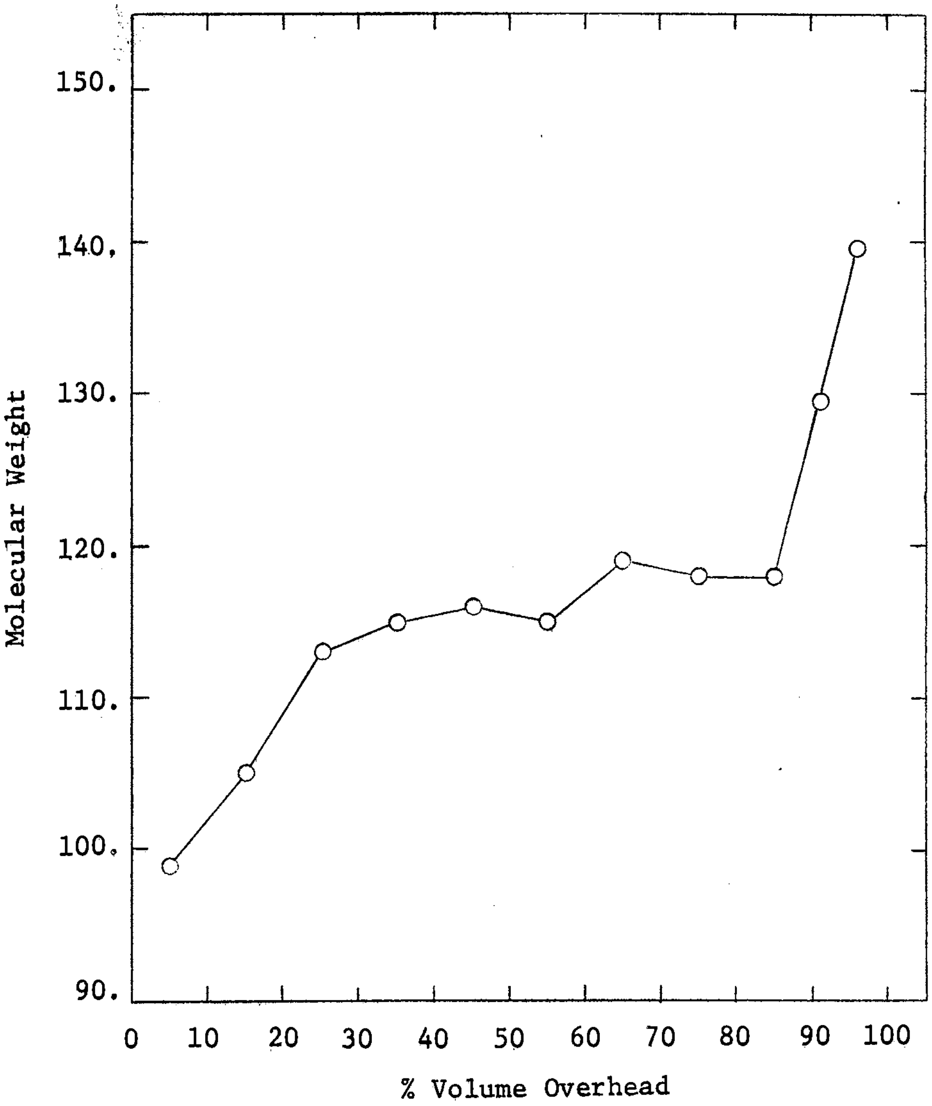

Figure 35. Molecular Weight as a Function of Overhead for Highly Naphthenic Lean Oil

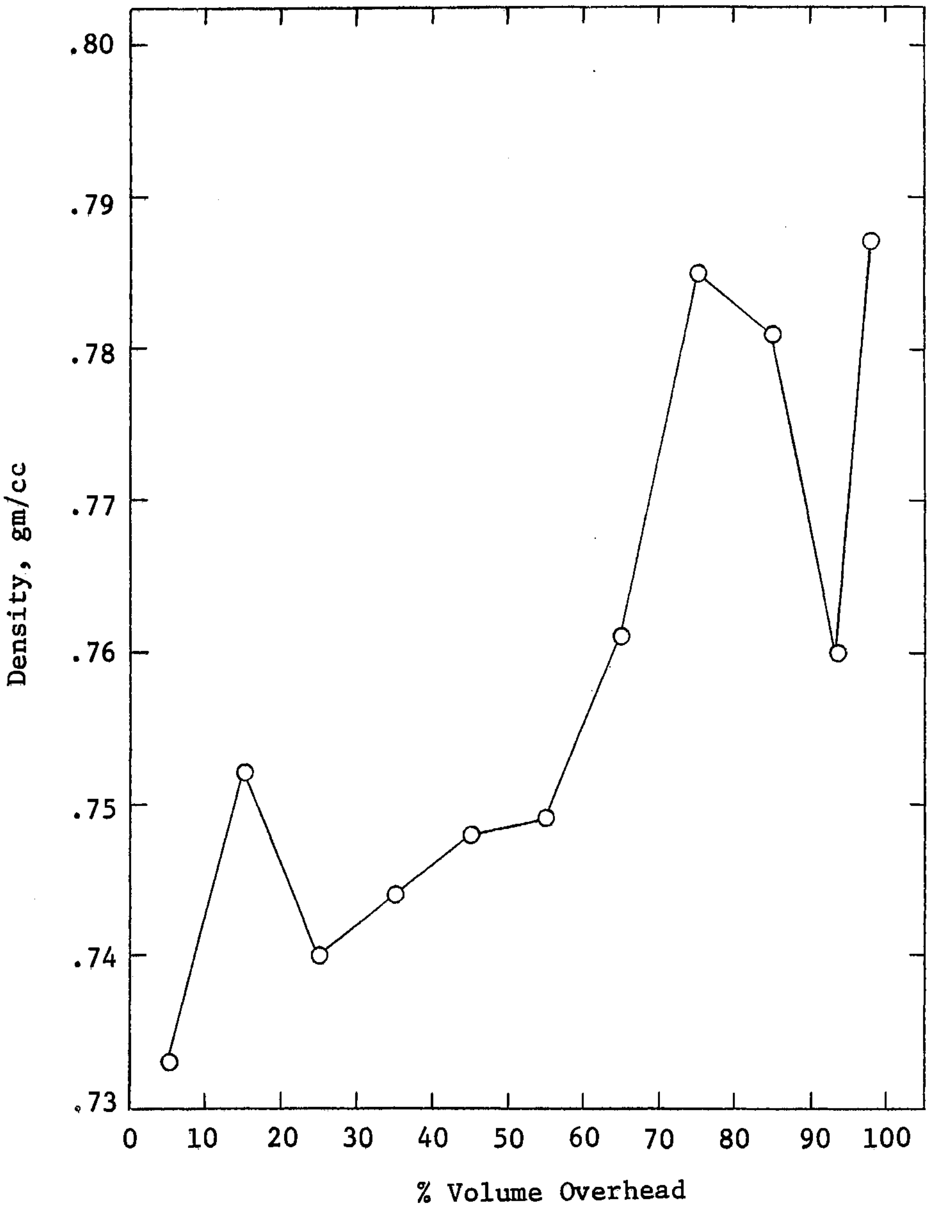

Figure 36. Density as a Function of % Volume Overhead for Highly Naphthenic Lean Oil

curves, Figures 31 and 32, are used likewise in Figures 33 through 36 to determine the average density and molecular weight for each hypothetical component. ^{o}API data for each hypothetical component was obtained from Figure 63 of (2) using the average boiling point and molecular weight of each fraction. The critical properties of each fraction were taken from (1). The results of this analysis are presented in Tables X, XI and XII.

In order to determine the equilibrium behavior for each oil system, two milliliters of sample along with 1223 cc of methane was flashed at each desired temperature and pressure. The number of moles of methane occupied by the cell at each operating condition was calculated using the ideal gas relation with the appropriate compressibility factor as obtained from (3). The mole equivalent of each sample is presented in Table XIII.

TABLE X

OIL CHARACTERIZATION

Oil Name	$\overline{BP}$ (°F)	Tc (°F)	Pc (psia)	°API	$\overline{MW}$
MS 135	324.	655.	375.	49.5	135.
HS No. 1	427.	--	--	42.0	--
50/50 MS 135/ HS No. 1	375.	705.	340.	45.8	153.
Virgin Oil	270.	588.	380.	58.0	118.

TABLE XI

HIGHLY AROMATIC LEAN OIL

Fraction Volume	Boiling Pt. (°F)	Molecular Weight	Density (g/cc)	Mole Fraction
0.1	284	110	0.764	0.107
0.2	287	113	0.799	0.109
0.3	289	114	0.805	0.111
0.4	291	115	0.806	0.108
0.5	293	113	0.787	0.107
0.6	296	112	0.768	0.106
0.7	299	116	0.769	0.102
0.8	302	125	0.788	0.097
0.9	308	128	0.805	0.097
1.0	320	140	0.812	0.089

Fraction Volume	Moles	°API	Tc (°F)	Pc (Psia)
0.1	.00138	33.	1110.	520.
0.2	.00141	37.	1110.	495.
0.3	.00142	37.	1110.	490.
0.4	.00139	39.	1110.	474.
0.5	.00138	35.	1120.	500.
0.6	.00137	37.	1120.	480.
0.7	.00131	37.	1120.	474.
0.8	.00125	49.	1095.	400.
0.9	.00125	52.	1095.	378.
1.0	.00115	60.	1090.	326.

TABLE XII

HIGHLY NAPHTHENIC LEAN OIL

Fraction Volume	Boiling Pt. (°F)	Molecular Weight	Density (g/cc)	Mole Fraction
0.1	230.	90.	0.733	0.111
0.2	240.	105.	0.752	0.107
0.3	244.	113.	0.740	0.105
0.4	247.	115.	0.744	0.097
0.5	250.	116.	0.748	0.097
0.6	254.	115.	0.749	0.097
0.7	258.	119.	0.761	0.096
0.8	263.	118.	0.785	0.099
0.9	271.	118.	0.781	0.099
1.0	297.	131.	0.773	0.088

Fraction Volume	Moles	°API	Tc (°F)	Pc (Psia)
0.1	.00149	45.	1035.	520.
0.2	.00143	49.	1038.	480.
0.3	.00140	63.	1015.	400.
0.4	.00129	65.	1015.	385.
0.5	.00129	64.	1020.	388.
0.6	.00129	63.	1025.	385.
0.7	.00129	65.	1025.	370.
0.8	.00132	60.	1040.	390.
0.9	.00132	53.	1060.	414.
1.0	.00117	61.	1065.	348.

TABLE XIII

OIL SAMPLE EQUIVALENT IN MOLES

Oil Name	Sample Volume (cc)	Average Molecular Weight (g/g mole)	Average Density (g/cc)	moles
Mineral Spirits 135	2.0	135	.7818	.0116
50/50 Mineral Spirits 135/ Heavy Solvent No. 1	2.0	153	.7987	.0104
Highly Aromatic Oil	2.0	122	.7892	.0129
Highly Naphthenic Oil	2.0	113	.7560	.0134
Virgin Oil	2.0	118	.7818	.0127

APPENDIX D

VISCOMETER CALIBRATION

TABLE XIV

U-3502

Distilled Water
Pressure = 743.65 mm Hg.

Visc., No.	Run No.,	Temp., °F	Flow Time, sec.	Percent Deviation
U-3502	1	20.	302.61	+.314
	2	20.	301.88	+.069
	3	20.	301.79	+.040
	4	20.	303.10	+.474
	5	20.	302.17	+.166
	6	20.	301.90	+.076
	7	20.	301.39	-.093
	8	20.	301.55	-.043
	9	20.	301.59	-.027
	10	20.	301.89	+.073
	11	20.	301.34	-.109
	12	20.	301.31	-.119
	13	20.	301.54	-.043
	14	20.	301.14	-.175
	15	20.	300.91	-.248
	16	20.	301.22	-.149
	17	20.	301.35	-.100
	18	20.	301.94	+.089
	19	20.	301.37	-.099
	20	20.	301.42	-.086
	Avg.	20.	301.67	

TABLE XV

U-3820

Distilled Water
Pressure = 743.65 mm Hg.

Visc., No.	Run No.	Temp., °F	Flow Time, sec.	Percent Deviation
U-3820	1	20.	294.03	+.478
	2	20.	294.03	+.478
	3	20.	292.80	+.068
	4	20.	292.47	-.044
	5	20.	292.47	-.044
	6	20.	293.34	+.430
	7	20.	292.05	-.188
	8	20.	292.08	-.178
	9	20.	292.15	-.154
	10	20.	292.44	-.056
	11	20.	293.00	+.137
	12	20.	292.48	-.041
	13	20.	292.40	-.068
	14	20.	292.29	-.106
	15	20.	292.35	-.085
	16	20.	292.35	-.085
	17	20.	292.60	0.000
	18	20.	292.21	-.133
	19	20.	292.29	-.106
	20	20.	292.26	-.116
	Avg.	20.	292.60	

TABLE XVI

U-2893

Distilled Water
Pressure = 741.10 mm Hg.

Visc., No.	Run No.	Temp., °F	Flow Time, sec.	Percent Deviation
U-2893	1	20.	92.13	+.502
	2	20.	91.93	+.393
	3	20.	91.92	+.273
	4	20.	91.84	+.185
	5	20.	91.76	+.098
	6	20.	91.69	+.022
	7	20.	91.62	-.054
	8	20.	91.58	-.098
	9	20.	91.70	+.033
	10	20.	91.79	+.131
	11	20.	91.78	+.120
	12	20.	91.62	-.054
	13	20.	91.66	-.011
	14	20.	91.72	+.055
	15	20.	91.69	+.022
	16	20.	91.66	-.011
	17	20.	91.51	-.174
	18	20.	91.50	-.185
	19	20.	91.63	-.044
	20	20.	91.59	-.087
	21	20.	91.50	-.185
	22	20.	91.60	-.076
	23	20.	91.49	-.196
	24	20	91.38	-.316
	25	20.	91.47	-.218
	Avg.	20.	91.67	

TABLE XVII

CALCULATED VISCOMETER CONSTANTS

Viscometer Number	Calibration Avg. Time(sec.)	Constants	
		Reported	Calculated
U-3502	301.67	0.003	0.0033274
U-3820	292.60	0.003	0.0034305
U-2893	91.67	0.010	0.0109498

Water viscosity at 20.°C = 0.01002 Poise (12)

Water density at 20.°C = 0.9982343 g/ml (13)

APPENDIX E

CALIBRATION OF HEISE GAUGE NO. 51054

CALIBRATION OF HEISE GAUGE NO. 51054

Calibration of the 3000 psig Heise Gauge No. 51054 was performed using a Ruska Dual Range Dead Weight Gage, Model 2400.21, Serial Nos. 14203 (Gage) and 14462 (weights). Ambient conditions present during calibration were a pressure of 742.9 mm Hg and a temperature of 24°C.

Calibration values are listed in Table XVIII and graphically illustrated in Figure 37.

TABLE XVIII

CALIBRATION OF HEISE GAUGE NO. 51054

Ambient Conditions:

Pressure = 742.9 mm Hg.
Temperature = 24°C

Heise Gauge Reading (psig)	Dead Weight Test (psig)
100	93.4
200	193.3
300	291.9
400	395.8
500	493.8
600	592.1
700	692.1
800	794.3
900	893.2
1000	992.3
1100	1095.4
1200	1196.2

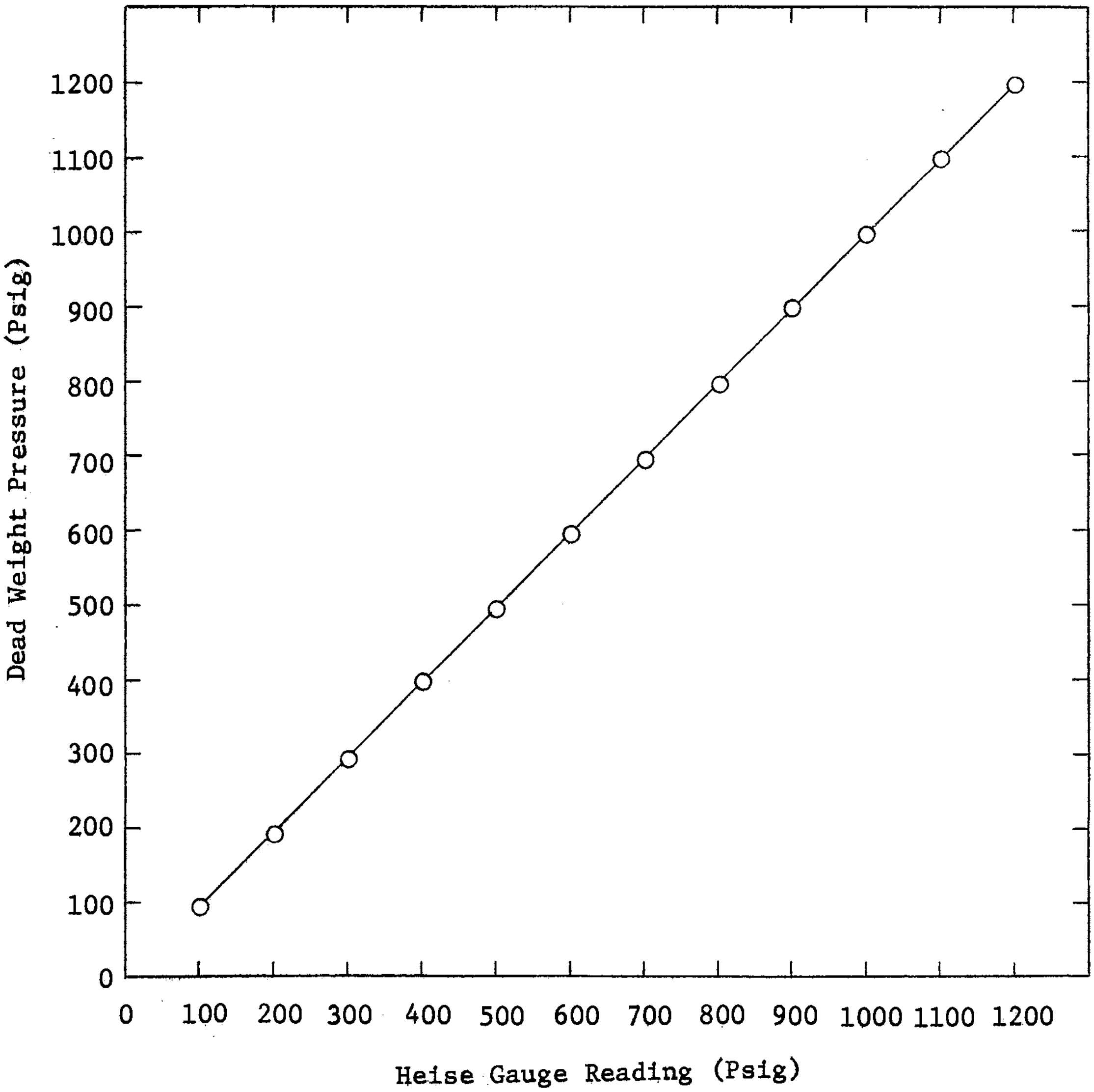

Figure 37. Calibration of Heise Gauge No. 51054

APPENDIX F

EXPERIMENTAL DATA

TABLE XIX

MINERAL SPIRITS 135

Saturation Gas Viscometer No. Temperature(^oF) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Air	1	97.21	+.021
U-2893	2	97.21	+.021
77.18	3	97.15	-.041
14.4	Avg.	97.19	
Methane	1	94.58	-.042
U-2893	2	94.67	+.053
77.45	3	94.65	+.032
107.8	4	94.58	-.042
	Avg.	94.62	
Methane	1	83.66	+.012
U-2893	2	83.58	-.084
77.45	3	83.76	-.132
508.2	4	83.70	+.060
	5	83.63	-.095
	6	83.59	-.072
	7	83.68	-.036
	8	83.62	-.036
	Avg.	83.65	
Methane	1	73.67	-.054
U-2893	2	73.79	+.108
77.45	3	73.70	0.014
1006.7	4	73.69	-.027
	Avg.	73.71	

TABLE XIX (Continued)

Saturation Gas Viscometer No. Temperature(°F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Air U-3820 68 14.4	1	325.58	-.086
	2	325.66	-.061
	3	325.63	-.071
	4	325.94	+.025
	5	325.88	+.006
	6	325.95	+.028
	7	325.86	0.000
	8	325.72	-.043
	9	325.83	-.009
	10	325.78	-.025
	11	325.84	-.006
	12	326.04	+.055
	13	326.04	+.055
	14	325.95	+.028
	15	326.25	+.119
	Avg.	325.86	
Air U-3820 32 14.4	1	436.60	-.082
	2	436.42	-.124
	3	436.98	+.005
	4	435.93	-.236
	5	435.57	-.014
	6	436.90	-.014
	7	436.20	-.174
	8	436.52	-.101
	9	436.95	-.002
	10	437.32	+.082
	11	437.65	+.158
	12	436.97	+.002
	13	437.54	+.113
	14	437.27	+.071
	15	437.48	+.119
	16	437.20	+.055
	17	437.54	+.039
	18	437.41	+.103
	19	437.44	+.109
	20	437.30	+.078
	Avg.	436.96	

TABLE XIX (Continued)

Saturation Gas Viscometer No. Temperature(^{o}F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Air	1	158.78	-.076
U-2893	2	158.76	-.088
20	3	158.89	-.006
14.4	4	159.19	+.182
	Avg.	158.90	
Methane	1	150.42	+.073
U-2893	2	150.30	-.007
20	3	150.33	+.013
107.8	4	150.18	-.086
	Avg.	150.31	
Methane	1	124.58	+.040
U-2893	2	124.62	+.072
20	3	124.40	-.104
508.2	Avg.	124.53	
Methane	1	102.30	+.098
U-2893	2	102.41	+.205
20	3	102.01	-.186
1006.7	4	102.03	-.166
	5	102.23	+.029
	Avg.	102.20	
Air	1	646.64	-.015
U-3820	2	646.21	-.082
-4	3	646.11	-.098
14.4	4	645.68	-.164
	5	646.35	-.060
	6	646.64	-.015
	7	647.00	+.040
	8	645.50	-.192
	9	647.54	+.124
	10	646.59	-.023
	11	647.19	+.069
	12	647.64	+.139
	13	647.75	+.156
	14	647.22	+.074
	15	647.05	+.048
	Avg.	646.74	

TABLE XIX (Continued)

Saturation Gas Viscometer No. Temperature($^{\circ}$F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Methane	1	188.55	+.090
U-2893	2	188.49	+.058
-4	3	188.14	-.127
107.8	4	188.33	-.027
	Avg.	188.38	
Methane	1	149.57	-.047
U-2893	2	149.78	+.094
-4	3	149.75	+.074
508.2	4	149.47	-.114
	Avg.	149.64	
Methane	1	119.29	-.067
U-2893	2	119.29	-.067
-4	3	119.51	+.109
1006.7	4	119.42	+.034
	Avg.	119.38	
Air	1	267.40	-.067
U-2893	2	267.73	+.056
-26	3	267.73	+.056
14.4	4	267.47	-.041
	Avg.	267.58	
Methane	1	246.28	-.053
U-2893	2	246.55	+.056
-26	3	246.39	-.008
107.8	Avg.	246.41	
Methane	1	180.93	+.033
U-2893	2	181.07	+.110
-26	3	180.62	-.138
508.2	Avg.	180.87	
Methane	1	135.73	+.077
U-2893	2	135.75	+.022
-26	3	135.69	-.022
1006.7	Avg.	135.72	

TABLE XX

50/50 MINERAL SPIRITS 135/ HEAVY SOLVENT NO. 1

Saturation Gas Viscometer No. Temperature(^{o}F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Air	1	147.07	+.020
U-2893	2	146.99	-.034
77.45	3	147.06	+.014
14.4	Avg.	147.04	
Methane	1	141.39	-.028
U-2893	2	141.45	+.014
77.45	3	141.44	+.017
107.8	Avg.	141.43	
Methane	1	123.39	-.008
U-2893	2	123.40	0.000
77.45	3	123.42	+.016
508.2	Avg.	123.40	
Methane	1	106.53	+.009
U-2893	2	106.53	+.009
77.72	3	106.50	-.019
1006.7	Avg.	106.52	
Air	1	159.70	+.107
U-2893	2	159.61	+.050
68	3	159.64	+.069
14.4	4	159.61	+.050
	5	159.65	+.075
	6	159.52	-.006
	7	159.30	-.144
	8	159.35	-.112
	9	159.50	-.019
	10	159.58	+.031
	11	159.65	+.081
	12	159.58	+.031

TABLE XX (Continued)

Saturation Gas Viscometer No. Temperature(^{o}F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
	13	159.42	-.068
	14	159.49	-.025
	15	159.59	-.025
	16	159.45	-.050
	17	159.51	-.013
	18	159.50	-.019
	19	159.50	-.019
	20	159.53	0.000
	Avg.	159.53	
Air	1	233.38	-.004
U-2893	2	232.94	-.193
32	3	233.85	-.197
14.4	4	233.59	+.086
	5	234.13	+.317
	6	233.69	+.129
	7	233.57	+.077
	8	233.44	+.021
	9	233.42	+.013
	10	232.89	-.214
	11	233.21	-.077
	12	233.69	+.129
	13	233.31	-.034
	14	233.28	-.004
	15	233.15	-.103
	16	233.16	-.099
	17	233.33	-.026
	18	233.28	-.047
	19	233.09	-.086
	20	233.43	+.017
	Avg.	233.39	
Air	1	271.44	-.037
U-2893	2	271.53	-.004
20	3	271.66	+.044
14.4	Avg.	271.54	

TABLE XX (Continued)

Saturation Gas Viscometer No. Temperature(°F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Methane	1	253.70	-.043
U-2893	2	254.00	+.074
20	3	253.80	-.004
107.8	4	253.76	-.019
	Avg.	253.81	
Methane	1	203.08	-.044
U-2893	2	203.36	+.094
20	3	203.23	+.029
508.2	4	203.00	-.084
	Avg.	203.00	
Methane	1	163.34	-.018
U-2893	2	163.41	+.024
20	3	163.35	-.012
1006.7	Avg.	163.37	
Air	1	385.61	+.158
U-2893	2	386.06	+.275
-4	3	385.99	+.257
14.4	4	386.14	+.296
	5	386.11	+.288
	6	385.65	+.169
	7	385.56	+.145
	8	385.51	+.132
	9	385.83	+.217
	10	384.09	-.236
	11	383.09	-.496
	12	383.72	-.332
	13	383.23	-.459
	14	384.62	-.099
	15	383.82	-.306
	Avg.	385.00	
Methane	1	345.91	+.087
U-2893	2	345.30	-.089
-4	3	345.72	+.032
107.8	4	345.34	-.078
	5	345.78	+.049
	Avg.	345.61	

TABLE XX (Continued)

Saturation Gas Viscometer No. Temperature($^{\circ}$F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Methane	1	256.60	-.004
U-2893	2	257.08	+.183
-4	3	256.76	+.058
508.2	4	256.45	-.062
	5	256.51	-.039
	6	256.24	-.144
	Avg.	256.61	
Methane	1	197.37	-.081
U-2893	2	197.76	+.116
-4	3	197.46	-.035
1006.7	4	197.62	+.046
	Avg.	197.53	
Air*	1	612.92	+.178
U-2893	2	611.18	-.106
-26	3	611.40	-.070
14.4	Avg.	611.83	
Methane*	1	503.67	-.460
U-2893	2	504.22	-.371
-26	3	510.01	+.818
107.8	Avg.	506.01	
Methane	1	259.82	+.054
U-2893	2	260.12	+.169
-26	3	259.09	-.227
1006.7	Avg.	259.68	

* Three phase system, solid, liquid, gas.

TABLE XXI

HIGHLY AROMATIC LEAN OIL

Saturation Gas Viscometer No. Temperature(^{o}F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Air	1	81.64	-.012
U-2893	2	81.66	0.000
77.36	3	81.65	+.012
14.4	Avg.	81.65	
Methane	1	78.79	+.013
U-2893	2	78.79	+.013
77.71	3	78.77	-.013
107.8	Avg.	78.78	
Methane	1	70.33	-.014
U-2893	2	70.34	0.000
77.90	3	70.35	+.014
508.2	Avg.	70.34	
Methane	1	62.38	+.016
U-2893	2	62.35	-.032
78.08	3	62.38	+.016
1006.7	Avg.	62.37	
Air	1	126.39	+.063
U-2893	2	126.22	-.071
20	3	126.31	0.000
14.4	Avg.	126.31	
Methane	1	120.57	+.008
U-2893	2	120.58	+.017
20	3	120.52	-.033
107.8	Avg.	120.56	
Methane	1	101.47	+.019
U-2893	2	101.46	+.010
20	3	101.43	-.019
508.2	Avg.	101.45	

TABLE XXI (Continued)

Saturation Gas Viscometer No. Temperature($^{\circ}$F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Methane	1	84.37	+.012
U-2893	2	84.34	-.024
20	3	84.35	-.012
1006.7	4	84.37	+.012
	Avg.	84.36	
Air	1	159.79	+.301
U-2893	2	159.75	+.276
-4	3	159.29	-.013
14.4	4	158.72	-.370
	5	159.00	-.195
	Avg.	159.31	
Methane	1	147.94	-.061
U-2893	2	148.12	+.061
-4	3	148.04	+.007
107.8	Avg.	148.04	
Methane	1	120.32	+.167
U-2893	2	120.04	-.067
-4	3	119.89	-.191
508.2	4	120.34	+.183
	5	120.00	-.099
	Avg.	120.00	
Methane	1	97.34	+.021
U-2893	2	97.48	+.164
-4	3	97.15	-.175
1006.7	4	97.23	-.092
	Avg.	97.32	
Air	1	207.35	-.009
U-2893	2	207.42	+.024
-26	3	207.35	-.009
14.4	Avg.	207.37	
Methane	1	189.37	-.084
U-2893	2	189.66	+.069
-26	3	189.57	-.021
107.8	Avg.	189.53	

TABLE XXI (Continued)

Saturation Gas Viscometer No. Temperature(^{o}F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Methane	1	144.71	+.007
U-2893	2	144.69	-.007
-26	3	144.69	-.007
508.2	Avg.	144.70	
Methane	1	115.74	+.190
U-2893	2	115.36	-.138
-26	3	115.47	-.043
1006.7	Avg.	115.52	

TABLE XXII

HIGHLY NAPHTHENIC LEAN OIL

Saturation Gas Viscometer No. Temperature(^{o}F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Air	1	74.67	+.121
U-2893	2	74.65	+.094
77.54	3	74.55	-.040
14.4	4	74.45	-.174
	5	74.58	0.000
	6	74.66	+.107
	7	74.50	-.107
	Avg.	74.58	
Methane	1	72.07	+.139
U-2893	2	71.88	-.125
77.72	3	72.02	+.069
107.8	4	71.92	-.060
	Avg.	71.97	
Methane	1	63.44	-.079
U-2893	2	63.48	-.016
77.72	3	63.56	+.110
508.2	4	63.42	-.110
	5	63.55	+.095
	6	63.50	+.016
	7	63.45	-.063
	Avg.	63.49	
Methane	1	55.38	+.018
U-2893	2	55.46	+.163
77.90	3	55.28	-.163
1006.7	4	55.37	0.000
	Avg.	55.37	

TABLE XXII (Continued)

Saturation Gas Viscometer No. Temperature(°F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Air	1	256.14	-.098
U-3502	2	256.20	-.074
68	3	256.22	-.066
14.4	4	256.51	+.047
	5	256.30	-.035
	6	256.35	-.016
	7	256.28	-.043
	8	256.37	-.008
	9	256.35	-.016
	10	256.64	+.097
	11	256.41	+.008
	12	256.32	-.027
	13	256.38	-.004
	14	256.62	+.090
	15	256.70	+.121
	Avg.	256.39	
Air	1	328.44	-.015
U-3502	2	328.38	-.033
32	3	328.46	-.009
14.4	4	328.70	-.064
	5	328.47	-.006
	Avg.	328.49	
Air	1	112.87	+.062
U-2893	2	112.92	+.106
20	3	112.69	-.098
14.4	4	112.81	+.009
	5	112.73	-.062
	Avg.	112.80	
Methane	1	105.78	+.047
U-2893	2	105.79	+.057
20	3	105.97	+.218
107.8	4	105.56	-.161
	5	105.56	-.161
	Avg.	105.73	
Methane	1	87.99	+.034
U-2893	2	87.93	-.034
20	3	87.96	0.000
508.2	Avg.	87.96	

TABLE XXII (Continued)

Saturation Gas Viscometer No. Temperature(^{o}F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Methane	1	72.59	0.000
U-2893	2	72.56	-.014
20	3	72.62	+.041
1006.7	Avg.	72.59	
Air	1	453.14	+.232
U-2893	2	452.61	+.115
-4	3	453.31	+.269
14.4	4	452.60	+.113
	5	452.04	-.011
	6	452.01	-.018
	7	452.02	-.015
	8	451.97	-.027
	9	451.40	-.153
	10	451.65	-.097
	11	451.52	-.126
	12	452.30	+.046
	13	451.81	-.062
	14	451.45	-.142
	15	451.54	-.122
	Avg.	452.09	
Methane	1	129.49	-.139
U-2893	2	129.92	+.193
-4	3	129.59	-.062
107.8	Avg.	129.67	
Methane	1	103.80	+.183
U-2893	2	103.55	-.058
-4	3	103.49	-.116
508.2	Avg.	103.61	
Methane	1	81.38	+.037
U-2893	2	81.32	-.037
-4	3	81.36	+.012
1006.7	Avg.	81.35	
Air	1	177.04	+.028
U-2893	2	176.92	-.039
-26	3	176.88	-.062
14.4	4	177.13	+.079
	Avg.	176.99	

TABLE XXII (Continued)

Saturation Gas Viscometer No. Temperature(^{o}F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Methane	1	161.23	-.031
U-2893	2	161.39	+.068
-26	3	161.21	-.043
107.8	Avg.	161.28	
Methane	1	120.11	+.100
U-2893	2	119.80	-.158
-26	3	119.90	-.075
508.2	4	120.15	+.133
	5	120.00	+.008
	Avg.	119.99	
Methane	1	90.42	0.000
U-2893	2	90.40	-.022
-26	3	90.43	+.011
1006.7	Avg.	90.42	

TABLE XXIII

VIRGIN OIL

Saturation Gas Viscometer No. Temperature(^{o}F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Air	1	68.85	+.044
U-2893	2	68.87	+.073
77.45	3	68.75	-.102
14.4	4	68.77	-.073
	5	68.85	+.044
	Avg.	68.82	
Methane	1	66.81	+.015
U-2893	2	66.75	-.075
77.45	3	66.83	+.045
107.8	Avg.	66.80	
Methane	1	59.47	-.084
U-2893	2	59.57	+.084
77.54	3	59.52	0.000
508.2	Avg.	59.52	
Methane	1	52.67	-.019
U-2893	2	52.70	+.038
77.54	3	52.67	-.019
1006.7	Avg.	52.68	
Air	1	102.50	-.039
U-2893	2	102.61	+.068
20	3	102.50	-.039
14.4	Avg.	102.54	
Methane	1	97.46	-.021
U-2893	2	97.46	-.021
20	3	97.51	+.031
107.8	Avg.	97.48	

TABLE XXIII (Continued)

Saturation Gas Viscometer No. Temperature (°F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Methane	1	81.89	-.024
U-2893	2	81.93	+.024
20	3	81.90	-.012
508.2	Avg.	81.91	
Methane	1	68.93	+.029
U-2893	2	68.90	-.015
20	3	68.90	-.015
1006.7	Avg.	68.91	
Air	1	126.20	-.002
U-2893	2	126.48	+.000
-4	3	126.63	+.015
14.4	4	126.39	-.000
	5	126.51	+.001
	Avg.	126.44	
Methane	1	119.45	+.001
U-2893	2	119.41	+.001
-4	3	119.27	-.000
107.8	4	118.98	-.003
	Avg.	119.28	
Methane	1	96.16	-.000
U-2893	2	96.21	+.000
-4	3	96.15	-.000
508.2	4	96.28	+.001
	Avg.	96.20	
Methane	1	77.92	+.004
U-2893	2	77.45	-.002
-4	3	77.75	+.002
1006.7	4	77.38	
	Avg.	77.63	
Air	1	159.12	+.031
U-2893	2	159.04	-.019
-26	3	159.04	-.019
14.4	Avg.	159.07	
Methane	1	145.54	+.009
U-2893	2	145.51	-.014
-26	3	145.55	+.013
107.8	Avg.	145.53	

TABLE XXIII (Continued)

Saturation Gas Viscometer No. Temperature(^{o}F) Pressure(psia)	Run No.	Flow Time, sec.	Percent Deviation
Methane	1	111.71	+.009
U-2893	2	111.73	+.027
-26	3	111.62	-.072
508.2	4	111.75	+.045
	Avg.	111.70	
Methane	1	86.36	-.012
U-2893	2	86.41	+.046
-26	3	86.34	-.035
1006.7	Avg.	86.37	

APPENDIX G

CALCULATED KINEMATIC VISCOSITY

TABLE XXIV

CALCULATED KINEMATIC VISCOSITY

Mineral Spirits 135

Temperature (^{o}F)	Pressure (psia)	Kinematic Viscosity (centistokes)
77	14.4	1.0642
	107.8	1.0361
	508.2	0.9160
	1006.7	0.8071
68	14.4	1.1179
32	14.4	1.4989
20	14.4	1.7399
	107.8	1.6459
	508.2	1.3636
	1006.7	1.1191
-4	14.4	2.2186
	107.8	2.0627
	508.2	1.6385
	1006.7	1.3072
-26	14.4	2.9299
	107.8	2.6981
	508.2	1.9805
	1006.7	1.4861

50/50 : Mineral Spirits 135/ Heavy Solvent No. 1

Temperature (^{o}F)	Pressure (psia)	Kinematic Viscosity (centistokes)
77	14.4	1.6101
	107.8	1.5486
	508.2	1.3512
	1006.7	1.1664

TABLE XXIV (Continued)

50/50 : Mineral Spirits 135
Heavy Solvent No. 1

Temperature (^oF)	Pressure (psia)	Kinematic Viscosity (centistokes)
68	14.4	1.7468
32	14.4	2.5556
20	14.4	2.9733
	107.8	2.7792
	508.2	2.2247
	1006.7	1.7889
-4	14.4	4.2157
	107.8	3.7844
	508.2	2.8098
	1006.7	2.1629
-26	14.4	6.6994*
	107.8	5.5407*
	508.2	------
	1006.7	2.8434

Highly Aromatic
Lean Oil

Temperature (^oF)	Pressure (psia)	Kinematic Viscosity (centistokes)
77	14.4	0.8941
	107.8	0.8626
	508.2	0.7702
	1006.7	0.6839
20	14.4	1.3831
	107.8	1.3201
	508.2	1.1109
	1006.7	0.9237

TABLE XXIV (Continued)

Highly Aromatic Lean Oil

Temperature (^oF)	Pressure (psia)	Kinematic Viscosity (centistokes)
-4	14.4	1.7444
	107.8	1.6209
	508.2	1.3153
	1006.7	1.0656
-26	14.4	2.2707
	107.8	2.0753
	508.2	1.5844
	1006.7	1.2649

Highly Naphthenic Lean Oil

Temperature (^oF)	Pressure (psia)	Kinematic Viscosity (centistokes)
77	14.4	0.8166
	107.8	0.7881
	508.2	0.6952
	1006.7	0.6063
68	14.4	0.8531
32	14.4	1.0930
20	14.4	1.2351
	107.8	1.1577
	508.2	0.9628
	1006.7	0.7948
-4	14.4	1.5043
	107.8	1.4198
	508.2	1.1345
	1006.7	0.8908

TABLE XXIV (Continued)

Highly Naphthenic Lean Oil

Temperature (°F)	Pressure (psia)	Kinematic Viscosity (centistokes)
-26	14.4	1.9380
	107.8	1.7660
	508.2	1.3139
	1006.7	0.9901

Virgin Oil

Temperature (°F)	Pressure (psia)	Kinematic Viscosity (centistokes)
77	14.4	0.7536
	107.8	0.7315
	508.2	0.6517
	1006.7	0.5768
20	14.4	1.1228
	107.8	1.0674
	508.2	0.8969
	1006.7	0.7546
-4	14.4	1.3845
	107.8	1.3061
	508.2	1.0534
	1006.7	0.8500
-26	14.4	1.7418
	107.8	1.5935
	508.2	1.2231
	1006.7	0.9457

* Solid phase in sample

APPENDIX H

CALCULATED DENSITY AND ABSOLUTE VISCOSITY

TABLE XXV

CALCULATED DENSITY AND ABSOLUTE VISCOSITY

Mineral Spirits 135

Temp. (^{o}F)	Press. (Psia)	Density (g/cc) (C-S)*	Density (g/cc) (S-RK)*	Absolute Viscosity (cp) (C-S)*	Absolute Viscosity (cp) (S-RK)*
77	14.4	.8753**		.9315**	
	107.8	.8664	.8666	.8977	.8979
	508.2	.8356	.8363	.7654	.7661
	1006.7	.8010	.7994	.6465	.6452
68	14.4	.8798**		.9835**	
	107.8	.8706	.8708	-	-
	508.2	.8389	.8394	-	-
	106.7	.8036	.8038	-	-
32	14.4	.8975**		1.3453**	
	107.8	.8870	.8869	-	-
	508.2	8509	.8505	-	-
	1006.7	.8119	.8099	-	-
20	14.4	.9033		1.5716**	
	107.8	.8922	.8920	1.4685	1.4681
	508.2	.8543	.8534	1.1649	1.1637
	1006.7	.8136	.8107	.9105	.9073
- 4	14.4	.9148**		2.0296**	
	107.8	.9023	.9019	1.8612	1.8603
	508.2	.8598	.8578	1.4087	1.4055
	1006.7	.8151	.8099	1.0655	1.0587
-26	14.4	.9253**		2.7110**	
	107.8	.9110	.9103	2.4579	2.4561
	508.2	.8629	.8594	1.7089	1.7020
	1006.7	.8134	.8053	1.2087	1.1968

TABLE XXV (Continued)

50/50 Mineral Spirits 135 /
Heavy Solvent No. 1

Temp. (°F)	Press. (Psia)	Density (g/cc) (C-S)*	Density (g/cc) (S-RK)*	Absolute Viscosity (cp) (C-S)*	Absolute Viscosity (cp) (S-RK)*
77	14.4	.8785**		1.4145**	
	107.8	.8701	.8701	1.3474	1.3474
	508.2	.8411	.8411	1.1365	1.1365
	1006.7	.8093	.8086	.9439	.9432
68	14.4	.8827**		1.5419**	
	107.8	.8740	.8740	-	-
	508.2	.8443	.8440	-	-
	1006.7	.8118	.8106	-	-
32	14.4	.8993**		2.2983**	
	107.8	.8893	.8891	-	-
	508.2	.8556	.8541	-	-
	1006.7	.8197	.8160	-	-
20	14.4	.9048**		2.6902**	
	107.8	.8942	.8939	2.4852	2.4843
	508.2	.8587	.8568	1.9103	1.9061
	1006.7	.8214	.8168	1.4694	1.4612
- 4	14.4	.9156**		3.8603**	
	107.8	.9037	.9030	3.4199	3.4173
	508.2	.8640	.8607	2.4277	2.4184
	1006.7	.8232	.8159	1.7805	1.7647
-26	14.4	.9254**		6.1996**	
	107.8	.9119	.9108	5.0526	5.0465
	508.2	.8670	.8620	-	-
	1006.7	.8221	.8115	2.3376	2.3074

TABLE XXV (Continued)

Highly Aromatic Lean Oil

Temp. (^oF)	Press. (Psia)	Density (g/cc) (C-S)*	Density (g/cc) (S-RK)*	Absolute Viscosity (cp) (C-S)*	Absolute Viscosity (cp) (S-RK)*
77	14.4	1.0174**		.9097**	
	107.8	1.0049	1.0356	.8668	.8933
	508.2	.9632	.9630	.7419	.7417
	1006.7	.9154	.9157	.6260	.6262
68	14.4	1.0233**		-	
	107.8	1.0108	1.0409	-	-
	508.2	.9676	.9664	-	-
	1006.7	.9193	.9186	-	-
32	14.4	1.0450**		-	
	107.8	1.0308	1.0302	-	-
	508.2	.9832	.9804	-	-
	1006.7	.9311	.9256	-	-
20	14.4	1.0522**		1.4553**	
	107.8	1.0373	1.0364	1.3693	1.3682
	508.2	.9875	.9837	1.0970	1.0928
	1006.7	.9338	.9269	.8626	.8562
- 4	14.4	1.0663**		1.8571**	
	107.8	1.0498	1.0483	1.7016	1.6992
	508.2	.9945	.9884	1.3081	1.3000
	1006.7	.9364	.9253	.9978	.9859
-26	14.4	1.0790**		2.4501**	
	107.8	1.0605	1.0582	2.2008	2.1961
	508.2	.9985	.9895	1.5820	1.5677
	1006.7	.9351	.9190	1.1828	1.1624

TABLE XXV (Continued)

Highly Naphthenic Lean Oil					
Temp. (^oF)	Press. (Psia)	Density (g/cc) (C-S)*	Density (g/cc) (S-RK)*	Absolute Viscosity (cp) (C-S)*	Absolute Viscosity (cp) (S-RK)*
77	14.4	.8357**		.6824**	
	107.8	.8241	.8248	.6495	.6500
	508.2	.7893	.7903	.5487	.5494
	1006.7	.7488	.7510	.4540	.4553
68	14.4	.8406**		.7171**	
	107.8	.8290	.8296	-	-
	508.2	.7934	.7951	-	-
	1006.7	.7521	.7541	-	-
32	14.4	.8597**		.9396**	
	107.8	.8476	.8481	-	-
	508.2	.8075	.8086	-	-
	1006.7	.7623	.7628	-	-
20	14.4	.8660**		1.0696**	
	107.8	.8534	.8538	.9880	.9884
	508.2	.8113	.8122	.7811	.7820
	1006.7	.7643	.7643	.6075	.6075
- 4	14.4	.8784**		1.3214**	
	107.8	.8645	.8647	1.2274	1.2277
	508.2	.8174	.8176	.9273	.9276
	1006.7	.7657	.7641	.6821	.6807
-26	14.4	.8896**		1.7240**	
	107.8	.8739	.8736	1.5433	1.5428
	508.2	.8205	.8198	1.0781	1.0771
	1006.7	.7630	.7594	.7554	.7519

TABLE XXV (Continued)

Virgin Oil					
Temp. (^{o}F)	Press. (Psia)	Density (g/cc) (C-S)*	Density (g/cc) (S-RK)*	Absolute Viscosity (cp) (C-s)*	Absolute Viscosity (cp) (S-RK)*
77	14.4	.8367**		.6305**	
	107.8	.8269	.8267	.6049	.6047
	508.2	.7927	.7915	.5166	.5158
	1006.7	.7545	.7510	.4352	.4332
68	14.4	.8415**		-	
	107.8	.8314	.8312	-	-
	508.2	.7963	.7945	-	-
	1006.7	.7573	.7532	-	-
32	14.4	.8606**		-	
	107.8	.8489	.8484	-	-
	508.2	.8088	.8063	-	-
	1006.7	.7655	.7590	-	-
20	14.4	.8668**		.9732**	
	107.8	.8545	.8539	.9121	.9115
	508.2	.8123	.8093	.7286	.7259
	1006.7	.7671	.7596	.5789	.5732
- 4	14.4	.8792**		1.2173**	
	107.8	.8652	.8643	1.1300	1.1288
	508.2	.8178	.8135	.8615	.8569
	1006.7	.7680	.7577	.6528	.6440
-26	14.4	.8903**		1.5507**	
	107.8	.8743	.8731	1.3932	1.3913
	508.2	.8206	.8147	1.0037	.9965
	1006.7	.7652	.7514	.7236	.7106

* Correlation as applied to determine equilibrium composition.
** Correlation does not apply; not methane saturated.

APPENDIX I

CALCULATED EQUILIBRIUM DATA

TABLE XXVI

MINERAL SPIRITS 135

			Chao-Seader		Soave RK	
Press. (Psia)	Temp. (^oF)	Comp.*	Liquid Mol. Fr.	K Value	Liquid Mol. Fr.	K Value
107.8	77	(1)	0.0362	27.6163	0.0354	28.2345
		(2)	0.9638	0.0009	0.9646	0.0006
	68	(1)	0.0372	26.8595	0.0366	27.3337
		(2)	0.9576	0.0007	0.9634	0.0004
	32	(1)	0.0424	23.5988	0.0425	23.5035
		(2)	0.9576	0.0002	0.9575	0.0001
	20	(1)	0.0446	22.4386	0.0451	22.1624
		(2)	0.9554	0.0001	0.9549	0.0001
	- 4	(1)	0.0499	20.0317	0.0515	19.4160
		(2)	0.9501	0.0001	0.9485	0.0000
	-26	(1)	0.0563	17.7517	0.0593	16.8659
		(2)	0.9437	0.0000	0.9407	0.0000
508.2	77	(1)	0.1572	6.3591	0.1547	6.4631
		(2)	0.8428	0.0005	0.8453	0.0004
	68	(1)	0.1611	6.2035	0.1593	6.2748
		(2)	0.8389	0.0004	0.8407	0.0003
	32	(1)	0.1811	5.5213	0.1829	5.4682
		(2)	0.8189	0.0002	0.8171	0.0001
	20	(1)	0.1896	5.2742	0.1929	5.1833
		(2)	0.8104	0.0001	0.8071	0.0001

TABLE XXVI (Continued)

Press. (Psia)	Temp. (^{o}F)	Comp.*	Chao-Seader Liquid Mol. Fr.	Chao-Seader K Value	Soave RK Liquid Mol. Fr.	Soave RK K Value
508.2	- 4	(1)	0.2103	4.7543	0.2176	4.5959
		(2)	0.7897	0.0001	0.7824	0.0000
	-26	(1)	0.2352	4.2523	0.2473	4.0439
		(2)	0.7648	0.0000	0.7527	0.0000
1006.7	77	(1)	0.2815	3.5509	0.2796	3.5750
		(2)	0.7186	0.0008	0.7204	0.0006
	68	(1)	0.2874	3.4783	0.2870	3.4834
		(2)	0.7126	0.0007	0.7130	0.0005
	32	(1)	0.3171	3.1526	0.3237	3.0885
		(2)	0.6829	0.0003	0.6763	0.0002
	20	(1)	0.3297	3.0323	0.3392	2.9480
		(2)	0.6703	0.0003	0.6608	0.0002
	- 4	(1)	0.3602	2.7757	0.3763	2.6570
		(2)	0.6398	0.0002	0.6237	0.0001
	-26	(1)	0.3961	2.5244	0.4198	2.3809
		(2)	0.6039	0.0001	0.5802	0.0001

* (1) Methane
(2) Fraction No.

TABLE XXVII

50/50 MINERAL SPIRITS 135 / HEAVY SOLVENT NO. 1

			Chao-Seader		Soave RK	
Press. (Psia)	Temp. (°F)	Comp.*	Liquid Mol. Fr.	K Value	Liquid Mol. Fr.	K Value
107.8	77	(1)	0.0360	27.7430	0.0359	27.8335
		(2)	0.9640	0.0003	0.9641	0.0001
	68	(1)	0.0370	26.9856	0.0371	26.9286
		(2)	0.9630	0.0002	0.9629	0.0001
	32	(1)	0.0422	23.7208	0.0433	23.1001
		(2)	0.9578	0.0001	0.9567	0.0000
	20	(1)	0.0443	22.5588	0.0459	21.7652
		(2)	0.9557	0.0001	0.9541	0.0000
	- 4	(1)	0.0496	20.1477	0.0525	19.0414
		(2)	0.9504	0.0000	0.9475	0.0000
	-26	(1)	0.0560	17.8631	0.0605	16.5306
		(2)	0.9440	0.0000	0.9395	0.0000
508.2	77	(1)	0.1561	6.4064	0.1563	6.3978
		(2)	0.8439	0.0002	0.8437	0.0001
	68	(1)	0.1600	6.2511	0.1611	6.2079
		(2)	0.8400	0.0001	0.8389	0.0001
	32	(1)	0.1795	5.5700	0.1852	5.3996
		(2)	0.8205	0.0001	0.8148	0.0000
	20	(1)	0.1879	5.3232	0.1955	5.1157
		(2)	0.8122	0.0000	0.8045	0.0000
	- 4	(1)	0.2082	4.8040	0.2207	4.5319
		(2)	0.7918	0.0000	0.7793	0.0000

TABLE XXVII (Continued)

			Chao-Seader		Soave RK	
Press. (Psia)	Temp. (^{o}F)	Comp.*	Liquid Mol. Fr.	K Value	Liquid Mol. Fr.	K Value
508.2	-26	(1)	0.2324	4.3028	0.2509	3.9856
		(2)	0.7676	0.0000	0.7491	0.0000
1006.7	77	(1)	0.2786	3.5881	0.2811	3.5574
		(2)	0.7214	0.0003	0.7189	0.0002
	68	(1)	0.2843	3.5165	0.2886	3.4647
		(2)	0.7157	0.0002	0.7114	0.0002
	32	(1)	0.3132	3.1930	0.3260	3.0678
		(2)	0.6868	0.0001	0.6740	0.0001
	20	(1)	0.3253	3.0735	0.3416	2.9275
		(2)	0.6747	0.0000	0.6584	0.0000
	- 4	(1)	0.3548	2.8188	0.3791	2.6379
		(2)	0.6453	0.0000	0.6209	0.0000
	-26	(1)	0.3892	2.5695	0.4227	2.3657
		(2)	0.6108	0.0000	0.5773	0.0000

* (1) Methane
(2) Fraction No.

TABLE XXVIII

HIGHLY AROMATIC LEAN OIL

			Chao-Seader		Soave RK	
Press. (Psia)	Temp. (°F)	Comp.*	Liquid Mol. Fr.	K Value	Liquid Mol. Fr.	K Value
107.8	77	(1)	0.0306	32.6460	0.0309	32.2732
		(2)	0.0992	0.0023	0.0994	0.0017
		(3)	0.1017	0.0022	0.1018	0.0016
		(4)	0.1027	0.0021	0.1028	0.0015
		(5)	0.1007	0.0020	0.1007	0.0015
		(6)	0.1009	0.0020	0.1009	0.0014
		(7)	0.0996	0.0019	0.0997	0.0013
		(8)	0.0957	0.0017	0.0956	0.0012
		(9)	0.0917	0.0015	0.0916	0.0011
		(10)	0.0921	0.0014	0.0919	0.0009
		(11)	0.0851	0.0012	0.0848	0.0008
107.8	68	(1)	0.0314	31.8450	0.0320	31.2668
		(2)	0.0994	0.0018	0.0996	0.0013
		(3)	0.1018	0.0017	0.1019	0.0012
		(4)	0.1028	0.0016	0.1029	0.0011
		(5)	0.1008	0.0016	0.1008	0.0011
		(6)	0.1002	0.0015	0.1002	0.0010
		(7)	0.0996	0.0015	0.0995	0.0010
		(8)	0.0956	0.0013	0.0955	0.0009
		(9)	0.0916	0.0012	0.0914	0.0008
		(10)	0.0919	0.0011	0.0916	0.0007
		(11)	0.0849	0.0009	0.0846	0.0006
107.8	32	(1)	0.0353	28.3401	0.0371	26.9713
		(2)	0.0997	0.0006	0.0996	0.0004
		(3)	0.1019	0.0006	0.1018	0.0003
		(4)	0.1027	0.0005	0.1026	0.0003
		(5)	0.1006	0.0005	0.1005	0.0003
		(6)	0.0999	0.0005	0.0998	0.0003
		(7)	0.0993	0.0005	0.0991	0.0003
		(8)	0.0951	0.0004	0.0949	0.0002
		(9)	0.0908	0.0004	0.0906	0.0002
		(10)	0.0910	0.0003	0.0907	0.0002
		(11)	0.0838	0.0003	0.0835	0.0001

TABLE XXVIII (Continued)

			Chao-Seader		Soave RK	
Press. (Psia)	Temp. (^{o}F)	Comp.*	Liquid Mol. Fr.	K Value	Liquid Mol. Fr.	K Value
107.8	20	(1)	0.0369	27.0697	0.0393	25.4576
		(2)	0.0996	0.0004	0.0994	0.0002
		(3)	0.1018	0.0004	0.1016	0.0002
		(4)	0.1026	0.0003	0.1024	0.0002
		(5)	0.1005	0.0003	0.1003	0.0002
		(6)	0.0998	0.0003	0.0996	0.0002
		(7)	0.0991	0.0003	0.0989	0.0002
		(8)	0.0949	0.0003	0.0946	0.0001
		(9)	0.0906	0.0002	0.0903	0.0001
		(10)	0.0907	0.0002	0.0904	0.0001
		(11)	0.0835	0.0002	0.0832	0.0001
107.8	- 4	(1)	0.0410	24.3999	0.0447	22.3509
		(2)	0.0993	0.0002	0.0990	0.0001
		(3)	0.1015	0.0002	0.1011	0.0001
		(4)	0.1023	0.0001	0.1019	0.0001
		(5)	0.1001	0.0001	0.0997	0.0001
		(6)	0.0994	0.0001	0.0990	0.0001
		(7)	0.0987	0.0001	0.0983	0.0001
		(8)	0.0944	0.0001	0.0940	0.0001
		(9)	0.0901	0.0001	0.0898	0.0000
		(10)	0.0902	0.0001	0.0898	0.0000
		(11)	0.0830	0.0001	0.0826	0.0000
107.8	-26	(1)	0.0458	21.8302	0.0514	19.4542
		(2)	0.0898	0.0000	0.0983	0.0000
		(3)	0.1010	0.0000	0.1005	0.0000
		(4)	0.1018	0.0000	0.1012	0.0000
		(5)	0.0996	0.0000	0.0991	0.0000
		(6)	0.0989	0.0000	0.0983	0.0000
		(7)	0.0982	0.0000	0.0976	0.0000
		(8)	0.0939	0.0000	0.0934	0.0000
		(9)	0.0896	0.0000	0.0891	0.0000
		(10)	0.0897	0.0000	0.0891	0.0000
		(11)	0.00825	0.0000	0.0820	0.0000

TABLE XXVIII (Continued)

Press. (Psia)	Temp. (^{o}F)	Comp.*	Chao-Seader Liquid Mol. Fr.	Chao-Seader K Value	Soave RK Liquid Mol. Fr.	Soave RK K Value
508.2	77	(1)	0.1349	7.4070	0.1364	7.3275
		(2)	0.0876	0.0011	0.0879	0.0008
		(3)	0.0900	0.0011	0.0901	0.0008
		(4)	0.0913	0.0010	0.0912	0.0008
		(5)	0.0894	0.0010	0.0895	0.0007
		(6)	0.0892	0.0010	0.0892	0.0007
		(7)	0.0888	0.0010	0.0889	0.0007
		(8)	0.0859	0.0009	0.0856	0.0006
		(9)	0.0825	0.0008	0.0821	0.0006
		(10)	0.0832	0.0007	0.0826	0.0005
		(11)	0.0771	0.0007	0.0765	0.0005
508.2	68	(1)	0.1379	7.2455	0.1404	7.1181
		(2)	0.0877	0.0009	0.0878	0.0007
		(3)	0.0900	0.0009	0.0900	0.0006
		(4)	0.0911	0.0008	0.0910	0.0006
		(5)	0.0893	0.0008	0.0892	0.0006
		(6)	0.0890	0.0008	0.0889	0.0005
		(7)	0.0885	0.0008	0.0885	0.0005
		(8)	0.0854	0.0007	0.0851	0.0005
		(9)	0.0820	0.0006	0.0815	0.0004
		(10)	0.0826	0.0006	0.0819	0.0004
		(11)	0.0764	0.0005	0.0758	0.0004
508.2	32	(1)	0.1533	6.5197	0.1608	6.2198
		(2)	0.0871	0.0004	0.0865	0.0002
		(3)	0.0891	0.0003	0.0885	0.0002
		(4)	0.0900	0.0003	0.0893	0.0002
		(5)	0.0881	0.0003	0.0874	0.0002
		(6)	0.0876	0.0003	0.0869	0.0002
		(7)	0.0870	0.0003	0.0864	0.0002
		(8)	0.0836	0.0003	0.0826	0.0002
		(9)	0.0800	0.0002	0.0791	0.0001
		(10)	0.0802	0.0002	0.0793	0.0001
		(11)	0.0740	0.0002	0.0731	0.0001

TABLE XXVIII (Continued)

			Chao-Seader		Soave RK	
Press. (Psia)	Temp. (^oF)	Comp.*	Liquid Mol. Fr.	K Value	Liquid Mol. Fr.	K Value
508.2	20	(1)	0.1599	6.2510	0.1695	5.8998
		(2)	0.0866	0.0003	0.0858	0.0001
		(3)	0.0886	0.0002	0.0877	0.0001
		(4)	0.0894	0.0002	0.0884	0.0001
		(5)	0.0875	0.0002	0.0866	0.0001
		(6)	0.0870	0.0002	0.0860	0.0001
		(7)	0.9864	0.0002	0.0855	0.0001
		(8)	0.0829	0.0002	0.0819	0.0001
		(9)	0.0792	0.0002	0.0782	0.0001
		(10)	0.0794	0.0002	0.0783	0.0001
		(11)	0.0732	0.0001	0.0721	0.0001
508.2	- 4	(1)	0.1761	5.6771	0.1909	5.2376
		(2)	0.0852	0.0001	0.0837	0.0001
		(3)	0.0871	0.0001	0.0856	0.0001
		(4)	0.0878	0.0001	0.0862	0.0001
		(5)	0.0859	0.0001	0.0844	0.0001
		(6)	0.0854	0.0001	0.0839	0.0001
		(7)	0.0848	0.0001	0.0833	0.0001
		(8)	0.0812	0.0001	0.0797	0.0001
		(9)	0.0776	0.0001	0.0761	0.0000
		(10)	0.0776	0.0001	0.0761	0.0000
		(11)	0.0715	0.0001	0.0701	0.0000
508.2	-26	(1)	0.1976	5.1129	0.2168	4.6123
		(2)	0.0833	0.0001	0.0811	0.0000
		(3)	0.0851	0.0001	0.0829	0.0000
		(4)	0.0858	0.0001	0.0835	0.0000
		(5)	0.0839	0.0001	0.0818	0.0000
		(6)	0.0834	0.0001	0.0812	0.0000
		(7)	0.0828	0.0000	0.0806	0.0000
		(8)	0.0792	0.0000	0.0771	0.0000
		(9)	0.0756	0.0000	0.0736	0.0000
		(10)	0.0757	0.0000	0.0736	0.0000
		(11)	0.0697	0.0000	0.0677	0.0000

TABLE XXVIII (Continued)

			Chao-Seader		Soave RK	
Press. (Psia)	Temp. (^{o}F)	Comp.*	Liquid Mol. Fr.	K Value	Liquid Mol. Fr.	K Value
1006.7	77	(1)	0.2460	4.0610	0.2491	4.0119
		(2)	0.0744	0.0016	0.0750	0.0012
		(3)	0.0766	0.0015	0.0770	0.0012
		(4)	0.0784	0.0015	0.0785	0.0011
		(5)	0.0767	0.0015	0.0770	0.0011
		(6)	0.0772	0.0014	0.0776	0.0011
		(7)	0.0766	0.0014	0.0775	0.0010
		(8)	0.0756	0.0013	0.0754	0.0010
		(9)	0.0734	0.0012	0.0721	0.0009
		(10)	0.0749	0.0011	0.0731	0.0009
		(11)	0.0701	0.0010	0.0677	0.0009
1006.7	68	(1)	0.2505	3.9882	0.2554	3.9126
		(2)	0.0745	0.0013	0.0748	0.0010
		(3)	0.0766	0.0013	0.0768	0.0010
		(4)	0.0783	0.0012	0.0781	0.0009
		(5)	0.0766	0.0012	0.0766	0.0009
		(6)	0.0769	0.0012	0.0770	0.0009
		(7)	0.0763	0.0012	0.0768	0.0008
		(8)	0.0749	0.0011	0.0746	0.0008
		(9)	0.0726	0.0010	0.0712	0.0008
		(10)	0.0738	0.0009	0.0721	0.0007
		(11)	0.0689	0.0008	0.0667	0.0007
1006.7	32	(1)	0.2739	3.6499	0.2875	3.4773
		(2)	0.0736	0.0006	0.0728	0.0004
		(3)	0.0754	0.0006	0.0745	0.0004
		(4)	0.0766	0.0006	0.0754	0.0004
		(5)	0.0749	0.0006	0.0738	0.0004
		(6)	0.0749	0.0006	0.0738	0.0004
		(7)	0.0742	0.0006	0.0734	0.0004
		(8)	0.0721	0.0005	0.0708	0.0003
		(9)	0.0694	0.0005	0.0676	0.0003
		(10)	0.0700	0.0004	0.0679	0.0003
		(11)	0.0649	0.0004	0.0626	0.0003

TABLE XXVIII (Continued)

			Chao-Seader		Soave RK	
Press. (Psia)	Temp. (^{o}F)	Comp.*	Liquid Mol. Fr.	K Value	Liquid Mol. Fr.	K Value
1006.7	20	(1)	0.2839	3.5214	0.3011	3.3209
		(2)	0.0729	0.0005	0.0717	0.0003
		(3)	0.0747	0.0005	0.0733	0.0003
		(4)	0.0757	0.0005	0.0741	0.0003
		(5)	0.0740	0.0005	0.0725	0.0003
		(6)	0.0739	0.0005	0.0724	0.0003
		(7)	0.0733	0.0005	0.0720	0.0003
		(8)	0.0710	0.0004	0.0693	0.0003
		(9)	0.0682	0.0004	0.0661	0.0003
		(10)	0.0687	0.0003	0.0664	0.0002
		(11)	0.0636	0.0003	0.0611	0.0002
1006.7	- 4	(1)	0.3084	3.2420	0.3339	2.9949
		(2)	0.0709	0.0003	0.0686	0.0002
		(3)	0.0725	0.0003	0.0701	0.0002
		(4)	0.0733	0.0003	0.0708	0.0002
		(5)	0.0717	0.0003	0.0693	0.0002
		(6)	0.0715	0.0003	0.0691	0.0002
		(7)	0.0709	0.0003	0.0686	0.0002
		(8)	0.0684	0.0003	0.0659	0.0002
		(9)	0.0656	0.0002	0.0629	0.0002
		(10)	0.0659	0.0002	0.0630	0.0001
		(11)	0.0609	0.0002	0.0580	0.0001
1006.7	-26	(1)	0.3374	2.9631	0.3724	2.6849
		(2)	0.0681	0.0002	0.0648	0.0001
		(3)	0.0696	0.0002	0.0662	0.0001
		(4)	0.0703	0.0002	0.0668	0.0001
		(5)	0.0688	0.0002	0.0654	0.0001
		(6)	0.0690	0.0002	0.0651	0.0001
		(7)	0.0679	0.0002	0.0646	0.0001
		(8)	0.0654	0.0002	0.0620	0.0001
		(9)	0.0627	0.0002	0.0591	0.0001
		(10)	0.0629	0.0002	0.0592	0.0001
		(11)	0.0580	0.0001	0.0544	0.0001

* (1) Methane
(2)------(11) Fraction No.

TABLE XXIX

HIGHLY NAPHTHENIC LEAN OIL

			Chao-Seader		Soave RK	
Press. (Psia)	Temp. (°F)	Comp.*	Liquid Mol. Fr.	K Value	Liquid Mol. Fr.	K Value
107.8	77	(1)	0.0382	26.0896	0.0367	27.1793
		(2)	0.0994	0.0077	0.1006	0.0064
		(3)	0.0995	0.0060	0.1002	0.0049
		(4)	0.0993	0.0050	0.0997	0.0043
		(5)	0.0923	0.0050	0.0926	0.0040
		(6)	0.0932	0.0050	0.0934	0.0037
		(7)	0.0940	0.0040	0.0941	0.0034
		(8)	0.0948	0.0040	0.0948	0.0031
		(9)	0.0980	0.0030	0.0979	0.0028
		(10)	0.0995	0.0030	0.0993	0.0023
		(11)	0.0918	0.0016	0.0909	0.0011
107.8	68	(1)	0.0393	25.3587	0.0378	26.3573
		(2)	0.1007	0.0061	0.1018	0.0049
		(3)	0.1001	0.0047	0.1007	0.0038
		(4)	0.0996	0.0041	0.1000	0.0033
		(5)	0.0924	0.0039	0.0927	0.0030
		(6)	0.0932	0.0036	0.0934	0.0028
		(7)	0.0938	0.0033	0.0939	0.0026
		(8)	0.0944	0.0031	0.0945	0.0024
		(9)	0.0975	0.0028	0.0974	0.0021
		(10)	0.0987	0.0023	0.0984	0.0017
		(11)	0.0903	0.0012	0.0895	0.0008
107.8	32	(1)	0.0450	22.2092	0.0438	22.8043
		(2)	0.1041	0.0022	0.1049	0.0016
		(3)	0.1015	0.0017	0.1019	0.0012
		(4)	0.1000	0.0014	0.1003	0.0010
		(5)	0.0924	0.0014	0.0926	0.0009
		(6)	0.0927	0.0012	0.0929	0.0008
		(7)	0.0930	0.0011	0.0930	0.0008
		(8)	0.0932	0.0011	0.0932	0.0007
		(9)	0.0957	0.0009	0.0956	0.0006
		(10)	0.0962	0.0008	0.0960	0.0005
		(11)	0.0862	0.0004	0.0857	0.0002

TABLE XXIX (Continued)

			Chao-Seader		Soave RK	
Press. (Psia)	Temp. (°F)	Comp.*	Liquid Mol. Fr.	K Value	Liquid Mol. Fr.	K Value
107.8	20	(1)	0.0474	21.0893	0.0464	21.5401
		(2)	0.1047	0.0015	0.1054	0.0010
		(3)	0.1016	0.0012	0.1019	0.0008
		(4)	0.0999	0.0010	0.1002	0.0006
		(5)	0.0923	0.0009	0.0924	0.0006
		(6)	0.0925	0.0008	0.0926	0.0005
		(7)	0.0927	0.0008	0.0927	0.0005
		(8)	0.0928	0.0007	0.0928	0.0004
		(9)	0.0952	0.0006	0.0952	0.0004
		(10)	0.0955	0.0005	0.0954	0.0003
		(11)	0.0854	0.0003	0.0850	0.0001
107.8	- 4	(1)	0.0533	18.7699	0.0528	18.9327
		(2)	0.1051	0.0007	0.1055	0.0004
		(3)	0.1014	0.0005	0.1016	0.0003
		(4)	0.0995	0.0004	0.0997	0.0002
		(5)	0.0918	0.0004	0.0919	0.0002
		(6)	0.0919	0.0004	0.0920	0.0002
		(7)	0.0920	0.0003	0.0920	0.0002
		(8)	0.0921	0.0003	0.0921	0.0002
		(9)	0.0943	0.0003	0.0943	0.0001
		(10)	0.0945	0.0002	0.0944	0.0001
		(11)	0.0841	0.0001	0.0838	0.0000
107.8	-26	(1)	0.0603	16.5795	0.0606	16.4881
		(2)	0.1049	0.0003	0.1050	0.0002
		(3)	0.1009	0.0002	0.1010	0.0001
		(4)	0.0989	0.0002	0.0989	0.0001
		(5)	0.0912	0.0002	0.0912	0.0001
		(6)	0.0912	0.0002	0.0912	0.0001
		(7)	0.0913	0.0001	0.0912	0.0001
		(8)	0.0913	0.0001	0.0912	0.0001
		(9)	0.0935	0.0001	0.0934	0.0001
		(10)	0.0935	0.0001	0.0934	0.0000
		(11)	0.0831	0.0000	0.0829	0.0000

TABLE XXIX (Continued)

			Chao-Seader		Soave RK	
Press. (Psia)	Temp. (^{o}F)	Comp.*	Liquid Mol. Fr.	K Value	Liquid Mol. Fr.	K Value
508.2	77	(1)	0.1664	5.9988	0.1615	6.1839
		(2)	0.0808	0.0036	0.0830	0.0029
		(3)	0.0834	0.0029	0.0848	0.0024
		(4)	0.0840	0.0026	0.0848	0.0022
		(5)	0.0785	0.0025	0.0792	0.0020
		(6)	0.0801	0.0023	0.0807	0.0019
		(7)	0.0813	0.0022	0.0818	0.0018
		(8)	0.0826	0.0020	0.0829	0.0016
		(9)	0.0866	0.0018	0.0868	0.0014
		(10)	0.0897	0.0015	0.0895	0.0012
		(11)	0.0866	0.0009	0.0851	0.0007
508.2	68	(1)	0.1707	5.8486	0.1661	6.0147
		(2)	0.0822	0.0029	0.0843	0.0024
		(3)	0.0840	0.0023	0.0853	0.0019
		(4)	0.0842	0.0021	0.0850	0.0017
		(5)	0.0785	0.0020	0.0792	0.0016
		(6)	0.0799	0.0019	0.0804	0.0015
		(7)	0.0809	0.0018	0.0814	0.0014
		(8)	0.0820	0.0017	0.0823	0.0013
		(9)	0.0856	0.0015	0.0857	0.0011
		(10)	0.0882	0.0012	0.0879	0.0009
		(11)	0.0837	0.0007	0.0824	0.0005
508.2	32	(1)	0.1926	5.1890	0.1895	5.2737
		(2)	0.0854	0.0012	0.0869	0.0009
		(3)	0.0845	0.0010	0.0854	0.0007
		(4)	0.0838	0.0009	0.0843	0.0006
		(5)	0.0776	0.0008	0.0781	0.0006
		(6)	0.0782	0.0008	0.0786	0.0005
		(7)	0.0787	0.0007	0.0789	0.0005
		(8)	0.0792	0.0007	0.0793	0.0005
		(9)	0.0817	0.0006	0.0817	0.0004
		(10)	0.0828	0.0005	0.0826	0.0003
		(11)	0.0756	0.0003	0.0747	0.0002

TABLE XXIX (Continued)

			Chao-Seader		Soave RK	
Press. (Psia)	Temp. (°F)	Comp.*	Liquid Mol. Fr.	K Value	Liquid Mol. Fr.	K Value
508.2	20	(1)	0.2019	4.9501	0.1997	5.0072
		(2)	0.0856	0.0009	0.0868	0.0006
		(3)	0.0841	0.0007	0.0848	0.0005
		(4)	0.0831	0.0006	0.0836	0.0004
		(5)	0.0769	0.0006	0.0773	0.0004
		(6)	0.0774	0.0006	0.0776	0.0004
		(7)	0.0777	0.0005	0.0779	0.0003
		(8)	0.0781	0.0005	0.0782	0.0003
		(9)	0.0804	0.0004	0.0804	0.0003
		(10)	0.0812	0.0004	0.0810	0.0002
		(11)	0.0735	0.0002	0.0728	0.0001
508.2	- 4	(1)	0.2248	4.4477	0.2246	4.4520
		(2)	0.0848	0.0005	0.0855	0.0003
		(3)	0.0825	0.0004	0.0828	0.0002
		(4)	0.0812	0.0003	0.0813	0.0002
		(5)	0.0750	0.0003	0.0751	0.0002
		(6)	0.0752	0.0003	0.0753	0.0002
		(7)	0.0754	0.0003	0.0754	0.0002
		(8)	0.0756	0.0002	0.0755	0.0001
		(9)	0.0776	0.0002	0.0775	0.0001
		(10)	0.0780	0.0002	0.0777	0.0001
		(11)	0.0699	0.0001	0.0694	0.0000
508.2	-26	(1)	0.2523	3.9637	0.2848	3.9248
		(2)	0.0827	0.0002	0.0828	0.0001
		(3)	0.0799	0.0002	0.0799	0.0001
		(4)	0.0785	0.0002	0.0783	0.0001
		(5)	0.0724	0.0002	0.0723	0.0001
		(6)	0.0726	0.0001	0.0723	0.0001
		(7)	0.0727	0.0001	0.0724	0.0001
		(8)	0.0728	0.0001	0.0725	0.0001
		(9)	0.0746	0.0001	0.0742	0.0001
		(10)	0.0748	0.0001	0.0744	0.0000
		(11)	0.0667	0.0000	0.0661	0.0000

TABLE XXIX (Continued)

Press. (Psia)	Temp. (^oF)	Comp.*	Chao-Seader Liquid Mol. Fr.	Chao-Seader K Value	Soave RK Liquid Mol. Fr.	Soave RK K Value
1006.7	77	(1)	0.2985	3.3431	0.2943	3.3912
		(2)	0.0584	0.0047	0.0619	0.0040
		(3)	0.0640	0.0039	0.0664	0.0033
		(4)	0.0658	0.0036	0.0664	0.0032
		(5)	0.0623	0.0034	0.0626	0.0031
		(6)	0.0652	0.0031	0.0653	0.0028
		(7)	0.0670	0.0031	0.0674	0.0027
		(8)	0.0693	0.0029	0.0692	0.0026
		(9)	0.0752	0.0026	0.0755	0.0023
		(10)	0.0823	0.0022	0.0825	0.0019
		(11)	0.0921	0.0013	0.0684	0.0012
1006.7	68	(1)	0.3050	3.2730	0.3016	3.3105
		(2)	0.0601	0.0040	0.0634	0.0033
		(3)	0.0650	0.0033	0.0672	0.0028
		(4)	0.0665	0.0030	0.0670	0.0027
		(5)	0.0627	0.0029	0.0629	0.0026
		(6)	0.0652	0.0027	0.0653	0.0024
		(7)	0.0668	0.0026	0.0671	0.0023
		(8)	0.0688	0.0024	0.0686	0.0021
		(9)	0.0740	0.0024	0.0741	0.0019
		(10)	0.0799	0.0019	0.0800	0.0016
		(11)	0.0860	0.0011	0.0827	0.0009
1006.7	32	(1)	0.3378	2.9574	0.3384	2.9527
		(2)	0.0637	0.0021	0.0661	0.0016
		(3)	0.0659	0.0017	0.0673	0.0013
		(4)	0.0664	0.0016	0.0665	0.0013
		(5)	0.0620	0.0015	0.0619	0.0012
		(6)	0.0635	0.0014	0.0632	0.0011
		(7)	0.0643	0.0013	0.0641	0.0011
		(8)	0.0655	0.0012	0.0649	0.0010
		(9)	0.0688	0.0011	0.0684	0.0009
		(10)	0.0718	0.0009	0.0712	0.0007
		(11)	0.0702	0.0005	0.0679	0.0004

TABLE XXIX (Continued)

Press. (Psia)	Temp. (^oF)	Comp.*	Chao-Seader Liquid Mol. Fr.	Chao-Seader K Value	Soave RK Liquid Mol. Fr.	Soave RK K Value
1006.7	20	(1)	0.3518	2.8407	0.3541	2.8226
		(2)	0.0640	0.0017	0.0660	0.0013
		(3)	0.0655	0.0014	0.0665	0.0010
		(4)	0.0657	0.0012	0.0655	0.0010
		(5)	0.0612	0.0012	0.0609	0.0010
		(6)	0.0624	0.0011	0.0620	0.0009
		(7)	0.0630	0.0011	0.0627	0.0008
		(8)	0.0639	0.0010	0.0633	0.0008
		(9)	0.0669	0.0009	0.0633	0.0007
		(10)	0.0692	0.0007	0.0685	0.0006
		(11)	0.0664	0.0004	0.0642	0.0003
1006.7	- 4	(1)	0.3857	2.5918	0.3922	2.5492
		(2)	0.0629	0.0011	0.0641	0.0008
		(3)	0.0633	0.0009	0.0636	0.0006
		(4)	0.0631	0.0008	0.0625	0.0006
		(5)	0.0585	0.0008	0.0579	0.0006
		(6)	0.0594	0.0007	0.0586	0.0006
		(7)	0.0598	0.0007	0.0590	0.0005
		(8)	0.0604	0.0006	0.0594	0.0005
		(9)	0.0627	0.0006	0.0618	0.0004
		(10)	0.0643	0.0005	0.0631	0.0003
		(11)	0.0601	0.0003	0.0579	0.0002
1006.7	-26	(1)	0.4258	2.3481	0.4372	2.2869
		(2)	0.0601	0.0008	0.0605	0.0005
		(3)	0.0598	0.0006	0.0594	0.0004
		(4)	0.0594	0.0006	0.0583	0.0004
		(5)	0.0550	0.0006	0.0539	0.0004
		(6)	0.0556	0.0005	0.0544	0.0004
		(7)	0.0558	0.0005	0.0546	0.0004
		(8)	0.0563	0.0005	0.0549	0.0003
		(9)	0.0583	0.0004	0.0568	0.0003
		(10)	0.0593	0.0003	0.0577	0.0002
		(11)	0.0547	0.0002	0.0524	0.0001

* (1) Methane
(2)----(11) Fraction No.

TABLE XXX

VIRGIN OIL

			Chao-Seader		Soave RK	
Press. (Psia)	Temp. (^{o}F)	Comp.*	Liquid Mol. Fr.	K Value	Liquid Mol. Fr.	K Value
107.8	77	(1)	0.0375	26.5643	0.0383	26.0398
		(2)	0.9625	0.0031	0.9617	0.0024
	68	(1)	0.0386	25.8190	0.0396	25.2297
		(2)	0.9614	0.0024	0.9604	0.0018
	32	(1)	0.0442	22.6172	0.0459	21.7553
		(2)	0.9558	0.0008	0.9541	0.0005
	20	(1)	0.0465	21.4818	0.0487	20.5297
		(2)	0.9535	0.0006	0.9513	0.0003
	- 4	(1)	0.0523	19.1322	0.0555	18.0123
		(2)	0.9477	0.0002	0.9445	0.0001
	-26	(1)	0.0591	16.9134	0.0638	15.6640
		(2)	0.9409	0.0001	0.9362	0.0000
508.2	77	(1)	0.1634	6.1131	0.1678	5.9527
		(2)	0.8367	0.0017	0.8322	0.0013
	68	(1)	0.1676	5.9592	0.1728	5.7838
		(2)	0.8324	0.0013	0.8273	0.0010
	32	(1)	0.1891	5.2867	0.1978	5.0540
		(2)	0.8109	0.0005	0.8022	0.0004
	20	(1)	0.1982	5.0439	0.2085	4.7942
		(2)	0.8018	0.0004	0.7915	0.0002
	- 4	(1)	0.2205	4.5344	0.2349	4.2563
		(2)	0.7795	0.0002	0.7651	0.0001

TABLE XXX (Continued)

Press. (Psia)	Temp. (^{o}F)	Comp.*	Liquid Mol. Fr.	Value	Liquid Mol. Fr.	Value
508.2	-26	(1)	0.2473	4.0440	0.2668	3.7487
		(2)	0.7527	0.0001	0.7333	0.0001
1006.7	77	(1)	0.2926	3.4121	0.3040	3.2848
		(2)	0.7074	0.0024	0.6960	0.0021
	68	(1)	0.2990	3.3397	0.3118	3.2029
		(2)	0.7010	0.0020	0.6882	0.0017
	32	(1)	0.3313	3.0164	0.3511	2.8464
		(2)	0.6687	0.0010	0.6489	0.0008
	20	(1)	0.3450	2.8973	0.3677	2.7186
		(2)	0.6550	0.0008	0.6323	0.0006
	- 4	(1)	0.3780	2.6443	0.4077	2.4519
		(2)	0.6220	0.0005	0.5923	0.0004
	-26	(1)	0.4171	2.3970	0.4549	2.1982
		(2)	0.5829	0.0004	0.5452	0.0003

* (1) Methane
  (2) Fraction No.

TABLE XXXI

PREDICTED EQUILIBRIUM LIQUID MOLECULAR WEIGHTS

Mineral Spirits 135

Press. (Psia)	Temp. (°F)	Molecular Weight (Liquid)	
		Chao-Seader	Soave-RK
107.8	77	130.70	130.80
	68	130.57	130.66
	32	129.96	129.95
	20	129.70	129.64
	- 4	129.06	128.88
	-26	128.30	127.96
508.2	77	116.30	116.61
	68	115.83	116.05
	32	113.46	113.26
	20	112.45	112.06
	- 4	109.98	109.13
	-26	107.03	105.59
1006.7	77	101.52	101.75
	68	100.82	100.87
	32	97.28	96.50
	20	95.78	94.66
	- 4	92.15	90.24
	-26	87.88	85.07

50/50 Mineral Spirits 135 /
Heavy Solvent No. 1

Press. (Psia)	Temp. (°F)	Molecular Weight (Liquid)	
		Chao-Seader	Soave-RK
107.8	77	148.07	148.09
	68	147.93	147.93
	32	147.23	147.08
	20	146.93	146.71
	- 4	146.20	145.82
	-26	145.33	144.72

TABLE XXXI (Continued)

Press. (Psia)	Temp. (°F)	Molecular Weight (Liquid)	
		Chao-Seader	Soave-RK
508.2	77	131.63	131.60
	68	131.09	130.95
	32	128.41	127.65
	20	127.27	126.24
	- 4	124.49	122.79
	-26	121.17	118.64
1006.7	77	114.85	114.52
	68	114.06	113.48
	32	110.11	108.37
	20	108.44	106.23
	- 4	104.42	101.09
	-26	99.70	95.11

Highly Aromatic Lean Oil

Press. (Psia)	Temp. (°F)	Molecular Weight (Liquid)	
		Chao-Seader	Soave-RK
107.8	77	115.01	114.96
	68	114.92	114.85
	32	114.49	114.30
	20	114.31	114.07
	- 4	113.89	113.51
	-26	113.39	112.83
508.2	77	104.42	104.24
	68	104.09	103.81
	32	102.46	101.69
	20	101.78	100.79
	- 4	100.11	98.60
	-26	98.12	95.95
1006.7	77	93.21	92.79
	68	92.71	92.12
	32	90.23	88.78
	20	89.19	87.38
	- 4	86.66	84.02
	-26	83.68	80.08

TABLE XXXI (Continued)

Highly Naphthenic Lean Oil

Press. (Psia)	Temp. (°F)	Molecular Weight (Liquid)	
		Chao-Seader	Soave-RK
107.8	77	110.97	111.08
	68	110.80	110.91
	32	110.09	110.18
	20	109.82	109.90
	- 4	109.21	109.24
	-26	108.50	108.46
508.2	77	98.57	98.98
	68	98.05	98.45
	32	95.66	95.92
	20	94.69	94.89
	- 4	92.38	92.37
	-26	89.64	89.38
1006.7	77	86.04	86.32
	68	85.25	85.47
	32	81.63	81.48
	20	80.17	79.86
	- 4	76.71	76.01
	-26	72.70	71.52

Virgin Oil

Press. (Psia)	Temp. (°F)	Molecular Weight (liquid)	
		Chao-Seader	Soave-RK
107.8	77	114.17	114.10
	68	114.06	113.97
	32	113.50	113.32
	20	113.26	113.04
	- 4	112.67	112.35
	-26	111.97	111.50
508.2	77	101.35	100.90
	68	100.91	100.39
	32	98.72	97.84
	20	97.79	96.75
	- 4	95.52	94.05
	-26	92.79	90.81

TABLE XXXI (Continued)

Press. (Psia)	Temp. (^oF)	Molecular Weight (Liquid)	
		Chao-Seader	Soave-RK
1006.7	77	88.17	87.01
	68	87.52	86.21
	32	84.22	82.21
	20	82.83	80.52
	- 4	79.46	76.43
	-26	75.48	71.63

VITA

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