

EFFECTS OF C6+ CHARACTERIZATION
ON PHASE BEHAVIOR

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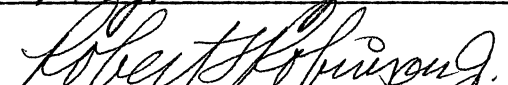
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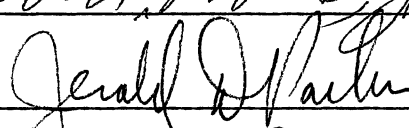
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PREFACE

This study focuses on improving GPA*SIM phase behavior prediction after an initial C6+ characterization has been preformed. Two methods of prediction were studied. First, an optimum critical property correlation was chosen. Second, an advanced characterization technique was used in an attempt to find a new critical property correlation.

I wish to dedicate this to the late Dr. John Erbar. This study is the best I can do without your advice. I don't know if it is what you wanted, but I hope that it lives up to the high standards that you demanded.

Special thanks is given to Mr. Arild Wilson and Norsk Hydro for the data they provided and Mr. Wilson's assistance throughout this study. I also extend thanks to Dr. Jan Wagner, my major advisor, who was willing to take over and help on my project. His advice and patience were instrumental in the completion of this study. I also appreciate the assistance given by Mr. John D. Freidemann, Dr. Ruth Erbar, and Dr. Ali Majeed. Their assistance made this study possible. Finally, I would like to thank the entire Chemical Engineering Department Staff for their invaluable assistance over the entire seven years I have been at Oklahoma State.

TABLE OF CONTENTS

Chapter	Page
I. INTRODUCTION	1
II. BACKGROUND	4
Characterization Methods	4
Advanced Characterization Methods	7
Critical Property Correlations	8
III. PROCEDURE	13
Data Set Selection	13
C6+ Characterization	15
Critical Property Correlations	23
Advanced Characterization	24
IV. ANALYSIS OF DATA AND RESULTS	31
V. SUMMARY AND CONCLUSIONS	41
BIBLIOGRAPHY	43
APPENDIX A - DATA SET EVALUATIONS	46
APPENDIX B - CALCULATION OF TWU MOLECULAR WEIGHT CORRELATION	50
APPENDIX C - CRITICAL PROPERTY CORRELATION EVALUATION	51
APPENDIX D - EXAMPLE ADVANCED CHARACTERIZATION	54

LIST OF TABLES

Table	Page
I. Roland Feed Composition	14
II. C6PLUS Output for Roland	21
III. Least-Squares Fit of Roland Tc	25
IV. Least-Squares Fit of Roland Pc	25
V. Example GPA*SIM Output of Roland Dew Point	33
VI. Calculated Saturation Pressure Error for Four Different Critical Property Correlations	34
VII. Example GPA*SIM Output for Roland Vapor Formation Curve	35
VIII. Calculated LV% Formation Curve Error for Four Different Critical Property Correlations	37
IX. Average Tc and Pc Adjustments for Four Critical Property Correlations	40
X. Standing and Katz Material Balance	48
XI. Tc and Pc Adjustment History	55

LIST OF FIGURES

Figure	Page
1. Roland Distillation	16
2. Roland Probability Smoothing	19
3. Roland True Boiling Curve	20
4. Roland Least-Squares Fit for Lee- Kesler Tc	26
5. Roland Least-Squares Fit for Lee- Kesler Pc	27
6. Roland Vapor Formation Curve	38
7. Standing-Katz Mole Balance	49
8. Tc for SG Equal to 0.6388	52
9. Pc for SG Equal to 0.6388	53

NOMENCLATURE

A	gravity, $^{\circ}\text{API}$
B	moles of component in liquid
C	moles of component in feed
D	moles of component in vapor
F	total moles of feed
L	total moles of liquid
MW	molecular weight
n	component number
Pc	critical pressure, psia
SG	specific gravity, spgr at 60°F
Tb	boiling temperature, $^{\circ}\text{F}$
Tc	critical temperature, $^{\circ}\text{R}$
UOP K	Watson characterization factor, or Universal Oil Products Constant
V	total moles of vapor
Vc	critical volume, $\text{ft}^3 / \text{lb-mole}$
Xn	mole fraction of component in liquid
x_n	Newton-Raphson root point
x_{n+1}	Newton-Raphson root point following x_n
Yn	mole fraction of component in vapor
Zn	mole fraction of component in feed

Greek Symbols

\emptyset group contribution parameter from molecular
characterization

CHAPTER I

INTRODUCTION

Accurate phase behavior prediction is essential in the petroleum industry, from reservoir performance prediction to surface equipment maintenance. Many equations of state have been introduced to handle a broad range of naturally occurring hydrocarbon systems. However, the phase behavior predicted by three parameter equations of state often does not match experimental data. The problem occurs because the composition, the actual molecular components, for crude oil can not be accurately determined. Even if composition were known, the number of components would be unmanageable.

Laboratory analysis of crude oils usually includes component-by-component analysis of the light components. Heavy components are described by a distillation analysis. The distillation analysis results in a true boiling point (TBP) curve and, sometimes, a specific gravity (SG) curve. Typically laboratory distillations include the crude oil components of normal hexane and everything heavier (C6+). A technique, called characterization, has evolved to translate the TBP information to properties usable in equations of state. The TBP and SG curves are broken into several narrow boiling point fractions. The average TBP and SG of each

fraction are used to find the parameters necessary for the equations of state. Careful attention to characterization has lessened the gap between predicted and experimental phase behavior.

In many cases, however, the discrepancy still exists after characterization. The parameters the characterization produces for the equations of state are critical properties. Therefore, attention must be given to critical property correlations. Admittedly, the discrepancy between equation of state and experimental phase behavior could be from other causes. Possible causes include inadequate experimental techniques, failure of the specific equation of state, or the characteristics of a specific crude oil. However, for the Soave-Redlich-Kwong (SRK) [19], and Peng-Robinson (PR) [15] equations of state, the most likely cause of the problems remains the critical property correlations. A number of correlations are available in open literature. Since each correlation predicts slightly different critical properties, an optimum critical property correlation can be chosen to predict the parameters for each equation of state.

Experimental critical properties of full range hydrocarbon mixtures are difficult to obtain because of hydrocarbon cracking problems. In addition, most correlations must be stretched beyond their optimum pressure ranges for many phase behavior predictions. Therefore, the critical properties can be adjusted to make phase behavior predicted by equations of state agree more closely with experimental

data. The adjustment procedure is in addition to the original characterizations of the C6+ fraction. Some conclusions can be drawn from the critical property adjustments. If the amount of adjustment necessary is always the same, an addition to the critical property correlation could be made for the C6+ fractions. The critical property correlation adjustment would only be applicable for the equation of state under study. The development of a new correlation depends on a high degree of consistency in the amount of adjustment. For less consistent results in the adjustment procedure, some general overall adjustment may still be possible. Automatic additions or subtraction from C6+ fraction critical properties are one example of a general adjustment. The amount of adjustment will depend on the consistency of the results found. No consistency may be found; each hydrocarbon system may require individual evaluation.

Hence, the effect of the critical properties on the equation of state can be tested in two ways. First, an optimum critical property correlation can be chosen that predicts the phase behavior most closely in a specific equation of state. Second, the amount of adjustment of critical properties necessary to predict phase behavior in equations of state could result in an automatic adjustment procedure.

CHAPTER II

BACKGROUND

Characterization Methods

Some equations of state predict K-values, vapor-liquid equilibrium, for hydrocarbon fractions. When component-by-component analysis of light hydrocarbon mixtures is available, most thermodynamic property prediction methods accurately match experimental K-values. However, for C6+ fractions in mixtures, difficulties occur. A small change in C6+ fraction K-values has been shown to dramatically affect phase behavior. Poor agreement between calculated and experimental data occurs for systems using C6+ fractions with equations such as SRK, PR, and the Starling version of Benedict-Webb-Rubin (BWRs) [21]. In order to compensate for the problem, a variety of C6+ characterization methods have been developed.

Early characterization methods are summarized by Nelson [13]. When a full TBP analysis is available, the TBP curve is broken into several narrow boiling range fractions using the paraffin-naphthene-aromatic liquid volume percent (PNA) distribution as a guide.

A full TBP analysis includes:

1. The TBP temperature at specific liquid volume percent (LV%) off
2. The specific gravity at specific LV% off
3. Detailed analysis of several fractions of the oil for PNA distribution and molecular weight

Sometimes full TBP analysis is not available. Nelson has two suggestions to help compensate. First, the Watson [25] characterization factor is used to estimate aromatic content. The Watson characterization factor, or UOP K, is defined as

$$\text{UOP K} = \frac{T_b^{1/3}}{\text{SG}} \quad (2.1)$$

where T_b is in $^{\circ}\text{R}$. The Watson characterization factor does not yield an estimate of naphthenic content. However, since paraffinic and aromatic content are known the TBP analysis can still be broken into fractions. The second approach is for C_6+ systems where not enough information is given to calculate a Watson characterization factor. For example, only part of the TBP curve for the C_6+ fraction may be shown with the SG for the whole fraction. Nelson suggests matching the partial information to known full TBP analysis for crude oils. The full TBP analysis is used for characterization. The matching strategy requires plots and compositions for a large number of crude oil types. The matching strategy is no longer practical because of the wide variety and

composition range of crude oil discoveries made in the Middle East and many other new fields.

As the importance of characterization to equations of state became obvious, more sophisticated methods were developed. Each of these methods is attached to a specific equation of state. The PR equation has a set of simultaneous equations to describe PNA distribution [16]. Hopke and Lin [9] introduced a more thorough, although similar, set of equations for the BWRS equation. Erbar [5] provided a more complete description of characterization for a variety of experimental data. Erbar's method is specifically for the SRK equation. All of these characterization methods are efforts to improve the prediction of the correlating factors for the equations of state. The parameters used in all three equations of state mentioned above include the critical properties and an acentric factor. Each of these equations have problems with high pressure bubble and dew points of C6+ systems. Even with careful characterization the dew point for some systems may still be in error [12]. Since the properties of crude oils and gas condensates are routinely being defined from only one isotherm, the difference can become crucial. Two advanced C6+ characterization methods have evolved to eliminate the saturation point problems.

Advanced Characterization Methods

The most obvious method for advanced characterization is the retuning of equation of state binary or tertiary interaction parameters. Unfortunately, the binary interaction parameters for the light gasses as well as the C6+ fractions have to be adjusted. Whether for crude oil or coal derived fluids, several authors have found deterioration in the predicted phase behavior results when changing only C6+ interaction parameters [10] [24]. Since the binary interaction parameters work for virtually all well-defined hydrocarbon systems, the readjustment of light gas parameters is hard to justify.

A second advanced characterization method introduced by Wilson, Maddox, and Erbar [26] allows the binary interaction parameters in the SRK equation to remain constant. Instead of adjusting binary interaction parameters, the critical temperature (T_c) and the critical pressure (P_c) are adjusted for the C6+ fractions. The adjustments are done systematically with careful attention to the SRK acentric factor. Since composition, or a component-by-component analysis, is not usually available for C6+ fractions, experimental T_c and P_c are not available. If component-by-component analysis were available, experimental values for T_c and P_c would still not be available reliably for all of the C6+ components. Therefore, T_c and P_c are used as adjustable parameters for the C6+ fractions.

An important difference exists between the two advanced

characterization methods. Adjustment of binary interaction parameters has improved the calculated liquid density of most hydrocarbon mixtures. Liquid density calculations have been shown to be poor both in the PR and SRK equations. Critical property adjustment has made the liquid density problem worse for the SRK equation. The problem, for the SRK equation, however, has largely been resolved by the Hankinson-Thomson equation [22]. The liquid densities from the Hankinson-Thomson equation have compensated for the density problems associated with critical property adjustment and the SRK equation.

Critical Property Correlations

The adjustment of critical properties can only be done after a characterization method is used and the appropriate correlation for the critical properties has been applied. The choice of correlation can be of some concern. From the time of Guldberg's [7] observations in the 1880's, many people have since tried to find correlations for critical properties. Originally, the correlations were based on atmospheric boiling point temperature alone. Gradually gravity has become a correlating factor, most notably in Nokay [14] and Cavett [1]. Four correlations selected for this study are Cavett [1], Lee-Kesler [11], Riazi-Daubert [17], and Twu [23].

The Cavett correlations were chosen from a group of early multi-ordered correlations. The other three correla-

tions all claim improvement over the Cavett correlations. Cavett was included as a check for claims of improvement and because the correlations were the first large multi-ordered correlations for critical properties. The equations introduced by Cavett are

$$\begin{aligned} T_c = & 768.07121 + 1.17133693 T_b - 0.10834003 \times 10^{-2} T_b^2 \\ & - 0.89212579 \times 10^{-2} A T_b + 0.38890584 \times 10^{-6} T_b^3 \\ & + 0.5309492 \times 10^{-5} A T_b^2 + 0.327116 \times 10^{-7} A^2 T_b^2 \end{aligned} \quad (2.2)$$

$$\begin{aligned} \log_{10} P_c = & 2.8290406 + 0.94120109 \times 10^{-3} T_b \\ & - 0.30474749 \times 10^{-5} T_b^2 - 0.2087611 \times 10^{-4} A T_b \\ & + 0.15184103 \times 10^{-8} T_b^3 + 0.11047899 \times 10^{-7} A T_b^2 \\ & - 0.48271599 \times 10^{-7} A^2 T_b + 0.13949619 \times 10^{-9} A^2 T_b^2 \end{aligned} \quad (2.3)$$

where A is $^{\circ}\text{API}$.

The Lee-Kesler equations are currently in wide use. The correlations were introduced to extend the boiling temperature limits of Cavett's equations beyond 1200°F . The correlations are extrapolations with no experimental evidence to back up their extensions [11]. The Lee-Kesler correlations are

$$\begin{aligned} T_c = & 341.7 + 811 SG + (0.4244 + 0.1174 SG) T_b \\ & + \frac{(0.4779 - 3.2623 SG) 10^5}{T_b} \end{aligned} \quad (2.4)$$

$$\begin{aligned}
\ln P_c = & 8.3634 - \frac{0.0566}{SG} \\
& - \left(0.24244 + \frac{2.2898}{SG} + \frac{0.11857}{SG^2}\right) 10^{-3} T_b \\
& + \left(1.4685 + \frac{3.648}{SG} + \frac{0.47227}{SG^2}\right) 10^{-7} T_b^2 \\
& - \left(0.42019 + \frac{1.6977}{SG^2}\right) 10^{-10} T_b^3
\end{aligned} \tag{2.5}$$

where T_b is in $^{\circ}R$.

The Riazi-Daubert correlations are included because of their simplicity. The correlations were developed to alleviate the problems of fourteen numerical constant correlations. The Riazi-Daubert correlations are limited to moderate temperatures and pressures. The correlations are shown below.

$$T_c = 24.2787 T_b^{0.58848} SG^{0.3596} \tag{2.6}$$

$$P_c = 3.12281 \times 10^9 T_b^{-2.3125} SG^{2.3201} \tag{2.7}$$

In the Riazi-Daubert correlation T_b is in $^{\circ}R$.

A new correlation has been developed by Twu [23] in tandem with an equation of state that uses boiling point, critical temperature, and critical volume for correlating parameters. Twu's method relies on normal alkane critical properties. The equation of state is a modified version of the BWRS equation. The normal alkane correlations are shown below.

$$\begin{aligned}
T_c^0 = & Tb (0.533272 + 0.191017 \times 10^{-3} Tb \\
& + 0.779681 \times 10^{-7} Tb^2 - 0.284376 \times 10^{-10} Tb^3 \\
& + \frac{0.959468 \times 10^{28}}{Tb^{13}})^{-1}
\end{aligned} \tag{2.8}$$

$$\alpha = 1 - \frac{Tb_0}{Tc} \tag{2.9}$$

$$\begin{aligned}
P_c^0 = & (3.83354 + 1.19629\alpha^{1/2} + 34.8888\alpha \\
& + 36.1952\alpha^2 + 104.193\alpha^4)^2
\end{aligned} \tag{2.10}$$

$$\begin{aligned}
V_c^0 = & [1 - (0.419869 - 0.505839\alpha \\
& - 1.56436\alpha^3 - 9481.70\alpha^{14})]^{-8}
\end{aligned} \tag{2.11}$$

$$\begin{aligned}
SG^0 = & 0.843593 - 0.128624\alpha - 3.36159\alpha^3 \\
& - 13749.5\alpha^{12}
\end{aligned} \tag{2.12}$$

For the Twu correlations, T_c^0 , P_c^0 , V_c^0 , and SG^0 are normal alkane properties. In the equations Tb is in $^{\circ}R$. The normal alkane equations are then used in a perturbation expansion to cover the rest of the hydrocarbon fractions or coal tar fractions. The rest of the equations are shown below.

$$\Delta SG_T = \text{EXP}[5 (SG^0 - SG)] - 1 \quad (2.13)$$

$$f_T = \Delta SG_T \left(\frac{-0.362456}{T_b^{1/2}} + \left(0.0398285 - \frac{0.948125}{T_b^{1/2}} \right) \Delta SG_T \right) \quad (2.14)$$

$$T_c = T_c^0 \left(\frac{1 + 2f_T}{1 - 2f_T} \right)^2 \quad (2.15)$$

$$\Delta SG_V = \text{EXP}[4(SG^{02} - SG^2)] - 1 \quad (2.16)$$

$$f_V = \Delta SG_V \left(\frac{0.46659}{T_b^{1/2}} + \left(-0.182421 + \frac{3.01721}{T_b^{1/2}} \right) \Delta SG_V \right) \quad (2.17)$$

$$V_c = V_c^0 \left(\frac{1 + 2f_V}{1 - 2f_V} \right)^2 \quad (2.18)$$

$$\Delta SG_p = \text{EXP}[0.5(SG^0 - SG)] - 1 \quad (2.19)$$

$$f_p = \Delta SG_p \left(\left(2.53262 - \frac{46.1955}{T_b^{1/2}} - 0.00127885 T_b \right) + \left(-11.4277 + \frac{252.140}{T_b^{1/2}} + 0.00230535 T_b \right) \Delta SG_p \right) \quad (2.20)$$

$$P_c = P_c^0 \left(\frac{T_c}{T_c^0} \right) \left(\frac{V_c^0}{V_c} \right) \left(\frac{1 + 2f_p}{1 - 2f_p} \right)^2 \quad (2.21)$$

The final equations have the same units as the normal alkane equations.

CHAPTER III

PROCEDURE

Data Set Selection

Data sets were collected from both the open literature and proprietary sources. The data sets must include the following:

1. Component-by-component composition of light hydrocarbons
2. A description of the C6+ fraction, TBP analysis, ASTM distillation, or whole fraction properties
3. A description of a constant composition isotherm with dew or bubble point and some vapor-liquid equilibrium points

Only two data sets were found in open literature which had the required information: Roland [18], and Standing and Katz [20]. The composition of the Roland data and the whole fraction C6+ properties are shown in Table I. The Roland data for the heavy fraction are reported as heptanes and heavier. The term C6+ is used to describe the heavy fraction, not specifically the hexanes and heavier fraction. The term C6+ will continue to be used even when the actual

TABLE I
ROLAND FEED COMPOSITION

Component	120 °F Isotherm Mole Percent	200 °F Isotherm Mole Percent
Methane	81.113	81.107
Ethane	3.896	3.914
Propane	1.948	1.958
Butanes	1.629	1.628
Pentanes	1.123	1.105
Hexanes	1.222	1.197
Heptanes and Heavier	9.069	9.091
specific gravity at 60 °F molecular weight		0.8268 198.

heavies fraction is heptanes and heavier. The TBP data available for Roland are shown in Figure 1.

In addition to the five different isotherms published by Roland [18] and Standing and Katz [20], seven proprietary data sets were collected [27]. A material balance calculation

$$V = \frac{Z_n - X_n}{Y_n - X_n} \quad (3.1)$$

was done for methane and the C6+ fraction to check the data sets for consistency. The only data sets failing the material balance were the Standing and Katz data sets. Detailed information on the material balance is shown in Appendix A.

C6+ Characterization

The next step in describing fraction properties is the initial prediction of physical properties. Unfortunately, each of the data sets has a different amount of information available for characterization of the C6+ fraction. The amount of data varies from the full TBP analysis described earlier to simply reporting a whole C6+ fraction molecular weight and SG. The data sets without full experimental TBP analysis must be converted to a calculated full TBP analysis. Admittedly, a calculated full TBP analysis is not as good as having a complete experimental full TBP analysis. Unfortunately, experimental full TBP analysis is done very rarely. Fairly standard procedures are available for con-

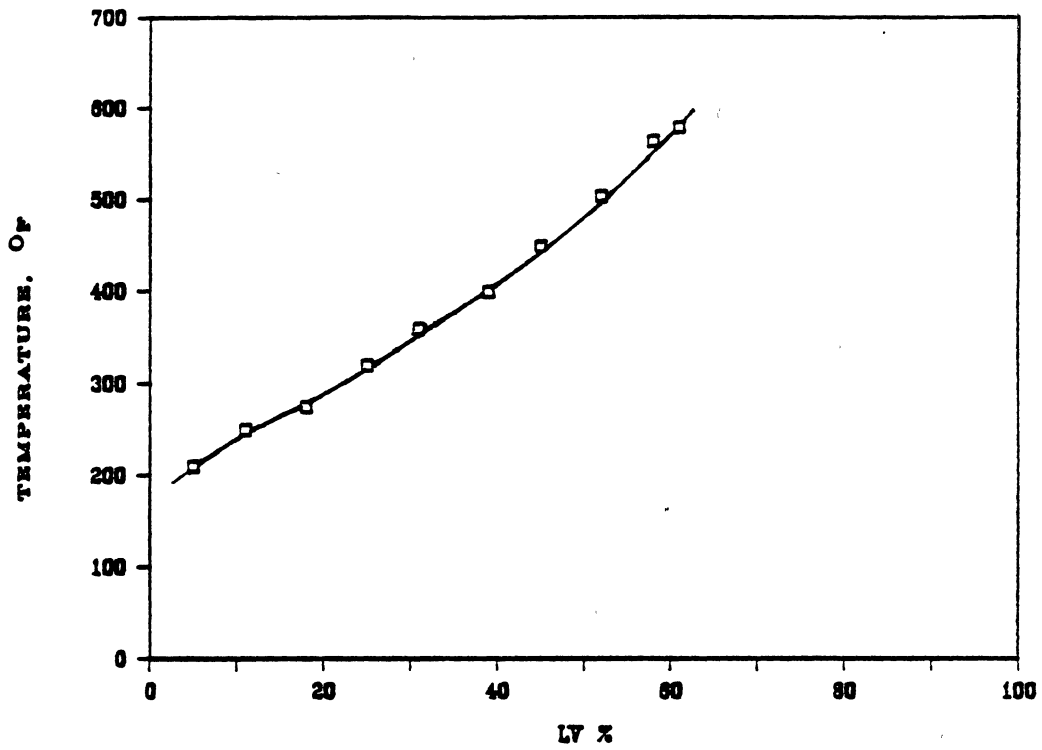


Figure 1. Roland Distillation

verting partial C6+ information to satisfactory full TBP information. Maddox and Erbar [12] describe the procedures required for characterization. An earlier report by Erbar [5] sets the basis for converting incomplete TBP information to a full TBP analysis.

Three of the procedures described by Erbar [5] relate to the selected data sets. The first is conversion of a partial TBP analysis to a complete TBP analysis. A partial TBP analysis includes TBP temperatures at specific LV% off, whole C6+ fraction SG, and whole C6+ fraction molecular weight. The Roland data sets shown earlier include a partial TBP analysis. The second procedure involves converting an ASTM distillation into a complete TBP analysis. The final procedure, where only the whole fraction molecular weight and the SG are given, requires estimation of the normal boiling point.

Most of the initial characterization was performed using C6PLUS, a computer program based on the Maddox and Erbar [12] work, written by Erbar [3]. The program requires normal boiling point information, whole C6+ fraction SG, and whole C6+ fraction molecular weight. The procedures described by Erbar [5] were used to prepare the data sets that lack the required input for C6PLUS.

A smoothing method which is not incorporated in Erbar's methods was used in this study. The smoothing method was used for TBP data that lacked end points. The Roland data provides a good example. In Figure 1, the TBP data are re-

ported only up to about 65 LV%. The data were plotted on log probability paper, where the S-shaped TBP curve usually forms a straight line. The probability plot for the Roland data is shown in Figure 2. The new smoothed TBP curve is shown in Figure 3. An example of C6PLUS output for the Roland data is shown in Table II.

One change was made in C6PLUS to add consistency to the final results. The molecular weight shown in Table II was always calculated in C6PLUS by the Lee-Kesler correlation. Two of the other correlations, Riazi-Daubert and Twu, have their own molecular weight correlations. The molecular weight correlation for the Lee-Kesler correlation is

$$\begin{aligned}
 MW = & -12272.6 + 9486.4 SG + (4.6523 - 3.3287 SG) Tb \\
 & + (1. - 0.77084 SG - 0.02058 SG^2) (1.3437 - \frac{720.79}{Tb}) (\frac{10^7}{Tb}) \\
 & + (1. - 0.80882 SG + 0.02226 SG^2) (1.8828 - \frac{181.98}{Tb}) \\
 & (\frac{10^{12}}{Tb^{13}}) \tag{3.2}
 \end{aligned}$$

and for the Riazi-Daubert correlation is

$$MW = 4.5673 \times 10^{-5} Tb^{2.1962} SG^{-1.0164} \tag{3.3}$$

The units for all of the correlations are given in Chapter II. The molecular weight correlation for the Twu correlations is more complex.

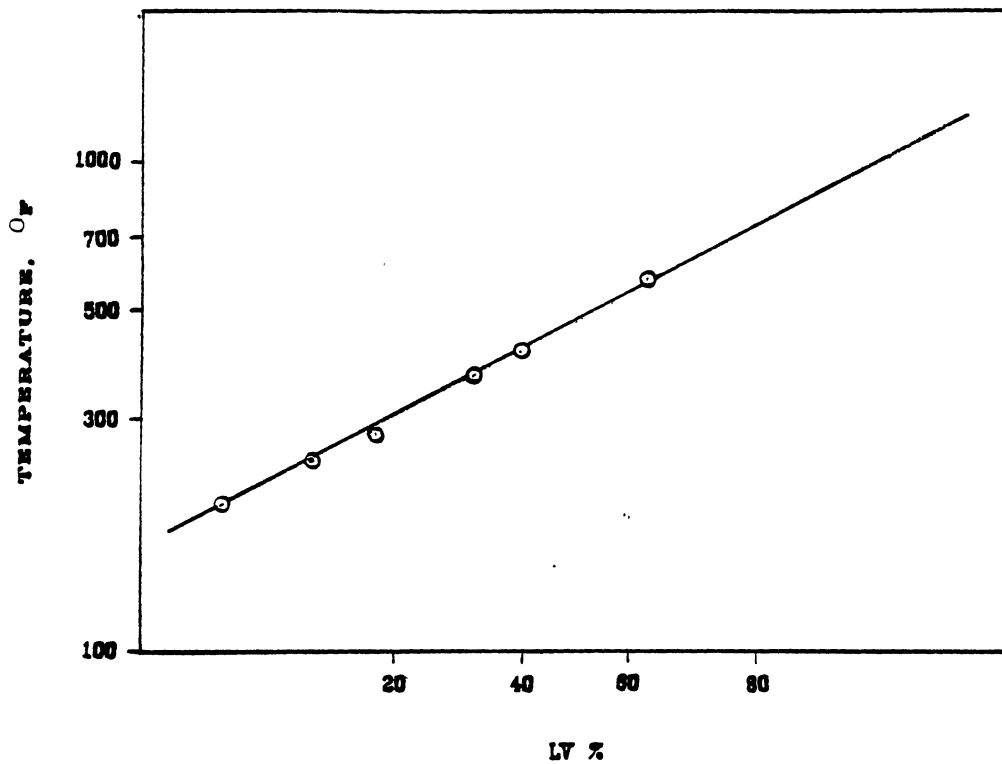


Figure 2. Roland Probability Smoothing

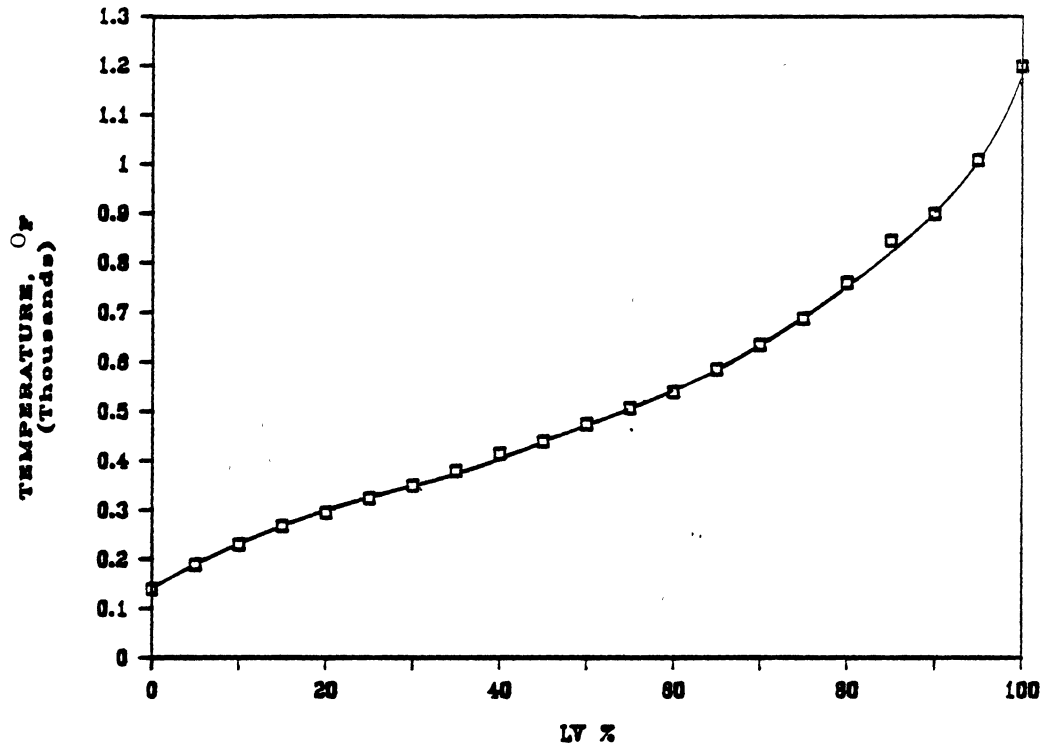


Figure 3. Roland True Boiling Curve

TABLE II
C6PLUS OUTPUT FOR ROLAND

LV% Range	TBP Range °F	Average TBP °F	Spgr	API	Mole Weight	Moles In Feed
0%- 20%	200.- 280.	240.0	.744	58.60	114.66	2.8267
20%- 40%	280.- 410.	348.0	.781	49.72	151.61	2.2425
40%- 60%	410.- 550.	475.0	.820	41.11	203.02	1.7582
60%- 80%	550.- 720.	620.0	.860	33.01	275.23	1.3608
80%-100%	720.-1200.	900.0	.929	20.83	447.91	0.9030

The molecular weight is first calculated for the normal alkanes using the following correlation:

$$\theta = \ln MW \quad (3.4)$$

$$T_b = \text{EXP}(5.71419 + 2.71579\theta - 0.28659\theta^2 - \frac{39.8544}{\theta} - \frac{0.122488}{\theta^2}) - 24.7522\theta + 35.3155\theta^2 \quad (3.5)$$

The normal alkane correlation, Equation 3.5, requires a trial-and-error procedure to determine molecular weight at any given boiling point temperature. The normal alkane molecular weight is solved using the Newton-Raphson [8] method. Twu [23] suggests use of the simple equation,

$$MW^0 = \frac{T_b}{10.44 - 0.0052 T_b} \quad (3.6)$$

as the starting value. The molecular weight is solved within four iterations for all of the points. The Newton-Raphson equations for the Twu normal alkane molecular weight are included in Appendix B. The actual molecular weight is calculated using a perturbation expansion. Equation 2.12 for the normal alkane SG is needed to solve the following equations for molecular weight.

$$\Delta SG_M = \text{EXP}[5(SG^0 - SG)] - 1 \quad (3.7)$$

$$|I| = |0.012342 - \frac{0.328086}{T_b^{1/2}}| \quad (3.8)$$

$$f_M = \Delta SG_M [|I| + (-0.0175691 + \frac{0.193168}{T_b^{1/2}}) \Delta SG_M] \quad (3.9)$$

$$\ln MW = \ln MW^0 \left(\frac{1 + 2f_M}{1 - 2f_M} \right)^2 \quad (3.10)$$

The Riazi-Daubert and the Twu correlations were added to the C6PLUS program. Cavett does not include a molecular weight correlation. The Lee-Kesler correlation for molecular weight was chosen for use with the Cavett correlations.

One difficulty was encountered with the C6PLUS program. The program uses a gravity guessing method when experimental SG curves are available. A new program was developed for data sets that included SG curves. The program is similar to C6PLUS, and does a characterization completely compatible with C6PLUS.

Critical Property Correlations

Next, the actual T_c and P_c are calculated for each data set using each of the four different critical property correlations. The four T_c and P_c correlations were checked for validity at T_b and SG extremes. The study was carried out using 1500°F maximum T_b . The results of the study on the correlations are included in Appendix C.

The T_c and P_c calculations were performed using a modified version of the GPA*SIM written by Erbar [4]. The GPA*SIM program uses the SRK equation of state. C6+ fractions are normally estimated in GPA*SIM using the Lee-Kesler correlations. The GPA*SIM program was modified to include all four correlations; Cavett, Lee-Kesler, Riazi-Daubert, and Twu.

An optimum set of critical property correlations can be found by comparing the equilibrium points calculated by GPA*SIM for each correlation.

Advanced Characterization

The next step involves adjustment of the estimated T_c and P_c data to fit the appropriate dew point or bubble point and the corresponding isotherm in the two phase region. To make manipulation easier, linear functions are preferred over curvilinear functions for describing T_c and P_c in a convenient graphical representation. Maddox and Erbar [12] suggest the use of the following correlating parameters:

$$f(T_c) = \frac{T_c}{T_b} \quad (3.11)$$

$$f(P_c) = \ln(P_c); f(\phi) = \ln(MW) \quad (3.12)$$

The functional relationships implied by Equations 3.11 and 3.12 have a basis in early estimation procedures. Now that nearly straight lines have been obtained, a least-squares fit is necessary to ensure that the best straight line is drawn through the points. If arbitrary straight lines were used here, difficulties could occur in the final data evaluation and bias the conclusions. A program called FITR developed by Friedemann [6] was used for the least-squares fit. The least-squares fit for the Roland data is summarized in Tables III and IV; data are plotted in Figures 4 and 5.

The major part of the procedure remains. The linear-

TABLE III
LEAST-SQUARES FIT OF ROLAND TC

Tb, °R	Tc/Tb	Tc/Tb Calculated	Percent Error
699.67	1.468	1.459335	0.590288
807.67	1.407	1.406649	0.024974
934.67	1.338	1.344694	0.500287
1079.67	1.263	1.273958	0.867623
1359.67	1.146	1.137365	0.753500

TABLE IV
LEAST-SQUARES FIT OF ROLAND PC

ln MW	ln Pc	ln Pc Calculated	Percent Error
4.742	6.083	6.181670	1.622060
5.021	5.870	5.849440	0.350263
5.313	5.589	5.501729	1.561479
5.618	5.227	5.138538	1.692403
6.105	4.461	4.558623	2.188376

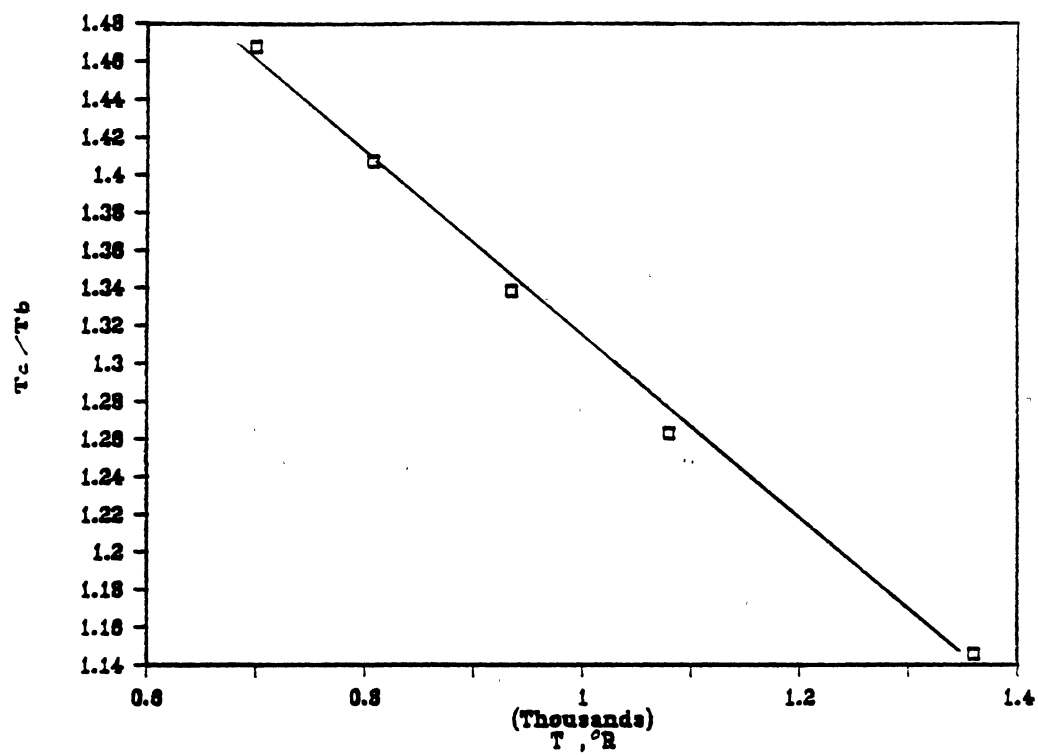


Figure 4. Roland Least-Squares Fit for Lee-Kesler T_c

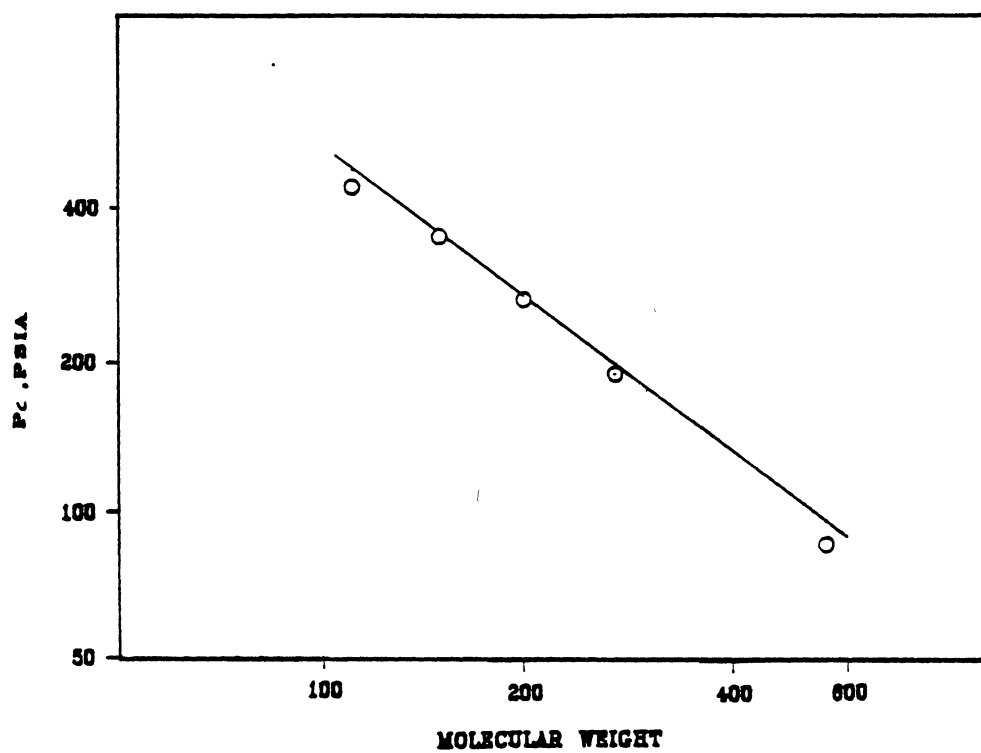


Figure 5. Roland Least-Squares Fit for Lee-Kesler Pc

ized correlations are adjusted until good agreement is reached between actual and experimental saturation pressure as well as the liquid formation curve. A complete example of the adjustment procedure is included in Appendix D. The adjustments are accomplished by first moving the critical temperature line up or down until the saturation pressure agrees with experimental value. The movements are first made as parallel adjustments. If the saturation pressure cannot be reached with parallel adjustments, a pivot of the straight line is required. Pivots are done around the lightest, or lowest T_c , C_6+ fraction component. Next the liquid or vapor formation curve is checked. If the agreement is not satisfactory, the critical pressure line is adjusted until the points agree.

Vapor or liquid formation in some of the data sets was defined in terms of relative volume. Relative volume is the saturation volume at a specific temperature divided by the actual volume at a pressure lower than saturation pressure but at the same specific temperature. The liquid density problems described earlier affect the relative volume, since the volume is calculated from the density. The pivoting procedure for relative volume data sets was slightly altered to take the density problems into account. The low pressure densities predicted by the GPA*SIM program are better than the high pressure densities. The saturated volumes were given in the data sets. When T_c was adjusted, the final saturated volume was taken into account so that

the calculated volume agrees within 5% of the experimental volume. Next, the low pressure (under 1000 psia.) part of the volume curve was used in the Pc adjustment procedure. For volume curves, as well as the formation curves, the saturation point is rechecked. If it does not agree, the procedure continues with adjustments to the linear Tc and Pc correlations until the experimental curves agree with the predicted curves.

The adjustment procedure is bounded by four limits. First, Tc cannot decrease from the lowest boiling fraction to the highest boiling fraction. The limit here is a straight line with the critical temperature constant for each fraction. Second, a similar limit is set for Pc; Pc cannot increase from lowest boiling fraction to the highest boiling fraction. Third, the SRK acentric factor is bounded. The acentric factors must be recalculated every time Tc or Pc is adjusted. Ideally, the acentric factors should not be greater than 3.5. The acentric factors also should be positive. A negative acentric factor corresponds to an impossible combination of SG, Tc, Pc, and TBP. The GPA*SIM program sets acentric factor limits of -1.5 and 4.5. Fourth, the hydrocarbon system K-values must decrease from methane to the heaviest C6+ fraction. A K-value inconsistency is a sign of a poor acentric factors or non-convergence of the equation of state. Sometimes the K-value inconsistencies can be eliminated by increasing or decreasing the number of hypothetical components in a fraction.

For some hydrocarbon systems, the K-values are inconsistent when the advanced characterization is performed. The K-values are consistent at the start of the advanced characterization. After critical property adjustment, when the calculated saturation and liquid formation points agree with experimental saturation and liquid formation points, the K-values are forced to be consistent. However, intermediate K-values may not satisfy this criterion.

The final results from these adjustments not only determine which critical property correlation is optimum for the GPA*SIM computer program, but ultimately could lead to a new critical property correlation.

CHAPTER IV

ANALYSIS OF DATA AND RESULTS

Three steps were required for analyzing the data and calculations. First, the error in the experimental data and the data preparation, C6+ characterization, are determined. Second, the Tc and Pc calculated from the C6+ characterizations are analyzed. The analysis will be used to determine the optimum critical property correlation for the GPA*SIM equilibrium calculation program. Third, the differences between the Tc and Pc calculated from the C6+ characterization and from the advanced characterization are tabulated. If the differences, or amount of change, forms a pattern or a trend, a new correlation for Tc and Pc may be developed.

The error in the experimental data was determined by the material balance, Equation 3.1, described in Appendix A. The average absolute error between actual and material balance mole fractions in the data sets used was 1%. The maximum error in mole fraction by material balance was 2%. Most of the error in the data preparation, C6+ characterization, occurs during the TBP curve smoothing. The maximum absolute error incurred during smoothing is 18% between original and smoothed TBP. The average absolute error is 2.0%.

Therefore, the total absolute average error before property prediction is 3.0%, with a maximum of 20%.

The optimum critical property correlation was found by statistical analysis of the calculated phase behavior. The C6+ systems for each data set were characterized using the C6PLUS program. All four of the critical property correlations were applied to the C6+ characterization for each data set. The only difference between the characterizations for the four equations is the molecular weight calculation discussed in Chapter III. The GPA*SIM program is used to calculate the saturation pressure of each isotherm and for each critical property correlation. An example of the GPA*SIM output for a Roland data set isotherm is shown in Table V. A complete example run for the Roland isotherm is shown in Appendix D. The absolute percent error between experimental and calculated saturation pressure was calculated for each critical property correlation. The errors are summarized in Table VI. The errors in Table VI are clear indications of the GPA*SIM programs ability to predict phase behavior starting from the four critical property correlations. The Riazi-Daubert correlations are better for use in GPA*SIM than the other correlations.

Formation, or volume, curves are also affected by the critical property correlations. The GPA*SIM output for one point on the Roland vapor formation curve is presented as an example in Table VII. Output for the rest of the curve is shown in Appendix D. The average absolute percent errors

TABLE V
 EXAMPLE GPA*SIM OUTPUT OF ROLAND DEW POINT

GPA*SIM
 PAGE 1

A.3 ROLAND DEW POINT

SRK METHOD USED TO PREDICT THERMO PROPS
 DEWPT:VARY P ;FIX T

TEMPERATURE= 200.00 DEG F; PRESSURE= 5098.33 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	VALUE
CH4	81.10	.8110	.00	.8013	81.10	.8110	1.01210
C2H6	3.91	.0391	.00	.0392	3.91	.0391	.99702
C3H8	1.96	.0196	.00	.0198	1.96	.0196	.98755
NC4H10	1.63	.0163	.00	.0167	1.63	.0163	.97826
NC5H12	1.11	.0111	.00	.0114	1.11	.0111	.97000
NC6H14	1.20	.0120	.00	.0125	1.20	.0120	.96245
1	2.83	.0283	.00	.0299	2.83	.0283	.94672
2	2.24	.0224	.00	.0241	2.24	.0224	.92988
3	1.76	.0176	.00	.0194	1.76	.0176	.90916
4	1.36	.0136	.00	.0153	1.36	.0136	.88643
5	.90	.0090	.00	.0104	.90	.0090	.86675
TOTAL	100.00	1.0000	.00	1.0000	100.00	1.0000	
H;KBTU	502.65	5.027	.00	5.091	502.65	5.027	
S;KBTU/R	3.99	.040	.00	.040	3.99	.040	
MOL WT	35.821		37.661		35.821		
D;LB/FT3			21.465		22.451		
LV%=	.00	VOL LIQ=	.000	VOL VAP=	159.549		
VOL=	159.549						

TEMPERATURE= 200.00 DEG F; PRESSURE= 5098.33 PSIA

TABLE VI
 CALCULATED SATURATION PRESSURE ERROR FOR FOUR
 DIFFERENT CRITICAL PROPERTY CORRELATIONS

Data Set	Lee-Kesler	Cavett	Riazi-Daubert	Twu
Roland 120	54.08	42.03	9.88	50.73
Roland 200	44.60	42.55	31.34	42.62
A	31.31	23.76	19.82	29.14
B	25.53	17.75	19.07	28.72
C	21.38	15.31	9.02	21.69
D	0.86	1.49	0.32	0.004
E	1.71	1.31	1.68	1.18
F	15.17	10.79	11.03	17.69
G	2.13	5.08	2.89	3.19
Mean	21.86	17.79	11.67	21.66
Standard deviation	19.17	15.77	10.15	18.15

TABLE VII
 EXAMPLE GPA*SIM OUTPUT FOR ROLAND
 VAPOR FORMATION CURVE

GPA*SIM
 PAGE 1

A.3 ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
 FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 1000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	3.67	.2436	77.43	.9116	3.74155
C2H6	3.91	.0391	.44	.0293	3.47	.0408	1.39278
C3H8	1.96	.0196	.41	.0269	1.55	.0183	.67908
NC4H10	1.63	.0163	.57	.0377	1.06	.0125	.33111
NC5H12	1.11	.0111	.57	.0379	.54	.0063	.16721
NC6H14	1.20	.0120	.81	.0536	.39	.0046	.08603
1	2.83	.0283	2.42	.1608	.41	.0048	.02981
2	2.24	.0224	2.16	.1436	.08	.0009	.00635
3	1.76	.0176	1.75	.1164	.01	.0001	.00071
4	1.36	.0136	1.36	.0903	.00	.0000	.00003
5	.90	.0090	.90	.0597	.00	.0000	.00000
TOTAL	100.00	1.0000	15.06	1.0000	84.94	1.0000	
H:KBTU	566.06	5.661	107.66	7.147	458.40	5.397	
S:KBTU/R	4.40	.044	.99	.065	3.41	.040	
MOL WT	35.821		130.968		18.946		
D:LB/FT3			42.468		2.851		
LV% =	7.60	VOL LIQ =	46.456	VOL VAP =	564.411		
VOL =	610.867						

TEMPERATURE= 200.00 DEG F; PRESSURE= 1000.00 PSIA

between experimental and calculated curves are summarized in Table VIII. The absolute percent error is an average across the entire curve. Individual points have a maximum absolute percent error of 23%. The errors summarized in Table VIII also indicate phase behavior prediction ability of GPA*SIM. The results of the formation curve errors show all of the correlations to be in the same range of error for the data sets used in this study. The two error types, saturation pressure and liquid volume percent errors, were both considered so that the optimum critical property correlation for GPA*SIM can be found using several different equilibrium calculations. The results clearly favor the Riazi-Daubert correlation over Cavett, Lee-Kesler, or Twu.

Adjustment of the critical properties, or advanced characterization, was done starting with the C6+ characterization T_c and P_c for all four critical property correlations. The step-by-step adjustments for the Roland isotherm are included in Appendix D. An example of the results after advanced characterization for the Roland data are pictured in Figure 6. The procedure used on the Roland isotherm was done for all the data sets. The saturation point, after T_c and P_c adjustments, matched the experimental pressures within 1% for all the data sets. The formation or volume curve points were matched within 5% average absolute error for all the data sets. The formation or volume curve points were either LV%, vapor volume percents, or relative volumes. The data sets with relative volume curves, as noted earlier

TABLE VIII
 CALCULATED LV% FORMATION CURVE ERROR
 FOR FOUR DIFFERENT CRITICAL
 PROPERTY CORRELATIONS

Data Set	Lee-Kesler	Cavett	Riazi-Daubert	Twu
Roland 120	10.74	9.44	3.22	9.82
Roland 200	9.43	8.03	5.72	3.53
A	4.75	5.89	9.56	3.63
B	7.32	11.84	8.87	9.01
C	15.83	12.17	13.58	15.97
D	5.00	6.24	6.19	5.68
E	3.66	4.49	3.60	3.63
F	7.67	5.32	15.88	9.09
G	4.33	5.45	4.36	4.34
Mean	7.64	7.65	7.89	7.74
Standard deviation	3.91	2.89	4.48	3.96

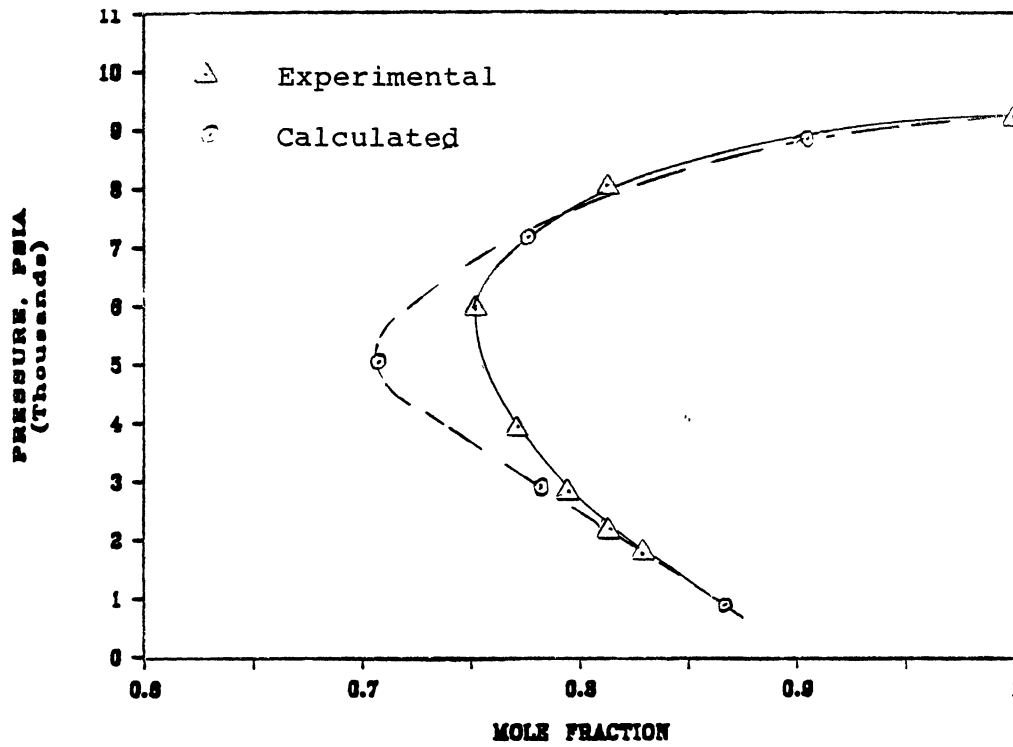


Figure 6. Roland Vapor Formation Curve

in Chapter III, were matched to 5% only at the low pressure. The deviations between initial T_c and P_c and adjusted T_c and P_c are shown in Table IX. Some adjustments were not made by parallel shifts. Pivoting, non-parallel T_c and P_c adjustment, is done by holding the lowest boiling fraction T_c or P_c constant. The pivot, therefore, started at the lowest boiling point and formed an angle with the original least-squares fit. The pivoted T_c or P_c lines are reported in Table IX as average deviations from the original least-squares fit of T_c or P_c .

The critical property adjustments varied with each data set. However, T_c values have a tendency to be low when initially calculated from C6+ characterizations. When the average T_c and P_c adjustment values from Table IX are inserted into the data sets, no improvement over initial saturation point prediction is found. However, the formation curves show a 2% improvement over the original predictions.

TABLE IX
 AVERAGE TC AND PC ADJUSTMENTS
 FOR FOUR CRITICAL PROPERTY
 CORRELATIONS

Data Sets	Lee-Kesler	Cavett	Riazi-Daubert	Twu
Tc/Tb				
Roland 120	.005	.006	.003	.005
Roland 200	.001	.003	.001	.001
A	.001	.002	-.001	.001
B	.001	.003	-.001	.001
C	.066	.061	.071	.057
D	.020	.015	.012	.012
E	.026	.024	.021	.021
F	.054	.050	.064	.052
G	.015	.013	.010	.007
Tc/Tb Mean	.021	.020	.020	.017
Pc				
Roland 120	112.26	100.38	89.42	110.43
Roland 200	17.40	16.32	19.23	16.98
A	51.72	37.50	40.09	49.23
B	65.37	48.91	50.23	60.27
C	0.0	0.0	0.0	0.0
D	0.0	0.0	0.0	0.0
E	0.0	0.0	0.0	0.0
F	0.0	0.0	0.0	0.0
G	0.0	0.0	0.0	0.0
Pc Mean	27.42	22.57	22.11	26.32

CHAPTER V

SUMMARY AND CONCLUSIONS

The first goal, finding an optimum critical property correlation for the GPA*SIM program was achieved. In Chapter, Table VI, evidence is presented that the Riazi-Daubert correlations are much better critical property correlations for the GPA*SIM program than the Lee-Kesler correlation now in use. The Riazi-Daubert equations consistently predict higher T_c values than the other three correlations. The advanced characterization technique yielded the same conclusion; the initial T_c calculation needs to be increased. Similarly, P_c must be higher so that the correlations remain consistent. The Riazi-Daubert correlations do not predict the best saturation and formation points for all the systems studied. In fact, the other three correlations are more consistent for the simpler gas condensate systems. When the data sets were gas condensates with 80 mole percent methane and less than 10 mole percent C_6+ , the Twu correlations are the best. However, the Riazi-Daubert correlations are by far better for crude oils containing heavier hydrocarbons. In fact, the Riazi-Daubert correlations used in GPA*SIM improve crude oil saturation points by as much as 50% over the other three correlations.

The benefits from 50% better prediction in heavier systems are more important than the 2-8% difference between Riazi-Daubert and Twu results for gas condensates. Therefore, the Riazi-Daubert correlations should be used in GPA*SIM instead of the Lee-Kesler correlations.

The only consistent adjustment for T_c and P_c is the relatively minor need for T_c to be higher initially. The 0.02 increase in T_c/T_b suggested in Chapter IV in combination with the Table IX increases for P_c are significant only because they help explain the results of the optimum critical property correlation search. The Riazi-Daubert correlations consistently predict higher T_c and P_c values than the other three correlations. Each data set still requires careful T_c and P_c adjustment done by hand. Since the attempt to find an automatic adjustment procedure for T_c and P_c failed, the adjustment procedure remains more of an art than a science.

Several possible expansions beyond the scope of this study are possible. The use of a linear function for the advanced characterization alters the original T_c and P_c relationship to T_b and SG . A study of T_c and P_c modification using the advanced characterization techniques without forcing a new relationship on T_c and P_c could yield a new correlation. If the new T_c and P_c from the advanced characterization are consistent, a new approach could be developed for advanced characterization. Also, if the GPA*SIM program is re-evaluated, a reason for the needed increase in T_c values may be found.

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APPENDIX A

DATA SET EVALUATIONS

The data sets were checked for consistency by a material balance, Equation 3.1, on methane and the C6+ fraction.

The derivation for Equation 3.1 is shown below.

B	moles of component in liquid
C	moles of component in feed
D	moles of component in vapor
F	total moles of feed
L	total moles of liquid
V	total moles of vapor
X _n	mole fraction of component in liquid
Y _n	mole fraction of component in vapor
Z _n	mole fraction of component in feed
n	components, methane or C6+ fraction

$$C = B + D \quad (A.1)$$

$$F = L + V \quad (A.2)$$

$$X_n = \frac{B}{L} \quad (A.3)$$

$$Y_n = \frac{D}{V} \quad (A.4)$$

$$Z_n = \frac{C}{F} \quad (A.5)$$

$$F = 1 \quad (A.6)$$

$$Z_n = X_n L + Y_n V \quad (\text{A.7})$$

$$Y_n V = Z_n - X_n(1 - V) \quad (\text{A.8})$$

$$V = \frac{Z_n - X_n}{Y_n - X_n} \quad (\text{A.9})$$

The result, A.9, is Equation 3.1. The Roland data [18] includes a material balance for methane and heptanes and heavier. The Standing-Katz data, [20], however, does not include a material balance. The material balance for the Standing-Katz data set 'A' is shown in Table X and Figure 7. The Standing-Katz data deviates from the material balance by an average absolute percent error of 8.22% and ranges from 3% to 15.9%. Roland has an average percent error of 0.009% and has a maximum error of 2%. On the basis of the high percent error in the Standing-Katz material balance, the Standing-Katz data were determined to be unusable. The rest of the data fall under the 2% maximum of the Roland data.

TABLE X
STANDING AND KATZ MATERIAL BALANCE

Pressure, psia	Vapor Fraction From Methane	Vapor Fraction From C6+
1000.	0.873	-
1600.	0.862	0.907
3185.	0.877	0.954
5270.	0.907	0.986
8220.	0.944	1.005

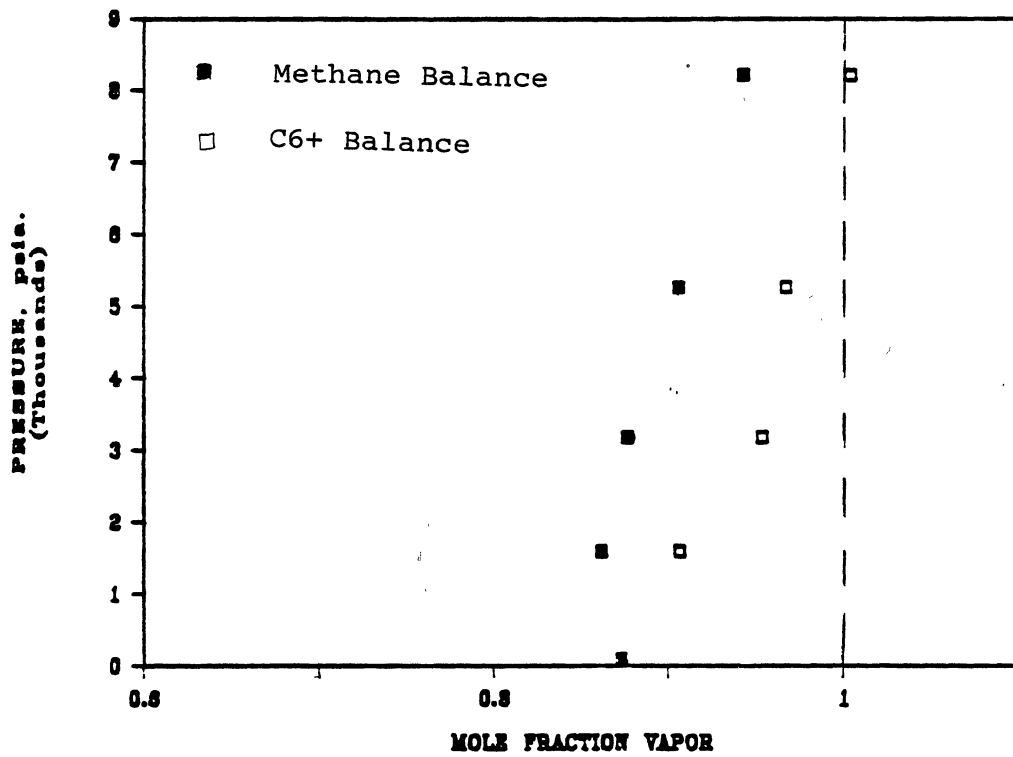


Figure 7. Standing-Katz Mole Balance

APPENDIX B

CALCULATION OF TWU MOLECULAR WEIGHT CORRELATION

The Twu [23] correlations for calculation of the alkane molecular weight appear in the main text as Equations 3.4, 3.5, and 3.6. The Newton-Raphson [8] method used to solve Equation 3.5 is shown below in general terms.

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)} \quad n = 1, 2, 3 \dots \quad (\text{B.1})$$

The computer algorithm required to solve Equation 3.5 using Newton-Raphson must start with an initial guess. Twu [23] supplies a formula for the initial guess, Equation 3.6. The correlation and first derivative of the correlation are solved using the initial guess. A new point is found using Equation B.1. The new point becomes the next guess. The derivative of the Twu correlation, Equation 3.5, is shown below.

$$\begin{aligned} f'(\theta) = & 2.71579 - 2\theta(0.28659) + \frac{39.8544}{\theta^2} \\ & + \frac{2(0.122488)}{\theta^3} \left(\text{EXP} \left(5.71419 + 2.71579\theta \right. \right. \\ & \left. \left. - 0.28659\theta^2 - \frac{39.8544}{\theta} - \frac{0.122488}{\theta^2} \right) \right) \\ & - 24.7522 + 2\theta(35.3155) \end{aligned} \quad (\text{B.2})$$

APPENDIX C

CRITICAL PROPERTY CORRELATION EVALUATION

The four critical property correlations, Cavett [1], Lee-Kesler [11], Riazi-Daubert [17], and Twu [23] were evaluated to insure their validity at extreme T_b and SG. A wide range of SG and T_b combinations were tried in all 4 correlations. The SG ranged from 0.6388 to 1.0. The temperature ranged from 100 °F to 1500 °F. The SG and T_b ranges were chosen by using Watson [25] characterization factors ranging from approximately 10 to 13. A UOP K of 10 describes a cracked residual, where a UOP K of 13 is a Pennsylvania type crude [2]. Graphs of the results for 0.6388 SG are shown in Figure 8 for T_c and Figure 9 for P_c . The graph of the correlations show the error in the Cavett correlations and possible problems for the Twu P_c correlation at extreme SG and T_b . All of the correlations will be used in the study with the knowledge that the Cavett correlations are poor at extreme T_b and SG.

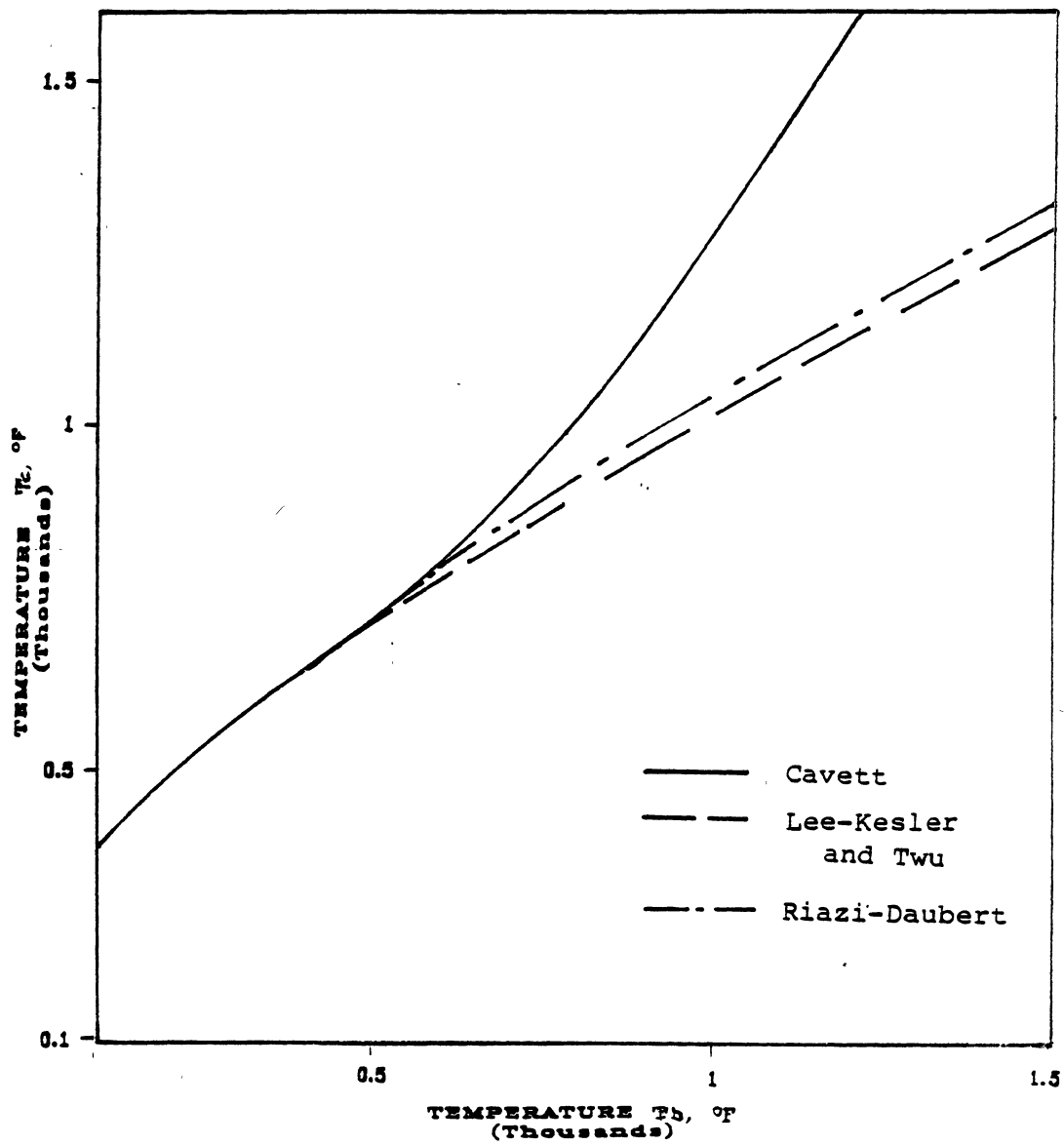


Figure 8. T_c for SG Equal to 0.6388

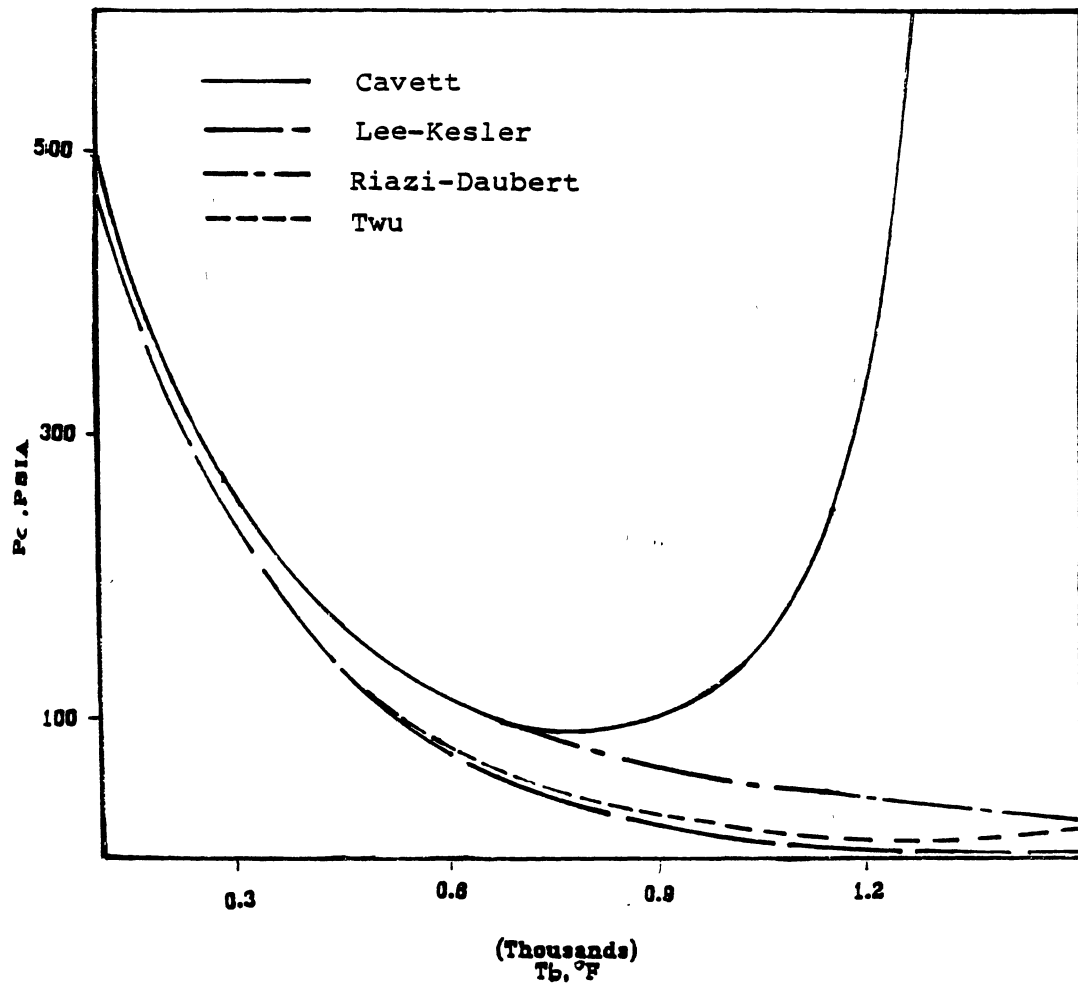


Figure 9. P_c for SG Equal to 0.6388

APPENDIX D

EXAMPLE ADVANCED CHARACTERIZATION

Subject: Advanced Characterization

Method: Wilson, Maddox, and Erbar [26]

Experimental Data: Roland 200 °F Isotherm [18]

Critical Property Correlations: Lee-Kesler [11]

Instructions: Example output from the GPA*SIM program is included at the back of this appendix. The example outputs are labeled the same as the steps in the instruction. Table XI is a history of the Tc and Pc adjustments. Table XI is also labeled the same as the steps in the instructions that follow.

Prerequisites: Section A

1. C6+ characterization, see Chapter III
2. Initial Tc and Pc from characterization
3. Predict dew point and vapor formation curve using A.2.
4. Linearized Tc and Pc, see Chapter III
5. Predict dew point and vapor formation curve using A.4.

TABLE XI
TC AND PC ADJUSTMENT HISTORY

A.2		A.4		B.1	
Tc, °R	Pc, psia	Tc, °R	Pc, psia	Tc, °R	Pc, psia
1027.34	438.16	1021.05	483.16	1004.61	483.80
1136.67	354.16	1136.11	347.04	1117.13	347.04
1250.27	267.38	1256.85	245.12	1234.88	245.12
1363.94	186.21	1375.45	170.47	1350.08	170.47
1558.52	86.53	1546.44	95.45	1514.49	95.45
B.3		B.5		B.7	
Tc, °R	Pc, psia	Tc, °R	Pc, psia	Tc, °R	Pc, psia
1004.61	534.68	1014.13	534.68	1014.13	590.91
1117.13	383.54	1128.11	383.54	1128.11	423.88
1234.88	270.89	1247.59	270.89	1247.59	299.38
1350.08	188.39	1364.77	188.39	1364.77	208.21
1514.49	105.49	1532.98	105.49	1532.98	116.59
B.9		B.11			
Tc, °R	Pc, psia	Tc, °R	Pc, psia		
1021.05	483.80	1021.75	483.80		
1136.11	370.00	1136.92	370.00		
1256.85	265.00	1257.78	265.00		
1375.45	195.00	1376.53	195.00		
1546.44	115.00	1547.70	115.00		

Characterization: Section B

1. Adjust Tc line up or down until dew point matched.
2. Predict formation curve at Tc in B.1.
3. Adjust Pc up or down until formation curve is matched.
4. Predict saturation pressure for adjusted Pc line, in B.3.
5. Adjust Tc until saturation pressure matches experimental.
6. Predict formation curve at Tc in B.5.
7. Adjust Pc until vapor formation curve matches experimental curve.
8. Predict saturation pressure at B.7 and B.6.
9. Adjust Pc with a pivot since saturation pressure is staying bad.
10. Predict saturation point.
11. Adjust Tc until saturation pressure matches experimental.
12. Predict formation curve.

A.3 ROLAND DEW POINT

SRK METHOD USED TO PREDICT THERMO PROPS
DEWPT:VARY P ;FIX T

TEMPERATURE= 200.00 DEG F; PRESSURE= 5098.33 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	.00	.8013	81.10	.8110	1.01210
C2H6	3.91	.0391	.00	.0392	3.91	.0391	.99702
C3H8	1.96	.0196	.00	.0198	1.96	.0196	.98755
NC4H10	1.63	.0163	.00	.0167	1.63	.0163	.97826
NC5H12	1.11	.0111	.00	.0114	1.11	.0111	.97000
NC6H14	1.20	.0120	.00	.0125	1.20	.0120	.96245
1	2.83	.0283	.00	.0299	2.83	.0283	.94672
2	2.24	.0224	.00	.0241	2.24	.0224	.92988
3	1.76	.0176	.00	.0194	1.76	.0176	.90916
4	1.36	.0136	.00	.0153	1.36	.0136	.88643
5	.90	.0090	.00	.0104	.90	.0090	.86675
TOTAL	100.00	1.0000	.00	1.0000	100.00	1.0000	
H;KBTU	502.65	5.027	.00	5.091	502.65	5.027	
S;KBTU/R	3.99	.040	.00	.040	3.99	.040	
MOL WT	35.821		37.661		35.821		
D;LB/FT3			21.465		22.451		
LV% =	.00	VOL LIQ =	.000	VOL VAP =	159.549		
VOL =	159.549						

TEMPERATURE= 200.00 DEG F; PRESSURE= 5098.33 PSIA

A.3 ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 1000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	3.67	.2436	77.43	.9116	3.74155
C2H6	3.91	.0391	.44	.0293	3.47	.0408	1.39278
C3H8	1.96	.0196	.41	.0269	1.55	.0183	.67908
NC4H10	1.63	.0163	.57	.0377	1.06	.0125	.33111
NC5H12	1.11	.0111	.57	.0379	.54	.0063	.16721
NC6H14	1.20	.0120	.81	.0536	.39	.0046	.08603
1	2.83	.0283	2.42	.1608	.41	.0048	.02981
2	2.24	.0224	2.16	.1436	.08	.0009	.00635
3	1.76	.0176	1.75	.1164	.01	.0001	.00071
4	1.36	.0136	1.36	.0903	.00	.0000	.00003
5	.90	.0090	.90	.0597	.00	.0000	.00000
TOTAL	100.00	1.0000	15.06	1.0000	84.94	1.0000	
H;KBTU	566.06	5.661	107.66	7.147	458.40	5.397	
S;KBTU/R	4.40	.044	.99	.065	3.41	.040	
MOL WT	35.821		130.968		18.946		
D;LB/FT3			42.468		2.851		
LV% =	7.60	VOL LIQ =	46.456	VOL VAP =	564.411		
VOL =	610.867						

TEMPERATURE= 200.00 DEG F; PRESSURE= 1000.00 PSIA

A.3 ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 3000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	16.28	.5655	64.82	.9103	1.60950
C2H6	3.91	.0391	1.21	.0421	2.70	.0379	.89990
C3H8	1.96	.0196	.79	.0274	1.17	.0165	.60128
NC4H10	1.63	.0163	.82	.0284	.81	.0114	.40230
NC5H12	1.11	.0111	.66	.0229	.45	.0063	.27650
NC6H14	1.20	.0120	.81	.0282	.39	.0054	.19320
1	2.83	.0283	2.26	.0783	.57	.0081	.10299
2	2.24	.0224	2.02	.0700	.22	.0031	.04486
3	1.76	.0176	1.70	.0590	.06	.0008	.01439
4	1.36	.0136	1.35	.0469	.01	.0001	.00313
5	.90	.0090	.90	.0312	.00	.0000	.00010
TOTAL	100.00	1.0000	28.79	1.0000	71.21	1.0000	
H;KBTU	516.57	5.166	176.45	6.128	340.11	4.776	
S;KBTU/R	4.13	.041	1.48	.051	2.65	.037	
MOL WT	35.822		75.760		19.673		
D;LB/FT3			31.108		9.064		
LV% =	31.21	VOL LIQ =	70.121	VOL VAP =	154.541		
VOL =	224.662						

TEMPERATURE= 200.00 DEG F; PRESSURE= 3000.00 PSIA

A.3 ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 5000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	47.47	.7641	33.63	.8878	1.16187
C2H6	3.91	.0391	2.51	.0404	1.40	.0370	.91690
C3H8	1.96	.0196	1.33	.0214	.63	.0167	.78281
NC4H10	1.63	.0163	1.16	.0186	.47	.0125	.66896
NC5H12	1.11	.0111	.82	.0132	.29	.0076	.57912
NC6H14	1.20	.0120	.92	.0148	.28	.0075	.50557
1	2.83	.0283	2.29	.0368	.54	.0144	.39064
2	2.24	.0224	1.91	.0307	.33	.0088	.28545
3	1.76	.0176	1.58	.0254	.18	.0048	.18851
4	1.36	.0136	1.27	.0205	.09	.0023	.11187
5	.90	.0090	.88	.0141	.02	.0006	.04422
TOTAL	100.00	1.0000	62.12	1.0000	37.88	1.0000	
H;KBTU	504.00	5.040	329.47	5.304	174.54	4.607	
S;KBTU/R	4.00	.040	2.62	.042	1.39	.037	
MOL WT	35.823		43.720		22.874		
D;LB/FT3			22.383		15.710		
LV% =	68.75	VOL LIQ =	121.331	VOL VAP =	55.158		
VOL =	176.489						

TEMPERATURE= 200.00 DEG F; PRESSURE= 5000.00 PSIA

A.5 LINEARIZED ROLAND DEW POINT

SRK METHOD USED TO PREDICT THERMO PROPS
DEWPT:VARY P ;FIX T

TEMPERATURE= 200.00 DEG F; PRESSURE= 6022.44 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	.00	.7998	81.10	.8110	1.01401
C2H6	3.91	.0391	.00	.0392	3.91	.0391	.99637
C3H8	1.96	.0196	.00	.0199	1.96	.0196	.98566
NC4H10	1.63	.0163	.00	.0167	1.63	.0163	.97520
NC5H12	1.11	.0111	.00	.0115	1.11	.0111	.96607
NC6H14	1.20	.0120	.00	.0125	1.20	.0120	.95786
1	2.83	.0283	.00	.0303	2.83	.0283	.93552
2	2.24	.0224	.00	.0243	2.24	.0224	.92261
3	1.76	.0176	.00	.0193	1.76	.0176	.91341
4	1.36	.0136	.00	.0150	1.36	.0136	.90878
5	.90	.0090	.00	.0116	.90	.0090	.77690
TOTAL	100.00	1.0000	.00	1.0000	100.00	1.0000	
H;KBTU	500.43	5.004	.00	5.062	500.43	5.004	
S;KBTU/R	3.95	.040	.00	.040	3.95	.040	
MOL WT	35.821		38.148		35.821		
D;LB/FT3			21.549		23.668		
LV% =	.00	VOL LIQ =	.000	VOL VAP =	151.347		
VOL =	151.347						

TEMPERATURE= 200.00 DEG F; PRESSURE= 6022.44 PSIA

B.1 ADJUSTED ROLAND DEW POINT

SRK METHOD USED TO PREDICT THERMO PROPS
DEWPT:VARY P ;FIX T

TEMPERATURE= 200.00 DEG F; PRESSURE= 9200.23 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	.00	.7786	81.10	.8110	1.04157
C2H6	3.91	.0391	.00	.0394	3.91	.0391	.99357
C3H8	1.96	.0196	.00	.0202	1.96	.0196	.96852
NC4H10	1.63	.0163	.00	.0173	1.63	.0163	.94466
NC5H12	1.11	.0111	.00	.0120	1.11	.0111	.92556
NC6H14	1.20	.0120	.00	.0132	1.20	.0120	.90988
1	2.83	.0283	.00	.0335	2.83	.0283	.84366
2	2.24	.0224	.00	.0271	2.24	.0224	.82531
3	1.76	.0176	.00	.0214	1.76	.0176	.82321
4	1.36	.0136	.00	.0163	1.36	.0136	.83593
5	.90	.0090	.00	.0210	.90	.0090	.42833
TOTAL	100.00	1.0000	.00	1.0000	100.00	1.0000	
H;KBTU	493.76	4.938	.00	4.863	493.76	4.938	
S;KBTU/R	3.83	.038	.00	.040	3.83	.038	
MOL WT	35.821		43.769		35.821		
D;LB/FT3			22.497		26.632		
LV% =	.00	VOL LIQ =	.000	VOL VAP =	134.504		
VOL =	134.504						

TEMPERATURE= 200.00 DEG F; PRESSURE= 9200.23 PSIA

B.2 PREDICT ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 1000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	3.04	.2125	78.06	.9111	4.28797
C2H6	3.91	.0391	.39	.0273	3.52	.0411	1.50500
C3H8	1.96	.0196	.37	.0259	1.59	.0185	.71448
NC4H10	1.63	.0163	.54	.0375	1.09	.0127	.33958
NC5H12	1.11	.0111	.55	.0386	.56	.0065	.16837
NC6H14	1.20	.0120	.79	.0554	.41	.0047	.08554
1	2.83	.0283	2.45	.1709	.38	.0045	.02606
2	2.24	.0224	2.17	.1517	.07	.0008	.00515
3	1.76	.0176	1.75	.1224	.01	.0001	.00065
4	1.36	.0136	1.36	.0949	.00	.0000	.00003
5	.90	.0090	.90	.0628	.00	.0000	.00000
TOTAL	100.00	1.0000	14.33	1.0000	85.67	1.0000	
H;KBTU	520.25	5.202	58.14	4.058	462.11	5.394	
S;KBTU/R	4.35	.044	.91	.063	3.45	.040	
MOL WT	35.821		136.822		18.933		
D;LB/FT3			44.285		2.849		
LV ₃ =	7.21	VOL LIQ=	44.260	VOL VAP=	569.383		
VOL=	613.643						

TEMPERATURE= 200.00 DEG F; PRESSURE= 1000.00 PSIA

B.2 PREDICTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 3000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	11.72	.4963	69.38	.9083	1.83004
C2H6	3.91	.0391	.96	.0406	2.95	.0386	.95036
C3H8	1.96	.0196	.66	.0279	1.30	.0170	.61187
NC4H10	1.63	.0163	.72	.0303	.91	.0120	.39492
NC5H12	1.11	.0111	.60	.0254	.51	.0067	.26394
NC6H14	1.20	.0120	.76	.0321	.44	.0058	.18043
1	2.83	.0283	2.25	.0952	.58	.0076	.07986
2	2.24	.0224	2.02	.0854	.22	.0029	.03414
3	1.76	.0176	1.69	.0716	.07	.0009	.01257
4	1.36	.0136	1.35	.0570	.01	.0002	.00319
5	.90	.0090	.90	.0381	.00	.0000	.00000
TOTAL	100.00	1.0000	23.61	1.0000	76.39	1.0000	
H;KBTU	473.57	4.736	109.13	4.622	364.44	4.771	
S;KBTU/R	4.08	.041	1.23	.052	2.85	.037	
MOL WT	35.821		87.951		19.708		
D;LB/FT3			35.556		9.093		
LV ₃ =	26.08	VOL LIQ=	58.404	VOL VAP=	165.572		
VOL=	223.976						

TEMPERATURE= 200.00 DEG F; PRESSURE= 3000.00 PSIA

B.2 PREDICTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 5000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	19.24	.6506	61.86	.8783	1.35002
C2H6	3.91	.0391	1.20	.0405	2.71	.0385	.94982
C3H8	1.96	.0196	.70	.0235	1.26	.0179	.76253
NC4H10	1.63	.0163	.66	.0224	.97	.0137	.61366
NC5H12	1.11	.0111	.50	.0170	.61	.0086	.50592
NC6H14	1.20	.0120	.60	.0202	.60	.0086	.42415
1	2.83	.0283	1.74	.0590	1.09	.0154	.26168
2	2.24	.0224	1.56	.0526	.68	.0097	.18437
3	1.76	.0176	1.34	.0454	.42	.0059	.13005
4	1.36	.0136	1.13	.0383	.23	.0032	.08475
5	.90	.0090	.90	.0304	.00	.0000	.00027
TOTAL	100.00	1.0000	29.57	1.0000	70.43	1.0000	
H;KBTU	463.63	4.636	138.70	4.690	324.94	4.614	
S;KBTU/R	3.96	.040	1.37	.046	2.59	.037	
MOL WT	35.822		65.087		23.534		
D;LB/FT3			24.520		16.236		
LV% =	43.47	VOL LIQ =	78.493	VOL VAP =	102.088		
VOL =	180.581						

TEMPERATURE= 200.00 DEG F; PRESSURE= 5000.00 PSIA

B.2 PREDICTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 7000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	14.75	.7081	66.35	.8381	1.18345
C2H6	3.91	.0391	.82	.0396	3.09	.0390	.98540
C3H8	1.96	.0196	.45	.0215	1.51	.0191	.88808
NC4H10	1.63	.0163	.40	.0193	1.23	.0155	.80194
NC5H12	1.11	.0111	.29	.0140	.82	.0103	.73581
NC6H14	1.20	.0120	.33	.0160	.87	.0109	.68305
1	2.83	.0283	.96	.0459	1.87	.0237	.51617
2	2.24	.0224	.82	.0392	1.42	.0180	.45956
3	1.76	.0176	.67	.0320	1.09	.0138	.43087
4	1.36	.0136	.53	.0252	.83	.0105	.41806
5	.90	.0090	.82	.0391	.09	.0011	.02746
TOTAL	100.00	1.0000	20.83	1.0000	79.17	1.0000	
H;KBTU	472.29	4.723	92.54	4.443	379.75	4.796	
S;KBTU/R	3.89	.039	.92	.044	2.97	.037	
MOL WT	35.822		59.187		29.676		
D;LB/FT3			24.118		22.702		
LV% =	33.06	VOL LIQ =	51.108	VOL VAP =	103.498		
VOL =	154.605						

TEMPERATURE= 200.00 DEG F; PRESSURE= 7000.00 PSIA

B.2 PREDICTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 9000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	8.94	.7704	72.16	.8163	1.05964
C2H6	3.91	.0391	.46	.0394	3.45	.0391	.99107
C3H8	1.96	.0196	.24	.0204	1.72	.0195	.95566
NC4H10	1.63	.0163	.20	.0175	1.43	.0161	.92228
NC5H12	1.11	.0111	.14	.0122	.97	.0110	.89573
NC6H14	1.20	.0120	.16	.0135	1.04	.0118	.87404
1	2.83	.0283	.41	.0349	2.42	.0274	.78558
2	2.24	.0224	.33	.0284	1.91	.0216	.76062
3	1.76	.0176	.26	.0224	1.50	.0170	.75642
4	1.36	.0136	.20	.0171	1.16	.0131	.77061
5	.90	.0090	.28	.0238	.62	.0071	.29720
TOTAL	100.00	1.0000	11.61	1.0000	88.39	1.0000	
H;KBTU	491.49	4.915	55.93	4.819	435.56	4.927	
S;KBTU/R	3.84	.038	.47	.041	3.37	.038	
MOL WT	35.824		45.721		34.524		
D;LB/FT3			22.757		26.161		
LV% =	16.66	VOL LIQ =	23.320	VOL VAP =	116.648		
VOL =	139.968						

TEMPERATURE= 200.00 DEG F; PRESSURE= 9000.00 PSIA

B.3 ADJUSTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 5000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	14.61	.5866	66.49	.8854	1.50931
C2H6	3.91	.0391	.99	.0399	2.92	.0388	.97470
C3H8	1.96	.0196	.60	.0242	1.36	.0181	.74808
NC4H10	1.63	.0163	.60	.0239	1.03	.0138	.57623
NC5H12	1.11	.0111	.47	.0187	.64	.0086	.45865
NC6H14	1.20	.0120	.56	.0227	.64	.0085	.37365
1	2.83	.0283	1.82	.0729	1.01	.0135	.18528
2	2.24	.0224	1.67	.0669	.57	.0077	.11453
3	1.76	.0176	1.46	.0586	.30	.0040	.06807
4	1.36	.0136	1.23	.0496	.13	.0017	.03378
5	.90	.0090	.90	.0361	.00	.0000	.00001
TOTAL	100.00	1.0000	24.91	1.0000	75.09	1.0000	
H;KBTU	446.94	4.469	104.79	4.207	342.15	4.556	
S;KBTU/R	3.95	.039	1.20	.048	2.75	.037	
MOL WT	35.821		76.588		22.299		
D;LB/FT3			30.950		15.491		
LV% =	36.31	VOL LIQ =	61.635	VOL VAP =	108.098		
VOL =	169.733						

TEMPERATURE= 200.00 DEG F; PRESSURE= 5000.00 PSIA

B.3 ADJUSTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 9000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	8.76	.6740	72.34	.8315	1.23370
C2H6	3.91	.0391	.50	.0386	3.41	.0392	1.01525
C3H8	1.96	.0196	.27	.0210	1.69	.0194	.92154
NC4H10	1.63	.0163	.25	.0190	1.38	.0159	.83901
NC5H12	1.11	.0111	.18	.0137	.93	.0107	.78044
NC6H14	1.20	.0120	.20	.0155	1.00	.0115	.73786
1	2.83	.0283	.66	.0508	2.17	.0249	.49146
2	2.24	.0224	.57	.0435	1.67	.0192	.44237
3	1.76	.0176	.46	.0351	1.30	.0150	.42665
4	1.36	.0136	.35	.0270	1.01	.0116	.43042
5	.90	.0090	.80	.0619	.10	.0011	.01791
TOTAL	100.00	1.0000	12.99	1.0000	87.01	1.0000	
H;KBTU	471.50	4.715	47.84	3.682	423.66	4.869	
S;KBTU/R	3.82	.038	.59	.045	3.23	.037	
MOL WT	35.821		71.006		30.567		
D;LB/FT3			25.244		25.629		
LV% =	26.04	VOL LIQ =	36.545	VOL VAP =	103.773		
VOL =	140.318						
TEMPERATURE =	200.00	DEG F;	PRESSURE =	9000.00	PSIA		

B.4 PREDICTED ROLAND DEW POINT

SRK METHOD USED TO PREDICT THERMO PROPS
DEWPT:VARY P ;FIX T

TEMPERATURE= 200.00 DEG F; PRESSURE=13222.88 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	.00	.7613	81.10	.8110	1.06530
C2H6	3.91	.0391	.00	.0392	3.91	.0391	.99787
C3H8	1.96	.0196	.00	.0202	1.96	.0196	.96812
NC4H10	1.63	.0163	.00	.0173	1.63	.0163	.94036
NC5H12	1.11	.0111	.00	.0121	1.11	.0111	.92066
NC6H14	1.20	.0120	.00	.0132	1.20	.0120	.90688
1	2.83	.0283	.00	.0361	2.83	.0283	.78345
2	2.24	.0224	.00	.0293	2.24	.0224	.76508
3	1.76	.0176	.00	.0228	1.76	.0176	.77169
4	1.36	.0136	.00	.0170	1.36	.0136	.80077
5	.90	.0090	.00	.0315	.90	.0090	.28604
TOTAL	100.00	1.0000	.00	1.0000	100.00	1.0000	
H;KBTU	522.21	5.222	.00	5.012	522.21	5.222	
S;KBTU/R	3.75	.038	.00	.040	3.75	.038	
MOL WT	35.821		49.294		35.821		
D;LB/FT3			23.346		29.765		
LV% =	.00	VOL LIQ =	.000	VOL VAP =	120.345		
VOL =	120.345						
TEMPERATURE =	200.00	DEG F;	PRESSURE =	13222.88	PSIA		

B.5 ADJUSTED ROLAND DEW POINT

SRK METHOD USED TO PREDICT THERMO PROPS
DEWPT:VARY P ;FIX T

TEMPERATURE= 200.00 DEG F; PRESSURE= 9199.26 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	.00	.7874	81.10	.8110	1.02994
C2H6	3.91	.0391	.00	.0393	3.91	.0391	.99524
C3H8	1.96	.0196	.00	.0201	1.96	.0196	.97694
NC4H10	1.63	.0163	.00	.0170	1.63	.0163	.95939
NC5H12	1.11	.0111	.00	.0117	1.11	.0111	.94525
NC6H14	1.20	.0120	.00	.0129	1.20	.0120	.93359
1	2.83	.0283	.00	.0323	2.83	.0283	.87632
2	2.24	.0224	.00	.0262	2.24	.0224	.85637
3	1.76	.0176	.00	.0208	1.76	.0176	.84517
4	1.36	.0136	.00	.0162	1.36	.0136	.84176
5	.90	.0090	.00	.0162	.90	.0090	.55511
TOTAL	100.00	1.0000	.00	1.0000	100.00	1.0000	
H;KBTU	497.51	4.975	.00	5.015	497.51	4.975	
S;KBTU/R	3.84	.038	.00	.040	3.84	.038	
MOL WT	35.821		41.257		35.821		
D;LB/FT3			22.101		27.460		
LV%=	.00	VOL LIQ=	.000	VOL VAP=	130.448		
VOL=	130.448						

TEMPERATURE= 200.00 DEG F; PRESSURE= 9199.26 PSIA

B.6 PREDICTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 1000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	2.80	.2000	78.30	.9106	4.55234
C2H6	3.91	.0391	.37	.0264	3.54	.0412	1.56099
C3H8	1.96	.0196	.36	.0254	1.60	.0187	.73439
NC4H10	1.63	.0163	.52	.0372	1.11	.0129	.34608
NC5H12	1.11	.0111	.54	.0387	.57	.0066	.17073
NC6H14	1.20	.0120	.78	.0559	.42	.0048	.08652
1	2.83	.0283	2.45	.1748	.38	.0044	.02525
2	2.24	.0224	2.18	.1552	.06	.0007	.00478
3	1.76	.0176	1.75	.1251	.01	.0001	.00058
4	1.36	.0136	1.36	.0970	.00	.0000	.00003
5	.90	.0090	.90	.0642	.00	.0000	.00000
TOTAL	100.00	1.0000	14.02	1.0000	85.98	1.0000	
H;KBTU	528.50	5.285	64.59	4.608	463.92	5.395	
S;KBTU/R	4.36	.044	.90	.064	3.46	.040	
MOL WT	35.821		139.331		18.945		
D;LB/FT3			44.267		2.851		
LV%=	7.17	VOL LIQ=	44.123	VOL VAP=	571.398		
VOL=	615.520						

TEMPERATURE= 200.00 DEG F; PRESSURE= 1000.00 PSIA

B.6 PREDICTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 3000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	10.58	.4730	70.52	.9084	1.92038
C2H6	3.91	.0391	.89	.0400	3.02	.0388	.97091
C3H8	1.96	.0196	.62	.0279	1.34	.0172	.61718
NC4H10	1.63	.0163	.69	.0308	.94	.0121	.39345
NC5H12	1.11	.0111	.58	.0261	.53	.0068	.26056
NC6H14	1.20	.0120	.74	.0332	.46	.0059	.17690
1	2.83	.0283	2.27	.1013	.56	.0073	.07179
2	2.24	.0224	2.04	.0910	.20	.0026	.02884
3	1.76	.0176	1.70	.0761	.06	.0007	.00980
4	1.36	.0136	1.35	.0603	.01	.0001	.00231
5	.90	.0090	.90	.0402	.00	.0000	.00000
TOTAL	100.00	1.0000	22.37	1.0000	77.63	1.0000	
H;KBTU	480.96	4.810	110.82	4.955	370.15	4.768	
S;KBTU/R	4.09	.041	1.20	.054	2.90	.037	
MOL WT	35.821		92.049		19.622		
D;LB/FT3			36.819		9.047		
LV% =	24.93	VOL LIQ =	55.916	VOL VAP =	168.378		
VOL =	224.294						

TEMPERATURE= 200.00 DEG F; PRESSURE= 3000.00 PSIA

B.6 PREDICTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 5000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	18.69	.6318	62.41	.8863	1.40286
C2H6	3.91	.0391	1.20	.0407	2.71	.0384	.94570
C3H8	1.96	.0196	.71	.0240	1.25	.0178	.73982
NC4H10	1.63	.0163	.68	.0231	.95	.0134	.58038
NC5H12	1.11	.0111	.53	.0178	.58	.0083	.46792
NC6H14	1.20	.0120	.63	.0212	.57	.0081	.38448
1	2.83	.0283	1.88	.0635	.95	.0135	.21278
2	2.24	.0224	1.69	.0571	.55	.0078	.13727
3	1.76	.0176	1.46	.0494	.30	.0043	.08634
4	1.36	.0136	1.22	.0412	.14	.0020	.04896
5	.90	.0090	.90	.0304	.00	.0000	.00018
TOTAL	100.00	1.0000	29.58	1.0000	70.42	1.0000	
H;KBTU	470.21	4.702	148.03	5.004	322.18	4.575	
S;KBTU/R	3.97	.040	1.40	.047	2.57	.037	
MOL WT	35.821		67.775		22.398		
D;LB/FT3			24.731		15.534		
LV% =	44.40	VOL LIQ =	81.068	VOL VAP =	101.535		
VOL =	182.603						

TEMPERATURE= 200.00 DEG F; PRESSURE= 5000.00 PSIA

B.6 PREDICTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 7000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	20.68	.7132	60.42	.8509	1.19305
C2H6	3.91	.0391	1.15	.0398	2.76	.0388	.97549
C3H8	1.96	.0196	.63	.0216	1.33	.0188	.86871
NC4H10	1.63	.0163	.56	.0194	1.07	.0150	.77521
NC5H12	1.11	.0111	.41	.0141	.70	.0099	.70364
NC6H14	1.20	.0120	.46	.0160	.74	.0104	.64662
1	2.83	.0283	1.33	.0459	1.50	.0211	.45919
2	2.24	.0224	1.15	.0397	1.09	.0153	.38630
3	1.76	.0176	.97	.0334	.79	.0112	.33422
4	1.36	.0136	.79	.0274	.57	.0080	.29161
5	.90	.0090	.86	.0295	.04	.0006	.02120
TOTAL	100.00	1.0000	28.99	1.0000	71.01	1.0000	
H;KBTU	477.98	4.780	142.81	4.925	335.17	4.720	
S;KBTU/R	3.90	.039	1.27	.044	2.63	.037	
MOL WT	35.823		55.931		27.613		
D;LB/FT3			23.781		21.979		
LV% =	43.32	VOL LIQ =	68.192	VOL VAP =	89.205		
VOL =	157.397						

TEMPERATURE= 200.00 DEG F; PRESSURE= 7000.00 PSIA

B.6 PREDICTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 9000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	16.26	.7787	64.84	.8195	1.05235
C2H6	3.91	.0391	.82	.0394	3.09	.0390	.99134
C3H8	1.96	.0196	.42	.0202	1.54	.0194	.95954
NC4H10	1.63	.0163	.36	.0173	1.27	.0160	.92944
NC5H12	1.11	.0111	.25	.0120	.86	.0109	.90536
NC6H14	1.20	.0120	.28	.0132	.92	.0117	.88560
1	2.83	.0283	.71	.0338	2.12	.0268	.79401
2	2.24	.0224	.58	.0276	1.66	.0210	.76165
3	1.76	.0176	.46	.0221	1.30	.0164	.74244
4	1.36	.0136	.36	.0172	1.00	.0126	.73407
5	.90	.0090	.39	.0184	.52	.0065	.35300
TOTAL	100.00	1.0000	20.88	1.0000	79.12	1.0000	
H;KBTU	495.44	4.954	104.59	5.010	390.84	4.940	
S;KBTU/R	3.85	.038	.84	.040	3.01	.038	
MOL WT	35.828		43.139		33.900		
D;LB/FT3			22.373		26.689		
LV% =	28.60	VOL LIQ =	40.252	VOL VAP =	100.501		
VOL =	140.752						

TEMPERATURE= 200.00 DEG F; PRESSURE= 9000.00 PSIA

B.7 ADJUSTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 5000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	13.54	.5630	67.56	.8895	1.57999
C2H6	3.91	.0391	.95	.0396	2.96	.0390	.98493
C3H8	1.96	.0196	.59	.0244	1.37	.0181	.74219
NC4H10	1.63	.0163	.59	.0244	1.04	.0137	.56157
NC5H12	1.11	.0111	.46	.0193	.65	.0085	.44067
NC6H14	1.20	.0120	.57	.0235	.63	.0083	.35490
1	2.83	.0283	1.90	.0789	.93	.0123	.15538
2	2.24	.0224	1.75	.0728	.49	.0064	.08861
3	1.76	.0176	1.53	.0636	.23	.0030	.04743
4	1.36	.0136	1.28	.0530	.08	.0011	.02092
5	.90	.0090	.90	.0374	.00	.0000	.00001
TOTAL	100.00	1.0000	24.05	1.0000	75.95	1.0000	

H;KBTU 454.48 4.545 109.80 4.565 344.69 4.538
S;KBTU/R 3.96 .040 1.19 .049 2.77 .036

MOL WT 35.821 80.502 21.672
D;LB/FT3 32.959 15.077
LV% = 34.98 VOL LIQ = 58.744 VOL VAP = 109.172
VOL = 167.916

TEMPERATURE= 200.00 DEG F; PRESSURE= 5000.00 PSIA

B.7 ADJUSTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 9000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	12.70	.6838	68.39	.8400	1.22841
C2H6	3.91	.0391	.72	.0389	3.19	.0392	1.00706
C3H8	1.96	.0196	.39	.0211	1.57	.0192	.91081
NC4H10	1.63	.0163	.35	.0190	1.28	.0157	.82620
NC5H12	1.11	.0111	.25	.0137	.86	.0105	.76560
NC6H14	1.20	.0120	.29	.0155	.91	.0112	.72098
1	2.83	.0283	.94	.0507	1.89	.0232	.45779
2	2.24	.0224	.82	.0444	1.42	.0174	.39177
3	1.76	.0176	.70	.0374	1.06	.0131	.34908
4	1.36	.0136	.57	.0307	.79	.0097	.31651
5	.90	.0090	.83	.0448	.07	.0008	.01864
TOTAL	100.00	1.0000	18.58	1.0000	81.42	1.0000	

H;KBTU 477.70 4.777 85.80 4.618 391.90 4.813
S;KBTU/R 3.83 .038 .83 .045 3.00 .037

MOL WT 35.824 65.150 29.132
D;LB/FT3 24.547 25.343
LV% = 34.51 VOL LIQ = 49.313 VOL VAP = 93.590
VOL = 142.904

TEMPERATURE= 200.00 DEG F; PRESSURE= 9000.00 PSIA

B.9 PIVOT ADJUSTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 5000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	17.93	.6346	63.17	.8804	1.38738
C2H6	3.91	.0391	1.14	.0405	2.77	.0386	.95276
C3H8	1.96	.0196	.67	.0238	1.29	.0180	.75459
NC4H10	1.63	.0163	.65	.0229	.98	.0137	.59926
NC5H12	1.11	.0111	.50	.0175	.61	.0086	.48860
NC6H14	1.20	.0120	.59	.0209	.61	.0085	.40574
1	2.83	.0283	1.74	.0617	1.09	.0152	.24598
2	2.24	.0224	1.58	.0560	.66	.0092	.16411
3	1.76	.0176	1.37	.0484	.39	.0055	.11271
4	1.36	.0136	1.18	.0419	.18	.0025	.05867
5	.90	.0090	.90	.0318	.00	.0000	.00031

TOTAL 100.00 1.0000 28.25 1.0000 71.75 1.0000

H;KBTU 479.78 4.798 148.57 5.260 331.21 4.616

S;KBTU/R 3.98 .040 1.34 .048 2.64 .037

MOL WT 35.821 68.027 23.143

D;LB/FT3 25.204 16.020

LV% = 42.38 VOL LIQ = 76.239 VOL VAP = 103.656

VOL = 179.895

TEMPERATURE= 200.00 DEG F; PRESSURE= 5000.00 PSIA

B.9 PIVOT ADJUSTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 9000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	10.27	.7602	70.83	.8189	1.07724
C2H6	3.91	.0391	.53	.0394	3.38	.0391	.99096
C3H8	1.96	.0196	.28	.0205	1.68	.0195	.94743
NC4H10	1.63	.0163	.24	.0177	1.39	.0161	.90679
NC5H12	1.11	.0111	.17	.0124	.94	.0109	.87492
NC6H14	1.20	.0120	.19	.0138	1.01	.0117	.84926
1	2.83	.0283	.49	.0362	2.34	.0271	.74746
2	2.24	.0224	.41	.0300	1.83	.0212	.70638
3	1.76	.0176	.32	.0239	1.44	.0166	.69662
4	1.36	.0136	.26	.0193	1.10	.0127	.66029
5	.90	.0090	.36	.0265	.54	.0063	.23610

TOTAL 100.00 1.0000 13.51 1.0000 86.49 1.0000

H;KBTU 504.73 5.047 69.85 5.170 434.88 5.028

S;KBTU/R 3.86 .039 .56 .042 3.30 .038

MOL WT 35.825 48.148 33.900

D;LB/FT3 22.942 26.639

LV% = 20.48 VOL LIQ = 28.352 VOL VAP = 110.065

VOL = 138.417

TEMPERATURE= 200.00 DEG F; PRESSURE= 9000.00 PSIA

B.11 ADJUSTED ROLAND DEW POINT

SRK METHOD USED TO PREDICT THERMO PROPS
DEWPT:VARY P ;FIX T

TEMPERATURE= 200.00 DEG F; PRESSURE= 9180.45 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	.00	.7760	81.10	.8110	1.04517
C2H6	3.91	.0391	.00	.0393	3.91	.0391	.99386
C3H8	1.96	.0196	.00	.0203	1.96	.0196	.96731
NC4H10	1.63	.0163	.00	.0173	1.63	.0163	.94206
NC5H12	1.11	.0111	.00	.0120	1.11	.0111	.92196
NC6H14	1.20	.0120	.00	.0133	1.20	.0120	.90556
1	2.83	.0283	.00	.0337	2.83	.0283	.83861
2	2.24	.0224	.00	.0276	2.24	.0224	.81076
3	1.76	.0176	.00	.0219	1.76	.0176	.80456
4	1.36	.0136	.00	.0174	1.36	.0136	.78020
5	.90	.0090	.00	.0212	.90	.0090	.42519
TOTAL	100.00	1.0000	.00	1.0000	100.00	1.0000	
H;KBTU	507.93	5.079	.00	5.182	507.93	5.079	
S;KBTU/R	3.86	.039	.00	.041	3.86	.039	
MOL WT	35.821		44.334		35.821		
D;LB/FT3			22.480		27.410		
LV% =	.00	VOL LIQ =	.000	VOL VAP =	130.683		
VOL =	130.683						

TEMPERATURE= 200.00 DEG F; PRESSURE= 9180.45 PSIA

B.12 PREDICTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 1000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	2.88	.2042	78.22	.9106	4.45946
C2H6	3.91	.0391	.38	.0267	3.53	.0411	1.54160
C3H8	1.96	.0196	.36	.0256	1.60	.0186	.72759
NC4H10	1.63	.0163	.53	.0374	1.10	.0128	.34391
NC5H12	1.11	.0111	.55	.0387	.56	.0066	.16997
NC6H14	1.20	.0120	.79	.0558	.41	.0048	.08622
1	2.83	.0283	2.44	.1732	.39	.0045	.02614
2	2.24	.0224	2.17	.1539	.07	.0008	.00536
3	1.76	.0176	1.75	.1243	.01	.0001	.00074
4	1.36	.0136	1.36	.0965	.00	.0000	.00004
5	.90	.0090	.90	.0639	.00	.0000	.00000
TOTAL	100.00	1.0000	14.10	1.0000	85.90	1.0000	
H;KBTU	540.68	5.407	76.98	5.461	463.70	5.398	
S;KBTU/R	4.38	.044	.92	.065	3.46	.040	
MOL WT	35.821		138.552		18.964		
D;LB/FT3			43.769		2.854		
LV% =	7.25	VOL LIQ =	44.619	VOL VAP =	570.746		
VOL =	615.365						

TEMPERATURE= 200.00 DEG F; PRESSURE= 1000.00 PSIA

B.12 PREDICTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 3000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	10.89	.4815	70.21	.9073	1.88440
C2H6	3.91	.0391	.91	.0402	3.00	.0388	.96486
C3H8	1.96	.0196	.63	.0278	1.33	.0172	.61752
NC4H10	1.63	.0163	.69	.0306	.94	.0121	.39630
NC5H12	1.11	.0111	.58	.0258	.53	.0068	.26387
NC6H14	1.20	.0120	.74	.0328	.46	.0059	.17995
1	2.83	.0283	2.22	.0984	.61	.0078	.07956
2	2.24	.0224	2.01	.0889	.23	.0030	.03341
3	1.76	.0176	1.69	.0746	.07	.0009	.01260
4	1.36	.0136	1.35	.0596	.01	.0002	.00265
5	.90	.0090	.90	.0398	.00	.0000	.00000
TOTAL	100.00	1.0000	22.61	1.0000	77.39	1.0000	
H;KBTU	492.57	4.926	122.86	5.433	369.71	4.777	
S;KBTU/R	4.11	.041	1.22	.054	2.89	.037	
MOL WT	35.821		90.764		19.766		
D;LB/FT3			36.450		9.127		
LV% = 25.15 VOL LIQ =			56.309 VOL VAP =		167.592		
VOL = 223.901							

TEMPERATURE= 200.00 DEG F; PRESSURE= 3000.00 PSIA

B.12 PREDICTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 5000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	18.22	.6374	62.88	.8805	1.38131
C2H6	3.91	.0391	1.16	.0405	2.75	.0385	.95129
C3H8	1.96	.0196	.68	.0238	1.28	.0179	.75446
NC4H10	1.63	.0163	.65	.0228	.98	.0137	.59995
NC5H12	1.11	.0111	.50	.0175	.61	.0086	.48964
NC6H14	1.20	.0120	.60	.0208	.60	.0085	.40692
1	2.83	.0283	1.75	.0611	1.08	.0152	.24806
2	2.24	.0224	1.58	.0554	.66	.0092	.16603
3	1.76	.0176	1.37	.0479	.39	.0055	.11440
4	1.36	.0136	1.18	.0414	.18	.0025	.06014
5	.90	.0090	.90	.0315	.00	.0000	.00036
TOTAL	100.00	1.0000	28.59	1.0000	71.41	1.0000	
H;KBTU	481.07	4.811	151.32	5.293	329.75	4.618	
S;KBTU/R	3.98	.040	1.36	.048	2.62	.037	
MOL WT	35.821		67.472		23.152		
D;LB/FT3			24.644		16.024		
LV% = 43.13 VOL LIQ =			78.267 VOL VAP =		103.180		
VOL = 181.447							

TEMPERATURE= 200.00 DEG F; PRESSURE= 5000.00 PSIA

B.12 PREDICTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 7000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	16.10	.7059	65.00	.8421	1.19298
C2H6	3.91	.0391	.90	.0396	3.01	.0390	.98355
C3H8	1.96	.0196	.49	.0216	1.47	.0190	.88135
NC4H10	1.63	.0163	.44	.0194	1.19	.0154	.79141
NC5H12	1.11	.0111	.32	.0141	.79	.0102	.72266
NC6H14	1.20	.0120	.37	.0161	.83	.0108	.66803
1	2.83	.0283	1.05	.0458	1.78	.0231	.50457
2	2.24	.0224	.91	.0400	1.33	.0172	.43086
3	1.76	.0176	.75	.0331	1.01	.0130	.39431
4	1.36	.0136	.65	.0284	.71	.0092	.32421
5	.90	.0090	.82	.0360	.08	.0010	.02814
TOTAL	100.00	1.0000	22.81	1.0000	77.19	1.0000	
H;KBTU	488.44	4.884	116.81	5.121	371.63	4.814	
S;KBTU/R	3.91	.039	1.02	.045	2.89	.037	
MOL WT	35.822		58.992		28.976		
D;LB/FT3			23.937		22.628		
LV% =	36.25	VOL LIQ =	56.214	VOL VAP =	98.845		
VOL =	155.058						

TEMPERATURE= 200.00 DEG F; PRESSURE= 7000.00 PSIA

B.12 PREDICTED ROLAND FORMATION CURVE

SRK METHOD USED TO PREDICT THERMO PROPS
FLASH:VARY L/F ;FIX T1;P1

TEMPERATURE= 200.00 DEG F; PRESSURE= 9000.00 PSIA

COMPONENT NAME	FEED		LIQUID		VAPOR		K VALUE
	MOLS	MOL FR	MOLS	MOL FR	MOLS	MOL FR	
CH4	81.10	.8110	7.87	.7682	73.23	.8159	1.06201
C2H6	3.91	.0391	.40	.0394	3.51	.0391	.99188
C3H8	1.96	.0196	.21	.0204	1.75	.0195	.95593
NC4H10	1.63	.0163	.18	.0175	1.45	.0162	.92208
NC5H12	1.11	.0111	.13	.0123	.98	.0110	.89528
NC6H14	1.20	.0120	.14	.0135	1.06	.0118	.87351
1	2.83	.0283	.36	.0350	2.47	.0275	.78734
2	2.24	.0224	.30	.0288	1.94	.0217	.75150
3	1.76	.0176	.23	.0229	1.53	.0170	.74258
4	1.36	.0136	.19	.0184	1.17	.0131	.71083
5	.90	.0090	.24	.0236	.66	.0073	.31091
TOTAL	100.00	1.0000	10.25	1.0000	89.75	1.0000	
H;KBTU	506.05	5.060	53.09	5.181	452.96	5.047	
S;KBTU/R	3.86	.039	.42	.041	3.44	.038	
MOL WT	35.824		46.142		34.646		
D;LB/FT3			22.706		26.891		
LV% =	15.26	VOL LIQ =	20.822	VOL VAP =	115.640		
VOL =	136.462						

TEMPERATURE= 200.00 DEG F; PRESSURE= 9000.00 PSIA

VITA \

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Master of Science

Thesis: EFFECTS OF C6+ CHARACTERIZATIONS ON PHASE
BEHAVIOR

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