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APPENDIX A

COMPUTER PROGRAM AND SAMPLE CALCULATION

Program **OMEGA** is the program used to evaluate parameters Ω_a and Ω_b of the modified hard sphere equation of state by Chang & Lu 's procedure, which inputs vapor pressure and saturated liquid densities. A Schematic diagram is shown in Figure 3.1. The program is self-explanatory ; Example 1. shows displays of example calculations.

Program **SQUARE** is the program used to determine correlation coefficients (a_o ,a_1 ,a_2 ,b_o ,b_1 and b_2) of the temperature-dependent parameters (Ω_a and Ω_b) by a method of least-squares. This program tests to find out whether the data may conform to the relationship $Y = b_o + b_1 X + b_2 X^2$, where Y is the Ω_a or Ω_b and X is the reduced temperature. The program also tests the data against the equations $Y = b_o + b_1 X^2$ and $Y = b_o + b_1 X$. Correlation coefficients are worked out for each of the three equations tested for proper fit. Finally, a t test compares the best two coefficients for statistical significance. Example 2 shows displays of example calculations.

Program **DENSITY** is the program for predict volume, density and compressibility factors for single phase systems (vapor or liquid phase) of pure substance by four equations of state, the Soave-Redlich-Kwong, the Peng-Robinson, the Ishikawa et al. hard-sphere, and this modified hard-sphere. For the SRK and PR equations, the data required are : critical temperature and pressure, and acentric factor. The ICL

hard-sphere equation requires the eight empirical constants, plus critical temperatures and pressures. The modified hard-sphere equation requires the six empirical constants, plus critical temperatures and pressures. The program is self-explanatory ; Example 3 shows displays of example calculations.

Program **VAPPRESS** is the program that calculates vapor pressure of pure substances by four equations of state ; SRK, PR, ICL and this modified hard-sphere, which inputs temperature and saturated vapor volume. The program is self-explanatory ; Example 4 shows displays of example calculations.

Program **BUBLP** is a program that does bubble point pressure calculations for binary systems, with a schematic diagram shown in Figure 3.2.Example 5 shows displays of example calculations.

Program OMEGA

```
10  REM  ****************************************************
20 REM  *     THIS PROGRAM FOR DETERMINES PARAMETERS OF       *
30 REM  *      MODIFIED HARD SPHERE EQUATION OF STATE         *
40 REM  *              FOR INDIVIDUAL FLUIDS.                 *
50 REM  ****************************************************
60 DEF FN P(X) = INT (100000!*(X+.000005))/100000!
70 DIM OMA(300),OMB(300),A(300),B(300),ERO(300)
80 PRINT "*****************************************************"
90 PRINT "*       THIS PROGRAM FOR DETERMINES PARAMETERS        *"
100 PRINT "*       OF MODIFIED HARD SPHERE EQUATION OF STATE     *"
110 PRINT "*       FOR INDIVIDUAL FLUIDS.                        *"
120 PRINT "*                                                     *"
130 PRINT "*       THE PARAMETERS ARE EVALUATED FROM SATURATED   *"
140 PRINT "*       LIQUID VOLUMES WITH INPUT TEMPERATURE AND     *"
150 PRINT "*       PRESSURE.                                     *"
160 PRINT "*                                                     *"
170 PRINT "*       DATA REQUIRED ARE THE CRITICAL TEMPERATURE    *"
180 PRINT "*       THE CRITICAL PRESSURE AND MOLECULAR WIEGHT.   *"
190 PRINT "*****************************************************"
200 PRINT:PRINT
210 INPUT " PRESS RETURN TO ENTER DATA :"; D$
220 CLS
230 PRINT " ENTER THE FOLLOWING DATA : "
240 INPUT " compound name :  ";N$
250 INPUT " critrical temperature (deg. K ) :  ";TC
260 INPUT " critical pressure (atm)   :  ";PC
270 INPUT " molecular weight (MW)  :  ";MW
280 PRINT:PRINT
290 INPUT "PRESS ANY KEY TO SELECT UNIT OF SYSTEM :";G$
300 CLS
310 REM SELECT UNIT OF INPUT DATA OF THIS SYSTEM
320 PRINT " SELECT UNIT OF TEMPERATURE OF THIS SYSTEM : "
330 PRINT " UNIT OF TEMPERATURE:     1. deg.K "
340 PRINT "                          2. deg.C "
350 PRINT "                          3. deg.F "
360 PRINT
370 INPUT " SELECT UNIT OF TEMPERATURE (1,2 or 3) ";OPT
380 CLS
390 PRINT " SELECT UNIT OF PRESSURE OF THIS SYSTEM :"
400 PRINT " UNIT OF PRESSURE:    1. ATM "
410 PRINT "                      2. PSIA"
420 PRINT "                      3. MPA "
430 PRINT "                      4. BAR "
440 PRINT
450 INPUT " SELECT UNIT OF PRESSURE (1,2,3 or 4) ";OPP
```

```
460 CLS
470 PRINT " SELECT UNIT OF VOLUME OF THIS SYSTEM :"
480 PRINT " UNIT OF VOLUME  :    1. LIT/G-MOLE "
490 PRINT "                      2. LIT/GM. "
500 PRINT "                      3. CC./G-MOLE "
510 PRINT "                      4. CC./GM.  "
520 PRINT "                      5. CU.FT./Lb."
530 PRINT "                      6. CU.FT./Lb.MOLE"
540 PRINT
550 INPUT " SELECT UNIT OF VOLUME (1,2,3,4,5,6 or 7)";OPV
560 PRINT:PRINT
570 INPUT "PRESS ANY KEY TO CONTINUE: ";F$
580 CLS
590 PRINT " FOR THIS SYSTEM :"
600 PRINT " INPUT DATA FOR CALCULATE PARAMETERS :"
610 PRINT:PRINT
620 INPUT "AT TEMPERATURE : " ;T1
630 INPUT "VAPOR PRESSURE : " ;P1
640 INPUT "SATURATED LIQUID VOLUME :";V0
650 ON OPT GOTO 660,670,680
660 T = T1  :GOTO 690
670 T = T1+273.16 :GOTO 690
680 T = ((T1-32)/1.8)+273.16
690 ON OPP GOTO 700,710,720,730
700 P = P1 :GOTO 740
710 P = P1/14.7 :GOTO 740
720 P = P1*9.869233 :GOTO 740
730 P = P1*.9869232
740 ON OPV GOTO 750,760,770,780,790,800
750 V1 = V0  :GOTO 810
760 V1 = V0*MW :GOTO 810
770 V1 = V0/1000 :GOTO 810
780 V1 = V0*MW/1000 :GOTO 810
790 V1 = (V0*.0624)*MW :GOTO 810
800 V1 = V0*.0624
810 TR = T/TC
820 PR = P/PC
830 R = .08205
840 REM [STEP 1] FOR GIVEN VALUE OF ZL AND ASSUMED VALUE
850 REM          OF VAPOR FUGACITY COEFFICIENT,CALCULATE HL
860 ZL = P*V1 /(R*T)
870 INPUT "ASSUMED FUCACITY COEFFICIENT OF VAPOR (OV) :";FUV
880 JO = 0
890 HL = 1.5
900 I = I + 1
910 PRINT " I = ";I
920 F1 = 0
930 RO = 0
940 GOSUB 1570
950 F0 = FZ
```

```
960 IF JO = 1 THEN GOTO 980
970 HL = 1.1 :GOTO 990
980 HL = HL2
990 F1 = 1
1000 GOSUB 1570
1010 GOTO 1000
1020 IF RO = 1 THEN GOTO 1290
1030 HL1 = HL
1040 PRINT "HL1 = ";FN P(HL1)
1050 REM [STEP 2] CALCULATED PARAMETERS A AND B
1060 B = HL*ZL/P
1070 A = B*((2+HL)-ZL*(2-HL))*(1+HL)/(HL*(2-HL))
1080 OMA = A*T^2*PC/TC^2
1090 OMB = B*T*PC/TC
1100 REM [STEP 3] CALCULATE ZV AND HV BY NEWTON'S RULE
1110 H = .05
1120 GOSUB 1650
1130 HV = H
1140 ZV = (2+HV)/(2-HV)-(A/B)*(HV/(1+HV))
1150 REM [STEP 4] CALCULATE VAPOR FUGACITY COEFFICIENT
1160 GOSUB 1730
1170 FUV = FU
1180 REM [STEP 5] CALCULATE HL AND COMPARE IT WITH STEP 1
1190 F1 =0
1200 RO = 1
1210 JO =1
1220 HL = 1.8
1230 GOSUB 1570
1240 FO = FZ
1250 HL = HL1
1260 F1 = 1
1270 GOSUB 1570
1280 GOTO 1270
1290 HL2 = HL
1300 PRINT "HL2 = ";FN P(HL2)
1310 ERO = HL1-HL2
1320 IF ABS (ERO)<= .00005 THEN GOTO 1350
1330 FUV = FU
1340 GOTO 890
1350 INPUT "PRESS ANY KEY TO CONTINUE";K$
1360 CLS
1370 PRINT "FOR THE FOLLOWING DATA :"
1380 PRINT "COMPOUND NAME ";N$
1390 PRINT "AT TEMP.";T;"deg.K  & PRESSURE ";P;"atm"
1400 PRINT "SAT.LIQUID VOLUME :";V1;"LIT/G-MOLE"
1410 PRINT:PRINT
1420 PRINT "THE RESULTS IS:"
1430 PRINT
1440 PRINT "REDUCED TEMPERATURE :";FN P(TR)
1450 PRINT "PARAMETER [A]  :";FN P(A)
```

```
1460 PRINT "PARAMETER [B]  :";FN P(B)
1470 PRINT "TEMPERATURE-DEPENDENT PARAMETER [omega a] : ";FN P(OMA)
1480 PRINT "TEMPERATURE-DEPENDENT PARAMETER [omega b] : ";FN P(OMB)
1490 PRINT
1500 INPUT "DO YOU WANT TO CALCULATE ANOTHER CONDITION(Y/N)";YY$
1510 IF YY$ ="Y"  THEN GOTO 580
1520 PRINT
1530 INPUT "DO YOU WANT TO CALCULATE ANOTHER UNIT OF SYSTEM (Y/N)";QY$
1540 IF QY$ ="Y"  THEN GOTO 300
1550 PRINT TAB(13);" END OF PROGRAM"
1560 END
1570 REM SOUROUTINE FOR CALCULATED (HL = B*P/Z)
1580 FZ = LOG (ZL*FUV)+1-ZL+2*LOG(2-HL)
1590 FZ = FZ + ((2+HL)-ZL*(2-HL))*(1+HL)/(HL*(2-HL))*LOG(1+HL)
1600 IF ABS (FZ) >=.00001  THEN GOTO 1620
1610 GOTO 1020
1620 IF F1 = 0 THEN GOTO 1640
1630 HL = HL-(2-HL)/(F0-FZ)*FZ
1640 RETURN
1650 REM SUBROUTINE FOR CALCULATED HV BY NEWTON'S RULE
1660 FA = (A+B)*H^3-(2*A-3*B-B^2*P)*H^2-(B^2*P-2*B)*H-2*B^2*P
1670 FB = 3*H^2*(A+B)-2*H*(2*A-3*B-B^2*P)-(B^2*P-2*B)
1680 H1 = FA/FB
1690 IF ABS(H1/H) <= .0001 THEN GOTO 1720
1700 H = H-H1
1710 GOTO 1660
1720 RETURN
1730 REM SUBROUTINE FOR  CALCULATED FUGACITY COEFFICIENT OF VAPOR
1740 FG = ZV-1-LOG(ZV)-2*LOG(2-HV)-A/B*LOG(1+HV)
1750 FU = EXP(FG)
1760 RETURN
```

EXAMPLE 1

(Start of first display)

```
*******************************************************
*       THIS PROGRAM FOR DETERMINES PARAMETERS        *
*       OF MODIFIED HARD SPHERE EQUATION OF STATE     *
*       FOR INDIVIDUAL FLUIDS.                        *
*                                                     *
*       THE PARAMETERS ARE EVALUATED FROM SATURATED   *
*       LIQUID VOLUMES WITH INPUT TEMPERATURE AND     *
*       PRESSURE.                                     *
*                                                     *
*       DATA REQUIRED ARE THE CRITICAL TEMPERATURE    *
*       THE CRITICAL PRESSURE AND MOLECULAR WIEGHT.   *
*******************************************************

 PRESS RETURN TO ENTER DATA :p
```

(Start of next display)

```
 ENTER THE FOLLOWING DATA :
 compound name :  METHANE
 critrical temperature (deg. K ) :   190.77
 critical pressure (atm)   :   45.65
 molecular weight (MW)  :   16.043


PRESS ANY KEY TO SELECT UNIT OF SYSTEM :P
 SELECT UNIT OF TEMPERATURE OF THIS SYSTEM :
 UNIT OF TEMPERATURE:     1. deg.K
                          2. deg.C
                          3. deg.F

 SELECT UNIT OF TEMPERATURE (1,2 or 3)  1
 SELECT UNIT OF PRESSURE OF THIS SYSTEM :
 UNIT OF PRESSURE:    1. ATM
                      2. PSIA
                      3. MPA
                      4. BAR

 SELECT UNIT OF PRESSURE (1,2,3 or 4)  1
 SELECT UNIT OF VOLUME OF THIS SYSTEM :
 UNIT OF VOLUME  :    1. LIT/G-MOLE
                      2. LIT/GM.
                      3. CC./G-MOLE
                      4. CC./GM.
                      5. CU.FT./Lb.
                      6. CU.FT./Lb.MOLE

 SELECT UNIT OF VOLUME (1,2,3,4,5,6 or 7) 1


PRESS ANY KEY TO CONTINUE: P
```

(Start of next display)

```
 FOR THIS SYSTEM :
 INPUT DATA FOR CALCULATE PARAMETERS :


AT TEMPERATURE :  125
VAPOR PRESSURE :  2.6636
SATURATED LIQUID VOLUME : .04
ASSUMED FUCACITY COEFFICIENT OF VAPOR (0V) : .9
 I =  1
HL1 =  .88069
HL2 =  1.15623
 I =  2
HL1 =  1.15623
HL2 =  1.16096
 I =  3
HL1 =  1.16096
HL2 =  1.16107
 I =  4
HL1 =  1.16107
HL2 =  1.16108
PRESS ANY KEY TO CONTINUEL
```

(Start of next display)

```
FOR THE FOLLOWING DATA :
COMPOUND NAME METHANE
AT TEMP. 125 deg.K  & PRESSURE  2.6636 atm
SAT.LIQUID VOLUME : .04 LIT/G-MOLE


THE RESULTS IS:

REDUCED TEMPERATURE : .65524
PARAMETER [A]  : .03167
PARAMETER [B]  : .00453
TEMPERATURE-DEPENDENT PARAMETER [omega a] :  .62072
TEMPERATURE-DEPENDENT PARAMETER [omega b] :  .13545

DO YOU WANT TO CALCULATE ANOTHER CONDITION(Y/N)Y
```

(Start of next display)

```
 FOR THIS SYSTEM :
 INPUT DATA FOR CALCULATE PARAMETERS :


AT TEMPERATURE :  130
VAPOR PRESSURE :  3.6458
SATURATED LIQUID VOLUME : .0408
ASSUMED FUCACITY COEFFICIENT OF VAPOR (0V) : .9
 I =  5
HL1 =  .78529
HL2 =  1.11208
 I =  6
HL1 =  1.11208
HL2 =  1.11937
```

```
 I =  7
HL1 =  1.11937
HL2 =  1.11962
 I =  8
HL1 =  1.11962
HL2 =  1.11962
PRESS ANY KEY TO CONTINUE
```

(Start of next display)

```
FOR THE FOLLOWING DATA :
COMPOUND NAME METHANE
AT TEMP. 130 deg.K  & PRESSURE  3.6458 atm
SAT.LIQUID VOLUME : .0408 LIT/G-MOLE


THE RESULTS IS:

REDUCED TEMPERATURE : .68145
PARAMETER [A]  : .02862
PARAMETER [B]  : .00428
TEMPERATURE-DEPENDENT PARAMETER [omega a] :  .60662
TEMPERATURE-DEPENDENT PARAMETER [omega b] :  .13322

DO YOU WANT TO CALCULATE ANOTHER CONDITION(Y/N)N

DO YOU WANT TO CALCULATE ANOTHER UNIT OF SYSTEM (Y/N)N
            END OF PROGRAM
```

Program SQUARE

```
10 REM  ****************************************
20 REM SECOND-DEGREE POLYNOMIAL COMPUTER PROGRAM
30 REM FROM CHEMICAL ENGINEERING.
40 REM ****************************************
50 REM SET DISPLAY TO FOUR DECIMALS AND DATA TO 1000 ITEMS
60 DEF FN P(X) = INT (10000!*(X+.00005))/10000!
70 DIM X(1000),Y(1000)
80 PRINT "*********************************************************"
90 PRINT "*   PROGRAM CORRELATES A DEPENDENT VARIABLE (OMEGA)     *"
100 PRINT "*   AGAINST AN INDEPENDENT VARIABLE (REDUCED TEMP.)     *"
110 PRINT "*   WITH A SECOND DEGREE POLYNOMIAL :                   *"
120 PRINT "*                                                       *"
130 PRINT "*      Y = B0 + B1*X + B2*X^2                           *"
140 PRINT "*                                                       *"
150 PRINT "*   IT ALSO CALCULATES THE CORRELATIONS FOR :           *"
160 PRINT "*                                                       *"
170 PRINT "*      Y = B0 + B1*X                                    *"
180 PRINT "*      Y = B0 + B1*X^2                                  *"
190 PRINT "*                                                       *"
200 PRINT "*   AND IT GIVES A COMPARISON OF THE                    *"
210 PRINT "*   THREE RESULTS.                                      *"
220 PRINT "*                                                       *"
230 PRINT "*   WHERE    X = REDUCED TEMPERATURE                    *"
240 PRINT "*            Y = OMEGA                                  *"
250 PRINT "*                                                       *"
260 PRINT "*   DATA ARE ENTER AS :  X,Y                            *"
270 PRINT "*                                                       *"
280 PRINT "*   THE DATA INPUT IS                                   *"
290 PRINT "*   TERMINATED WITH:   END,0                            *"
300 PRINT "*********************************************************"
310 INPUT "PRESS RETURN TO ENTER DATA.  ";Q$
320 CLS
330 PRINT "ENTER DATA AS : X,Y SEPERATED BY "
340 PRINT "A COMMA. WHEN ALL THE DATA ARE IN  "
350 PRINT "ENTER :  END,0 "
360 PRINT
370 PRINT "THE DATA WILL BE SAVED IN COMPUTER"
380 PRINT "MEMORY AS X(I),Y(I), FOR GOING "
390 PRINT "FROM 1 TO N ."
400 PRINT
410 INPUT "ENTER FRIST SET :      ";X$,Y
420 X2 = VAL (X$)^2
430 N = N+1
440 X1 = VAL (X$)
450 X(N) = X1
```

```
460 Y(N) = Y
470 REM SUMS,SUMS OF SQUARES AND SUMS OF CROSS PRODUCTS
480 S1 = S1+Y
490 S2 = S2+Y^2
500 S3 = S3+X1
510 S4 = S4+X1^2
520 S5 = S5+X2
530 S6 = S6+X2^2
540 S7 = S7+X1*Y
550 S8 = S8+X2*Y
560 S9 = S9+X1*X2
570 INPUT "NEXT SET OF : 'END,0'  ";X$,Y
580 IF X$ = "END" GOTO 600
590 GOTO 420
600 CLS
610 PRINT "CALCULATATION TAKES A "
620 PRINT "FEW SECONDS."
630 REM CALCULATION OF SUMS OF DEVIATION FROM MEANS
640 P1 = S2-S1^2/N
650 P2 = S4-S3^2/N
660 P3 = S6-S5^2/N
670 P4 = S7-S3*S1/N
680 P5 = S8-S5*S1/N
690 P6 = S9-S3*S5/N
700 B1(1) = P4/P2
710 B0(1) = (S1-B1(1)*S3)/N
720 R(1) = SQR (B1(1)*P4/P1)
730 B1(2) = P5/P3
740 B0(2) = (S1-B1(2)*S5)/N
750 R(2) = SQR (B1(2) *P5/P1)
760 TP = P2 *P3-P6^2
770 B1(3) = (P4*P3-P5*P6)/TP
780 B2(3) = (P5*P2-P4*P6)/TP
790 B0(3) = (S1-B1(3)*S3-B2(3)*S5)/N
800 R(3) = SQR ((B1(3)*P4+B2(3)*P5)/P1)
810 REM DEGREES OF FREEDOM
820 NU = N-3
830 IF R(1) > R(2) GOTO 860
840 R = R(2)
850 GOTO 870
860 R = R(1)
870 T = SQR (NU*(R(3)^2-R^2) / (1-R(3)^2))
880 GOTO 1200
890 IF PR < .00001 THEN PR = .0001
900 FOR I = 1 TO 3
910 B0(I) = FN P(B0(I))
920 B1(I) = FN P(B1(I))
930 B2(I) = FN P(B2(I))
940 R(I) = FN P(R(I))
950 NEXT I
```

```
960 CLS
970 PRINT TAB(10);"THE RESULS ARE :"
980 PRINT
990 PRINT "Y = B0+B1*X";TAB(25);"Y = B0+B1*X^2"
1000 PRINT
1010 PRINT "B0 = ";FN P(B0(1));TAB(28);FN P(B0(2))
1020 PRINT "B1 = ";FN P(B1(1));TAB(28);FN P(B1(2))
1030 PRINT "R =  ";FN P(R(1));TAB(28);FN P(R(2))
1040 PRINT
1050 PRINT "     Y=B0+B1*X+B2*X^2  "
1060 PRINT
1070 PRINT TAB(10);"B0 = ";FN P(B0(3))
1080 PRINT TAB(10);"B1 = ";FN P(B1(3))
1090 PRINT TAB(10);"B2 = ";FN P(B2(3))
1100 PRINT TAB(10);"R =  ";FN P(R(3))
1110 PRINT
1120 PRINT "T FOR COMPARISON OF THE POLYNOMIAL"
1130 PRINT "WITH THE BETTER OF THE SINGLE"
1140 PRINT "VARIABLE EQUATIONS IS:  ";FN P(T)
1150 PRINT
1160 PRINT "PROBABILITY OF ERROR IN SAYING THERE "
1170 PRINT "IS NO IMPROVEMENT IS :  ";FN P(PR)
1180 GOTO 1380
1190 REM PROBABILITY CALCULATION
1200 TH = ATN (ABS (T)/ SQR (NU))
1210 PI = 3.14159265#
1220 PA = 1
1230 IF NU/2 - INT(NU/2) = 0 GOTO 1320
1240 IF NU > 1 GOTO 1270
1250 PR = 1 -(2*TH/PI)
1260 GOTO 890
1270 FOR I = NU-3 TO 2 STEP -2
1280 PA = 1+PA*(I/(I+1)*(COS(TH))^2)
1290 NEXT I
1300 PR = 1-(2/PI)*(TH+SIN(TH)*COS(TH)*PA)
1310 GOTO 890
1320 IF NU = 2 GOTO 1360
1330 FOR I = (NU-3) TO 1 STEP -2
1340 PA = 1 + PA*(I/(I+1)*(COS(TH))^2)
1350 NEXT I
1360 PR = 1-SIN(TH)*PA
1370 GOTO 890
1380 PRINT TAB(13) ;"END OF PROGRAM"
1390 END
```

EXAMPLE 2

(Start of first display)

```
*********************************************************
*   PROGRAM CORRELATES A DEPENDENT VARIABLE (OMEGA)     *
*   AGAINST AN INDEPENDENT VARIABLE (REDUCED TEMP.)     *
*   WITH A SECOND DEGREE POLYNOMIAL :                   *
*                                                       *
*      Y = B0 + B1*X + B2*X^2                           *
*                                                       *
*   IT ALSO CALCULATES THE CORRELATIONS FOR :           *
*                                                       *
*      Y = B0 + B1*X                                    *
*      Y = B0 + B1*X^2                                  *
*                                                       *
*   AND IT GIVES A COMPARISON OF THE                    *
*   THREE RESULTS.                                      *
*                                                       *
*   WHERE    X = REDUCED TEMPERATURE                    *
*            Y = OMEGA                                  *
*                                                       *
*   DATA ARE ENTER AS :  X,Y                            *
*                                                       *
*   THE DATA INPUT IS                                   *
*   TERMINATED WITH:   END,0                            *
*********************************************************
PRESS RETURN TO ENTER DATA.
```

(Start of next display)

```
ENTER DATA AS : X,Y SEPERATED BY
A COMMA. WHEN ALL THE DATA ARE IN
ENTER :  END,0

THE DATA WILL BE SAVED IN COMPUTER
MEMORY AS X(I),Y(I), FOR GOING
FROM 1 TO N .

ENTER FRIST SET :      .65385          .66812
NEXT SET OF : 'END,0'  .67334          .65442
NEXT SET OF : 'END,0'  .69506          .63859
NEXT SET OF : 'END,0'  .71678          .62314
NEXT SET OF : 'END,0'  .73850          .60805
NEXT SET OF : 'END,0'  .76023          .59309
NEXT SET OF : 'END,0'  .78195          .57856
NEXT SET OF : 'END,0'  .80367          .56389
NEXT SET OF : 'END,0'  .82539          .54974
```

```
,NEXT SET OF : 'END,0'   .84711              .53535
 NEXT SET OF : 'END,0'   .86883              .5213001
 NEXT SET OF : 'END,0'   .89055              .50737
 NEXT SET OF : 'END,0'   .91227              .49351
 NEXT SET OF : 'END,0'   .93399              .47991
 NEXT SET OF : 'END,0'   .95571              .46666
 NEXT SET OF : 'END,0'   .96657              .46033
 NEXT SET OF : 'END,0'   .97743              .45453
 NEXT SET OF : 'END,0'   .97960              .45352
 NEXT SET OF : 'END,0'   .98178              .45255
 NEXT SET OF : 'END,0'   .98395              .45166
 NEXT SET OF : 'END,0'   .98612              .45087
 NEXT SET OF : 'END,0'   .98829              .45024
 NEXT SET OF : 'END,0'   .99046              .44977
 NEXT SET OF : 'END,0'   .99264              .44957
 NEXT SET OF : 'END,0'   .99481              .44979
 NEXT SET OF : 'END,0'   .99698              .45074
 NEXT SET OF : 'END,0'   .99807              .45192
 NEXT SET OF : 'END,0'   END   0
 CALCULATATION TAKES A
 FEW SECONDS.
```

(Start of next display)

```
          THE RESULS ARE :

 Y = B0+B1*X                Y = B0+B1*X^2

 B0 =  1.079                    .8134
 B1 = -.6372                   -.3746
 R =   .9988                    .9955

      Y=B0+B1*X+B2*X^2

          B0 =  1.303
          B1 = -1.1773
          B2 =  .3189
          R =   .9996

 T FOR COMPARISON OF THE POLYNOMIAL
 WITH THE BETTER OF THE SINGLE
 VARIABLE EQUATIONS IS:   7.5369

 PROBABILITY OF ERROR IN SAYING THERE
 IS NO IMPROVEMENT IS :   .0001
             END OF PROGRAM
```

Program DENSITY

```
10 REM ************************************************
20 REM *         THIS PROGRAM FOR PREDICTION OF       *
30 REM *   VOLUME,DENSITY ,AND COMPRESSIBILITY FACTOR  *
40 REM *          BY FOUR EQUATIONS OF STATE          *
50 REM ************************************************
60 DEF FN P(X) = INT (100000!*(X+.000005))/100000!
70 PRINT "************************************************"
80 PRINT "*          THIS PROGRAM FOR CALCULATE          *"
90 PRINT "*          THE VOLUME,DENSITY,AND              *"
100 PRINT "*          COMPRESSIBILITY FACTOR              *"
110 PRINT "*          OF PURE COMPOUND BY                 *"
120 PRINT "*          FOUR EQUATIONS OF STATE:            *"
130 PRINT "*                                              *"
140 PRINT "*           : 1.SOAVE-REDLICH-KWONG [SRK]      *"
150 PRINT "*           : 2.PENG-ROBINSON [PR]             *"
160 PRINT "*           : 3.ISHIKAWA-CHUNG-LU [ICL]        *"
170 PRINT "*           : 4.MODIFIED HARD-SPHERE [THIS WORK]*"
180 PRINT "*                                              *"
190 PRINT "*       WITH INPUT OF TEMPERATURE & PRESSURE.  *"
200 PRINT "************************************************"
210 PRINT:PRINT
220 INPUT " PRESS ANY KEY TO CONTINUE :";DR$
230 CLS
240 PRINT " DATA REQUIRED ARE THE CRITICAL TEMPERATURE"
250 PRINT " AND PRESSURE AND :"
260 PRINT
270 PRINT " FOR SOAVE-REDLICH-KWONG AND PENG-ROBINSON:"
280 PRINT "      THE ACENTRIC FACTOR ;"
290 PRINT
300 PRINT " FOR ISHIKAWA ET AL. :"
310 PRINT "      EIGHT EMPIRICAL CONSTANTS ;"
320 PRINT
330 PRINT " FOR MODIFIED HARD-SPHERE :"
340 PRINT "      SIX EMPIRICAL CONSTANTS ;"
350 PRINT "      FOR THE INDIVIDUAL COMPOUND."
360 PRINT:PRINT
370 INPUT "PRESS ANY KEY TO ENTER DATA";MS$
380 CLS
390 PRINT " ENTER THE FOLLOWING DATA : "
400 PRINT
410 INPUT " COMPOUND NAME :  ";N$
420 INPUT " CRITRICAL TEMPERATURE (deg. K ) :  ";TC
430 INPUT " CRITRICAL PRESSURE (atm)   :  ";PC
440 INPUT " MOLECULAR WIEGHT (MW)  : ";MW
450 PRINT:PRINT
```

```
460 INPUT " PRESS ANY KEY TO CONTINUE :";H$
470 CLS
480 PRINT " :FOR SOAVE-REDLICH-KWONG & PENG-ROBINSON EOS."
490 PRINT " INPUT THIS PARAMETER:"
500 PRINT
510 INPUT " PITZER'S ACENTRIC FACTOR (w) :";W
520 PRINT:PRINT
530 INPUT " PRESS ANY KEY TO CONTINUE :";H$
540 CLS
550 PRINT " :FOR ISHIKAWA ET AL. EOS."
560 PRINT " INPUT THIS CONSTANTS:"
570 PRINT
580 INPUT "COEFFICIENT A0 :";A0
590 INPUT "COEFFICIENT A1 :";A1
600 INPUT "COEFFICIENT A2 :";A2
610 INPUT "COEFFICIENT A3 :";A3
620 INPUT "COEFFICIENT B0 :";B0
630 INPUT "COEFFICIENT B1 :";B1
640 INPUT "COEFFICIENT B2 :";B2
650 INPUT "COEFFICIENT B3 :";B3
660 PRINT:PRINT
670 INPUT "PRESS ANY KEY TO CONTINUE :";H$
680 CLS
690 PRINT " :FOR MODIFIED HARD-SPHERE EOS."
700 PRINT " INPUT THIS CONSTANTS:"
710 PRINT
720 INPUT "COEFFICIENT A0 :";A10
730 INPUT "COEFFICIENT A1 :";A11
740 INPUT "COEFFICIENT A2 :";A12
750 INPUT "COEFFICIENT B0 :";B10
760 INPUT "COEFFICIENT B1 :";B11
770 INPUT "COEFFICIENT B2 :";B12
780 PRINT:PRINT
790 INPUT "PRESS ANY KEY TO CONTINUE :";H$
800 CLS
810 PRINT " FOR THIS SYSTEM:"
820 INPUT "TEMPERATURE ,DEG. C : ";T1
830 INPUT "PRESSURE ,   ATM    : ";P1
840 PRINT
850 INPUT "GAS OR LIQUID [G/L] :";GL$
860 T = T1+273.15
870 P = P1
880 TR = T/TC
890 PR = P/PC
900 REM GAS CONSTANT IS 0.08205 [LIT.ATM/G-MOLE.DEG.K]
910 R = .08205
920 REM ****FOR SOAVE-REDLICH-KWONG EOS****
930 OMAS = .42747
940 OMBS = .08664
950 ALPHA = (1 + (.48508 + 1.55171*W - .15613*W^2)*(1-TR^.5))^2
```

```
960 AS=OMAS*R^2*TC^2/PC
970 BS=OMBS*R*TC/PC
980 REM FOR CALCULATE Z FACTOR
990 IF GL$ = "L" THEN GOTO 1030
1000 REM FOR GAS PHASE
1010 Z = 1
1020 GOSUB 1840 :GOTO 1060
1030 REM FOR LIQUID PHASE
1040 Z = .005
1050 GOSUB 1840
1060 V1 = V
1070 Z1 = Z
1080 D1 = MW/V1
1090 REM ****FOR PENG-ROBINSON EOS****
1100 OMAP = .45724
1110 OMBP = .0778
1120 ALPHAP = (1 + (.37464 + 1.54226*W - .26992*W^2)*(1-TR^.5))^2
1130 AP=OMAP*R^2*TC^2/PC
1140 BP=OMBP*R*TC/PC
1150 REM FOR CALCULATE Z FACTOR
1160 IF GL$ = "L" THEN GOTO 1200
1170 REM FOR GAS PHASE
1180 Z =1
1190 GOSUB 1950 : GOTO 1230
1200 REM FOR LIQUID PHASE
1210 Z = .005
1220 GOSUB 1950
1230 V2 = V
1240 Z2 = Z
1250 D2 = MW/V2
1260 REM **** FOR ISHIKAWA ET AL.EOS ****
1270 OMAH = A0 + A1*TR + A2*TR^2 + A3*TR^3
1280 OMBH = B0 + B1*TR + B2*TR^2 + B3*TR^3
1290 AH=OMAH*R^2*TC^2.5/PC
1300 BH=OMBH*R*TC/PC
1310 REM FOR CALCULATE Z FACTOR
1320 IF GL$ = "L" THEN GOTO 1360
1330 REM FOR GAS PHASE
1340 Z =1
1350 GOSUB 2060 : GOTO 1390
1360 REM FOR LIQUID PHASE
1370 Z = .005
1380 GOSUB 2060
1390 V3 = V
1400 Z3 = Z
1410 D3 = MW/V3
1420 REM ****FOR MODIFIED HARD-SPHERE EOS****
1430 OMA1 = A10 + A11*TR + A12*TR^2
1440 OMB1 = B10 + B11*TR + B12*TR^2
1450 AM1=OMA1*R^2*TC^2/PC
```

```
1460 BM1=OMB1*R*TC/PC
1470 REM FOR CALCULATE Z FACTOR
1480 IF GL$ = "L" THEN GOTO 1520
1490 REM FOR GAS PHASE
1500 Z = 1
1510 GOSUB 2170 : GOTO 1550
1520 REM FOR LIQUID PHASE
1530 Z = .005
1540 GOSUB 2170
1550 V4 = V
1560 Z4 = Z
1570 D4 = MW/V4
1580 CLS
1590 PRINT " FOR THE FOLLOWING DATA :"
1600 PRINT
1610 PRINT " COMPOUND NAME :";N$
1620 PRINT " CRITRICAL TEMPERATURE ,DEG.K :";TC
1630 PRINT " CRITRICAL PRESSURE  , ATM    :";PC
1640 PRINT " MOLECULAR WIGHT              :";MW
1650 PRINT
1660 PRINT " FOR THIS SYSTEM :"
1670 PRINT " TEMPERATURE ,DEG.C :";T1
1680 PRINT " PRESSURE    ,ATM   :";P1
1690 PRINT
1700 PRINT " THE FOUR EQUATIONS OF STATE "
1710 PRINT
1720 PRINT " GIVES THE FOLLOWING RESULTS :"
1730 PRINT
1740 PRINT TAB(25);"SRK";TAB(40);"PR";TAB(55);"ICL";TAB(70);"THIS WORK"
1750 PRINT
1760 PRINT "Z FACTOR ";TAB(22);FN P(Z1);TAB(38);FN P(Z2);TAB(53);FN P(Z3);TAB(68
);FN P(Z4)
1770 PRINT "DENSITY(kg/m^3)";TAB(22);FN P(D1);TAB(38);FN P(D2);TAB(53);FN P(D3);
TAB(68);FN P(D4)
1780 PRINT "VOLUME(lit/gm.mole)";TAB(22);FN P(V1);TAB(38);FN P(V2);TAB(53);FN P(
V3);TAB(68);FN P(V4)
1790 PRINT:PRINT
1800 INPUT "DO YOU WANT TO CALCULATE ANOTHER CONDITIONS (Y/N)";Y$
1810 IF Y$ = "Y" THEN GOTO 800
1820 PRINT TAB(13);" END OF PROGRAM"
1830 END
1840 REM SUBROUTINE FOR CALCULATED Z FACTOR OF SRK EOS
1850 C = AS*ALPHA*P/R^2/T^2
1860 D = BS*P/R/T
1870 F1 = Z^3 - Z^2 + (C-D-D^2)*Z - C*D
1880 F2 = 3*Z^2 - 2*Z + (C-D-D^2)
1890 H1 = F1 / F2
1900 IF ABS (H1/Z) <= .00001 THEN GOTO 1930
1910 Z = Z -H1
1920 GOTO 1870
1930 V = Z*R*T/P
1940 RETURN
1950 REM SUBROUTINE FOR CALCULATED Z FACTOR OF PR EOS
```

```
1960 C = AP*ALPHAP*P/R^2/T^2
1970 D = BP*P/R/T
1980 F1 = Z^3 - (1-D)*Z^2 + (C-3*D^2-2*D)*Z - (C*D-D^2-D^3)
1990 F2 = 3*Z^2 - (1-D)*2*Z + (C-3*D^2-2*D)
2000 H1 = F1 / F2
2010 IF ABS (H1/Z) <= .00001 THEN GOTO 2040
2020 Z = Z -H1
2030 GOTO 1980
2040 V = Z*R*T/P
2050 RETURN
2060 REM SUBROUTINE FOR CALCULATED Z FACTOR OF ICL EOS
2070 C = AH*P/R^2/T^2.5
2080 D = BH*P/R/T
2090 F1 = 2*Z^3 + (D-2)*Z^2 + (2*C-3*D-D^2)*Z - (D^2+C*D)
2100 F2 = 6*Z^2 + (D-2)*2*Z + (2*C-3*D-D^2)
2110 H1 = F1 / F2
2120 IF ABS (H1/Z) <= .00001 THEN GOTO 2150
2130 Z = Z -H1
2140 GOTO 2090
2150 V = Z*R*T/P
2160 RETURN
2170 REM SUBROUTINE FOR CALCULATED Z FACTOR OF MODIFIED HS EOS
2180 C = AM1*P/R^2/T^2
2190 D = BM1*P/R/T
2200 F1 = 2*Z^3 + (D-2)*Z^2 + (2*C-3*D-D^2)*Z - (D^2+C*D)
2210 F2 = 6*Z^2 + (D-2)*2*Z + (2*C-3*D-D^2)
2220 H1 = F1 / F2
2230 IF ABS (H1/Z) <= .00001 THEN GOTO 2260
2240 Z = Z -H1
2250 GOTO 2200
2260 V = Z*R*T/P
2270 RETURN
```

EXAMPLE 3

(Start of first display)

```
*************************************************
*          THIS PROGRAM FOR CALCULATES          *
*          THE VOLUME, DENSITY, AND             *
*          COMPRESSIBILITY FACTOR               *
*          OF PURE COMPOUND BY                  *
*          FOUR EQUATIONS OF STATE:             *
*                                               *
*           : 1.SOAVE-REDLICH-KWONG [SRK]       *
*           : 2.PENG-ROBINSON [PR]              *
*           : 3.ISHIKAWA-CHUNG-LU [ICL]         *
*           : 4.MODIFIED HARD-SPHERE [THIS WORK]*
*                                               *
*      WITH INPUT OF TEMPERATURE & PRESSURE.    *
*************************************************

 PRESS ANY KEY TO CONTINUE :
 DATA REQUIRED ARE THE CRITICAL TEMPERATURE
 AND PRESSURE AND :

 FOR SOAVE-REDLICH-KWONG AND PENG-ROBINSON:
 THE ACENTRIC FACTOR ;

 FOR ISHIKAWA ET AL. :
 EIGHT EMPIRICAL CONSTANTS ;

 FOR MODIFIED HARD-SPHERE :
 SIX EMPIRICAL CONSTANTS ;
 FOR THE INDIVIDUAL COMPOUND.
```

(Start of next display)

```
PRESS ANY KEY TO ENTER DATA
 ENTER THE FOLLOWING DATA :

 COMPOUND NAME :  ETHANE
 CRITRICAL TEMPERATURE (deg. K ) :   305.4
 CRITRICAL PRESSURE (atm)   :   48.2
 MOLECULAR WIEGHT (MW)  :  30.07


 PRESS ANY KEY TO CONTINUE :
 :FOR SOAVE-REDLICH-KWONG & PENG-ROBINSON EOS.
 INPUT THIS PARAMETER:

 PITZER'S ACENTRIC FACTOR (w) : .098
```

(Start of next display)

```
 :FOR ISHIKAWA ET AL. EOS.
 INPUT THIS CONSTANTS:

COEFFICIENT A0 : .20176
COEFFICIENT A1 : 1.31256
COEFFICIENT A2 :-1.6798
COEFFICIENT A3 : .61622
COEFFICIENT B0 : .11802
COEFFICIENT B1 : .17279
COEFFICIENT B2 :-.31486
COEFFICIENT B3 : .12735


PRESS ANY KEY TO CONTINUE :
 :FOR MODIFIED HARD-SPHERE EOS.
 INPUT THIS CONSTANTS:

COEFFICIENT A0 : 1.09937
COEFFICIENT A1 :-.80583
COEFFICIENT A2 : .15014
COEFFICIENT B0 : .16815
COEFFICIENT B1 :-.03119
COEFFICIENT B2 :-.03572


PRESS ANY KEY TO CONTINUE :
```

(Start of next display)

```
 FOR THIS SYSTEM:
TEMPERATURE ,DEG. C :  17.6111
PRESSURE ,   ATM    :  35.71429

GAS OR LIQUID [G/L] :L
 FOR THE FOLLOWING DATA :

 COMPOUND NAME :ETHANE
 CRITRICAL TEMPERATURE ,DEG.K : 305.4
 CRITRICAL PRESSURE  , ATM    : 48.2
 MOLECULAR WIGHT              : 30.07

 FOR THIS SYSTEM :
 TEMPERATURE ,DEG.C : 17.6111
 PRESSURE    ,ATM   : 35.71429

 THE FOUR EQUATIONS OF STATE

 GIVES THE FOLLOWING RESULTS :
```

	SRK	PR	ICL	THIS WORK
Z FACTOR	.15317	.13631	.13123	.1299
DENSITY(kg/m^3)	293.8954	330.2423	343.0222	346.5515
VOLUME(lit/gm.mole)	.10232	.09105	.08766	.08677

```
DO YOU WANT TO CALCULATE ANOTHER CONDITIONS (Y/N)Y
```

(Start of next display)

```
 FOR THIS SYSTEM:
TEMPERATURE ,DEG. C :  17.6111
PRESSURE ,   ATM    :  35.71429

GAS OR LIQUID [G/L] :G
 FOR THE FOLLOWING DATA :

 COMPOUND NAME :ETHANE
 CRITRICAL TEMPERATURE ,DEG.K : 305.4
 CRITRICAL PRESSURE  , ATM    : 48.2
 MOLECULAR WIGHT              : 30.07

 FOR THIS SYSTEM :
 TEMPERATURE ,DEG.C : 17.6111
 PRESSURE    ,ATM   : 35.71429

 THE FOUR EQUATIONS OF STATE

 GIVES THE FOLLOWING RESULTS :
```

	SRK	PR	ICL	THIS WORK
Z FACTOR	.56718	.54126	.56235	.5689
DENSITY(kg/m^3)	79.36654	83.16793	80.0487	79.12765
VOLUME(lit/gm.mole)	.37888	.36156	.37565	.38002

```
DO YOU WANT TO CALCULATE ANOTHER CONDITIONS (Y/N)N
            END OF PROGRAM
```

Program VAPPRESS

```
10 REM  ***********************************************
20 REM *        THIS PROGRAM FOR CALCULATES             *
30 REM *        VAPOR PRESSURE OF PURE COMPOUND         *
40 REM *        BY FOUR EQUATIONS OF STATE              *
50 REM ***********************************************
60 DEF FN P(X) = INT (100000!*(X+.000005))/100000!
70 PRINT "***********************************************"
80 PRINT "*       THIS PROGRAM FOR CALCULATE             *"
90 PRINT "*       VAPOR PRESSURE OF PURE COMPOUND        *"
100 PRINT "*       BY FOUR EQUATIONS OF STATE:            *"
110 PRINT "*                                              *"
120 PRINT "*         : 1.SOAVE-REDLICH-KWONG [SRK]        *"
130 PRINT "*         : 2.PENG-ROBINSON [PR]               *"
140 PRINT "*         : 3.ISHIKAWA-CHUNG-LU [ICL]          *"
150 PRINT "*         : 4.MODIFIED HARD-SPHERE [THIS WORK] *"
160 PRINT "*                                              *"
170 PRINT "*      WITH INPUT OF TEMPERATURE & SATURATED   *"
180 PRINT "*      VAPOR VOLUME.                           *"
190 PRINT "***********************************************"
200 PRINT:PRINT
210 INPUT " PRESS ANY KEY TO CONTINUE :";DR$
220 CLS
230 PRINT " DATA REQUIRED ARE THE CRITICAL TEMPERATURE"
240 PRINT " AND PRESSURE AND :"
250 PRINT
260 PRINT " FOR SOAVE-REDLICH-KWONG AND PENG-ROBINSON:"
270 PRINT "      THE ACENTRIC FACTOR ;"
280 PRINT
290 PRINT " FOR ISHIKAWA ET AL. :"
300 PRINT "      EIGHT EMPIRICAL CONSTANTS ;"
310 PRINT
320 PRINT " FOR MADIFIED HARD-SPHERE :"
330 PRINT "      SIX EMPIRICAL CONSTANTS ;"
340 PRINT "      FOR THE INDIVIDUAL COMPOUND."
350 PRINT:PRINT
360 INPUT "PRESS ANY KEY TO ENTER DATA";MS$
370 CLS
380 PRINT " ENTER THE FOLLOWING DATA : "
390 PRINT
400 INPUT " COMPOUND NAME :  ";N$
410 INPUT " CRITRICAL TEMPERATURE (deg. K ) :  ";TC
420 INPUT " CRITRICAL PRESSURE (atm)   :  ";PC
430 INPUT " MOLECULAR WIEGHT (MW)  : ";MW
440 PRINT:PRINT
450 INPUT " PRESS ANY KEY TO CONTINUE :";H$
```

```
460 CLS
470 PRINT " :FOR SOAVE-REDLICH-KWONG & PENG-ROBINSON EOS."
480 PRINT " INPUT THIS PARAMETER:"
490 PRINT
500 INPUT " PITZER'S ACENTRIC FACTOR (w) :";W
510 PRINT:PRINT
520 INPUT " PRESS ANY KEY TO CONTINUE :";H$
530 CLS
540 PRINT " :FOR ISHIKAWA ET AL. EOS."
550 PRINT " INPUT THIS CONSTANTS:"
560 PRINT
570 INPUT "COEFFICIENT A0 :";A0
580 INPUT "COEFFICIENT A1 :";A1
590 INPUT "COEFFICIENT A2 :";A2
600 INPUT "COEFFICIENT A3 :";A3
610 INPUT "COEFFICIENT B0 :";B0
620 INPUT "COEFFICIENT B1 :";B1
630 INPUT "COEFFICIENT B2 :";B2
640 INPUT "COEFFICIENT B3 :";B3
650 PRINT:PRINT
660 INPUT "PRESS ANY KEY TO CONTINUE :";H$
670 CLS
680 PRINT " :FOR MODIFIED HARD-SPHERE EOS."
690 PRINT " INPUT THIS CONSTANTS:"
700 PRINT
710 INPUT "COEFFICIENT A0 :";A10
720 INPUT "COEFFICIENT A1 :";A11
730 INPUT "COEFFICIENT A2 :";A12
740 INPUT "COEFFICIENT B0 :";B10
750 INPUT "COEFFICIENT B1 :";B11
760 INPUT "COEFFICIENT B2 :";B12
770 PRINT:PRINT
780 INPUT "PRESS ANY KEY TO CONTINUE :";H$
790 CLS
800 PRINT " FOR THIS SYSTEM:"
810 INPUT "TEMPERATURE ,DEG. C : ";T1
820 INPUT "SATURATED VAPOR VOLUME,(LIT/G-MOLE) :";V1
830 PRINT
840 T = T1+273.15
850 V = V1
860 TR = T/TC
870 PR = P/PC
880 REM GAS CONSTANT IS 0.08205 [LIT.ATM/G-MOLE.DEG.K]
890 R = .08205
900 REM ****FOR SOAVE-REDLICH-KWONG EOS****
910 OMAS = .42747
920 OMBS = .08664
930 ALPHA = (1 + (.48508 + 1.55171*W - .15613*W^2)*(1-TR^.5))^2
940 AS=OMAS*R^2*TC^2/PC
950 BS=OMBS*R*TC/PC
```

```
960 REM FOR CALCULATE VAPOR PRESSURE
970 PS = R*T/(V-BS) - (AS*ALPHA/(V*(V+BS)))
980 REM ****FOR PENG-ROBINSON EOS****
990 OMAP = .45724
1000 OMBP = .0778
1010 ALPHAP = (1 + (.37464 + 1.54226*W - .26992*W^2)*(1-TR^.5))^2
1020 AP=OMAP*R^2*TC^2/PC
1030 BP=OMBP*R*TC/PC
1040 REM FOR CALCULATE VAPOR PRESSURE
1050 PP = R*T/(V-BP) - (AP*ALPHAP/(V^2+2*BP*V-BP^2))
1060 REM **** FOR ISHIKAWA ET AL.EOS ****
1070 OMAH = A0 + A1*TR + A2*TR^2 + A3*TR^3
1080 OMBH = B0 + B1*TR + B2*TR^2 + B3*TR^3
1090 AH = OMAH*R^2*TC^2.5/PC
1100 BH = OMBH*R*TC/PC
1110 REM FOR CALCULATE VAPOR PRESSURE
1120 PH = R*T/V * (2*V+BH)/(2*V-BH) - AH/(T^.5*V*(V+BH))
1130 REM ****FOR MODIFIED HARD-SPHERE EOS****
1140 OMA1 = A10 + A11*TR + A12*TR^2
1150 OMB1 = B10 + B11*TR + B12*TR^2
1160 AM1 = OMA1*R^2*TC^2/PC
1170 BM1 = OMB1*R*TC/PC
1180 REM FOR CALCULATE VAPOR PRESSURE
1190 PM = R*T/V * (2*V+BM1)/(2*V-BM1) - AM1/(V*(V+BM1))
1200 CLS
1210 PRINT " FOR THE FOLLOWING DATA :"
1220 PRINT
1230 PRINT " COMPOUND NAME :";N$
1240 PRINT " CRITRICAL TEMPERATURE ,DEG.K :";TC
1250 PRINT " CRITRICAL PRESSURE  , ATM    :";PC
1260 PRINT " MOLECULAR WIGHT              :";MW
1270 PRINT
1280 PRINT " FOR THIS SYSTEM :"
1290 PRINT " TEMPERATURE ,DEG.C :";T1
1300 PRINT " SAT. VAPOR VOLUME,LIT/G-MOLE  :";V1
1310 PRINT
1320 PRINT " THE FOUR EQUATIONS OF STATE "
1330 PRINT
1340 PRINT " GIVES THE FOLLOWING RESULTS :"
1350 PRINT
1360 PRINT TAB(30);"VAPOR PRESSURE [ATM]"
1370 PRINT
1380 PRINT "1.SOAVE-REDLICH-KWONG  :";TAB(35);FN P(PS)
1390 PRINT "2.PENG-ROBINSON        :";TAB(35);FN P(PP)
1400 PRINT "3.ISHIKAWA ET AL.      :";TAB(35);FN P(PH)
1410 PRINT "4.MODIFIED HARD-SPHERE :";TAB(35);FN P(PM)
1420 PRINT
1430 INPUT "DO YOU WANT TO CALCULATE ANOTHER CONDITIONS (Y/N)";Y$
1440 IF Y$ = "Y" THEN GOTO 790
1450 PRINT TAB(13);"END OF PROGRAM"
1460 END
```

EXAMPLE 4

(Start of first display)

```
***********************************************
*      THIS PROGRAM FOR CALCULATE             *
*      VAPOR PRESSURE OF PURE COMPOUND        *
*      BY FOUR EQUATIONS OF STATE:            *
*                                             *
*       : 1.SOAVE-REDLICH-KWONG [SRK]         *
*       : 2.PENG-ROBINSON [PR]                *
*       : 3.ISHIKAWA-CHUNG-LU [ICL]           *
*       : 4.MODIFIED HARD-SPHERE [THIS WORK]  *
*                                             *
*     WITH INPUT OF TEMPERATURE & SATURATED   *
*     VAPOR VOLUME.                           *
***********************************************

 PRESS ANY KEY TO CONTINUE :
 DATA REQUIRED ARE THE CRITICAL TEMPERATURE
 AND PRESSURE AND :

 FOR SOAVE-REDLICH-KWONG AND PENG-ROBINSON:
     THE ACENTRIC FACTOR ;

 FOR ISHIKAWA ET AL. :
     EIGHT EMPIRICAL CONSTANTS ;

 FOR MADIFIED HARD-SPHERE :
     SIX EMPIRICAL-CONSTANTS ;
     FOR THE INDIVIDUAL COMPOUND.


PRESS ANY KEY TO ENTER DATA
```

(Start of next display)

```
 ENTER THE FOLLOWING DATA :

 COMPOUND NAME :  ETHANE
 CRITRICAL TEMPERATURE (deg. K ) :   305.4
 CRITRICAL PRESSURE (atm)   :   48.2
 MOLECULAR WIEGHT (MW)  :  30.07


 PRESS ANY KEY TO CONTINUE :
 :FOR SOAVE-REDLICH-KWONG & PENG-ROBINSON EOS.
 INPUT THIS PARAMETER:

 PITZER'S.ACENTRIC FACTOR (w) : .098


 PRESS ANY KEY TO CONTINUE :
```

(Start of next display)

```
 :FOR ISHIKAWA ET AL. EOS.
 INPUT THIS CONSTANTS:

COEFFICIENT A0 : .20176
COEFFICIENT A1 : 1.31256
COEFFICIENT A2 :-1.6798
COEFFICIENT A3 : .61622
COEFFICIENT B0 : .11602
COEFFICIENT B1 : .17279
COEFFICIENT B2 :-.31486
COEFFICIENT B3 : .12735


PRESS ANY KEY TO CONTINUE :
 :FOR MODIFIED HARD-SPHERE EOS.
 INPUT THIS CONSTANTS:

COEFFICIENT A0 : 1.09937
COEFFICIENT A1 :-.80583
COEFFICIENT A2 : .15014
COEFFICIENT B0 : .16815
COEFFICIENT B1 :-.03119
COEFFICIENT B2 :-.03572


PRESS ANY KEY TO CONTINUE :
```

(Start of next display)

```
 FOR THIS SYSTEM:
TEMPERATURE ,DEG. C :  17.6111
SATURATED VAPOR VOLUME,(LIT/G-MOLE) : .37377

 FOR THE FOLLOWING DATA :

 COMPOUND NAME :ETHANE
 CRITRICAL TEMPERATURE ,DEG.K : 305.4
 CRITRICAL PRESSURE  , ATM    : 48.2
 MOLECULAR WIGHT              : 30.07

 FOR THIS SYSTEM :
 TEMPERATURE ,DEG.C : 17.6111
 SAT. VAPOR VOLUME,LIT/G-MOLE  : .37377

 THE FOUR EQUATIONS OF STATE

 GIVES THE FOLLOWING RESULTS :

                                VAPOR PRESSURE [ATM]

1.SOAVE-REDLICH-KWONG  :          35.8941
2.PENG-ROBINSON        :          35.27725
3.ISHIKAWA ET AL.      :          35.78236
4.MODIFIED HARD-SPHERE :          35.94526

DO YOU WANT TO CALCULATE ANOTHER CONDITIONS (Y/N)N
            END OF PROGRAM
```

Program BUBLP

```
10 REM  ******************************************************
20 REM * BUBBLE POINT PRESSURE CALCULATION OF BINARY SYSTEM  *
30 REM * FROM MODIFIED HARD-SPHERE EQUATION OF STATE         *
40 REM ******************************************************
50 DEF FN P(X)=INT(10000!*(X+.00005))/10000!
60 DIM X(15),Y(15),T(15),TC(15),PC(15),TR(15),P(15),OMA(15),OMB(15),A(15),B(15),
F(15),S(15),AX(15,15),FC(15),AA(15,15),Z(15),K(15)
70 PRINT "******************************************************"
80 PRINT "*   PROGRAM FOR BUBBLE POINT PRESSURE CALCULATION    *"
90 PRINT "*   [  BINARY SYSTEM   ]                             *"
100 PRINT "*   FROM MODIFIED HARD-SPHERE EQUATION OF STATE      *"
110 PRINT "*   AND USED VAN DER WAALS MIXING RULES              *"
120 PRINT "*                                                    *"
130 PRINT "*   FOR A GIVEN LIQUID COMPOSITION, X(I)             *"
140 PRINT "*   AND ASSUMED VAPOR COMPOSITION, Y(I)              *"
150 PRINT "*   & ASSUMED BUBBLE POINT PRESSURE, P               *"
160 PRINT "******************************************************"
170 PRINT:PRINT
180 INPUT "PRESS ANY KEY TO CONTINUE : ";WE$
190 CLS
200 PRINT "ENTER THE FOLLOWING DATA "
210 N = 2
220 FOR I=1 TO N
230 PRINT " COMPONENT NO.:";I
240 INPUT "COMPOUND NAME =";A$(I)
250 INPUT "critical temperature,DEG.K =   ";TC(I)
260 INPUT "critical pressure  ,ATM    =   ";PC(I)
270 PRINT
280 INPUT "constants a0 = ";A0(I)
290 INPUT "constants a1 = ";A1(I)
300 INPUT "constants a2 = ";A2(I)
310 INPUT "constants b0 = ";B0(I)
320 INPUT "constants b1 = ";B1(I)
330 INPUT "constants b2 = ";B2(I)
340 PRINT
350 NEXT I
360 CLS
370 INPUT "TEMPERATURE OF SYSTEM ; DEG.F   "; T1
380 PRINT
390 PRINT "ENTER MOL-FRACTION OF COMPONENT :  "
400 PRINT "COMPONENT NAME = ";A$(1)
410 INPUT "LIQUID COMPOSITION ,X(1)  =   ";X(1)
420 INPUT "assumed VAPOR COMPOSITION , Y(1) =   ";Y(1)
430 X(2) =1-X(1)
440 Y(2) =1-Y(1)
450 PRINT:PRINT
```

```
460 INPUT "BUBBLE POINT PRESSURE (assumed ) ,PSIA.  "; P1
470 R=.08205
480 T2 = (T1-32)/1.8
490 T = T2+273.16
500 P = P1/14.7
510 SO =0
520 FOR I=1 TO N
530 TR(I)=T/TC(I)
540 OMA(I)=A0(I)+A1(I)*TR(I)+A2(I)*TR(I)^2
550 OMB(I)=B0(I)+B1(I)*TR(I)+B2(I)*TR(I)^2
560 A(I)=OMA(I)*R^2*TC(I)^2/PC(I)
570 B(I)=OMB(I)*R*TC(I)/PC(I)
580 NEXT I
590 REM FOR LIQUID PHASE
600 FOR I=1 TO N
610 Z(I)=X(I)
620 NEXT I
630 GOSUB 1270
640 Z =.005
650 GOSUB 1390
660 PRINT "ZL=  ";FN P(Z)
670 GOSUB 1490
680 FOR I=1 TO N
690 L(I)=FC(I)
700 PRINT "PARTIAL FUGACITY COEFF. OF LIQUID,OL(";A$(I);") =";FN P(L(I))
710 NEXT I
720 REM FOR GAS PHASE
730 FOR I=1 TO N
740 Z(I) =Y(I)
750 NEXT I
760 GOSUB 1270
770 Z = 1!
780 GOSUB 1390
790 PRINT "ZV=  ";FN P(Z)
800 GOSUB 1490
810 S=0
820 FOR I=1 TO N
830 G(I)=FC(I)
840 PRINT "PARTIAL FUGACITY COEFF. OF GAS ,OV(";A$(I);") =";FN P(G(I))
850 K(I)=L(I)/G(I)
860 Y(I)=X(I)*K(I)
870 S=S+Y(I)
880 NEXT I
890 PRINT "S=  ";FN P(S)
900 IF ABS (S-SO)<=.0001 THEN 960
910 SO=S
920 FOR I=1 TO N
930 Y(I)=Y(I)/S
940 NEXT I
950 GOTO 720
```

```
960 IF ABS (S-1)<=.0001 THEN GOTO 980
970 GOTO 460
980 PRINT:PRINT
990 INPUT " PRESS ANY KEY TO CONTINUE :";GH$
1000 CLS
1010 PRINT " ********* BINARY SYSTEM *********"
1020 PRINT TAB(12);A$(1);"-";A$(2)
1030 PRINT
1040 PRINT " BY BUBBLE POINT PRESSURE CALCULATIONS."
1050 PRINT
1060 PRINT " GIVES THE FOLLOWING RESULTS:"
1070 PRINT
1080 PRINT " AT TEMPERATURE ";T1;"  DEG.F"
1090 PRINT " BUBBLE PRESSURE  IS  ";P1;"  PSIA."
1100 PRINT
1110 PRINT " COMPONENT NAME ";TAB(35);A$(1);TAB(51);A$(2)
1120 PRINT
1130 PRINT " MOLE-FRACTION OF LIQUID [X]";TAB(35);X(1);TAB(50);X(2)
1140 PRINT " MOLE-FRACTION OF VAPOR  [Y]";TAB(35);Y(1);TAB(50);Y(2)
1150 PRINT " EQUILIBRIUM CONSTANTS   [K]";TAB(35);K(1);TAB(50);K(2)
1160 PRINT " PARTIAL FUGACITY COEFF.OF LIQUID";TAB(35);L(1);TAB(50);L(2)
1170 PRINT " PARTIAL FUGACITY COEFF.OF VAPOR ";TAB(35);G(1);TAB(50);G(2)
1180 PRINT:PRINT
1190 INPUT "DO YOU WANT FOR ANOTHER COMPOSITION (Y/N)";YES$
1200 IF YES$ = "Y" THEN GOTO 390
1210 PRINT
1220 INPUT "DO YOU WANT FOR ANOTHER TEMPERATURE (Y/N)"; NH$
1230 IF NH$ = "Y" THEN GOTO 360
1240 PRINT:PRINT
1250 PRINT TAB(13);"END OF PROGRAM"
1260 END
1270 REM SUBROUTINE FOR MODIFIED HARD-SPHERE COEFFICIENTS
1280 A=0:B=0
1290 FOR I=1 TO N
1300 FOR J=1 TO N
1310 AX(I,J)=(A(I)*A(J))^.5
1320 A=A+Z(I)*Z(J)*AX(I,J)
1330 NEXT J
1340 NEXT I
1350 FOR I =1 TO N
1360 B=B+B(I)*Z(I)
1370 NEXT I
1380 RETURN
1390 REM SUBROUTINE FOR CALCULATED COMPRESSIBILITY FACTOR,Z
1400 C=A*P/R^2/T^2
1410 D=B*P/R/T
1420 F1= 2*Z^3+(D-2)*Z^2+(2*C-3*D-D^2)*Z-(D^2+C*D)
1430 F2= 6*Z^2+2*(D-2)*Z+(2*C-3*D-D^2)
1440 H1 =F1/F2
1450 IF ABS (H1/Z)<=.0001 THEN GOTO 1480
```

```
1460 Z = Z-H1
1470 GOTO 1420
1480 RETURN
1490 REM SUBROUTINE FOR CALCULATED FUGACITY COEFFICIENT
1500 V = Z*R*T/P
1510 FOR I =1 TO N
1520 S(I) =0
1530 FOR K =1 TO N
1540 AA(K,I) =(A(K)*A(I))^.5
1550 S(I) = S(I)+Z(K)*AA(K,I)
1560 NEXT K
1570 F(I) = 2*B(I)/(2*V-B)-2*LOG(1-(B/(2*V)))
1580 F(I) = F(I)-(2*S(I)/(R*T*B))*LOG((V+B)/V)
1590 F(I) = F(I)+ A*B(I)/(R*T*B^2)*(LOG((V+B)/V)-(B/(V+B)))-LOG(Z)
1600 FC(I)= EXP(F(I))
1610 NEXT I
1620 RETURN
```

EXAMPLE 5

(Start of first display)

```
*****************************************************
*   PROGRAM FOR BUBBLE POINT PRESSURE CALCULATION   *
*   [  BINARY SYSTEM   ]                            *
*   FROM MODIFIED HARD-SPHERE EQUATION OF STATE     *
*   AND USED VAN DER WAALS MIXING RULES             *
*                                                   *
*   FOR A GIVEN LIQUID COMPOSITION, X(I)            *
*   AND ASSUMED VAPOR COMPOSITION, Y(I)             *
*   & ASSUMED BUBBLE POINT PRESSURE, P              *
*****************************************************
PRESS ANY KEY TO CONTINUE
```

(Start of next display)

```
ENTER THE FOLLOWING DATA
 COMPONENT NO.: 1
COMPOUND NAME =ETHANE
critical temperature,DEG.K =    305.4
critical pressure  ,ATM    =    48.2

constants a0 =  1.09937
constants a1 = -.80583
constants a2 =  .15014
constants b0 =  .16815
constants b1 = -.03119
constants b2 = -.03572

 COMPONENT NO.: 2
COMPOUND NAME =PROPANE
critical temperature,DEG.K =    369.8
critical pressure  ,ATM    =    41.9

constants a0 =  1.176
constants a1 = -.92966
constants a2 =  .19417
constants b0 =  .16393
constants b1 = -.02232
constants b2 = -.04179

TEMPERATURE OF SYSTEM ; DEG.F    100

ENTER MOL-FRACTION OF COMPONENT :
COMPONENT NAME = ETHANE
LIQUID COMPOSITION ,X(1)  =     .0313
assumed VAPOR COMPOSITION , Y(1) =    .07
```

(Start of next display)

```
BUBBLE POINT PRESSURE (assumed ) ,PSIA.   200
ZL=   .0495
PARTIAL FUGACITY COEFF. OF LIQUID,OL(ETHANE) = 2.4331
PARTIAL FUGACITY COEFF. OF LIQUID,OL(PROPANE) = .7703
ZV=   .7708
PARTIAL FUGACITY COEFF. OF GAS ,OV(ETHANE) = .9412
PARTIAL FUGACITY COEFF. OF GAS ,OV(PROPANE) = .8042
S=   1.0088
ZV=   .7729
PARTIAL FUGACITY COEFF. OF GAS ,OV(ETHANE) = .9404
PARTIAL FUGACITY COEFF. OF GAS ,OV(PROPANE) = .8043
S=   1.0088
BUBBLE POINT PRESSURE (assumed ) ,PSIA.   202.5
ZL=   .0501
PARTIAL FUGACITY COEFF. OF LIQUID,OL(ETHANE) = 2.4045
PARTIAL FUGACITY COEFF. OF LIQUID,OL(PROPANE) = .7613
ZV=   .763
PARTIAL FUGACITY COEFF. OF GAS ,OV(ETHANE) = .9424
PARTIAL FUGACITY COEFF. OF GAS ,OV(PROPANE) = .8017
S=   .9998
ZV=   .7692
PARTIAL FUGACITY COEFF. OF GAS ,OV(ETHANE) = .94
PARTIAL FUGACITY COEFF. OF GAS ,OV(PROPANE) = .8018
S=   .9998
BUBBLE POINT PRESSURE (assumed ) ,PSIA.   202.4
ZL=   .0501
PARTIAL FUGACITY COEFF. OF LIQUID,OL(ETHANE) = 2.4056
PARTIAL FUGACITY COEFF. OF LIQUID,OL(PROPANE) = .7617
ZV=   .7695
PARTIAL FUGACITY COEFF. OF GAS ,OV(ETHANE) = .9399
PARTIAL FUGACITY COEFF. OF GAS ,OV(PROPANE) = .8019
S=   1.0002
ZV=   .7693
PARTIAL FUGACITY COEFF. OF GAS ,OV(ETHANE) = .94
PARTIAL FUGACITY COEFF. OF GAS ,OV(PROPANE) = .8019
S=   1.0002
BUBBLE POINT PRESSURE (assumed ) ,PSIA.   202.42
ZL=   .0501
PARTIAL FUGACITY COEFF. OF LIQUID,OL(ETHANE) = 2.4054
PARTIAL FUGACITY COEFF. OF LIQUID,OL(PROPANE) = .7616
ZV=   .7692
PARTIAL FUGACITY COEFF. OF GAS ,OV(ETHANE) = .94
PARTIAL FUGACITY COEFF. OF GAS ,OV(PROPANE) = .8019
S=   1.0001
ZV=   .7693
PARTIAL FUGACITY COEFF. OF GAS ,OV(ETHANE) = .94
PARTIAL FUGACITY COEFF. OF GAS ,OV(PROPANE) = .8019
S=   1.0001

PRESS ANY KEY TO CONTINUE :
```

(Start of next display)

```
********* BINARY SYSTEM *********
          ETHANE-PROPANE

BY BUBBLE POINT PRESSURE CALCULATIONS.

GIVES THE FOLLOWING RESULTS:

AT TEMPERATURE  100   DEG.F
BUBBLE PRESSURE  IS   202.42   PSIA.

COMPONENT NAME                      ETHANE          PROPANE

MOLE-FRACTION OF LIQUID [X]          .0313           .9687
MOLE-FRACTION OF VAPOR  [Y]          8.009809E-02    .9199887
EQUILIBRIUM CONSTANTS   [K]          2.559044        .9497148
PARTIAL FUGACITY COEFF.OF LIQUID     2.405415        .7615807
PARTIAL FUGACITY COEFF.OF VAPOR      .9399661        .8019047

DO YOU WANT FOR ANOTHER COMPOSITION (Y/N)N

DO YOU WANT FOR ANOTHER TEMPERATURE (Y/N)N

            END OF PROGRAM
```

APPENDIX B

NUMERICAL VALUES OF EXPERIMENTAL DATA AND CALCULATED RESULTS

Table B.1 Numerical Valuesof Experimental and Calulated Saturated Densities of Methane. [ref.(28)]

Temp.	Saturated Liquid Densities (gm./ cc.)				Saturated Vapor Densities (gm./ cc.)			
,K	EXP.	SRK	PR	THIS WORK	EXP.	SRK	PR	THIS WORK
90.66	0.45065	0.45463	0.51121	0.44353	0.00025	0.00025	0.00025	0.00025
95	0.44440	0.44862	0.50477	0.43917	0.00041	0.00040	0.00040	0.00040
100	0.43714	0.44140	0.49701	0.43388	0.00067	0.00067	0.00067	0.00067
105	0.43011	0.43385	0.48886	0.42830	0.00106	0.00105	0.00105	0.00105
110	0.42330	0.42593	0.48029	0.42240	0.00160	0.00159	0.00159	0.00159
115	0.41670	0.41762	0.47125	0.41614	0.00232	0.00231	0.00231	0.00232
120	0.40926	0.40889	0.46171	0.40950	0.00327	0.00325	0.00326	0.00328
125	0.40108	0.39970	0.45163	0.40243	0.00449	0.00446	0.00447	0.00451
130	0.39321	0.39001	0.44093	0.39490	0.00601	0.00598	0.00600	0.00606
135	0.38565	0.37978	0.42956	0.38686	0.00790	0.00785	0.00789	0.00799
140	0.37748	0.36888	0.41743	0.37824	0.01022	0.01015	0.01022	0.01035
145	0.36796	0.35730	0.40445	0.36898	0.01303	0.01293	0.01305	0.01323
150	0.35890	0.34492	0.39048	0.35898	0.01643	0.01628	0.01648	0.01671
155	0.34876	0.33161	0.37538	0.34814	0.02053	0.02033	0.02063	0.02090
160	0.33775	0.31720	0.35892	0.33630	0.02548	0.02521	0.02568	0.02597
165	0.32542	0.30144	0.34082	0.32327	0.03150	0.03115	0.03187	0.03213
170	0.31212	0.28397	0.32063	0.30878	0.03893	0.03848	0.03958	0.03969
175	0.29600	0.26418	0.29767	0.29236	0.04838	0.04775	0.04943	0.04915
180	0.10160	0.13203	0.14156	0.13709	0.06112	0.06000	0.06263	0.06145
185	0.25225	0.21184	0.23646	0.25096	0.08042	0.07779	0.08211	0.07866

Table B.2 Numerical Values Of Experimental and Calculated Saturated Densities of Ethane.

Temp.	Saturated Liquid Densities (gm./ cc.) [ref.31]				Temp.	Saturated Vapor Densities (gm./ cc.) [ref.33]			
, K	EXP.	SRK	PR	THIS WORK	, K	EXP.	SRK	PR	THIS WORK
135	0.60279	0.58018	0.65182	0.59182	226.18	0.01134	0.01108	0.01116	0.01125
140	0.59709	0.57536	0.64671	0.58742	234.58	0.01484	0.01457	0.01469	0.01482
150	0.58562	0.56528	0.63599	0.57834	238.90	0.01697	0.01669	0.01686	0.01699
160	0.57391	0.55456	0.62455	0.56881	243.22	0.01933	0.01905	0.01928	0.01942
170	0.56191	0.54316	0.61232	0.55879	248.65	0.02277	0.02240	0.02271	0.02286
180	0.54966	0.53101	0.59921	0.54820	253.03	0.02596	0.02562	0.02602	0.02616
190	0.53709	0.51801	0.58511	0.53697	258.80	0.03104	0.03024	0.03080	0.03089
200	0.52409	0.50408	0.56992	0.52501	263.28	0.03492	0.03431	0.03504	0.03505
210	0.51033	0.48911	0.55347	0.51220	268.73	0.04081	0.04008	0.04108	0.04090
220	0.49612	0.47295	0.53560	0.49842	273.09	0.04632	0.04529	0.04657	0.04615
230	0.48104	0.45542	0.51607	0.48350	278.84	0.05445	0.05293	0.05466	0.05375
240	0.46501	0.43629	0.49458	0.46721	283.58	0.06273	0.06157	0.06389	0.06224
250	0.44774	0.41522	0.47074	0.44926	288.26	0.07251	0.07130	0.07439	0.07157
260	0.42883	0.39176	0.44396	0.42924	294.27	0.09173	0.08977	0.09458	0.08841
270	0.40743	0.36518	0.41336	0.40652	299.83	0.11638	0.11295	0.12038	0.10690

Table B.3 Numerical Values of Experimental and Calculated Saturated Densities of Propane. [ref.(37)]

Temp. , F	Saturated Liquid Densities (gm./ cc.)				Saturated Vapor Densities (gm./ cc.)			
	EXP.	SRK	PR	THIS WORK	EXP.	SRK	PR	THIS WORK
-80	0.60474	0.57182	0.64488	0.59946	0.00099	0.00099	0.00100	0.00100
-60	0.59288	0.55993	0.63207	0.58896	0.00164	0.00165	0.00165	0.00166
-40	0.58001	0.54725	0.61834	0.57786	0.00260	0.00260	0.00260	0.00261
-20	0.56708	0.53369	0.60356	0.56607	0.00395	0.00394	0.00395	0.00397
0	0.55395	0.51914	0.58762	0.55352	0.00585	0.00579	0.00581	0.00584
10	0.54695	0.51146	0.57916	0.54695	0.00697	0.00695	0.00697	0.00702
20	0.53958	0.50348	0.57034	0.54008	0.00830	0.00825	0.00829	0.00835
30	0.53224	0.49519	0.56115	0.53300	0.01002	0.00979	0.00984	0.00991
40	0.52457	0.48656	0.55154	0.52563	0.01205	0.01152	0.01160	0.01168
50	0.51679	0.47757	0.54150	0.51797	0.01406	0.01349	0.01360	0.01369
60	0.50875	0.46818	0.53097	0.50999	0.01629	0.01573	0.01588	0.01598
70	0.49940	0.45836	0.51992	0.50166	0.01877	0.01829	0.01849	0.01860
80	0.49023	0.44807	0.50830	0.49295	0.02151	0.02118	0.02145	0.02155
90	0.48140	0.43727	0.49604	0.48381	0.02492	0.02445	0.02480	0.02489
100	0.47273	0.42589	0.48308	0.47421	0.02872	0.02816	0.02863	0.02868
110	0.46424	0.41388	0.46937	0.46409	0.03291	0.03237	0.03300	0.03298
120	0.45373	0.40113	0.45469	0.45339	0.03762	0.03717	0.03800	0.03785
130	0.44368	0.38753	0.43903	0.44201	0.04331	0.04262	0.04371	0.04335
140	0.43289	0.37287	0.42208	0.42987	0.05008	0.04890	0.05033	0.04963
150	0.41985	0.35706	0.40370	0.41684	0.05765	0.05624	0.05811	0.05689
160	0.40448	0.33966	0.38342	0.40265	0.06677	0.06472	0.06718	0.06515
170	0.38784	0.31982	0.36028	0.38673	0.07705	0.07414	0.07734	0.07409
180	0.36697	0.29748	0.33408	0.36967	0.08903	0.08695	0.09129	0.08588
190	0.34010	0.26984	0.30174	0.35016	0.10755	0.10297	0.10892	0.09981
200	0.30759	0.12366	0.24259	0.32609	0.14182	0.12366	0.13187	0.11632

Table B.4 Numerical values Experimental and Calculated Saturated Densities of n-Butane. [ref.(38)]

Temp. ,K	Saturated Liquid Densities (gm. / cc.)				Saturated Vapor Densities (gm./ cc.)			
	EXP.	SRK	PR	THIS WORK	EXP.	SRK	PR	THIS WORK
280	0.59335	0.55226	0.62452	0.59235	0.00349	0.00348	0.00349	0.00350
290	0.58223	0.54078	0.61198	0.58294	0.00482	0.00480	0.00481	0.00483
300	0.57097	0.52861	0.59862	0.57282	0.00649	0.00648	0.00650	0.00653
310	0.55889	0.51568	0.58435	0.56193	0.00858	0.00858	0.00862	0.00867
320	0.55741	0.51442	0.58295	0.56085	0.01114	0.01119	0.01126	0.01132
330	0.53325	0.48717	0.55259	0.53748	0.01433	0.01440	0.01452	0.01460
340	0.51943	0.47134	0.53482	0.52370	0.01827	0.01833	0.01852	0.01860
350	0.50499	0.45427	0.51551	0.50869	0.02315	0.02312	0.02343	0.02348
360	0.48926	0.43573	0.49444	0.49224	0.02918	0.02898	0.02947	0.02944
370	0.47256	0.41541	0.47114	0.47410	0.03669	0.03616	0.03693	0.03673
380	0.45374	0.39286	0.44516	0.45390	0.04606	0.04506	0.04625	0.04568
390	0.43279	0.36745	0.41568	0.43115	0.05789	0.05638	0.05824	0.05691
400	0.40789	0.33796	0.38127	0.40504	0.07351	0.07117	0.07408	0.07123
405	0.39353	0.32098	0.36140	0.39030	0.08348	0.08047	0.08416	0.07998
410	0.37670	0.30186	0.33893	0.37418	0.09535	0.09185	0.09660	0.09032
411	0.37307	0.29763	0.33397	0.37070	0.09790	0.09435	0.09934	0.09253
412	0.36904	0.29333	0.32892	0.36721	0.10074	0.09711	0.10238	0.09495
413	0.36510	0.28884	0.32364	0.36360	0.10370	0.09994	0.10551	0.09740
414	0.36080	0.28417	0.31818	0.35993	0.10702	0.10298	0.10886	0.09999
415	0.35615	0.27926	0.31242	0.35615	0.11050	0.10613	0.11234	0.10262
416	0.35142	0.27414	0.30641	0.35225	0.11449	0.10952	0.11612	0.10541
417	0.34618	0.26877	0.30011	0.34830	0.11872	0.11321	0.12022	0.10837
418	0.34071	0.26312	0.29349	0.34428	0.12351	0.11724	0.12472	0.11153
419	0.33462	0.25698	0.28631	0.34004	0.12885	0.12152	0.12950	0.11477
420	0.32802	0.25037	0.27856	0.33572	0.13539	0.12629	0.13484	0.11824
421	0.32060	0.24290	0.26986	0.33120	0.14327	0.13144	0.14064	0.12182
422	0.31199	0.23436	0.26000	0.32656	0.15320	0.13738	0.14731	0.12571
423	0.30132	0.22396	0.24817	0.32178	0.16429	0.14445	0.15526	0.12992
424	0.28689	0.15338	0.23088	0.31686	0.17830	0.15338	0.16529	0.13456

Table B.5 Numerical Values of Experimental and Calculated Saturated Densities of iso-Butane. [ref.(43)]

temp.	Saturated Liquid Densities (gm./ cc.)				Saturated Vapor Densities (gm./ cc.)			
,K	EXP.	SRK	PR	THIS WORK	EXP.	SRK	PR	THIS WORK
250	0.60569	0.57180	0.64570	0.60304	0.00182	0.00182	0.00182	0.00183
260	0.59488	0.56102	0.63402	0.59337	0.00268	0.00267	0.00267	0.00268
270	0.58377	0.54961	0.62160	0.58320	0.00382	0.00380	0.00381	0.00383
280	0.57241	0.53752	0.60836	0.57247	0.00530	0.00527	0.00528	0.00531
290	0.56054	0.52468	0.59423	0.56111	0.00719	0.00714	0.00717	0.00722
300	0.54794	0.51099	0.57909	0.54904	0.00957	0.00950	0.00955	0.00962
310	0.53505	0.49637	0.56282	0.53617	0.01255	0.01243	0.01251	0.01261
320	0.52110	0.48068	0.54526	0.52239	0.01622	0.01604	0.01619	0.01631
330	0.50659	0.46377	0.52621	0.50754	0.02076	0.02048	0.02073	0.02086
340	0.49092	0.44544	0.50541	0.49146	0.02633	0.02593	0.02633	0.02644
350	0.47416	0.42540	0.48253	0.47389	0.03321	0.03264	0.03326	0.03331
360	0.45579	0.40326	0.45708	0.45453	0.04177	0.04095	0.04193	0.04178
370	0.43516	0.37839	0.42832	0.43290	0.05258	0.05140	0.05294	0.05234
380	0.41135	0.34979	0.39503	0.40829	0.06667	0.06492	0.06735	0.06576
382	0.40601	0.34347	0.38766	0.40292	0.07003	0.06813	0.07080	0.06890
384	0.40048	0.33691	0.37999	0.39737	0.07353	0.07154	0.07448	0.07222
386	0.39463	0.33007	0.37199	0.39163	0.07740	0.07519	0.07842	0.07573
388	0.38850	0.32291	0.36361	0.38568	0.08150	0.07911	0.08267	0.07947
390	0.38212	0.31540	0.35481	0.37950	0.08598	0.08334	0.08727	0.08346
394	0.36792	0.29904	0.33561	0.36638	0.09615	0.09296	0.09780	0.09235
396	0.36010	0.29001	0.32501	0.35937	0.10206	0.09851	0.10391	0.09734
398	0.35137	0.28019	0.31352	0.35204	0.10871	0.10471	0.11074	0.10277
400	0.34165	0.26939	0.30087	0.34434	0.11629	0.11177	0.11859	0.10877

Table B.6 Numerical Values of Experimental and Calculated Densities of n-Pentane. [ref.(45)]

Temp.	Saturated Liquid Densities (gm./ cc.)				Saturated Vapor Densities (gm./ cc.)			
,K	EXP.	SRK	PR	THIS WORK	EXP.	SRK	PR	THIS WORK
310	0.60939	0.55552	0.62817	0.60738	0.00307	0.00303	0.00304	0.00305
320	0.59926	0.54523	0.61695	0.59817	0.00417	0.00412	0.00413	0.00414
330	0.58851	0.53435	0.60504	0.58837	0.00557	0.00548	0.00550	0.00552
340	0.57767	0.52283	0.59237	0.57792	0.00730	0.00718	0.00720	0.00723
350	0.56634	0.51062	0.57886	0.56676	0.00944	0.00926	0.00931	0.00934
360	0.55416	0.49762	0.56442	0.55481	0.01205	0.01180	0.01188	0.01192
370	0.54168	0.48375	0.54895	0.54200	0.01523	0.01488	0.01501	0.01504
380	0.52858	0.46890	0.53223	0.52820	0.01906	0.01860	0.01881	0.01882
390	0.51500	0.45291	0.51414	0.51330	0.02370	0.02309	0.02341	0.02337
400	0.50001	0.43561	0.49448	0.49713	0.02932	0.02852	0.02900	0.02886
410	0.48424	0.41675	0.47284	0.47951	0.03617	0.03510	0.03584	0.03549
420	0.46670	0.39592	0.44888	0.46008	0.04457	0.04317	0.04428	0.04357
430	0.44731	0.37265	0.42192	0.43853	0.05512	0.05323	0.05490	0.05351
440	0.42492	0.34605	0.39093	0.41426	0.06878	0.06610	0.06865	0.06599
450	0.39775	0.31442	0.35387	0.38636	0.08758	0.08341	0.08739	0.08219
455	0.38095	0.29563	0.33178	0.37060	0.10032	0.09479	0.09986	0.09238
460	0.36040	0.27340	0.30570	0.35326	0.11722	0.10935	0.11599	0.10469
461	0.35560	0.26835	0.29977	0.34956	0.12139	0.11285	0.11987	0.10750
462	0.35042	0.26302	0.29352	0.34579	0.12592	0.11661	0.12407	0.11045
463	0.34473	0.25733	0.28684	0.34192	0.13090	0.12069	0.12863	0.11356
464	0.33858	0.25122	0.27967	0.33796	0.13644	0.12514	0.13362	0.11683
465	0.33173	0.24458	0.27190	0.33393	0.14268	0.13013	0.13923	0.12034
466	0.32384	0.23717	0.26326	0.32974	0.14982	0.13577	0.14559	0.12408
467	0.31452	0.22865	0.25336	0.32549	0.15861	0.14237	0.15304	0.12811
468	0.30252	0.21812	0.24125	0.32111	0.17001	0.15051	0.16225	0.13249

Table B.7 Numerical Values of Experimental and Calculated Densities of iso-Pentane.[ref.(47)]

Temp.	Saturated Liquid Densities (gm./ cc.)				Saturated Vapor Densities (gm./ cc.)			
,K	EXP.	SRK	PR	THIS WORK	EXP.	SRK	PR	THIS WORK
301.02	0.61249	0.56943	0.64381	0.60763	0.00305	0.00303	0.00304	0.00305
310	0.60277	0.55992	0.63345	0.60060	0.00406	0.00402	0.00403	0.00405
320	0.59238	0.54876	0.62124	0.59209	0.00546	0.00540	0.00542	0.00544
330	0.58140	0.53696	0.60826	0.58281	0.00721	0.00712	0.00715	0.00718
340	0.56992	0.52444	0.59443	0.57268	0.00936	0.00923	0.00928	0.00933
350	0.55802	0.51113	0.57965	0.56163	0.01200	0.01181	0.01189	0.01196
360	0.54536	0.49694	0.56379	0.54954	0.01520	0.01494	0.01506	0.01513
370	0.53248	0.48175	0.54673	0.53630	0.01907	0.01870	0.01890	0.01897
380	0.51833	0.46541	0.52826	0.52177	0.02374	0.02322	0.02354	0.02358
390	0.50385	0.44773	0.50818	0.50576	0.02940	0.02867	0.02915	0.02913
400	0.48784	0.42846	0.48611	0.48803	0.03629	0.03527	0.03599	0.03583
410	0.47035	0.40722	0.46167	0.46829	0.04479	0.04332	0.04440	0.04396
420	0.45095	0.38349	0.43420	0.44608	0.05542	0.05330	0.05493	0.05396
430	0.42845	0.35638	0.40264	0.42065	0.06931	0.06602	0.06850	0.06651
440	0.40129	0.32421	0.36499	0.39103	0.08853	0.08303	0.08689	0.08285
445	0.38481	0.30516	0.34264	0.37407	0.10184	0.09417	0.09907	0.09318
450	0.36477	0.28280	0.31643	0.35521	0.11924	0.10833	0.11468	0.10576
451	0.36004	0.27775	0.31051	0.35115	0.12340	0.11169	0.11843	0.10863
452	0.35508	0.27244	0.30430	0.34701	0.12784	0.11532	0.12246	0.11167
453	0.34974	0.26679	0.29769	0.34273	0.13253	0.11920	0.12677	0.11484
454	0.34391	0.26081	0.29070	0.33836	0.13775	0.12347	0.13155	0.11825
455	0.33747	0.25437	0.28315	0.33387	0.14324	0.12820	0.13684	0.12191
456	0.33021	0.24727	0.27487	0.32923	0.14913	0.13343	0.14272	0.12579
457	0.32196	0.23931	0.26565	0.32446	0.15533	0.13947	0.14951	0.13000
458	0.31194	0.23018	0.25511	0.31959	0.16228	0.14674	0.15772	0.13465
459	0.29876	0.21803	0.24156	0.31451	0.17534	0.15581	0.16797	0.13972
459.5	0.28976	0.20928	0.23293	0.31196	0.18453	0.16199	0.17494	0.14256
460	0.27634	0.16988	0.18375	0.30931	0.19844	0.16988	0.18375	0.14548
460.39	0.23579	0.18385	0.19833	0.20464	0.23579	0.18385	0.19833	0.14811

Table B.8 Numerical Values of Experimental and Calculated Densities of n-Hexane.

Temp.	Saturated Liquid Densities (gm./cc.) [ref.(48)]				Temp.	Saturated Vapor Densities (gm./cc.) [ref.(50)]			
, F	EXP.	SOAVE	PR	THIS WORK	, F	EXP.	SOAVE	PR	THIS WORK
100	0.64295	0.56543	0.63825	0.63385	50	0.00037	0.00037	0.00037	0.00037
130	0.62775	0.55158	0.62330	0.62283	80	0.00076	0.00075	0.00075	0.00075
158	0.61220	0.53757	0.60810	0.61109	100	0.00117	0.00115	0.00115	0.00115
160	0.61217	0.53653	0.60697	0.61020	150	0.00294	0.00291	0.00292	0.00292
190	0.59554	0.52012	0.58903	0.59579	180	0.00479	0.00470	0.00471	0.00472
212	0.58140	0.50710	0.57470	0.58400	200	0.00642	0.00630	0.00633	0.00633
220	0.57761	0.50214	0.56923	0.57944	250	0.01234	0.01221	0.01230	0.01229
250	0.55891	0.48231	0.54717	0.56093	260	0.01391	0.01380	0.01392	0.01390
280	0.53842	0.46028	0.52247	0.54001	280	0.01772	0.01749	0.01768	0.01762
302	0.52070	0.44244	0.50231	0.52298	290	0.01976	0.01962	0.01986	0.01977
310	0.51648	0.43555	0.49448	0.51640	300	0.02254	0.02198	0.02227	0.02214
340	0.49218	0.40729	0.46222	0.48973	310	0.02502	0.02457	0.02494	0.02475
370	0.46438	0.37430	0.42417	0.45955	320	0.02791	0.02743	0.02789	0.02764
392	0.43650	0.34562	0.39084	0.43471	330	0.03141	0.03060	0.03117	0.03082
400	0.42757	0.32084	0.36359	0.41408	340	0.03488	0.03410	0.03482	0.03435
446	0.33290	0.23487	0.26085	0.36523	350	0.03872	0.03800	0.03889	0.03827

Table B.9 Numerical Values of Experimental and Calculated Densities of Ethylene.

Temp.	Saturated Liquid Densities (gm./cc.) [ref.(51)]				Temp.	Saturated Vapor Densities (gm./cc.) [ref.(32)]			
, K	EXP	SRK	PR	THIS WORK	, K	EXP	SRK	PR	THIS WORK
110.0	0.64745	0.61772	0.69299	0.64160	130.0	0.00012	0.00012	0.00012	0.00012
120.0	0.63456	0.60761	0.68231	0.63030	140.0	0.00029	0.00029	0.00029	0.00029
130.0	0.62135	0.59684	0.67090	0.61867	150.0	0.00062	0.00062	0.00062	0.00062
140.0	0.60789	0.58537	0.65869	0.60667	160.0	0.00121	0.00121	0.00121	0.00121
150.0	0.59449	0.57312	0.64559	0.59424	160.8	0.00110	0.00126	0.00126	0.00127
160.0	0.58095	0.56002	0.63151	0.58131	164.3	0.00140	0.00156	0.00156	0.00156
164.5	0.57620	0.55389	0.62488	0.57536	168.3	0.00180	0.00195	0.00195	0.00196
170.0	0.56698	0.54599	0.61633	0.56779	169.1	0.00190	0.00204	0.00204	0.00205
174.1	0.56300	0.53992	0.60974	0.56205	170.0	0.00216	0.00215	0.00215	0.00216
176.0	0.56010	0.53705	0.60662	0.55935	176.0	0.00260	0.00294	0.00294	0.00295
180.0	0.55235	0.53090	0.59991	0.55360	180.0	0.00359	0.00357	0.00358	0.00360
184.9	0.54650	0.52315	0.59143	0.54643	180.4	0.00320	0.00364	0.00365	0.00367
190.0	0.53754	0.51462	0.58208	0.53862	184.9	0.00400	0.00448	0.00449	0.00452
199.0	0.52470	0.49890	0.56474	0.52442	190.0	0.00565	0.00561	0.00563	0.00567
205.0	0.51372	0.48762	0.55222	0.51438	205.0	0.01030	0.01021	0.01027	0.01035
220.0	0.48756	0.45678	0.51771	0.48747	220.0	0.01749	0.01731	0.01749	0.01764
235.0	0.45810	0.42088	0.47701	0.45701	235.0	0.02836	0.02803	0.02849	0.02865
250.0	0.42079	0.37769	0.42739	0.42158	250.0	0.04506	0.04437	0.04554	0.04538

Table B.10 Numerical Values of Experimental and Calculated Densities of Propylene.

Temp.	Saturated Liquid Densities (gm./cc.) [ref.(53)]				Temp.	Saturated Vapor Densities (gm./cc.) [ref.(52)]			
, F	EXP.	SRK	PR	THIS WORK	, F	EXP.	SRK	PR	THIS WORK
-108.8	0.64860	0.61538	0.69322	0.62662	40.0	0.01427	0.01399	0.01410	0.01419
-79.6	0.62850	0.59797	0.67455	0.61571	42.2	0.01461	0.01431	0.01443	0.01452
-72.0	0.62330	0.59319	0.66940	0.61254	56.3	0.01624	0.01786	0.01804	0.01815
-66.6	0.61940	0.58971	0.66564	0.61019	69.0	0.02192	0.02144	0.02170	0.02181
-60.7	0.61510	0.58580	0.66142	0.60751	70.0	0.02224	0.02175	0.02202	0.02212
-55.3	0.61090	0.58218	0.65750	0.60500	90.1	0.02958	0.02886	0.02934	0.02940
-49.0	0.60690	0.57788	0.65283	0.60198	100.0	0.03397	0.03308	0.03371	0.03371
-42.1	0.60260	0.57361	0.64819	0.59893	107.6	0.03773	0.03670	0.03746	0.03739
-35.4	0.59730	0.56828	0.64239	0.59506	122.6	0.04651	0.04507	0.04622	0.04590
-33.7	0.59630	0.56704	0.64104	0.59416	130.0	0.05155	0.04986	0.05127	0.05075
-29.9	0.59370	0.56427	0.63802	0.59212	135.9	0.05602	0.05409	0.05575	0.05501
-21.3	0.58760	0.55780	0.63095	0.58729	147.8	0.06652	0.06398	0.06628	0.06491
-9.2	0.57870	0.54844	0.62068	0.58015	158.6	0.07839	0.07502	0.07814	0.07582
3.8	0.56910	0.53782	0.60899	0.57186	160.0	0.08005	0.07655	0.07980	0.07732
32.0	0.54730	0.51301	0.58147	0.55175	168.6	0.09221	0.08755	0.09176	0.08799
66.2	0.51830	0.47865	0.54293	0.52253	177.9	0.10927	0.10229	0.10793	0.10193
77.0	0.53700	0.46656	0.52929	0.51188	180.0	0.11414	0.10636	0.11242	0.10570
122.0	0.47800	0.40787	0.46207	0.45918	186.5	0.13282	0.12096	0.12864	0.11886
167.0	0.39700	0.32489	0.36542	0.38468	190.0	0.14729	0.13195	0.14095	0.12832
194.0	0.29400	0.23375	0.25815	0.31933	194.3	0.17767	0.15091	0.16230	0.14328

Table B.11 Numerical Values of Experimental and Calculated Vapor Pressure of Methane, Ethane, and Ethylene.

Methane					Ethane					Ethylene				
Temp.	Vapor Presure (atm)				Temp.	Vapor Pressure (atm)				Temp.	Vapor Pressure (atm)			
, K	EXP.	SRK	PR	THIS WORK	, K	EXP.	SRK	PR	THIS WORK	, K	EXP.	SRK	PR	THIS WORK
95	0.1930	0.1958	0.1958	0.1954	164.96	0.2999	0.2673	0.2672	0.2668	130.00	0.0436	0.0436	0.0436	0.0436
100	0.3357	0.3395	0.3394	0.3385	174.96	0.5765	0.5621	0.5618	0.5603	140.00	0.1169	0.1170	0.1170	0.1169
105	0.5524	0.5575	0.5572	0.5552	184.11	0.9789	0.9283	0.9274	0.9242	150.00	0.2700	0.2707	0.2707	0.2702
110	0.8665	0.8734	0.8726	0.8684	194.36	1.6599	1.5279	1.5255	1.5187	160.00	0.5550	0.5568	0.5565	0.5551
115	1.3040	1.3134	1.3116	1.3037	199.16	2.0823	1.9163	1.9126	1.9031	160.76	0.5826	0.5086	0.5084	0.5072
120	1.8932	1.9057	1.9020	1.8881	226.18	6.0730	6.1956	6.1594	6.1142	164.26	0.7306	0.6589	0.6584	0.6566
125	2.6636	2.6800	2.6728	2.6500	234.58	8.0440	8.1716	8.1107	8.0539	168.26	0.9345	0.8634	0.8627	0.8599
130	3.6458	3.6674	3.6541	3.6190	238.90	9.2290	9.3580	9.2796	9.2185	169.06	0.9801	0.9146	0.9138	0.9107
135	4.8709	4.8998	4.8763	4.8254	248.65	12.3540	12.5105	12.3774	12.3166	170.00	1.0373	1.0420	1.0409	1.0370
140	6.3704	6.4099	6.3707	6.3009	258.80	16.4210	16.7329	16.5112	16.4792	176.01	1.4537	1.2930	1.2914	1.2863
145	8.1761	8.2307	8.1679	8.0779	263.28	18.4480	18.6690	18.4021	18.4020	180.00	1.7953	1.8052	1.8021	1.7930
150	10.3206	10.3951	10.2984	10.1897	268.73	21.1850	21.4303	21.0965	21.1538	180.41	1.8339	1.6208	1.6182	1.6111
155	12.8379	12.9348	12.7913	12.6705	273.09	23.5440	23.8627	23.4688	23.5927	184.86	2.2913	2.0586	2.0545	2.0443
160	15.7638	15.8838	15.6783	15.5593	278.84	26.8370	27.2577	26.7816	27.0279	190.00	2.9175	2.9364	2.9281	2.9099
165	19.1379	19.2785	18.9943	18.9010	283.58	30.1060	30.3847	29.8402	30.2236	205.00	5.4945	5.5389	5.5106	5.4702
170	23.0043	23.1631	22.7851	22.7537	288.26	33.4680	33.7086	33.1062	33.6610	220.00	9.4519	9.5324	9.4537	9.3886
175	27.4143	27.5991	27.1192	27.1994	290.77	35.7143	35.8973	35.2802	35.9486	235.00	15.1513	15.2846	15.0997	15.0399
180	32.4285	32.6724	32.1058	32.3566	294.99	39.1157	39.3769	38.7732	39.6419	250.00	22.9956	23.2159	22.8451	22.8965
185	38.1197	38.4597	37.9002	38.3551	300.88	44.2177	44.4062	44.0032	45.0934					
190	44.5771	44.7190	44.6409	44.8474	304.60	47.6191	47.5001	47.4818	48.2295					

Table B.12 Numerical Values of Experimental and Calculated Vapor Pressure of Propane, Propylene, and n-Hexane.

Propane					Propylene					n-Hexane				
Temp.	Vapor Presure (atm)				Temp.	Vapor Pressure (atm)				Temp.	Vapor Pressure (atm)			
, F	EXP.	SRK	PR	THIS WORK	, F	EXP.	SRK	PR	THIS WORK	, F	EXP.	SRK	PR	THIS WORK
-80	0.3844	0.3823	0.3821	0.3813	40.0	6.6327	6.7487	6.7035	6.6658	50	0.0980	0.1000	0.1000	0.1000
-70	0.5088	0.5066	0.5063	0.5050	42.2	6.8027	6.9224	6.8751	6.8374	60	0.1281	0.1295	0.1295	0.1294
-60	0.6653	0.6618	0.6613	0.6594	56.3	8.5034	8.6506	8.5789	8.5371	70	0.1654	0.1680	0.1680	0.1679
-50	0.8571	0.8530	0.8521	0.8493	70.0	10.3469	10.5319	10.4289	10.3890	80	0.2114	0.2142	0.2142	0.2140
-40	1.0884	1.0899	1.0885	1.0844	90.1	13.6054	13.8580	13.6899	13.6688	90	0.2672	0.2732	0.2731	0.2728
-30	1.3728	1.3606	1.3584	1.3527	100.0	15.4626	15.7574	15.5474	15.5468	100	0.3345	0.3399	0.3397	0.3393
-20	1.7041	1.7079	1.7044	1.6965	107.6	17.0068	17.3381	17.0913	17.1133	130	0.5101	0.5159	0.5155	0.5148
-10	2.1054	2.1112	2.1060	2.0952	122.6	20.4082	20.8186	20.4868	20.5760	140	0.7523	0.7592	0.7582	0.7571
0	2.5721	2.5966	2.5887	2.5745	130.0	22.2517	22.7002	22.3218	22.4574	160	1.0771	1.0908	1.0887	1.0871
20	3.7415	3.7622	3.7462	3.7239	135.9	23.8095	24.2926	23.8754	24.0554	180	1.5019	1.5279	1.5240	1.5219
40	5.2925	5.5045	5.4714	5.4371	147.8	27.2109	27.7560	27.2601	27.5509	200	2.0450	2.0812	2.0740	2.0717
60	7.2721	7.4866	7.4276	7.3864	158.6	30.6123	31.2115	30.6538	31.0694	220	2.7261	2.7478	2.7356	2.7341
80	9.7687	9.8899	9.7915	9.7533	160.0	31.0612	31.6664	31.1022	31.5353	240	3.5654	3.5636	3.5435	3.5444
100	12.8367	13.0266	12.8658	12.8491	168.0	34.0136	34.6630	34.0747	34.6189	260	4.5842	4.6146	4.5819	4.5883
120	16.5578	16.6921	16.4467	16.4912	177.9	37.4150	38.1074	37.5465	38.1980	280	5.8047	5.8657	5.8145	5.8312
140	20.9796	21.2783	20.9198	21.0911	180.0	38.2313	38.9235	38.3837	39.0516	300	7.2506	7.3975	7.3193	7.3541
160	26.1905	26.5920	26.1134	26.5102	186.5	40.8163	41.4777	41.0608	41.7280	320	8.9472	9.0635	8.9512	9.0131
180	32.1905	32.4622	31.9042	32.6323	190.0	42.3197	42.8555	42.5688	43.1590	330	9.8982	10.0876	9.9524	10.0335
190	35.5782	35.9812	35.4578	36.3708	194.3	44.2177	44.4238	44.4110	44.6240	340	10.9225	11.0960	10.9370	11.0396
200	39.1157	39.7993	39.5307	40.4445	197.0	45.4422	45.8334	45.4978	46.1230	350	12.0243	12.1755	11.9900	12.1174

Table B.13 Numerical Values of Experimental and Calculated Vapor Pressure of n-Butane, iso-Butane, n-Pentane, and iso-Pentane.

n-Butane					iso-Butane					n-Pentane					iso-Pentane				
Temp.	Vapor Presure (atm)				Temp.	Vapor Pressure (atm)				Temp.	Vapor Pressure (atm)				Temp.	Vapor Pressure (atm)			
. K	EXP.	SRK	PR	THIS WORK	. K	EXP.	SRK	PR	THIS WORK	. K	EXP.	SRK	PR	THIS WORK	. K	EXP.	SRK	PR	THIS WORK
272.67	1.0000	1.0098	1.0085	1.0051	250	0.6257	0.6273	0.6268	0.6249	309.19	1.0000	1.0126	1.0111	1.0083	301.03	1.0000	1.0056	1.0041	1.0007
280	1.3170	1.3221	1.3197	1.3147	260	0.9465	0.9492	0.9480	0.9444	310	1.0290	1.0409	1.0393	1.0363	310	1.3510	1.3621	1.3593	1.3540
290	1.9560	1.9626	1.9580	1.9498	270	1.3827	1.3877	1.3850	1.3787	320	1.4250	1.4439	1.4408	1.4363	320	1.8480	1.8661	1.8610	1.8529
300	2.5520	2.5559	2.5475	2.5351	280	1.9590	1.9690	1.9637	1.9534	330	1.9310	1.9589	1.9532	1.9467	330	2.4740	2.5013	2.4922	2.4807
310	3.4300	3.4274	3.4125	3.3949	290	2.7042	2.7204	2.7105	2.6946	340	2.5640	2.6056	2.5957	2.5869	340	3.2470	3.2879	3.2725	3.2572
320	4.5180	4.5013	4.4762	4.4532	300	3.6467	3.6702	3.6525	3.6298	350	3.3450	3.4036	3.3872	3.3763	350	4.1890	4.2457	4.2207	4.2018
330	5.8480	5.8232	5.7824	5.7546	310	4.8132	4.8537	4.8237	4.7935	360	4.2950	4.3752	4.3487	4.3368	360	5.3190	5.3991	5.3598	5.3386
340	7.4490	7.4286	7.3644	7.3348	320	6.2403	6.2999	6.2510	6.2142	370	5.4360	5.5427	5.5013	5.4909	370	6.6610	6.7706	6.7108	6.6907
350	9.3550	9.3638	9.2659	9.2408	330	7.9595	8.0446	7.9679	7.9284	380	6.7910	6.9285	6.8659	6.8618	380	8.2380	8.3824	8.2942	8.2813
360	11.6000	11.6606	11.5159	11.5076	340	10.0044	10.1217	10.0057	9.9721	390	8.3850	8.5586	8.4667	8.4770	390	10.0750	10.2657	10.1392	10.1438
370	14.2200	14.3642	14.1574	14.1863	350	12.4125	12.5691	12.3997	12.3878	400	10.2440	10.4574	10.3262	10.3636	400	12.2000	12.4478	12.2715	12.3094
380	17.2500	17.4881	17.2040	17.3017	360	15.2223	15.4229	15.1848	15.2206	410	12.3960	12.6560	12.4741	12.5574	410	14.6440	14.9619	14.7238	14.8179
390	20.7500	21.0554	20.6834	20.8945	370	18.4732	18.7200	18.3996	18.5221	420	14.8710	15.1753	14.9310	15.0969	420	17.4390	17.8362	17.5263	17.7080
400	24.7500	25.1191	24.6632	25.0450	380	22.2137	22.5102	22.1023	22.3659	430	17.7020	18.0582	17.7419	18.0064	430	20.6290	21.1316	20.7480	21.0577
410	29.3100	29.6758	29.1923	29.7880	390	26.4999	26.8210	26.3484	26.8166	440	20.9270	21.3348	20.9461	21.3638	440	24.2640	24.8723	24.4397	24.9203
414	31.3000	31.6267	31.1521	31.6484	400	31.4098	31.6926	31.2648	31.9600	450	24.5860	25.0415	24.6061	25.2226	450	28.4130	29.0495	28.6811	29.3336
420	34.4900	34.8278	34.5118	35.2617	405	34.2200	34.4790	34.3338	34.9313	460	28.7290	29.1730	28.7997	29.6098	455	30.7080	31.1447	30.9125	31.5694
422	35.6000	35.9051	35.7378	36.3887	406	34.7800	34.9489	34.8668	35.3797	468	32.4310	32.5477	32.5048	33.0598	459	32.6610	32.7692	32.7267	33.1645
424.5	37.0400	37.0951	37.1166	37.2796	407	35.3500	35.4124	35.4029	35.7408	469	32.9190	32.9469	32.9569	33.2683	460	33.1670	33.1772	33.1914	33.2997
425.16	37.4700	37.9016	37.5395	36.6605	408.13	36.0000	36.2308	36.0263	35.4011	469.5	33.1660	33.2089	33.1785	33.0578	460.39	33.3700	33.8442	33.4551	32.7437

Table B.14 Numerical Values of Experimental and Calculated Compressibility Factor of Ethane. [ref.(30)]

P (PSIA.)	TEMPERATURE , F														
	100					130					160				
	EXP.	SRK	PR	ICL	THIS WORK	EXP.	SRK	PR	ICL	THIS WORK	EXP.	SRK	PR	ICL	THIS WORK
14.70	0.99151	0.99337	0.99250	0.99328	0.99331	0.99243	0.99436	0.99363	0.99434	0.99445	0.99326	0.99519	0.99450	0.99518	0.99538
20	0.98943	0.99084	0.98978	0.99071	0.99088	0.99067	0.99223	0.99122	0.99219	0.99244	0.99187	0.99347	0.99242	0.99346	0.99370
40	0.98043	0.98159	0.97946	0.98132	0.98166	0.98336	0.98440	0.98238	0.98433	0.98481	0.98582	0.98673	0.98481	0.98671	0.98736
60	0.97172	0.97223	0.96905	0.97184	0.97233	0.97585	0.97650	0.97348	0.97640	0.97712	0.95247	0.98003	0.97716	0.98001	0.98098
100	0.95346	0.95318	0.94794	0.95256	0.95346	0.96113	0.96050	0.95552	0.96034	0.96154	0.96747	0.96652	0.96178	0.96649	0.96809
150	0.93007	0.92862	0.92081	0.92773	0.92904	0.94202	0.94014	0.93263	0.93993	0.94168	0.95193	0.94941	0.94239	0.94937	0.95175
200	0.90528	0.90322	0.89292	0.90212	0.90391	0.92172	0.91911	0.90931	0.91887	0.92137	0.93521	0.93192	0.92262	0.93187	0.93521
250	0.88019	0.87685	0.86413	0.87558	0.87789	0.90023	0.89761	0.88551	0.89738	0.90054	0.91810	0.91418	0.90267	0.91411	0.91822
300	0.85270	0.84937	0.83431	0.84799	0.85083	0.87841	0.87551	0.86117	0.87530	0.87916	0.89987	0.89611	0.88247	0.89603	0.90099
400	0.79531	0.79017	0.77062	0.78881	0.79292	0.83292	0.82928	0.81059	0.82919	0.83448	0.86327	0.85895	0.84123	0.85880	0.86551
500	0.72897	0.72332	0.69974	0.72245	0.72809	0.78329	0.77959	0.75704	0.77973	0.78672	0.82468	0.82023	0.79871	0.82002	0.82848
600	0.64571	0.64381	0.61682	0.64434	0.65219	0.72740	0.72569	0.69970	0.72611	0.73486	0.78193	0.77986	0.75492	0.77922	0.78954
700	0.53549	0.53740	0.50841	0.54161	0.55369	0.66348	0.66617	0.63737	0.66673	0.67751	0.73670	0.73772	0.70980	0.73634	0.74846
800	0.29595	0.33220	0.30876	0.26774	0.25565	0.59229	0.59930	0.56878	0.59896	0.61200	0.68910	0.69387	0.66351	0.69098	0.70473
1000	0.25271	0.29867	0.27129	0.24750	0.23911	0.42021	0.45313	0.42434	0.42223	0.43053	0.58685	0.60368	0.57086	0.59171	0.60701
1250	0.28906	0.33272	0.30075	0.27568	0.26730	0.34422	0.39952	0.36794	0.33138	0.31337	0.47334	0.51561	0.48260	0.46765	0.46627
1500	0.33014	0.37332	0.33674	0.30837	0.29953	0.36292	0.41733	0.38126	0.34164	0.32322	0.43455	0.49003	0.45437	0.41276	0.38644
1750	0.37141	0.41519	0.37405	0.34178	0.33232	0.39556	0.44859	0.40812	0.36494	0.34592	0.44197	0.50020	0.46053	0.41012	0.37852
2000	0.41296	0.45714	0.41157	0.37497	0.36491	0.43165	0.48395	0.43916	0.39182	0.37197	0.44139	0.52383	0.48001	0.42412	0.39055

Table B.15 Numerical Values of Experimental and Calculated Compressibility Factor of Propane. [ref.(35)]

P (ATM)	TEMPERATURE (C)														
	100					125					150				
	EXP.	SRK	PR	ICL	THIS WORK	EXP.	SRK	PR	ICL	THIS WORK	EXP.	SRK	PR	ICL	THIS WORK
5	0.95710	0.95949	0.95500	0.95906	0.95972	0.96560	0.96739	0.96319	0.96747	0.96844	0.97110	0.97359	0.96965	0.97376	0.97505
10	0.91370	0.91665	0.90781	0.91590	0.91728	0.93100	0.93356	0.92528	0.93378	0.93573	0.94280	0.94663	0.93882	0.94696	0.94952
15	0.86650	0.87100	0.85801	0.87010	0.87224	0.90250	0.89833	0.88616	0.89877	0.90174	0.91510	0.91890	0.90750	0.91939	0.92324
20	0.81600	0.82173	0.80477	0.82097	0.82395	0.85850	0.86151	0.84563	0.86224	0.86624	0.88670	0.89054	0.87565	0.89115	0.89626
25	0.76180	0.76760	0.74694	0.76715	0.77109	0.81950	0.82285	0.80338	0.82394	0.82899	0.85720	0.86146	0.84328	0.86213	0.86846
30	0.70010	0.70646	0.68247	0.70696	0.71202	0.77850	0.78178	0.75917	0.78333	0.78947	0.82700	0.83165	0.81031	0.83228	0.83977
35	0.62870	0.63377	0.60690	0.63630	0.64282	0.73360	0.73808	0.71258	0.74010	0.74731	0.79650	0.80095	0.77684	0.80138	0.80999
40	0.53300	0.53659	0.50793	0.54428	0.55313	0.68520	0.69109	0.66308	0.69349	0.70172	0.76420	0.76956	0.74289	0.76951	0.77907
50	0.22500	0.27525	0.25056	0.22472	0.20982	0.57600	0.58436	0.55373	0.58518	0.59443	0.69330	0.70495	0.67430	0.70238	0.71307
55	0.23260	0.27969	0.25362	0.23009	0.21710	0.50900	0.52548	0.49525	0.51977	0.52696	0.65800	0.67233	0.64027	0.66704	0.67762
60	0.24320	0.28983	0.26226	0.23898	0.22671	0.44150	0.47131	0.44228	0.44653	0.44251	0.62430	0.64040	0.60745	0.63073	0.64008
65	0.25620	0.30214	0.27300	0.24925	0.23728	0.39200	0.43517	0.40624	0.38439	0.35729	0.59070	0.61029	0.57689	0.59389	0.60049
70	0.27020	0.31547	0.28475	0.26018	0.24830	0.36880	0.41847	0.38840	0.35415	0.32235	0.55720	0.58354	0.54993	0.55757	0.55890
75	0.28420	0.32934	0.29705	0.27145	0.25954	0.36100	0.41378	0.38218	0.34362	0.31298	0.52660	0.56160	0.52780	0.52363	0.51623
80	0.29940	0.34353	0.30965	0.28292	0.27089	0.36140	0.41558	0.38248	0.34186	0.31246	0.50240	0.54534	0.51112	0.49439	0.47536
85	0.31330	0.35789	0.32244	0.29444	0.28227	0.36500	0.42111	0.38643	0.34443	0.31579	0.48620	0.53468	0.49976	0.47183	0.44104
90	0.32760	0.37238	0.33532	0.30600	0.29370	0.37200	0.42889	0.39267	0.34939	0.32123	0.47800	0.52890	0.49301	0.45622	0.41677
95	0.34200	0.38685	0.34825	0.31757	0.30507	0.38030	0.43812	0.40038	0.35581	0.32790	0.47370	0.52701	0.48998	0.44659	0.40198
100	0.35630	0.40135	0.36121	0.32914	0.31640	0.39130	0.44832	0.40908	0.36316	0.33535	0.47260	0.52813	0.48983	0.44146	0.39406
105	0.37100	0.41583	0.37415	0.34063	0.32767	0.40230	0.45919	0.41847	0.37115	0.34331	0.47400	0.53150	0.49189	0.43966	0.39075
110	0.38570	0.43029	0.38712	0.35207	0.33888	0.41400	0.47057	0.42834	0.37957	0.35162	0.47780	0.53658	0.49563	0.44025	0.39040
115	0.40050	0.44471	0.40001	0.36347	0.35004	0.42640	0.48224	0.43858	0.38830	0.36019	0.48300	0.54297	0.50066	0.44259	0.39210
120	0.41540	0.45909	0.41287	0.37480	0.36113	0.43900	0.49418	0.44908	0.39725	0.36892	0.48950	0.55039	0.50668	0.44621	0.39523
125	0.43020	0.47342	0.42570	0.38608	0.37216	0.45200	0.50630	0.45978	0.40636	0.37778	0.49800	0.55854	0.51348	0.45078	0.39937
130	0.44480	0.48769	0.43849	0.39729	0.38312	0.46520	0.51857	0.47067	0.41561	0.38672	0.50720	0.56730	0.52090	0.45609	0.40426

Table B.16 Numerical Values of Experimental and Calculated Compressibility Factor of Ethylene. [ref.(51)]

TEMPERATURE (C)															
15						25						50				
P	Z FACTOR					P	Z FACTOR					P	Z FACTOR			
(ATM.)	EXP.	SRK	PR	ICL	THIS WORK	(ATM.)	EXP.	SRK	PR	ICL	THIS WORK	(ATM.)	EXP.	SRK	PR	ICL	THIS WORK
16.7369	0.88486	0.88379	0.87164	0.88387	0.88341	17.4754	0.89291	0.89192	0.87966	0.89400	0.89270	19.3077	0.91021	0.90973	0.89731	0.91609	0.91217
20.2727	0.85743	0.85659	0.84205	0.85685	0.85623	21.2229	0.86751	0.86664	0.85195	0.86936	0.86765	23.5693	0.88890	0.88875	0.87381	0.89663	0.89160
28.0888	0.79201	0.79162	0.77208	0.79268	0.79151	29.6058	0.80679	0.80643	0.78659	0.81091	0.80802	33.3400	0.83826	0.83906	0.81866	0.85050	0.84248
34.5454	0.73055	0.73117	0.70791	0.73346	0.73153	36.6927	0.74993	0.75049	0.72674	0.75694	0.75259	41.9523	0.79110	0.79316	0.76855	0.80781	0.79637
43.9832	0.62009	0.62343	0.59571	0.62945	0.62503	42.6251	0.69694	0.69882	0.67217	0.70735	0.70120	49.5291	0.74718	0.75120	0.72336	0.76847	0.75320
47.2589	0.57109	0.57602	0.54725	0.58451	0.57809	47.8462	0.65193	0.64819	0.61954	0.65901	0.65040	56.1928	0.70642	0.71320	0.68301	0.73230	0.71272
49.7627	0.52618	0.53276	0.50367	0.54410	0.53479	51.6058	0.60270	0.60779	0.57809	0.62044	0.60911	62.1137	0.66930	0.67890	0.64699	0.69881	0.67428
51.6408	0.48536	0.49357	0.46469	0.50790	0.49429	54.9254	0.56129	0.56856	0.53832	0.58270	0.56771	67.4019	0.63550	0.64819	0.61531	0.66770	0.63761
53.0228	0.44852	0.45833	0.43014	0.47544	0.45472	57.6427	0.52361	0.53340	0.50325	0.54821	0.52836	71.1613	0.59640	0.62682	0.59346	0.64493	0.60994
54.0295	0.41549	0.42725	0.40022	0.44589	0.41039	59.6848	0.48957	0.50241	0.47273	0.51642	0.49003	76.4843	0.57691	0.59801	0.56427	0.61185	0.56817
54.7707	0.38609	0.40075	0.37503	0.41763	0.36055	61.7544	0.45896	0.47572	0.44674	0.48677	0.45109	80.5324	0.55222	0.57798	0.54413	0.58620	0.53423
55.3360	0.36007	0.37935	0.35481	0.38692	0.33713	63.3632	0.43168	0.45308	0.42480	0.45834	0.40861	84.3775	0.53037	0.56109	0.52718	0.56175	0.50059
55.7973	0.33713	0.36295	0.33908	0.33886	0.32105	64.7941	0.40747	0.43427	0.40659	0.43032	0.36086	88.1421	0.51142	0.54698	0.51296	0.53815	0.46741

Table B.17 Numerical Values of Experimental and Calculated Compressibility Factor of Propylene. [ref.(52)]

REDUCED PRESSURE	TEMPERATURE , F														
	91.4					100					125				
	EXP.	SRK	PR	ICL	THIS WORK	EXP.	SRK	PR	ICL	THIS WORK	EXP.	SRK	PR	ICL	THIS WORK
0.05	0.98200	0.98271	0.98079	0.98248	0.98241	0.98400	0.98396	0.98208	0.98386	0.98377	0.98700	0.98704	0.98529	0.98719	0.98704
0.10	0.96600	0.96504	0.96123	0.96459	0.96445	0.96900	0.96760	0.96388	0.96743	0.96723	0.97500	0.97392	0.97043	0.97421	0.97391
0.15	0.94800	0.94697	0.94132	0.94634	0.94612	0.95300	0.95093	0.94540	0.95069	0.95039	0.96300	0.96062	0.95543	0.96107	0.96062
0.20	0.93000	0.92834	0.92082	0.92754	0.92723	0.93600	0.93381	0.92645	0.93353	0.93312	0.94900	0.94715	0.94030	0.94778	0.94716
0.25	0.91200	0.90926	0.89993	0.90831	0.90792	0.91800	0.91633	0.90720	0.91604	0.91551	0.93500	0.93338	0.92485	0.93421	0.93341
0.30	0.88900	0.88962	0.87851	0.88856	0.88807	0.89900	0.89841	0.88754	0.89813	0.89747	0.91900	0.91946	0.90930	0.92049	0.91950
0.40	0.84800	0.84841	0.83386	0.84723	0.84653	0.86100	0.86108	0.84685	0.86093	0.85999	0.89000	0.89094	0.87761	0.89241	0.89100
0.50	0.80000	0.80395	0.78609	0.80286	0.80189	0.81800	0.82138	0.80391	0.82159	0.82023	0.85900	0.86142	0.84507	0.86339	0.86150
0.60	0.74800	0.75528	0.73432	0.75455	0.75326	0.77400	0.77871	0.75821	0.77934	0.77766	0.82800	0.83080	0.81151	0.83331	0.83087
0.70	0.69200	0.70059	0.67674	0.70071	0.69898	0.72700	0.73216	0.70885	0.73359	0.73138	0.79500	0.79880	0.77687	0.80191	0.79882
0.80	0.62500	0.63617	0.60985	0.63809	0.63565	0.67300	0.68017	0.65434	0.68292	0.67994	0.76100	0.76541	0.74100	0.76914	0.76526
0.90	0.53600	0.55233	0.52413	0.55867	0.55475	0.60800	0.61991	0.59205	0.62463	0.62059	0.72400	0.73038	0.70375	0.73469	0.72985
1.00	0.27300	0.27632	0.25217	0.39521	0.20341	0.52900	0.54480	0.51580	0.55304	0.54678	0.68500	0.69352	0.66494	0.69827	0.69222
1.10	0.20200	0.25149	0.22791	0.20383	0.20268	0.41800	0.43251	0.40571	0.44485	0.42863	0.64400	0.65457	0.62455	0.65941	0.65175
1.20	0.20900	0.25602	0.23146	0.20977	0.20904	0.26800	0.32085	0.29653	0.25813	0.25019	0.60000	0.61367	0.58272	0.61769	0.60785
1.30	0.21900	0.26495	0.23917	0.21793	0.21740	0.25500	0.30502	0.27914	0.24760	0.24377	0.54900	0.57143	0.54026	0.57258	0.55963
1.40	0.23000	0.27558	0.24851	0.22703	0.22664	0.25600	0.30611	0.27892	0.24949	0.24679	0.49900	0.52989	0.49910	0.52383	0.50635
1.50	0.24200	0.28705	0.25865	0.23661	0.23631	0.26200	0.31232	0.28384	0.25499	0.25284	0.45600	0.49331	0.46315	0.47311	0.45014
1.60	0.25400	0.29897	0.26924	0.24645	0.24621	0.27000	0.32086	0.29108	0.26210	0.26028	0.42100	0.46620	0.43615	0.42698	0.40140
1.70	0.26600	0.31114	0.28009	0.25641	0.25624	0.28000	0.33064	0.29954	0.27008	0.26848	0.39700	0.44961	0.41896	0.39437	0.37134
1.80	0.27800	0.32353	0.29108	0.26644	0.26631	0.28800	0.34114	0.30874	0.27857	0.27713	0.38100	0.44138	0.40968	0.37609	0.35674

Table b.18 Results of bubble point pressure calculations for ETHANE(1)-PROPANE(2) system at 100°F.

Pressure (psia.)		X1	Y1		K value			
					Ethane		Propane	
EXP.	THIS WORK		EXP.	THIS WORK	EXP.	THIS WORK	EXP.	THIS WORK
188.7	188.2	0	0	0	2.66	2.7269	1	1.0001
200	202.3	0.0313	0.0789	0.0801	2.52	2.5604	0.951	0.9501
250	257.0	0.149	0.310	0.3107	2.08	2.0852	0.811	0.8090
300	304.2	0.255	0.455	0.4544	1.79	1.7819	0.732	0.7325
350	357.0	0.353	0.558	0.5628	1.58	1.5943	0.683	0.6753
400	406.0	0.447	0.638	0.6456	1.43	1.4443	0.655	0.6414
450	454.5	0.535	0.704	0.7113	1.32	1.3291	0.636	0.6219
500	505.3	0.622	0.764	0.7693	1.23	1.2368	0.625	0.6112
550	556.7	0.705	0.816	0.8189	1.16	1.1629	0.624	0.6123
600	607.3	0.781	0.861	0.8635	1.10	1.1057	0.635	0.6249
650	652.0	0.843	0.894	0.8986	1.06	1.0660	0.672	0.6472
700	700.0	0.895	0.922	0.8951	1.03	1.0001	0.739	0.9994
725	725.0	0.919	0.935	0.9190	1.02	1.0000	0.825	1.0002
731.5	731.5	0.935	0.935	0.9350	1.00	1.0000	1	1.0000

Table b.19 Results of bubble point pressure calculations for ETHANE(1)-PROPANE(2) at 140°F.

Pressure (psia.)		X1	Y1		K value			
					Etane		Propane	
EXP.	THIS WORK		EXP.	THIS WORK	EXP.	THIS WORK	EXP.	THIS WORK
308.4	307.8	0	0	0.0003	2.21	2.1696	1	0.9999
350	350.3	0.0711	0.140	0.1388	1.97	1.8444	0.926	0.9277
400	401.0	0.152	0.267	0.2661	1.76	1.7504	0.864	0.8653
450	450.7	0.230	0.367	0.3673	1.60	1.5971	0.822	0.8222
500	501.0	0.305	0.448	0.4493	1.47	1.4731	0.794	0.7924
550	551.5	0.378	0.515	0.5186	1.36	1.3719	0.780	0.7738
600	601.4	0.448	0.573	0.5776	1.28	1.2892	0.774	0.7654
650	651.2	0.515	0.618	0.6282	1.20	1.2198	0.788	0.7667
700	702.3	0.581	0.655	0.6735	1.13	1.1592	0.823	0.7793
725	727.6	0.613	0.672	0.6941	1.10	1.1322	0.848	0.7907
750	750.0	0.652	0.670	0.6517	1.03	0.9996	0.947	1.0008
752	752.0	0.669	0.669	0.6653	1.00	1.0000	1.000	1.0097

Table B.20 Results of bubble point pressure calculations for ETHANE(1)-PROPANE(2) system at 180°F.

Pressure (psia.)		X1	Y1		K value			
					Ethane		Propane	
EXP.	THIS WORK		EXP.	THIS WORK	EXP.	THIS WORK	EXP.	THIS WORK
473.2	473.3	0	0	0	1.69	1.6873	1	1.0001
500	500.1	0.0356	0.0576	0.0575	1.60	1.6149	0.978	0.9774
525	525.8	0.0693	0.106	0.1075	1.53	1.5517	0.961	0.9590
550	550.9	0.102	0.149	0.1525	1.46	1.4949	0.948	0.9438
575	576.6	0.135	0.188	0.1947	1.39	1.4419	0.939	0.9311
600	602.6	0.168	0.225	0.2338	1.34	1.3919	0.931	0.9210
625	629.0	0.201	0.262	0.2702	1.30	1.3445	0.924	0.9133
650	656.2	0.235	0.294	0.3053	1.25	1.2991	0.923	0.9062
675	684.5	0.270	0.324	0.3386	1.20	1.2542	0.926	0.9061
700	700.0	0.309	0.331	0.3078	1.07	0.9961	0.968	1.0017
705	705.0	0.3215	0.322	0.3190	1.00	0.9921	1	1.0037

Table B.21 Results of bubble point pressure calculations for ETHANE(1)-n-BUTANE(2) system at 150°F.

Pressure (psia.)		X1	Y1		K value			
					Ethane		n-Butane	
EXP.	THIS WORK		EXP.	THIS WORK	EXP.	THIS WORK	EXP.	THIS WORK
514	505.2	0.482	0.797	0.7868	1.654	1.6324	0.392	0.4113
558	545.2	0.524	0.795	0.8038	1.517	1.5339	0.431	0.4123
637	617.0	0.596	0.818	0.8290	1.372	1.3909	0.450	0.4234
701	677.0	0.653	0.833	0.8462	1.276	1.2958	0.481	0.4434
765	745.0	0.714	0.842	0.8625	1.179	1.2079	0.552	0.4809
805	790.5	0.753	0.845	0.8720	1.122	1.1581	0.628	0.5180

Table B.22 Results of bubble point pressure calculations for ETHANE(1)-n-BUTANE(2) system at 200°F

Pressure (psia.)		X1	Y1		K value			
					Ethane		n-Butane	
EXP.	THIS WORK		EXP.	THIS WORK	EXP.	THIS WORK	EXP.	THIS WORK
509	506.0	0.299	0.575	0.5779	1.923	1.9328	0.606	0.6021
547	530.6	0.322	0.599	0.5966	1.860	1.8527	0.591	0.5951
594	578.2	0.364	0.614	0.6264	1.687	1.7208	0.607	0.5875
613	597.8	0.381	0.618	0.6372	1.622	1.6724	0.617	0.5861
666	648.0	0.424	0.639	0.6619	1.507	1.5611	0.627	0.5870
691	663.5	0.437	0.650	0.6688	1.487	1.5305	0.622	0.5888
769	747.0	0.506	0.662	0.7002	1.308	1.3888	0.684	0.6068
795	775.5	0.529	0.665	0.7091	1.257	1.3405	0.711	0.6175

Table B.23 Results of bubble point pressure calculations for ETHANE(1)-n-BUTANE(2) system at 250°F.

Pressure (psia.)		X1	Y1		K value			
					Ethane		n-Butane	
EXP.	THIS WORK		EXP.	THIS WORK	EXP.	THIS WORK	EXP.	THIS WORK
470	472.5	0.118	0.258	0.2556	2.186	2.1662	0.841	0.8439
518	510.8	0.149	0.294	0.3014	1.973	2.0228	0.830	0.8209
624	612.5	0.230	0.377	0.3958	1.639	1.7210	0.809	0.7847
701	689.0	0.290	0.422	0.4468	1.455	1.5406	0.814	0.7793
730	717.6	0.312	0.424	0.4636	1.359	1.4860	0.837	0.7795

Table B.24 Results of bubble point pressure calculations for ETHANE(1)-iso-BUTANE (2) system at 100.6°F.

Pressure (psia.)		X1	Y1		K value			
					Ethane		iso-Butane	
EXP.	THIS WORK		EXP.	THIS WORK	EXP.	THIS WORK	EXP.	THIS WORK
73	73.0	0	0	0	_	6.9175	1	1.0000
155	166.5	0.1782	0.5524	0.5701	3.100	3.1991	0.5447	0.5232
207	219.5	0.2742	0.6863	0.6820	2.503	2.4872	0.4322	0.4382
326	344.2	0.4841	0.8277	0.8148	1.710	1.6831	0.3340	0.3589
401	417.3	0.5955	0.8639	0.8589	1.451	1.4424	0.3356	0.3486
449	466.1	0.6648	0.8879	0.8823	1.336	1.3271	0.3344	0.3513
516	534.0	0.7536	0.9152	0.9095	1.214	1.2069	0.3442	0.3672
584	600.2	0.8314	0.9267	0.9328	1.127	1.1219	0.3761	0.3988
585	600.4	0.8318	0.9370	0.9330	1.127	1.1216	0.3750	0.3990
636	652.0	0.8858	0.9481	0.9496	1.071	1.0721	0.4529	0.4404
639	653.5	0.8875	0.9524	0.9504	1.072	1.0708	0.4230	0.4416
664	680.5	0.8135	0.9588	0.9592	1.050	1.0500	0.4763	0.4726
712	727.3	0.8541	0.9788	0.9747	1.026	1.0216	0.4619	0.5534

Table B.25 Results of bubble point pressure calculations for ETHANE(1)-iso-BUTANE (2) system at 160.4 °F.

Pressure (psia.)		X1	Y1		K value			
					Ethane		iso-Butane	
EXP.	THIS WORK		EXP.	THIS WORK	EXP.	THIS WORK	EXP.	THIS WORK
170	162.3	0	0	0	_	4.3952	1	1.0001
191	190.4	0.0367	0.1771	0.1399	4.826	3.8113	0.8543	0.8929
224	229.2	0.0867	0.2999	0.2800	3.459	3.2290	0.7666	0.7884
289	295.5	0.1697	0.4513	0.4376	2.659	2.5785	0.6609	0.6775
336	347.7	0.2328	0.5330	0.5208	2.290	2.2373	0.6087	0.6245
418	430.0	0.3285	0.6201	0.6129	1.888	1.8659	0.5657	0.5763
513	525.3	0.4333	0.6962	0.6853	1.607	1.6070	0.5361	0.5552
569	582.5	0.4931	0.7194	0.7180	1.459	1.4561	0.5536	0.5562
608	625.5	0.5366	0.7382	0.7389	1.376	1.3771	0.5650	0.5635
693	716.1	0.624	0.7766	0.7749	1.225	1.2418	0.6104	0.5989
779	813.0	0.7118	0.7792	0.8025	1.095	1.1274	0.7661	0.6850

Table B.26 Results of bubble point pressure calculations for ETHANE(1)-iso-BUTANE (2) system at 219.7 °F.

Pressure (psia.)		X1	Y1		K value			
					Ethane		iso-Butane	
EXP.	THIS WORK		EXP.	THIS WORK	EXP.	THIS WORK	EXP.	THIS WORK
327	312.4	0	0	0	_	2.7514	1	1.0001
340	335.2	0.0226	0.0593	0.0586	2.624	2.5920	0.9625	0.9632
394	395.3	0.0812	0.1827	0.1829	2.250	2.2522	0.8895	0.8892
441	451.0	0.1345	0.2657	0.2706	1.975	2.0119	0.8582	0.8427
489	482.0	0.1638	0.3342	0.3113	2.040	1.9003	0.7962	0.8237
532	550.0	0.2269	0.3854	0.3840	1.699	1.6924	0.7950	0.7968
602	602.0	0.2742	0.4248	0.4278	1.476	1.5603	0.8200	0.7882
657	677.3	0.3421	0.4554	0.4809	1.333	1.4057	0.8270	0.7890
701	721.0	0.3811	0.4694	0.5044	1.232	1.3236	0.8580	0.8006
720	760.0	0.4169	0.4690	0.5232	1.124	1.2549	0.9100	0.8178

Table B.27 Results of bubble point pressure calculations for PROPYLENE-PROPANE system.

X1	TEMPERATURE (K)											
	250				270				300			
	Pressure (bar)		Y1		Pressure (bar)		Y1		Pressure (bar)		Y1	
	EXP.	THIS WORK	EXP.	THIS WORK	EXP.	THIS WORK	EXP.	THIS WORK	EXP.	THIS WORK	EXP.	THIS WORK
0	2.18	2.149	0	0	4.31	4.257	0	0	9.99	9.936	0	0
0.1	2.27	2.209	0.1300	0.1227	4.45	4.363	0.1241	0.1192	10.26	10.153	0.1175	0.1148
0.2	2.34	2.269	0.2479	0.2393	4.58	4.468	0.2392	0.2333	10.51	10.367	0.2291	0.2258
0.3	2.41	2.329	0.3563	0.3501	4.70	4.574	0.3470	0.3426	10.75	10.585	0.3357	0.3331
0.4	2.48	2.389	0.4573	0.4557	4.82	4.680	0.4489	0.4474	10.98	10.800	0.4380	0.4371
0.5	2.54	2.449	0.5529	0.5564	4.92	4.785	0.5462	0.5483	11.19	11.018	0.5368	0.5378
0.6	2.59	2.509	0.6447	0.6527	5.02	4.891	0.6401	0.6452	11.40	11.234	0.6328	0.6358
0.7	2.63	2.569	0.7340	0.7449	5.11	4.996	0.7314	0.7387	11.60	11.453	0.7266	0.7305
0.8	2.68	2.628	0.8220	0.8334	5.19	5.102	0.8212	0.8287	11.78	11.670	0.8186	0.8228
0.9	2.71	2.688	0.9103	0.9183	5.26	5.207	0.9104	0.9158	11.95	11.890	0.9096	0.9126
1	2.74	2.747	1	1	5.33	5.312	1	1.0001	12.11	12.110	1	1

Table B.28 Numerical values of Experimental and Calculated Saturated Liquid and Vapor Volume for Methane and Ethane (calculated by Equation (3.34)).

METHANE						ETHANE					
		SATURATED VOLUME (lit/g-mole)						SATURATED VOLUME (lit/g-mole)			
TEMP.	P	VAPOR		LIQUID		TEMP.	P	VAPOR		LIQUID	
, K	(atm)	EXP.	CAL.	EXP.	CAL.	, K	(atm)	EXP.	CAL.	EXP.	CAL.
90.66	0.1133	64.13991	65.09928	0.03560	0.03567	164.96	0.2999	50.11668	44.39437	0.05259	0.05282
95	0.1930	39.45350	39.86282	0.03610	0.03612	167.36	0.3536	37.58750	38.11084	0.05287	0.05309
100	0.3357	23.83000	23.94901	0.03670	0.03665	168.06	0.3707	37.58750	36.47826	0.05295	0.05317
105	0.5524	15.13770	15.13248	0.03730	0.03720	173.46	0.5254	27.33636	26.39774	0.05362	0.05378
110	0.8665	10.03730	9.97880	0.03790	0.03778	174.96	0.5765	25.05833	24.21781	0.05380	0.05395
115	1.3040	6.90430	6.82143	0.03850	0.03840	177.86	0.6863	21.47857	20.59515	0.05416	0.05429
120	1.8932	4.90110	4.80738	0.03920	0.03907	184.11	0.9789	15.82632	14.79285	0.05498	0.05504
125	2.6636	3.57430	3.47657	0.04000	0.03980	185.06	1.0309	15.03500	14.09443	0.05510	0.05515
130	3.6458	2.66720	2.56955	0.04080	0.04060	190.06	1.3403	12.02800	11.02085	0.05578	0.05578
140	6.3704	1.56980	1.47834	0.04250	0.04247	194.36	1.6599	10.02333	9.01075	0.05637	0.05634
145	8.1761	1.23100	1.14434	0.04360	0.04358	199.16	2.0823	8.12703	7.26962	0.05705	0.05700
150	10.3206	0.97630	0.89494	0.04470	0.04482	290.77	35.7143	0.37377	0.31718	0.08613	0.08680
155	12.8379	0.78140	0.70532	0.04600	0.04625	292.94	37.4150	0.34488	0.29443	0.08828	0.08880
160	15.7638	0.62960	0.55910	0.04750	0.04788	294.99	39.1157	0.31804	0.27274	0.08997	0.09084
165	19.1379	0.50930	0.44465	0.04930	0.04979	297.05	40.8163	0.29403	0.25352	0.09232	0.09327
175	27.4143	0.33160	0.28074	0.05420	0.05478	300.88	44.2177	0.24261	0.21607	0.09932	0.09853
185	38.1197	0.19950	0.16940	0.06360	0.06262	302.77	45.9184	0.21428	0.19934	0.10534	0.10213
190	44.5771	0.12690	0.06797	0.08010	0.06797	304.60	47.6191	0.18276	0.18230	0.11596	0.10654

Table B.29 Numerical Values of Experimental and Calculated Saturated Vapor and Liquid Volume for n-Butane and n-Pentane (calculated by Equation (3.34)).

n-BUTANE						n-PENTANE					
TEMP.	P	SATURATED VOLUME (lit/g-mole)				TEMP.	P	SATURATED VOLUME (lit/g-mole)			
		VAPOR		LIQUID				VAPOR		LIQUID	
, K	(atm)	EXP.	CAL.	EXP.	CAL.	, K	(atm)	EXP.	CAL.	EXP.	CAL.
272.67	1.000	21.3840	21.28564	0.0967	0.09715	309.19	1.000	24.1040	24.05774	0.1182	0.11829
280	1.317	16.6360	16.39740	0.0980	0.09822	310	1.029	23.4910	23.41215	0.1184	0.11845
290	1.856	12.0700	11.82474	0.0998	0.09981	320	1.425	17.2830	17.17633	0.1204	0.12042
300	2.552	8.9580	8.69698	0.1018	0.10155	330	1.931	12.9610	12.82666	0.1226	0.12252
310	3.430	6.7780	6.51093	0.1040	0.10348	340	2.564	9.8810	9.73503	0.1249	0.12479
320	4.518	5.2160	4.94677	0.1064	0.10566	350	3.345	7.6440	7.48704	0.1274	0.03116
330	5.848	4.0560	3.80280	0.1090	0.10812	360	4.285	5.9870	5.82245	0.1302	0.12995
340	7.449	3.1820	2.95271	0.1119	0.11094	370	5.436	4.7390	4.57103	0.1332	0.13296
350	9.355	2.5110	2.31004	0.1151	0.11418	380	6.791	3.7850	3.61634	0.1365	0.13632
360	11.600	1.9920	1.81684	0.1188	0.11799	390	8.385	3.0440	2.87813	0.1401	0.14011
370	14.220	1.5840	1.43370	0.1230	0.12250	400	10.244	2.4610	2.29998	0.1443	0.14448
380	17.250	1.2620	1.13261	0.1281	0.12796	410	12.396	1.9950	1.84257	0.1490	0.14955
390	20.750	1.0040	0.89120	0.1343	0.13479	420	14.871	1.6190	1.47684	0.1546	0.15554
400	24.750	0.7907	0.69638	0.1425	0.14370	430	17.702	1.3090	1.18105	0.1613	0.16284
405	26.950	0.6963	0.61274	0.1477	0.14940	440	20.927	1.0490	0.93930	0.1698	0.17205
410	29.310	0.6096	0.53519	0.1543	0.15633	450	24.586	0.8238	0.73863	0.1814	0.18439
411	29.790	0.5937	0.52104	0.1558	0.15797	455	26.593	0.7192	0.65018	0.1894	0.19256
412	30.290	0.5770	0.50620	0.1575	0.15963	460	28.729	0.6155	0.56741	0.2002	0.20296
413	30.790	0.5605	0.49187	0.1592	0.16141	461	29.172	0.5944	0.55140	0.2029	0.03055
414	31.300	0.5431	0.47767	0.1611	0.16328	462	29.621	0.5730	0.53546	0.2059	0.20812
415	31.810	0.5260	0.46397	0.1632	0.16530	463	30.075	0.5512	0.51968	0.2093	0.21099
416	32.330	0.5077	0.45016	0.1654	0.16747	464	30.534	0.5288	0.50398	0.2131	0.21410
417	32.860	0.4896	0.43622	0.1679	0.16974	465	31.000	0.5057	0.48820	0.2175	0.21749
418	33.400	0.4706	0.42211	0.1706	0.17216	466	31.471	0.4816	0.47248	0.2228	0.22123
419	33.940	0.4511	0.40849	0.1737	0.17485	467	31.948	0.4569	0.45666	0.2294	0.22542
420	34.490	0.4293	0.39463	0.1772	0.17774	468	32.431	0.4244	0.44068	0.2385	0.23016
421	35.040	0.4057	0.38129	0.1813	0.18107	469	32.919	0.3887	0.42454	0.2537	0.23573
422	35.600	0.3794	0.36758	0.1863	0.18475	469.5	33.166	0.3504	0.41623	0.2716	0.23887
423	36.170	0.3538	0.35337	0.1929	0.18887	469.65	33.250	0.3040	0.41224	0.3040	0.23934

VITA

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