NBS TECHNICAL NOTE 1045

U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

An Equation of State for Fluid Ethylene

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A thermodynamic property formulation for ethylene, developed as a part of a joint industry-government project, is presented. The formulation includes an equation of state, vapor pressure equation, and equation for the ideal gas heat capacity. The coefficients were determined by a least squares fit of selected experimental data. Comparisons of property values calculated using the equation of state with measured values are given. The equation of state is not valid in the critical region ($\rho_c \pm 0.3\ \rho_c$ for temperatures of $T_c \pm 0.05\ T_c$). Errors on the order of 20 percent for derived properties and 10 percent for density may be encountered near the critical point. Tables of the thermodynamic properties of ethylene for the liquid and vapor phases for temperatures from the freezing line to 450 K with pressures to 40 MPa are presented. The equation of state and its derivative and integral functions for calculating thermodynamic properties are included. Estimates of the accuracy of calculated properties are given. A guide for use of computer programs for the calculation of thermodynamic properties of ethylene with listings of subprograms and a sample program to illustrate the use and results of the program are included.

Key words: Computer programs; equation of state; ethylene; thermodynamic properties; tabular values.

1. Introduction

Six years ago a group of Petrochemical companies and the National Bureau of Standards embarked on a joint industry-government project to determine the thermodynamic properties of ethylene. The first four years of the project were devoted to experimental work, which provided data for the development of a

[1] This work was a joint Industry-Government project under the sponsorship of Celanese Chemical Company, Cities Service Oil Company, Continental Oil Company, Gulf Research and Development, Mobil Chemical Company, Monsanto Polymers and Petrochemicals Company, Phillips Chemical Company, Union Carbide Corp. and the National Bureau of Standards.

[2] Participated in this project during a temporary assignment with the Thermophysical Properties Division. Permanent affiliation is the Center for Applied Thermodynamic Studies, University of Idaho, Moscow, Idaho 83843.

mathematical model for the thermodynamic properties of ethylene. The fifth and final year of the project was spent developing the model.

One of two resulting equations of state for ethylene is presented here for the range of liquid and vapor states for temperatures from the triple-point temperature to 450 K, with pressures to 40 MPa. The second equation of state is for the critical region and appears elsewhere (Hastings, et al. [14]). With a few exceptions, the equation of state presented here represents the selected experimental P-ρ-T data to within the estimated accuracies of these data. Comparisons to various experimental values of other thermodynamic properties indicate some discrepancies between those experimental data and values calculated using the equation of state. These discrepancies, which are discussed in sections 8 and 9, are particularly evident in the critical region, though some irreconcilable discrepancies are found outside of the critical region. The equation of state given here is not valid in the critical region ($\rho_c \pm 0.3\ \rho_c$ for temperatures of $T_c \pm 0.05\ T_c$).

The equation of state may be used for the calculation of accurate tables of thermodynamic properties of ethylene within the range of its applicability. This equation may also be readily adapted to systems analysis work where iterative solutions are required to solve the equation for known variable pairs other than density and temperature. A table of thermodynamic properties of ethylene for the range of applicability of the formulation is included here.

In determining the equation of state for ethylene, considerable experimentation in the use of various least squares methods and different functional forms was conducted. Also, experimentation in the use of different groupings of the independent data sets used in determining the equation of state led to the selection of several data sets for use in the least squares determination of the final coefficients.

In addition to the equation of state, the ancillary functions required for the calculation of thermodynamic properties are given. These include a vapor pressure equation, an equation for the ideal gas heat capacity, and equations for the density of the saturated liquid and saturated vapor.

A summary of the available data for ethylene is given, and the ranges of these data are tabulated. Comparisons of these measured data to values calculated from the equation of state have been made to establish the accuracy of the equation of state in representing P-ρ-T values and other thermodynamic properties. These comparisons have been divided into two groups. The first

group includes those data which were used in the fit and the second group consists of all the data sets that were known to the authors, including those used in the fit. The comparisons to data used in the fit are an indication of the success of the model in representing the data selected for the least squares process, while the comparisons to all data provide information about the relative agreement of data sets from different sources. The latter comparisons are included in Appendix A.

The thermodynamic properties reported here have been calculated using the equation of state and derivative relations among the thermodynamic properties. Since the equation of state has been developed to conform to the Maxwell criterion for phase equilibrium, properties of the liquid may be calculated by continuous integration of the equation of state through the two-phase (liquid-vapor) region of the surface. The liquid-vapor coexistence properties included in the tables have been calculated using the vapor pressure equation to establish the saturation temperature for each specified pressure.

No estimate of the accuracy of this formulation for the region near the critical point is presented here. Since analytic equations of state must fail at the critical point in the representation of anomalous behavior of certain properties, the user of this work is advised that this formulation should not be used within about 5 percent of the critical temperature and 30 percent of the critical density. The recent work of Hastings, et al. [14] should be used to calculate thermodynamic properties of ethylene within the near-critical region. The formulation of Hastings, et al. [14] includes a scaled fundamental equation using revised and extended scaling techniques that is accurate in the representation of critical region data to within 5×10^{-4} K in temperature, 5×10^{-5} MPa in pressure, and 0.03 percent in density. The critical point values of P-ρ-T used here are taken from Hastings, et al. [14].

Much of the experimental data used in the development of the equation of state for ethylene has been measured as a part of the joint industry-government ethylene project under the direction of the National Bureau of Standards, Office of Standard Reference Data. The availability of high quality measurements of the thermodynamic properties of ethylene has provided excellent definition of the surface of state, and has uncovered some problems of scientific interest in the representation of this surface by present modeling techniques. Further studies of the modeling of the surface of state of fluids of engineering interest may

well make use of the data for ethylene in efforts to improve the representation of data near saturation and in the critical region.

2. Experimental Measurements of the Thermodynamic Properties of Ethylene

2.1 Pressure-Density-Temperature Data

The experimental P-ρ-T data sets for ethylene are listed in table 1. The data for the liquid and vapor states of ethylene form a comprehensive network of values to represent the surface. The distribution of these data is shown in figure 1. For clarity, this figure includes only 2331 data points from the total of 2706 points listed in table 1. The data omitted are near the critical point. In instances where there are two or more papers by the same principal author, the symbols used in the data map represent data by that author from more than one reference.

2.2 Coexistence Properties

Recent measurements of the vapor pressure of ethylene are reported in Douslin and Harrison [6], Straty [33], Bigeleisen, et al. [3], Egan and Kemp [8], Hastings and Levelt-Sengers [13], Michels and Wassenaar [26], Tickner and Lossing [39], and Gammon [9]. Measurements of the orthobaric densities of ethylene are reported in Hastings, et al. [14], Golovskii and Tsymarnyi [10], Menes, et al. [24], and Haynes [15].

2.3 Calorimetric Data

Measurements of the isochoric heat capacity of ethylene for eight isochores have been made by Weber [47]. Nominal densities of these isochores are 4.6, 5.9, 6.7, 11.8, 15.6, 17.8, 21.6 and 20.0 mol/dm^3. Values of C_v have been derived from velocity of sound measurements by Gammon [9]. Isobaric heat capacity values for ethylene are reported by Vaschenko [42], by Hejmadi and Powers [16], and by Watanabe [45]. The C_v data of Weber [47] and Gammon [9] and the C_p data of Vaschenko [42], Hejmadi and Powers [16], and Watanabe [45] are illustrated in figure 2. Four C_p data points of Watanabe [45] and one C_p data point of Vaschenko [42] are for pressures below the scale of figure 2 and are not included in the figure. Selected values of the C_v data of Weber [47] were included in the data set used for determining the equation of state. However, these data were used in this work primarily to provide an indication of the reliability of values of C_v and C_p calculated using the equation of state and the ideal gas heat capacity equation.

Table 1. Summary of P-ρ-T Data for Ethylene

Source	Number of Data Points	Pressure Range (MPa)	Temperature Range (K)
Douslin and Harrison [6][3]	331[5]	1.4 - 39.6	248-448
	296[6]	1.3 - 27.6	238-284
	31[7]	5. - 24.6	282-448
Golovskii, et al. [11]	114	1.2 - 59.8	106-232
Golovskii, et al. [12]	162	5.7 - 201.1	199-329
Hastings and Levelt-Sengers [14][3]	141	4.7 - 8.4	279-303
Lee [21]	90	0.2 - 81.8	298-348
Levelt-Sengers [22]	91	0.2 - 3.5	220-273
Michels, et al. [27][4]	110	1.7 - 27.8	273-423
Michels and Geldermans [25][4]	311	1.7 - 308.3	273-423
Prasad [30]	145	0.2 - 5.6	298-423
Saville [31]	90	0.2 - 4.1	244-293
Straty [33]	244	0.6 - 370.5	105-320
Thomas, et al. [37]	123	3.7 - 25.4	244-354
Thomas and Zander [36]	43	0.3 - 3.0	273-323
Thomas, et al. [38]	87	0.3 - 9.9	253-348
Trappeniers, et al. [40]	675	1.6 - 289.8	273-423
Voityuk and Labinov [44]	74	sat.liq. - 6.0	183-273

[3] Data taken as a part of this project.

[4] These data have been superseded by those of Trappeniers, et al. [40] and are not used in this work.

[5] Data reported on isochores.

[6] Data reported on isotherms.

[7] Data for the critical isochore.

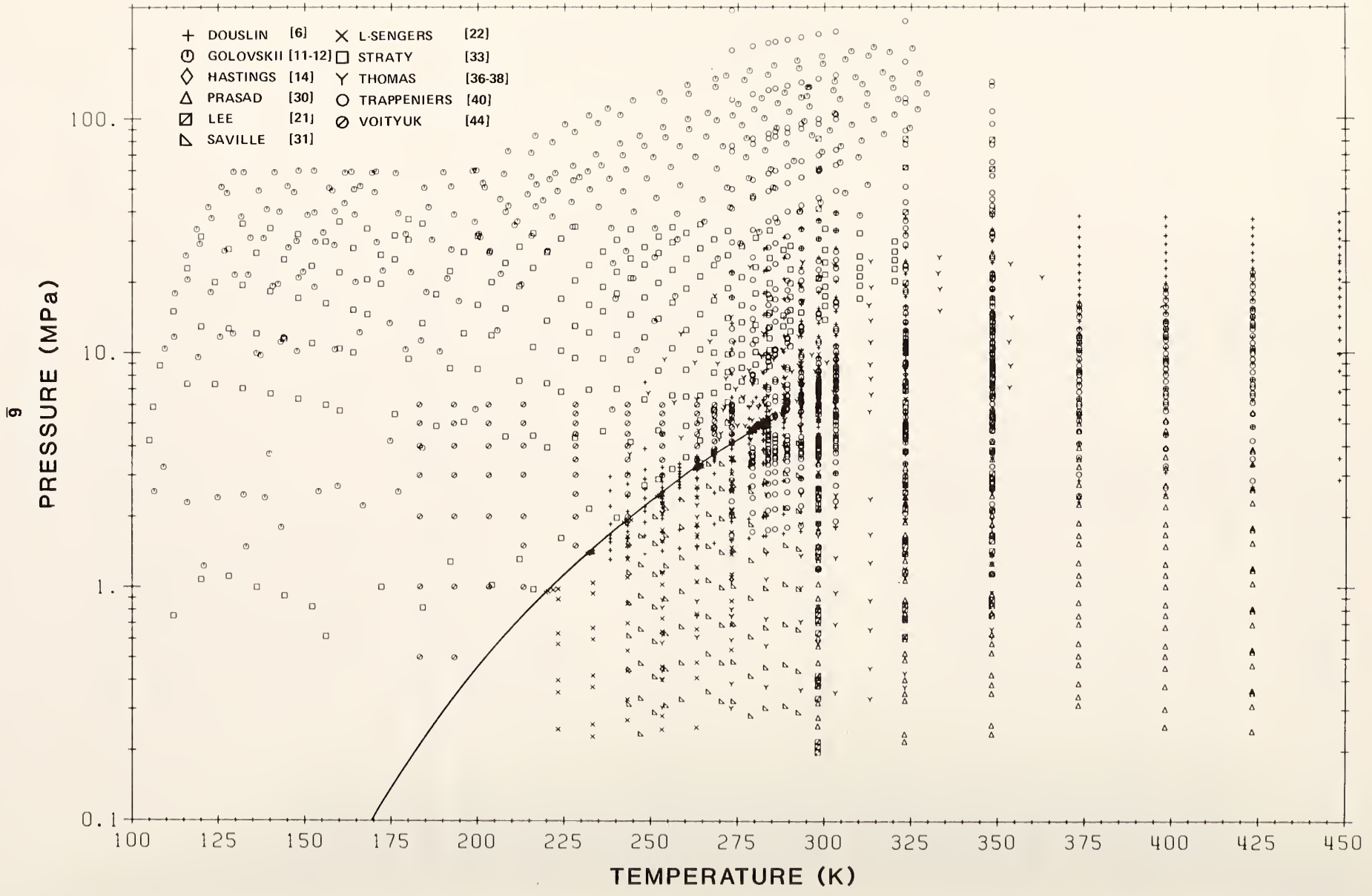


Figure 1. Ethylene PVT Data

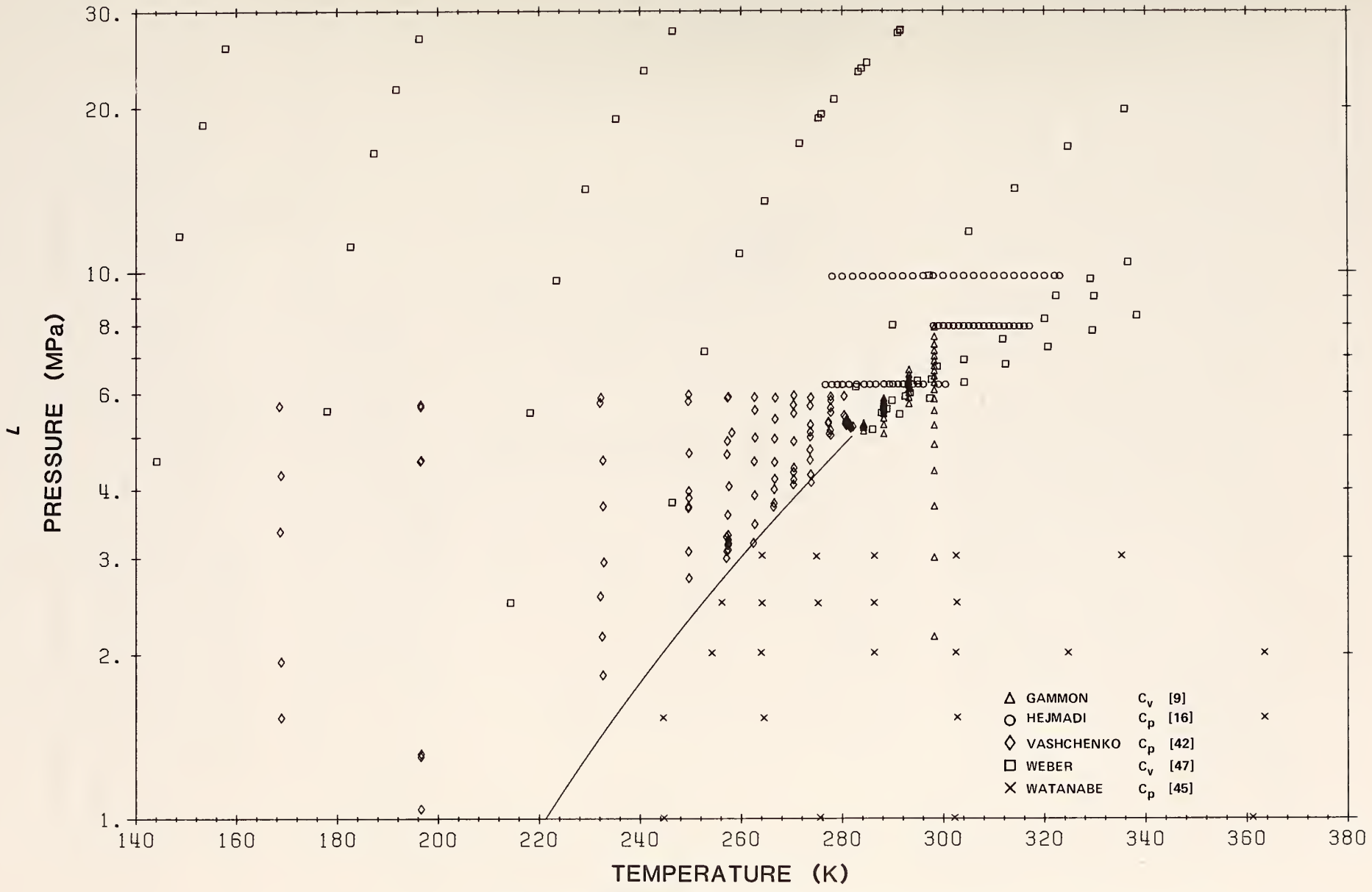


Figure 2. Ethylene Heat Capacity Data

2.4 Velocity of Sound Measurements

The velocity of sound of ethylene has been measured extensively. The 753 data points of Dregulyas and Stavtzev [7], Gammon [9], Soldatenko and Dregulyas [32], Terres, et al. [35], Mehl [23], and Herget [17] cover the surface of state as shown in figure 3. Five data points of Gammon [9] on the saturated liquid line are for pressures below the scale of figure 3 and are not shown on the figure. These data were not used in the fitting of the coefficients, except as noted below, but were used to provide confirmation of the accuracy of the resulting equation of state for the calculation of velocity of sound for both liquid and vapor states. Table 2 summarizes the recent velocity of sound data for ethylene.

Table 2. Recent Velocity of Sound Measurements for Ethylene

Source	Number of Data Points	Pressure Range (MPa)	Temperature Range (K)
Dregulyas and Stavtzev [7][8]	116	0.15 -59.0	193-282
Gammon [9][8]	200[9]	0.0002- 7.9	104-298
Soldatenko and Dregulyas [32][10]	262	0.03 - 9.9	193-473
Terres, et al. [35]	94	0.1 -11.8	296-448
Mehl [23]	24	0.1 - 1.0	273-373
Herget [17]	57	3.6 - 7.3	282-296

[8] Data taken as a part of this project.
[9] Including 28 data points for the saturated liquid.
[10] Including 10 data points for the saturated vapor.

2.5 Second Virial Coefficients

The second virial coefficient for ethylene is given in a number of the references in section 12. Three of the references, Douslin and Harrison [6], Levelt Sengers and Hastings [22], and Waxman [46] contain second virial coefficients from work which was a part of this project. These values, which are considered to be the best values available, are repeated in table 3 for the

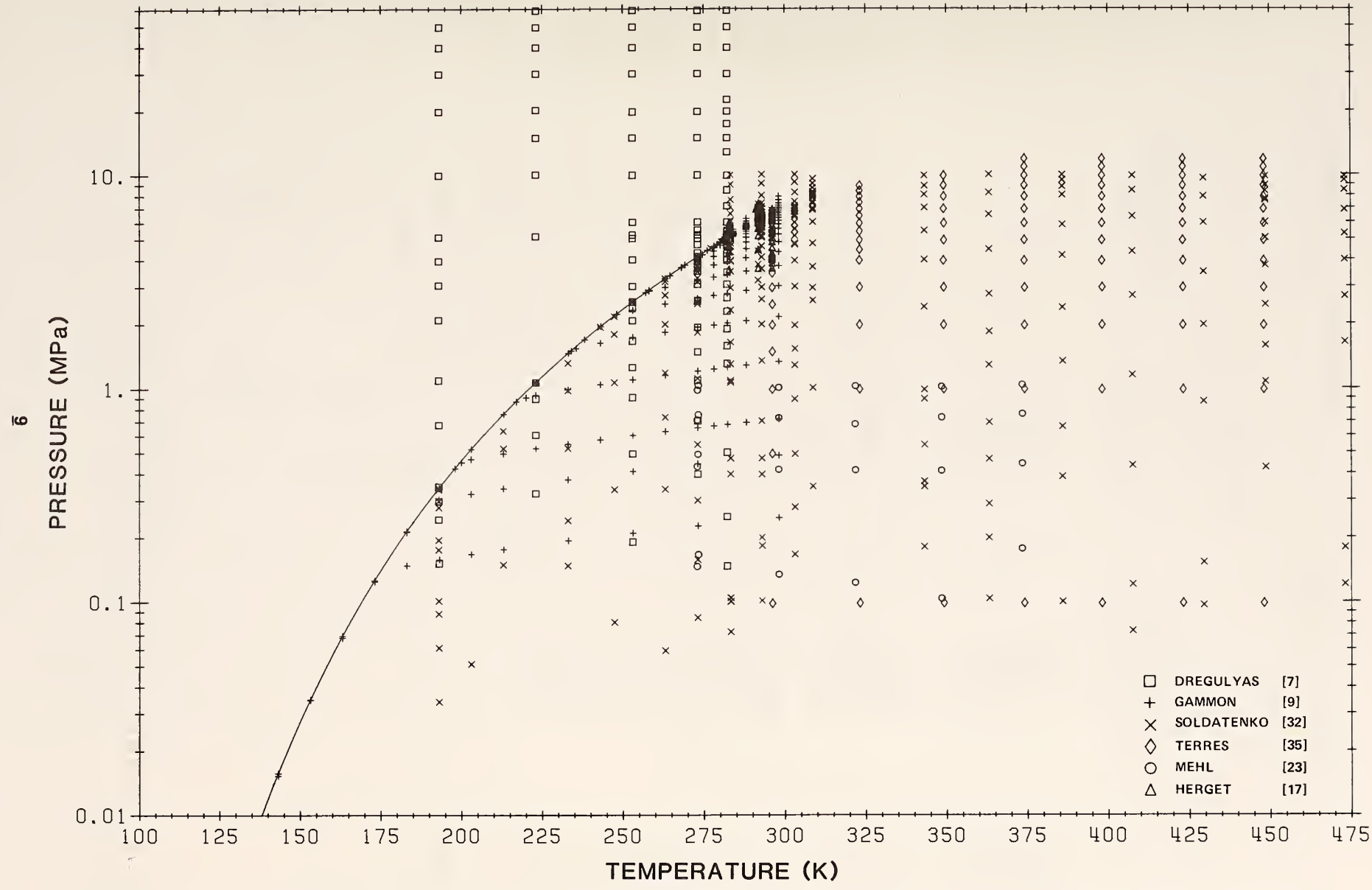


Figure 3. Ethylene Velocity of Sound Data

Table 3. The Second Virial Coefficient B(T) for Ethylene in the Infinite Series PV/RT = 1 + B(T)/V + . . .

	10^3 B(T)(dm^3/mol)			
T(K)	Douslin and Harrison [6]	Waxman [46]	Levelt Sengers and Hastings [22]	This Work
448.15	- 52.4	- 52.19		
423.15	- 61.6	- 61.34		
398.15	- 72.3	- 72.11		
373.15	- 84.8	- 84.61		
348.15	- 99.7	- 99.61		
323.15	-117.7	-117.69		
303.15	-135.0			
298.15	-139.8	-139.82		
293.15	-144.9			
288.15	-150.3			
283.15	-155.7			
282.35	-156.7			
278.15	-161.6			
273.15	-167.6	-167.67	-162.53	
268.15	-174.1			
263.15	-180.9		-180.58	
258.15	-188.1			
253.15	-195.5		-194.71	
248.15	-203.5			
243.15	-212.0		-211.57	
238.15	-220.9			
235				- 226.5
233.15			-228.78	
230				- 236.6
223.15			-249.17	
220				- 259.1
210				- 286.0
200				- 318.5
190				- 358.4
180				- 407.9
170				- 469.6
160				- 545.8
150				- 638.4
140				- 746.3
130				- 881.4
120				-1104.7
110				-1427.6
100				-1911.9

convenience of the reader. Temperatures in the table are given on the International Practical Temperature Scale of 1968. There is good agreement among the results of the three independent experiments. The values below 235 K were obtained by the authors by means of a simultaneous fit of Douslin and Harrison [6], Waxman [46] and the velocity of sound data by Gammon [9]. These values were not used in the fit of the final equation of state [eq (1)] but were used to determine saturated vapor densities at temperatures below 235 K.

3. Weighting of the Data

Each data point used in the least squares determination of the coefficients of the equation of state was assigned a weighting factor based upon estimates of uncertainties of the variables reported by the experimenter. In most cases these estimated uncertainties were taken from assessments of the overall accuracy of the data sets. Where reliable estimates of uncertainties were not available, estimated accuracies were determined by comparison to preliminary least squares representations of the surface. The weights used in the fitting process were calculated using approximating functions and the error propagation formula. In several instances, the error propagation weights were modified by the assignment of arbitrary multiplicative factors to increase or lessen the effect of a particular data set on the overall representation of the surface.

4. The Determination of the Equation of State

4.1 Analysis of the Functional Form of the Equation of State

Several functional representations were suggested as possible forms for the equation of state for ethylene. Among these are a 32-term modified Benedict-Webb-Rubin (BWR) equation originally proposed in Jacobsen [18], and four other forms which utilize stepwise regression methods to select individual terms from an initial comprehensive function containing a large number (50 to 80) of possible terms. These four forms include an 80-term modified BWR equation, two 50-term modified BWR equations (one using reduced coordinates and the other a dimensional form), and a 51-term fundamental equation which has been used successfully for other fluids (Jacobsen, et al. [19] and Mui, et al. [29]). For the ethylene data set described in this work, no clear preference for one of these forms over the others could be established on the basis of the quality of the fit of the data, and it was decided to use the pressure explicit dimensional

BWR equation proposed in Jacobsen [18] to represent the data for ethylene excluding a wide range of values near the critical point. This equation form is widely used for other fluids and has been shown to exhibit correct thermodynamic behavior for much of the surface of state. The equation form is given as eq (1).[11]

$$
\begin{aligned}
P = \rho RT &+ \rho^2(N_1T + N_2T^{1/2} + N_3 + N_4/T + N_5/T^2) \\
&+ \rho^3(N_6T + N_7 + N_8/T + N_9/T^2) \\
&+ \rho^4(N_{10}T + N_{11} + N_{12}/T) + \rho^5(N_{13}) \\
&+ \rho^6(N_{14}/T + N_{15}/T^2) + \rho^7(N_{16}/T) \\
&+ \rho^8(N_{17}/T + N_{18}/T^2) + \rho^9(N_{19}/T^2) \\
&+ \rho^3(N_{20}/T^2 + N_{21}/T^3)\ \exp(-\gamma\rho^2) \\
&+ \rho^5(N_{22}/T^2 + N_{23}/T^4)\ \exp(-\gamma\rho^2) \\
&+ \rho^7(N_{24}/T^2 + N_{25}/T^3)\ \exp(-\gamma\rho^2) \\
&+ \rho^9(N_{26}/T^2 + N_{27}/T^4)\ \exp(-\gamma\rho^2) \\
&+ \rho^{11}(N_{28}/T^2 + N_{29}/T^3)\ \exp(-\gamma\rho^2) \\
&+ \rho^{13}(N_{30}/T^2 + N_{31}/T^3 + N_{32}/T^4)\ \exp(-\gamma\rho^2)
\end{aligned}
\qquad (1)
$$

4.2 The Selection of Data for Multiproperty Fitting

This equation of state for ethylene was determined using experimental thermodynamic data including selected P-ρ-T, C_v, C_σ, velocity of sound data, and data to define saturation states to satisfy the Maxwell criterion for phase equilibrium. The P-ρ-T data selected for use in the least squares fitting process are illustrated in figure 4. The C_v data of Weber [47] used in the least squares fit were 7 points on the 11.8 mol/dm^3 isochore, 13 points at

[11] The nonlinear coefficient, $\gamma = 0.0172$, in each exponential term was specified prior to the determination of the linear coefficients.

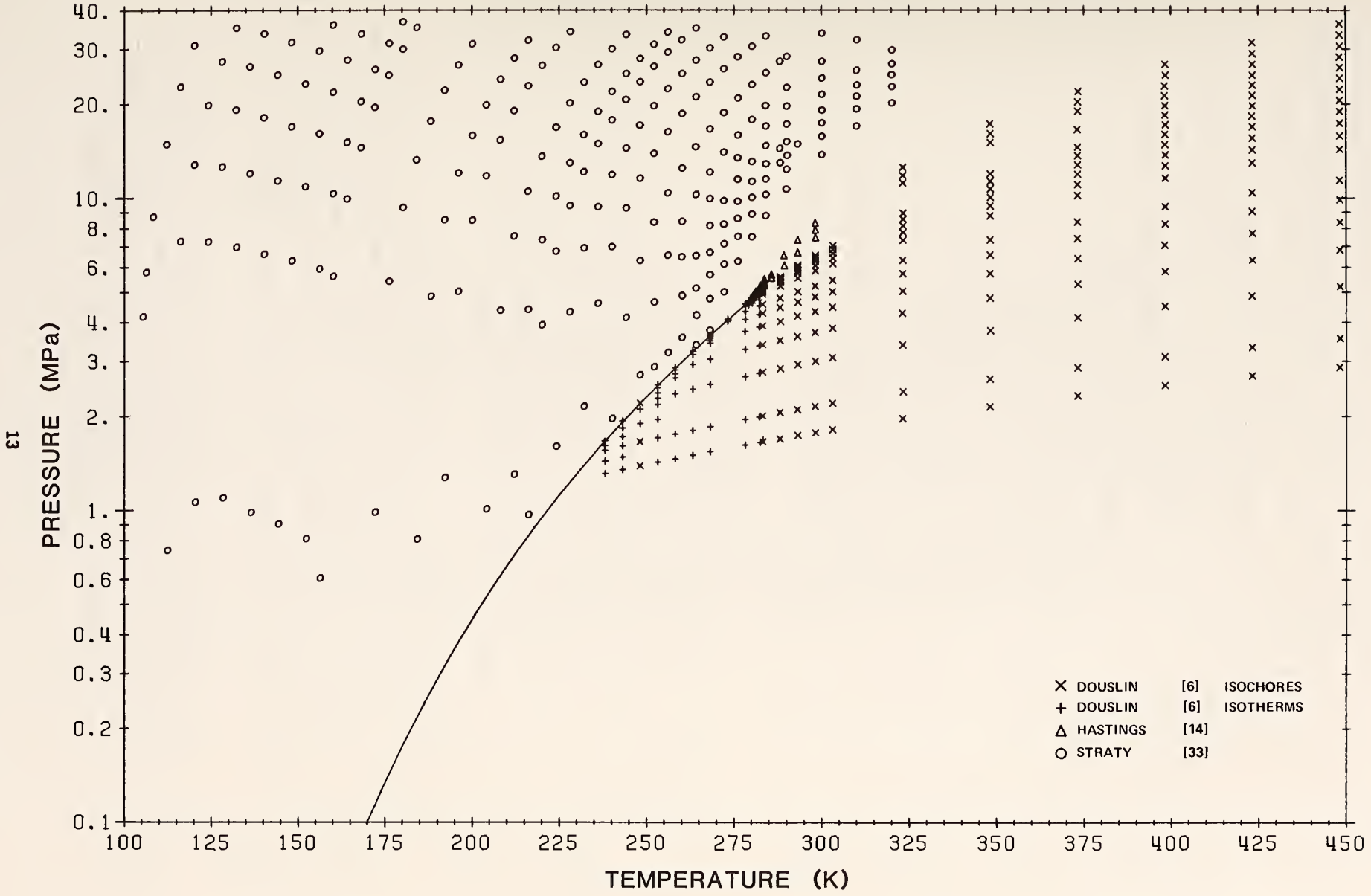


Figure 4. Ethylene PVT Data Used in the Determination of the Equation of State

15.6 mol/dm^3 and 4 points at 19.9 mol/dm^3. The velocity of sound data used in determining the equation of state data are illustrated in figure 5.

The multiproperty fitting procedures used here suggest the existence of systematic inconsistencies among the various data. The data sets which were not used in determining the final constants are those which seemed to exacerbate the problem of overall consistency. However, the authors were unable to determine the exact nature of the inconsistencies, and no conclusion as to probable or possible systematic errors within any given data set can be inferred from this work. Although the data near the critical point were excluded from the selected set, the critical point of the equation of state was constrained to the values T_c = 282.3428 K, P_c = 5.0403 MPa, and ρ_c = 7.6340 mol/dm^3. A later value of the critical temperature given in [14] is 282.3452 K. The equation of state for ethylene reported here, eq (1) with coefficients from table 4, has been compared to selected data sets to illustrate its accuracy. These comparisons are presented in section 8 and 9. Coefficients for the equation of state (1) for ethylene are given in table 4.

5. Liquid-Vapor and Liquid-Solid Coexistence

5.1 Liquid-Vapor Coexistence

The most difficult part of the fluid surface to model mathematically is that defining the liquid-vapor coexistence conditions. Even excluding the critical region, $T = T_c \pm .05\ T_c$ and $\rho = \rho_c \pm .3\ \rho_c$, where the equation of state is not valid, the rest of the two phase boundary is subject to errors in representation which may be most obvious in the derivative properties at saturation, i.e., C_v, C_p, and velocity of sound.

The procedure used here was to first obtain equations for the vapor pressure, the saturated vapor density, and the saturated liquid density as functions of saturation temperature. These equations, together with the condition of equality of Gibbs free energy for the coexisting liquid and vapor phases, were then used as input data in the least squares fit of the equation of state.

Recent vapor pressure data for ethylene are summarized in table 5. The vapor pressure equation for ethylene has been determined using the data of Gammon [9], Straty [33], Hastings and Levelt Sengers [13], Douslin and Harrison [6], and Bigeleisen, et al. [3]. The equation used in this work is

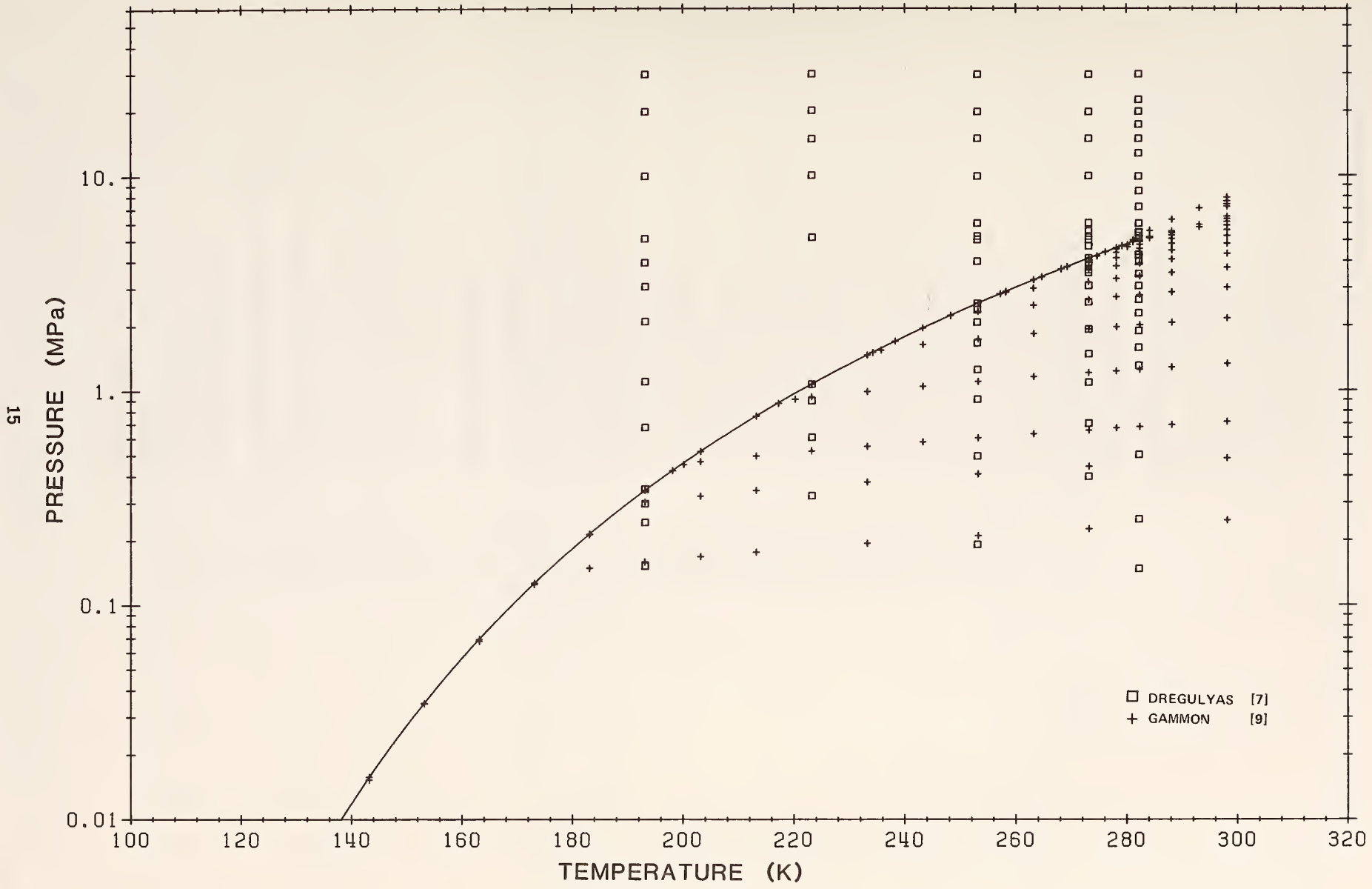


Figure 5. Ethylene Velocity of Sound Data Used in the Determination of the Equation of State

Table 4. Coefficients for the Equation of State (1) for Ethylene[12]

N_1	=	-.2146684366683E-02
N_2	=	.1791433722534E+00
N_3	=	-.3675315603930E+01
N_4	=	.3707178934669E+03
N_5	=	-.3198282566709E+05
N_6	=	.5809379774732E-04
N_7	=	-.7895570824899E-01
N_8	=	.1148620375835E+02
N_9	=	.2713774629193E+05
N_{10}	=	-.8647124319107E-05
N_{11}	=	.1617727266385E-01
N_{12}	=	-.2731527496271E+01
N_{13}	=	-.2672283641459E-03
N_{14}	=	-.4752381331990E-02
N_{15}	=	-.6255637346217E+01
N_{16}	=	.4576234964434E-03
N_{17}	=	-.7534839269320E-05
N_{18}	=	.1638171982209E-01
N_{19}	=	-.3563090740740E-03
N_{20}	=	-.1833000783170E+05
N_{21}	=	-.1805074209985E+07
N_{22}	=	-.4794587918874E+03
N_{23}	=	.3531948274957E+07
N_{24}	=	-.2562571039155E+01
N_{25}	=	.1044308253292E+03
N_{26}	=	-.1695303363659E-01
N_{27}	=	-.1710334224958E+03
N_{28}	=	-.2054114462372E-04
N_{29}	=	.6727558766661E-02
N_{30}	=	-.1557168403328E-06
N_{31}	=	-.1229814736077E-04
N_{32}	=	.4234325938573E-04
γ	=	0.0172
R	=	.00831434

[12] Coefficients are given for temperature in kelvins, pressure in MPa, and density in mol/dm^3.

$$\ell n\, P = N_1 + N_2 x + N_3 x^2 + N_4 x^3 + N_5 x^4 + N_6 x(1 - x)^{N_7} \qquad (2)$$

where,

$x = (1 - T_{tp}/T)/(1 - T_{tp}/T_c)$.

Table 5. Summary of Vapor Pressure Data for Ethylene

Author	Temperature Range Kelvins	No. of Points
1. Bigeleisen, et al. [3]	104-176	31
2. Douslin and Harrison [6]	238-282	18
3. Gammon [9]	104-282	28
4. Michels and Wassenaar [26]	149-281	30
5. Hastings and Sengers [13]	220-282	35
6. Straty [33]	200-282	27
7. Tickner and Lossing [39][13]	95-138	24

[13] This reference also contains vapor pressures for states below the triple point temperature. Values given in the reference are rounded values. Angus [1], page 3, gives 11 experimental values of the vapor pressure supplied by Lossing. These data have been omitted from comparisons in this section because of their apparent lack of agreement with other vapor pressure data for ethylene.

The values of T_{tp} and T_c for use in this equation are T_{tp} = 103.986 K and T_c = 282.3428 K. The coefficients of this equation for pressure in MPa and temperature in kelvins are given in table 6. Comparisons of values of saturation temperature calculated from the vapor pressure equation at data point pressures with the measured temperatures are given in figure 6. Three values from Gammon [9] for temperatures from 104-113 K exhibit deviations of from -0.8 to -1.8 K and are not included in figure 6. Saturated liquid and vapor density data used in constructing the two phase boundaries as outlined above are summarized in table 7.

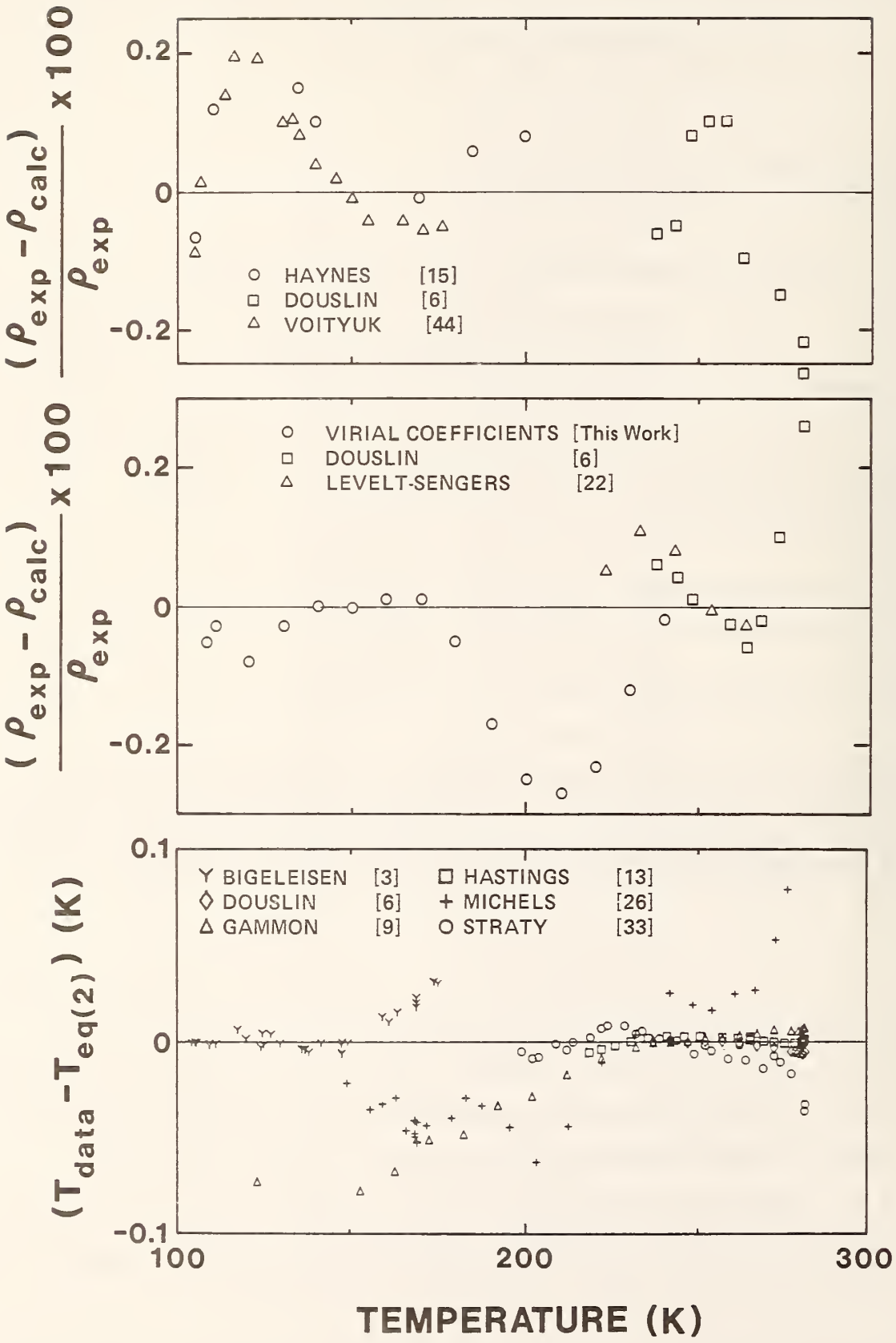


Figure 6. Comparisons of PVT Values at Saturation

Table 6. Coefficients for the Vapor Pressure Eq (2) for Ethylene

N_1	=	-9.017286635
N_2	=	8.209579800
N_3	=	4.315424145
N_4	=	-1.692585975
N_5	=	-0.1976495575
N_6	=	3.446501098
N_7	=	1.5

Table 7. Summary of Saturation Density Data Used in This Work

Author	Phase	Temperature Range Kelvins	No. of Points
Douslin and Harrison [6]	Liquid	238-282	14
	Vapor	238-281	12
Golovskii and Tsymarnyi [10]	Liquid	105-260	30
Hastings and Levelt-Sengers [13]	Liquid	279-282	9
Levelt-Sengers and Hastings [22]	Vapor	220-263	5
Haynes [15]	Liquid	105-200	7
Menes [24]	Liquid	105-175	15

The function for the saturated liquid density is

$$Y = A_1 \ln x + \sum_{i=2}^{4} A_i [1 - x^{(i-5)/3}] + \sum_{i=5}^{7} A_i [1 - x^{(i-4)/3}]$$

$$\rho_{satl} = \rho_c + e^{Y} (\rho_{tpl} - \rho_c) \quad , \tag{3}$$

where $x = (T - T_c)/(T_{tp} - T_c)$ and that for the saturated vapor density is

$$Y = A_i \ln(x) + \sum_{i=2}^{4} A_i [1 - x^{(i-5)/3}] + \sum_{i=5}^{13} A_i [1 - x^{(i-4)/3}] \quad (4)$$

$$\rho_{satv} = \rho_c + e^{Y}(\rho_{tpv} - \rho_c) \ ,$$

where x is as defined above. The coefficients for these equations used to represent the saturated liquid and vapor densities are given in table 8. These functions for the saturated liquid and saturated vapor densities are also useful to obtain a first approximation to the saturation density when solving the equation of state iteratively for the conditions at phase equilibrium.

Table 8. Coefficients for Approximating Functions for Saturation Densities for Ethylene[14]

Coefficients for Saturated Vapor (eq 4)		Coefficients for Saturated Liquid (eq 3)	
ρ_{tpv}	.142545512709E-03	ρ_{tpl}	.233429669403E+02
A_1	-.609621515594E+02	A_1	-.479047060183E+01
A_2	.203185312702E-01	A_2	.151381345283E-01
A_3	-.925441265813E+00	A_3	-.403456079445E+00
A_4	.243630795888E+02	A_4	.508683920225E+01
A_5	-.854745622888E+03	A_5	-.246711997987E+02
A_6	.123927868183E+04	A_6	.980030915247E+01
A_7	-.142710711789E+04	A_7	-.216846516122E+01
A_8	.837358670405E+03		
A_9	.432203696552E+03		
A_{10}	-.137917541161E+04		
A_{11}	.126858600124E+04		
A_{12}	-.571552321713E+03		
A_{13}	.106012234360E+03		

[14] Coefficients are given for T in kelvins and ρ in mol/dm^3.

The table of saturation properties in Appendix 3 was calculated by specifying T and then solving the vapor pressure equation, (2), for the saturation pressure. Using the P-T coordinates of a vapor pressure point, the equation of state (1) was then solved for the density of the saturated liquid and vapor using an appropriate iterative procedure. Figure 6 illustrates the agreement between the densities calculated in the above manner and corresponding values from various sources.

An alternative method of calculating the saturation properties is to solve the equation of state for the thermodynamic conditions for coexisting phases, i.e., equal Gibbs free energy for constant P and T. This calculation is accomplished by equating Gibbs free energy of the liquid to the Gibbs free energy of the vapor and the pressure of the liquid equal to the pressure of the vapor at a common temperature. This results in two equations in two unknows, i.e., density of the vapor and density of the liquid. As a matter of interest this calculation was done for the equation of state reported here and the results are shown in table 9.

5.2 Liquid-Solid Coexistence

The melting line equation used in this work is taken from Straty [33]. This equation is

$$P = 0.00012 + 357.924\ (T/T_{tp} - 1.0)^{2.0645} \qquad (5)$$

for pressure in MPa and temperature in kelvins where T_{tp} is 103.986 K.

6. The Ideal Gas Heat Capacity Equation

The ideal gas isobaric heat capacity values from Angus, et al. [1] for temperatures from 100 to 500 K have been represented by an equation suggested by Barieau [2].

$$C_p^o/R = N_1/T^3 + N_2/T^2 + N_3/T + N_4 + N_5T + N_6T^2 + N_7T^3 + N_8u^2e^u/(e^u-1)^2, \qquad (6)$$

where C_p^o is the ideal gas heat capacity, T is the temperature in kelvins, and $u = N_9/T$. The coefficients of eq (6) for temperatures in kelvins are given in table 10.

Table 9. Differences Between Saturation Properties Calculated From Equation of State (1) Using the Maxwell Criterion and the Intersection of the Vapor Pressure eq (2) With the Equation of State (1).

Temp. K	ΔP[15] (MPa)	$\Delta\rho_{vapor}$ (mol/dm^3)	$\Delta\rho_{liq}$ (mol/dm^3)	ΔG_{vapor} (J/mol)	ΔG_{liq} (J/mol)
110	-0.03	-0.3	$-5. \times 10^{-5}$	0.1	$1. \times 10^{-6}$
120	-0.008	-0.08	$-7. \times 10^{-8}$	0.02	$1. \times 10^{-6}$
130	-0.002	-0.02	$-9. \times 10^{-9}$	$4. \times 10^{-3}$	$3. \times 10^{-7}$
140	-0.006	-0.06	$-6. \times 10^{-7}$	$1. \times 10^{-2}$	$5. \times 10^{-6}$
150	-0.01	-0.1	$-4. \times 10^{-5}$	$2. \times 10^{-2}$	$2. \times 10^{-5}$
160	-0.02	-0.2	$-5. \times 10^{-5}$	$2. \times 10^{-2}$	$7. \times 10^{-5}$
170	-0.02	-0.2	$-4. \times 10^{-4}$	$4. \times 10^{-2}$	$1. \times 10^{-4}$
180	-0.02	-0.3	$-9. \times 10^{-5}$	$3. \times 10^{-2}$	$2. \times 10^{-4}$
190	-0.02	-0.2	$-2. \times 10^{-4}$	$3. \times 10^{-2}$	$3. \times 10^{-4}$
200	-0.02	-0.2	$-2. \times 10^{-4}$	$1. \times 10^{-2}$	$3. \times 10^{-4}$
210	-0.009	-0.1	$-2. \times 10^{-4}$	$9. \times 10^{-3}$	$2. \times 10^{-4}$
220	-0.003	-0.04	$-1. \times 10^{-4}$	$3. \times 10^{-3}$	$8. \times 10^{-5}$
230	0.001	0.01	$2. \times 10^{-4}$	$-9. \times 10^{-4}$	$-1. \times 10^{-4}$
240	0.004	0.05	$8. \times 10^{-4}$	$-3. \times 10^{-3}$	$-3. \times 10^{-4}$
250	0.005	0.08	$2. \times 10^{-3}$	$-3. \times 10^{-3}$	$-5. \times 10^{-4}$
260	0.004	0.08	$4. \times 10^{-3}$	$-2. \times 10^{-3}$	$-5. \times 10^{-4}$
270	0.002	0.07	$8. \times 10^{-3}$	$-8. \times 10^{-4}$	$-4. \times 10^{-3}$

[15] All property differences are formed by subtracting the property obtained by using the equation of state only from the property obtained by intersecting the vapor pressure equation with the equation of state.

Table 10. Coefficients for the Ideal Gas Heat Capacity Eq (6) for Ethylene

N_1	=	0.5603615762E+6
N_2	=	-0.2141069802E+5
N_3	=	0.2532008897E+3
N_4	=	0.3554495281E+1
N_5	=	-0.9951927478E-2
N_6	=	0.5108931070E-4
N_7	=	-0.1928667482E-7
N_8	=	-0.2061703241E+2
N_9	=	0.3000000000E+4

Values of the ideal gas heat capacity calculated using this equation have been compared to values calculated using the equation published by Angus, et al. [1]. The agreement of these calculated values is generally within $\pm$ 0.01 percent except at temperatures above 460 K where the differences increase to 0.03 percent. A comparison of values of the ideal gas heat capacity calculated using this equation with those of more recent work by Chao and Zwolinski [4], ideal gas heat capacities derived from the low density velocity of sound measurements by Moldover [28] values from Angus [1], and values from the JANAF tables [34] are shown in figure 7. Not shown in the figure are three points of Chao and Zwolinski [4] at 50 K, 319 K, and 340 K which exhibit deviations of -4.1 percent, -0.95 percent, and -1.25 percent respectively.

7. Derived Thermodynamic Properties

Functions for the calculation of entropy, enthalpy, internal energy, the isotherm derivative $(\partial P/\partial \rho)_T$, the isochore derivative $(\partial P/\partial T)_\rho$, C_v, C_p, and the velocity of sound have been calculated for the thermodynamic formulation presented here. The basis for these calculations is described in this section.

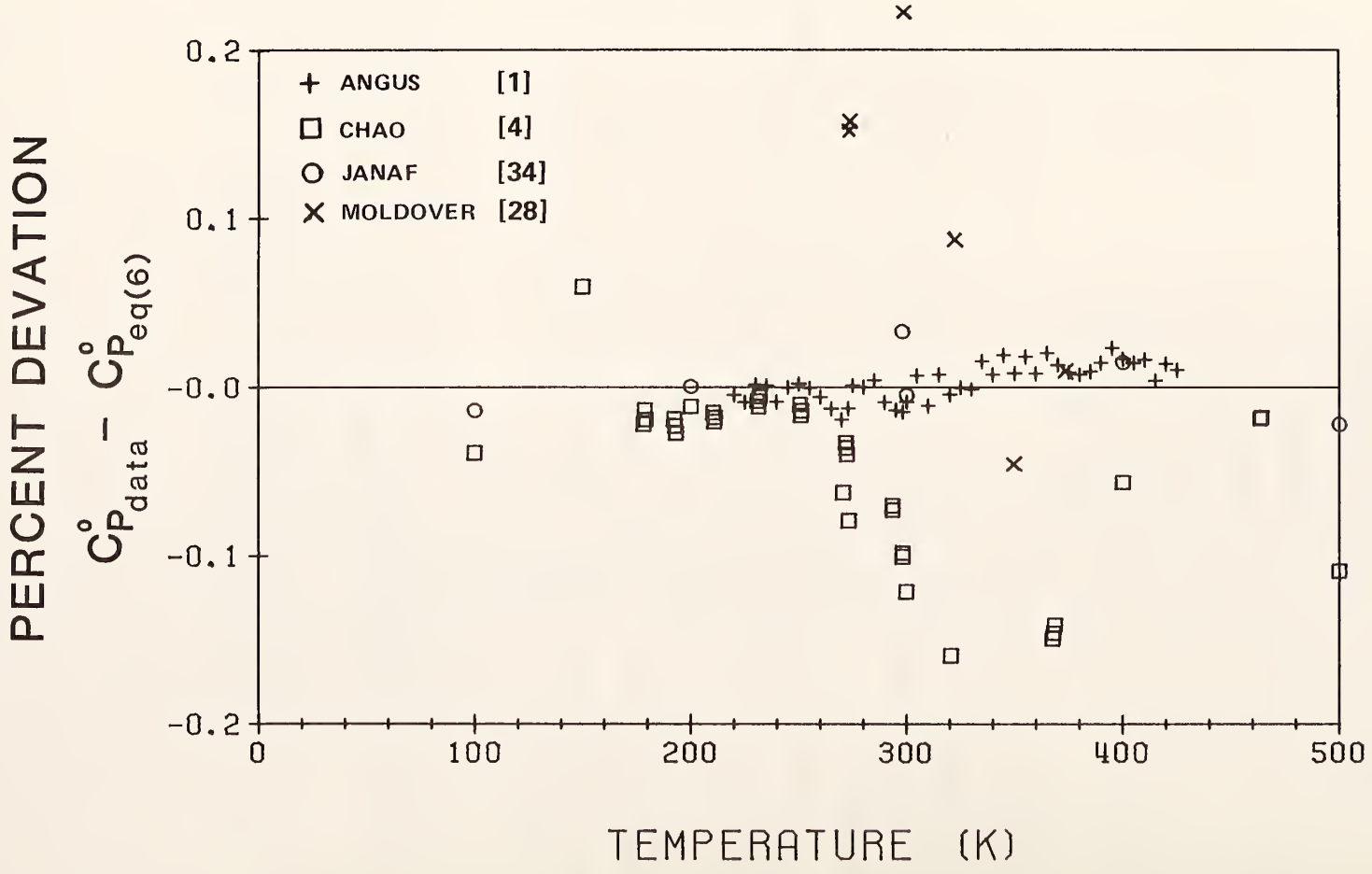


Figure 7. Comparisons of Ideal Gas Heat Capacity Values

The entropy of any thermodynamic state may be calculated from

$$S(T,\rho) = S^{o}_{T_o} + \int_{T_o}^{T} (C^{o}_{p}/T)dT - R\,\ell n(RT\rho/P_o) + \int_{o}^{\rho} [R/\rho - (1/\rho^2)(\partial P/\partial T)_\rho]_T\, d\rho \quad . \tag{7}$$

The ideal gas specific heat, C^{o}_{p}, is from eq (6). The reference entropy of the ideal gas at T_o = 298.15 K and P_o = 0.101325 MPa, $S^{o}_{T_o}$ = 219.225 J/(mol K) is taken from Angus, et al. [1].

The enthalpy of any state may be calculated from

$$H(T,\rho) = H^{o}_{T_o} + T\int_{o}^{\rho} [(R/\rho) - (1/\rho^2)(\partial P/\partial T)_\rho]_T\, d\rho + \int_{o}^{\rho} [(P/\rho^2) - (RT/\rho)_T]\, d\rho + (P - \rho RT)/\rho + \int_{T_o}^{T} C^{o}_{p}\, dT \quad . \tag{8}$$

The reference enthalpy of the ideal gas at T_o = 298.15 K of $H^{o}_{T_o}$ = 29.610 J/mol was taken from Angus, et al. [1].

The internal energy of a fluid state is calculated from

$$U(T,\rho) = H(T,\rho) - P/\rho \quad . \tag{9}$$

The specific heat at constant volume, C_v, of liquid and gas phase points is calculated using the relation

$$C_v(T,\rho) = (C^{o}_{p} - R) - \int_{o}^{\rho} [(T/\rho^2)(\partial^2 P/\partial T^2)_\rho]_T\, d\rho \quad , \tag{10}$$

where C^{o}_{p} at temperature, T, is calculated from eq (6).

The specific heat at constant pressure, C_p, is given by

$$C_p(T,\rho) = C_v(T,\rho) + [(T/\rho^2)(\partial P/\partial T)^2_\rho/(\partial P/\partial \rho)_T] \quad . \tag{11}$$

The velocity of sound is calculated from the relation,

$$W(T,\rho) = [(C_p/C_v)\,(\partial P/\partial \rho)_T]^{1/2} \quad . \tag{12}$$

The representations for the properties are continuously integrated through the two-phase region to define states in the liquid range. This was made possible by

the fitting procedures employed in the development of the equation of state in which the conditions for two-phase equilibrium were included in the least squares determination of the coefficients for the equation of state. A table of properties of ethylene is included in Appendix B.

8. Comparisons of the Equation of State to P-ρ-T Data

Comparisons of values of density calculated using the equation of state with experimental densities used in determining the coefficients of eq (1) are included in the graphs of figure 8. Calculated density deviations for thirty-nine of the selected data points of Douslin and Harrison [6] and six data points of Hastings, et al. [14] exceeded the scale of figure 8. Thirty-four of these points of Douslin and Harrison and all of the points of Hastings are in the critical region (within $\pm$ 30 percent of the critical density and within $\pm$ 5 percent of the critical temperature). Comparisons to all P-ρ-T data including those data not used in the determination of the equation of state are given in Appendix A. The critical region is outside the range of this formulation; however to illustrate the actual behavior of the formulation in the critical region, comparisons with critical region data are included in Appendix A.

9. Comparisons of the Equation of State With Related Thermodynamic Data

Although only selected thermodynamic data together with the P-ρ-T data were used in determining the equation of state, comparisons to these data as well as other derived property data are given here to indicate the accuracy of the equation of state in representing these related properties. Figure 9 includes comparisons with the C_v data of Weber [47][16] and with values from Gammon [9]. Table A-2 includes values of C_v which exhibit deviations larger than the scale of figure 9.

Comparisons to the velocity of sound data used in determining the equation of state are illustrated in figure 10. Five data points of Dregulyas [7] have deviations beyond the scale of figure 10 ranging from -1.1 to -3.8 percent. Thirteen data points of Gammon [9] have absolute deviations from 1.1 to 1.7 percent, and are also excluded from figure 10. Figure 11 is a comparison to the

[16] Data taken as a part of this project.

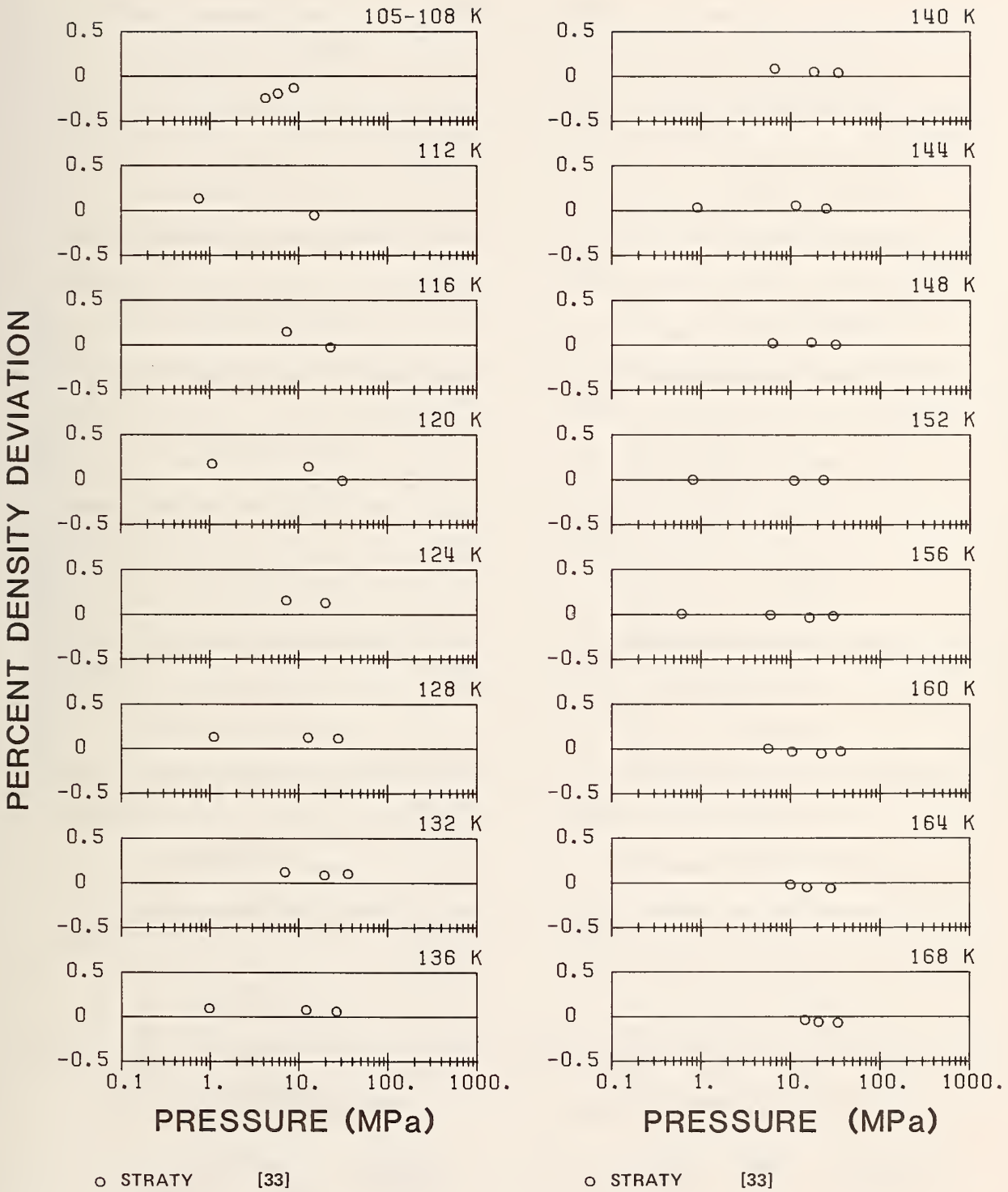


Figure 8. Deviations of Calculated Values of Density from Selected PVT Data

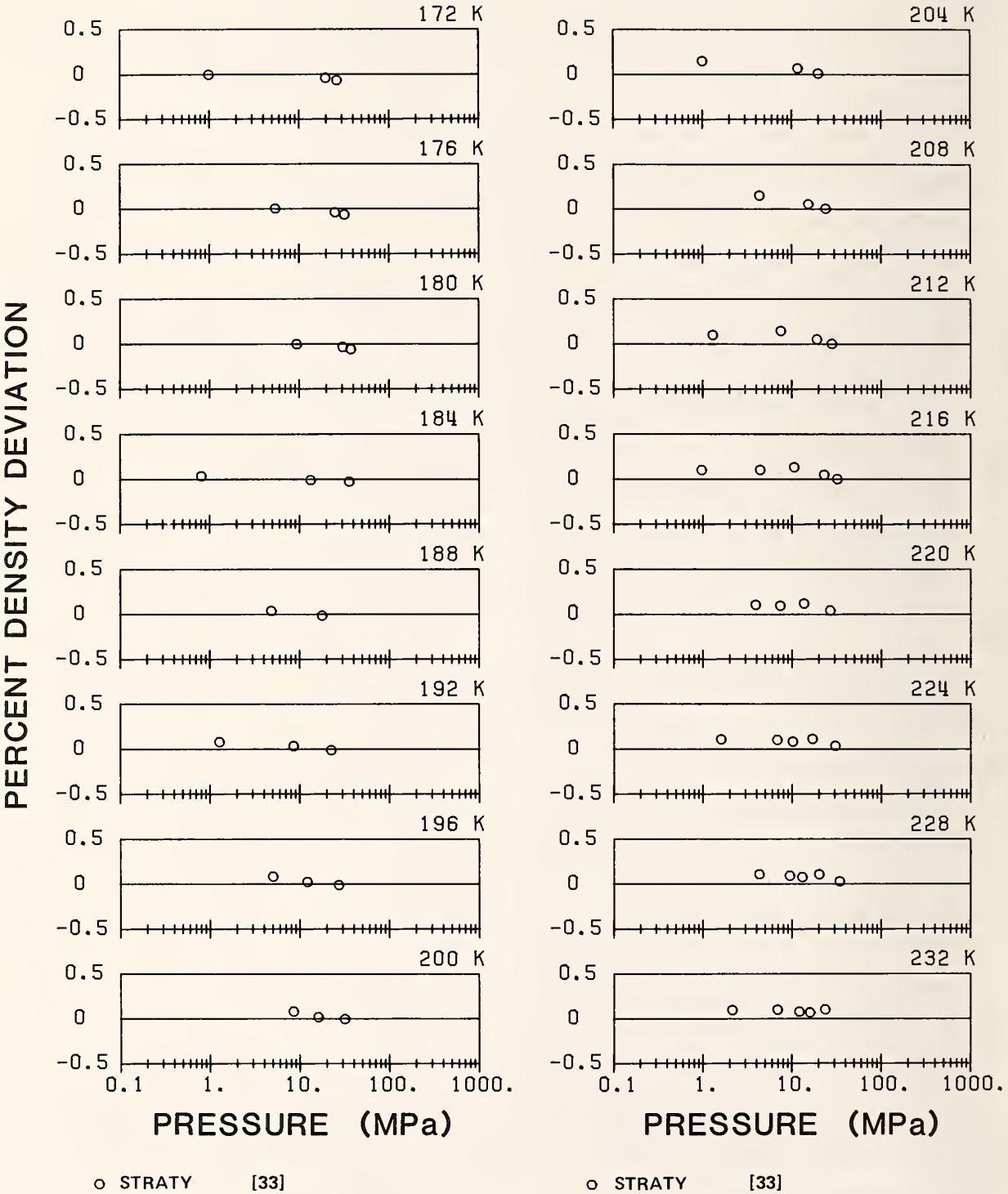


Figure 8. Deviations of Calculated Values of Density from Selected PVT Data (Continued)

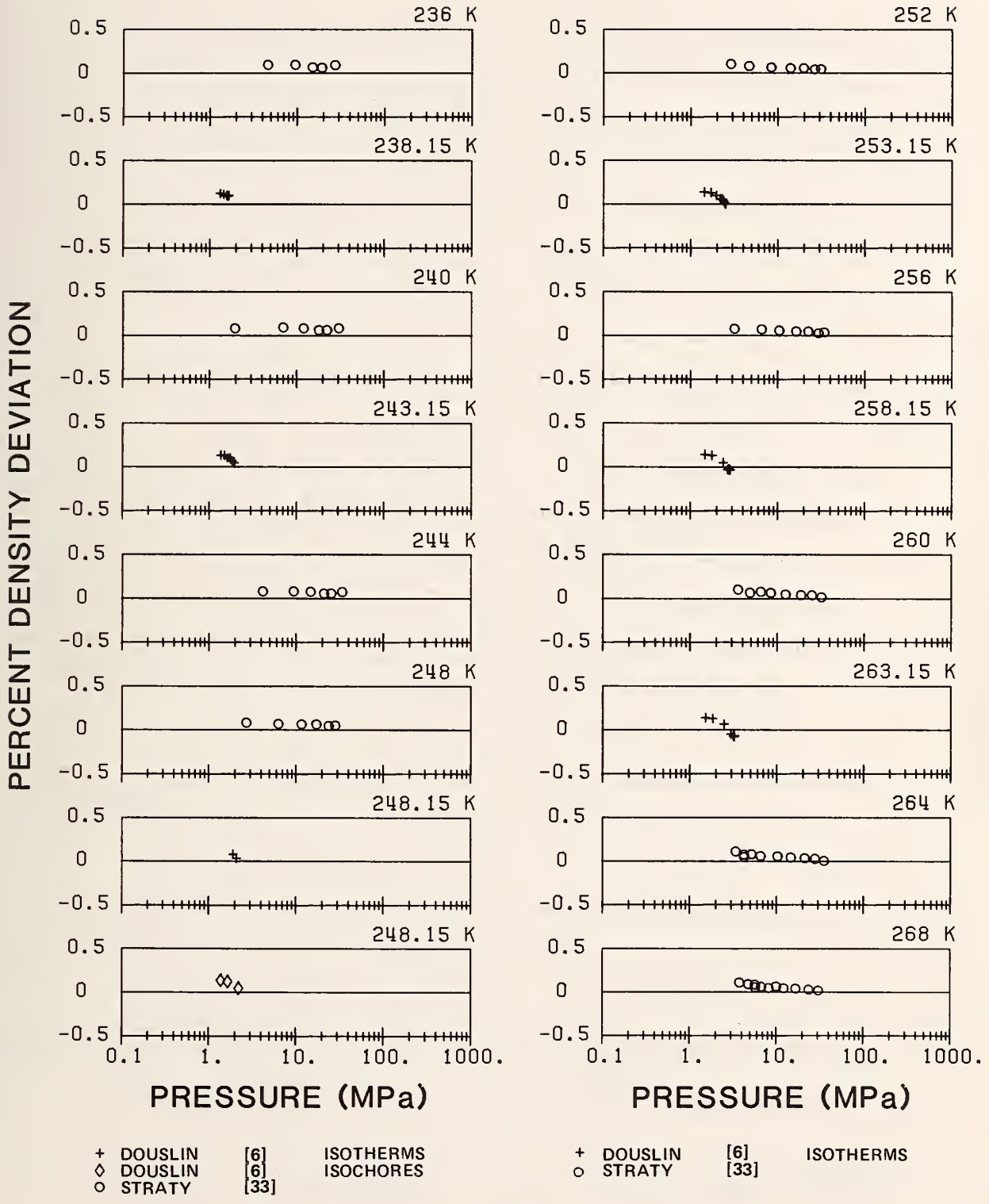


Figure 8. Deviations of Calculated Values of Density from Selected PVT Data (Continued)

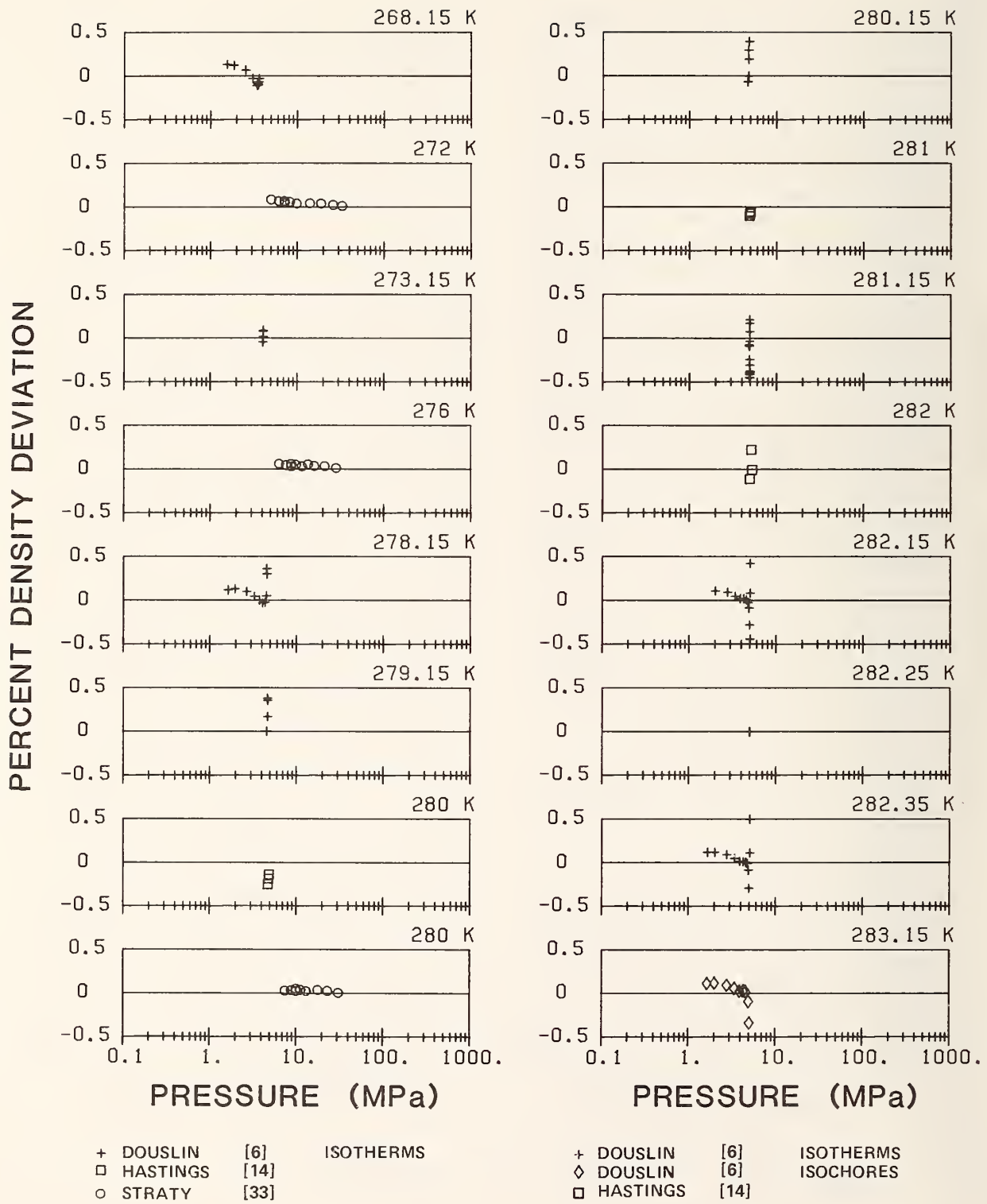


Figure 8. Deviations of Calculated Values of Density from Selected PVT Data (Continued)

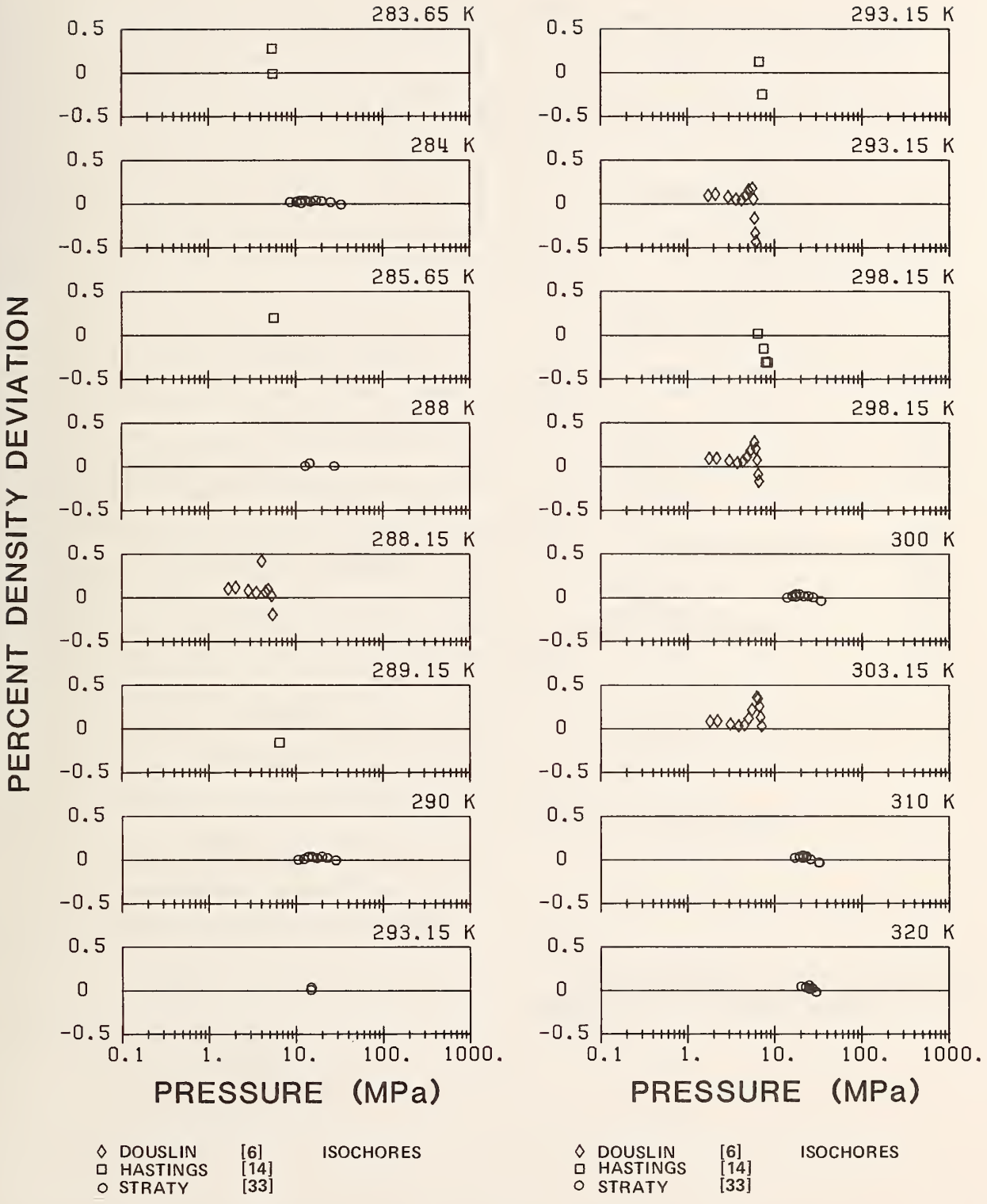


Figure 8. Deviations of Calculated Values of Density from Selected PVT Data (Continued)

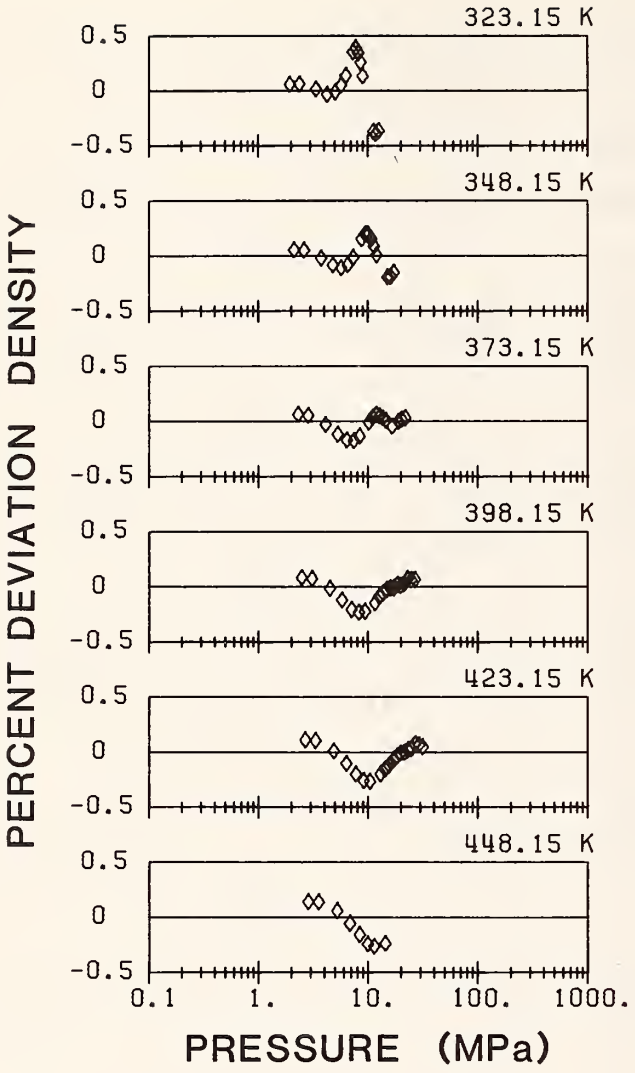
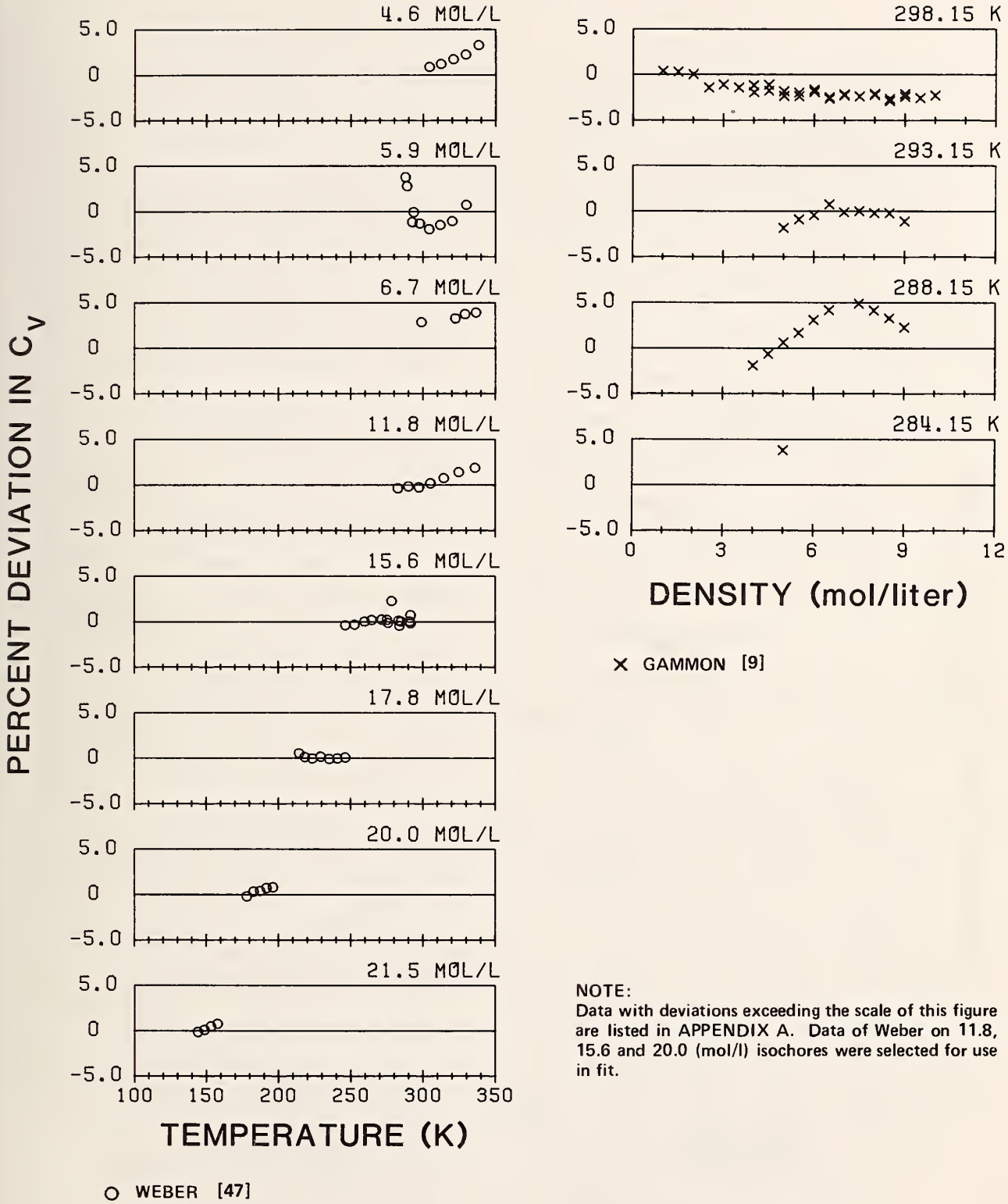


Figure 8. Deviations of Calculated Values of Density from Selected PVT Data (Continued)



NOTE:
Data with deviations exceeding the scale of this figure are listed in APPENDIX A. Data of Weber on 11.8, 15.6 and 20.0 (mol/l) isochores were selected for use in fit.

Figure 9. Deviations of Calculated Values of Heat Capacity From Data

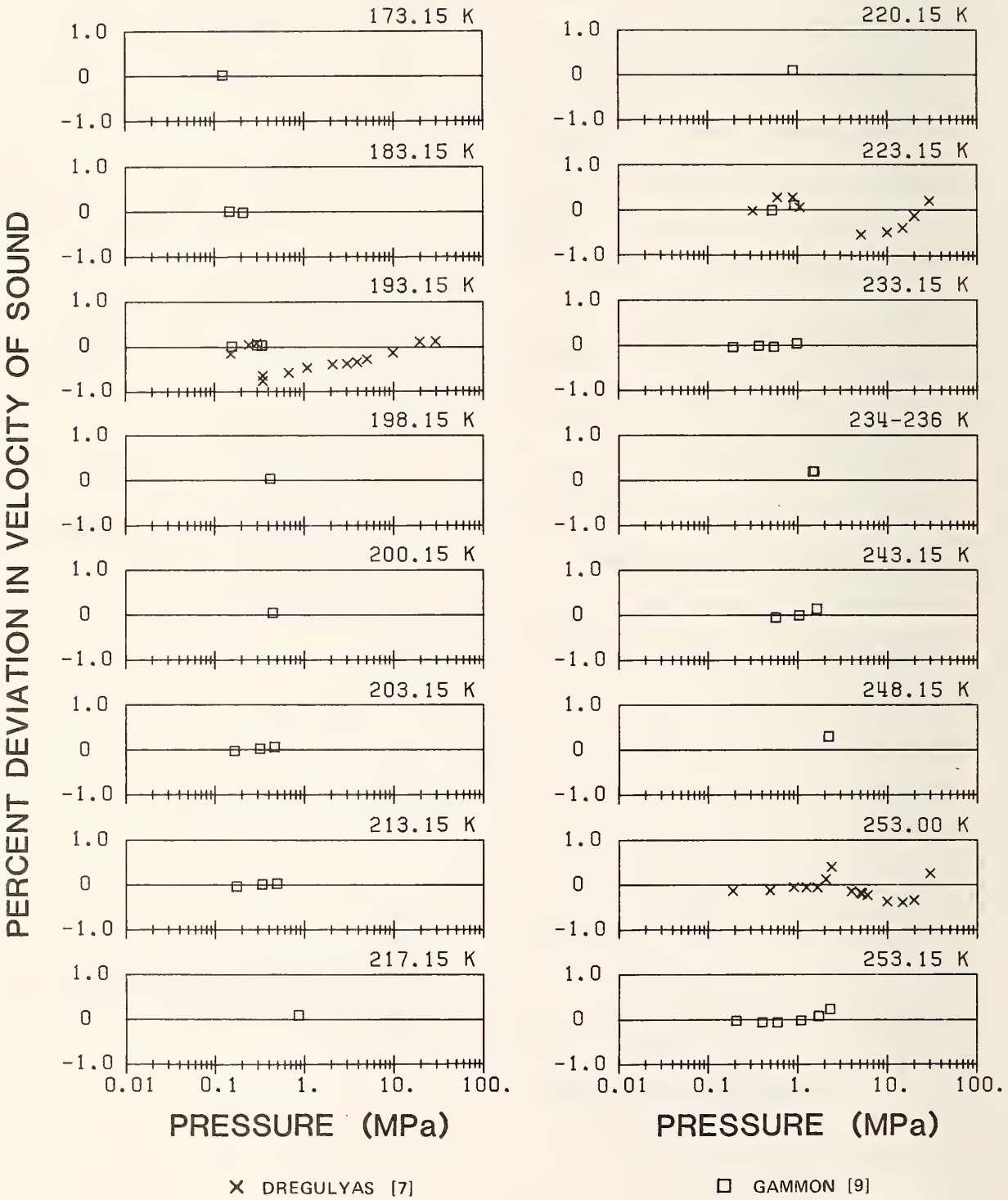


Figure 10. Deviations of Calculated Values of Velocity of Sound from Selected Data

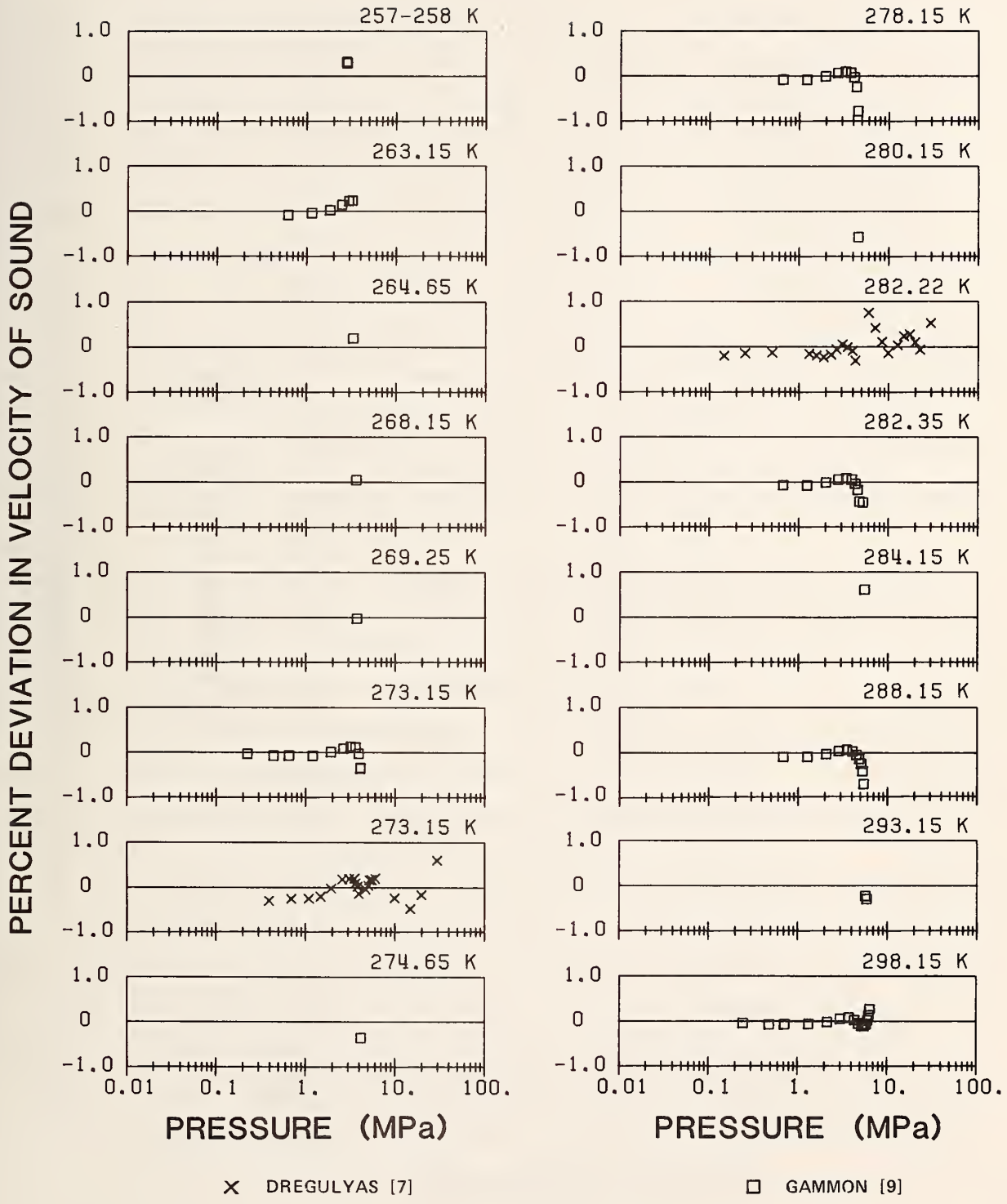


Figure 10. Deviations of Calculated Values of Velocity of Sound from Selected Data (Continued)

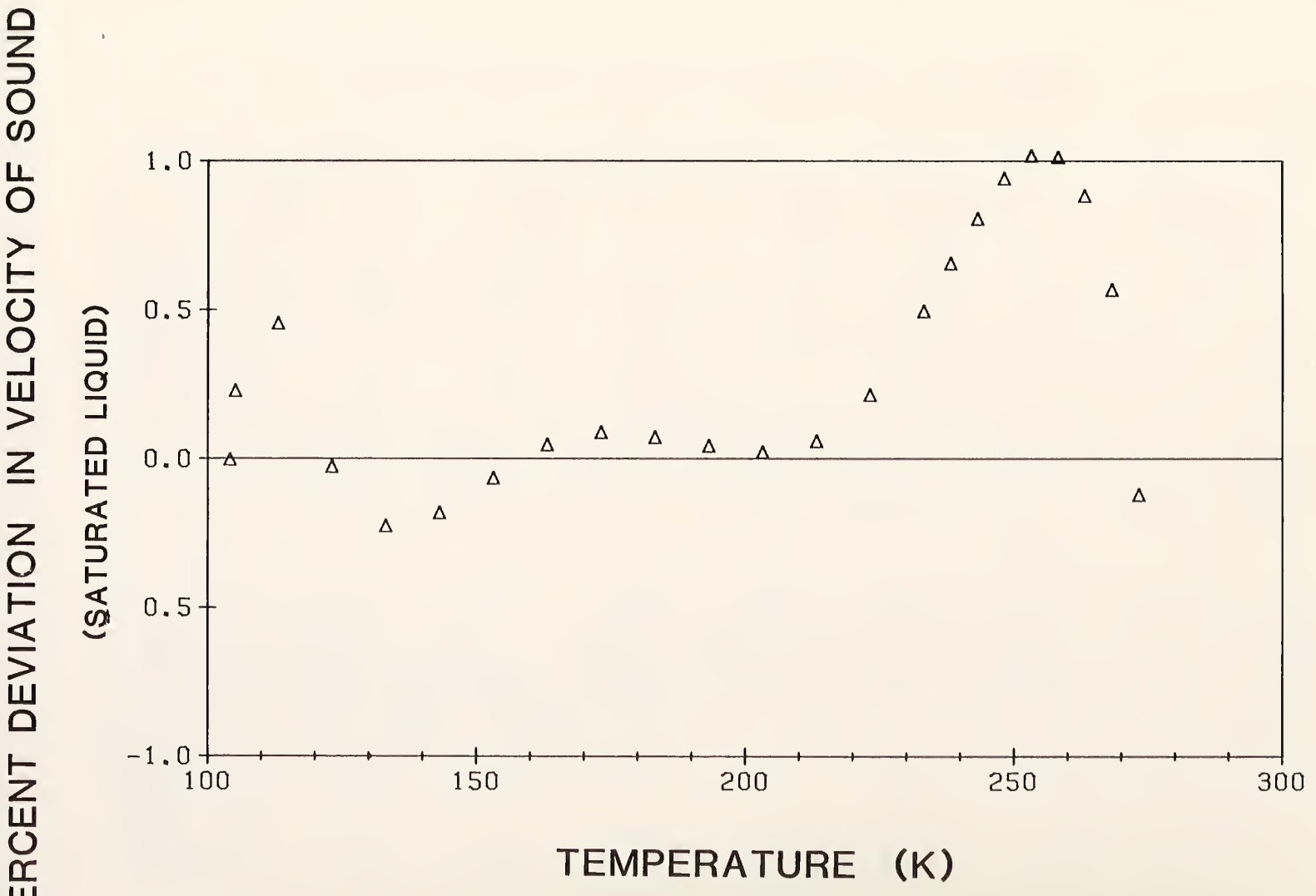


Figure 11. Deviation of Calculated Values of Velocity of Sound from Selected Data for the Saturated Liquid of Gammon [9]

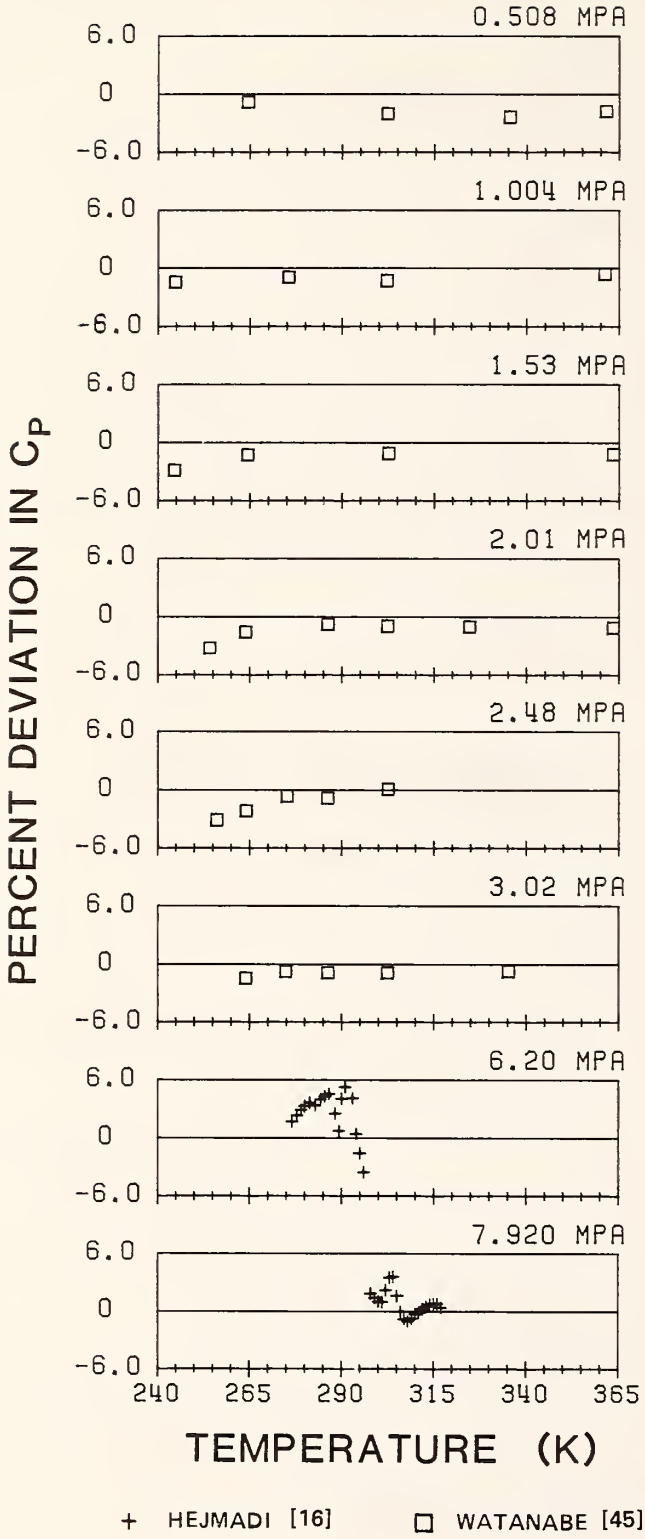
data of Gammon [9] for the velocity of sound of the saturated liquid used in the fit of the equation of state. Four data points between temperatures of 280 K and 282.15 K were excluded from the fit, and one point near 260 K has a deviation exceeding one percent and is not shown in figure 11. Comparisons to all available single phase velocity of sound data are given in Appendix A. Using saturated vapor states determined by extrapolation of the equation of state to the vapor pressure has resulted in some improvement in the comparison to the saturated liquid velocity of sound values of Gammon over saturation values determined by other methods. The resulting improvements did not significantly alter the P-ρ-T representation of this formulation from that of preliminary fits of the P-ρ-T data alone, and the final values of saturation densities are generally within the estimated accuracy of the measured data of Golovskii and Tsymarnyi [10] and Haynes [15]. These comparisons indicate large discrepancies between the data and values of the velocity of sound calculated from this formulation at and near saturation above 230 K in both liquid and vapor states. The values calculated using this formulation in this region must be considered unreliable.

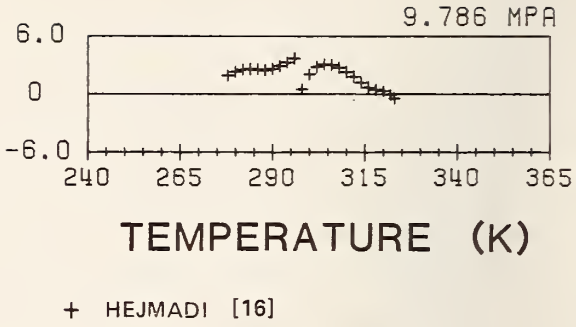
Figure 12 shows comparisons between the experimental C_p data by Hejmadi and Powers [16][16] by Watanabe [45], and by Vashchenko [43] and corresponding calculated values from eq (1). Data points with deviations beyond the scale of figure 12 are also included in table A-2 in Appendix A.

Table 11 gives a comparison among the heats of vaporization calculated using the eq (1), those of Douslin [6], and the data of Kozlov [20]. Other heat of vaporization data, Douslin [6], Egan and Kemp [8], Clusius and Konnertz [5], and Tully and Edmister [41], are included for comparative purposes.

The data from Kozlov [20] are a result of a cooperative effort between this project and the Data Center of the State Service of Standard Reference Data for Organic Compounds at Kiev in the USSR. This project furnished the laboratory in Kiev with an ultra-pure sample of ethylene; in return, the Kiev laboratory agreed to make heat of vaporization measurements and velocity of sound measurements on that sample and furnish the project with the results prior to their publication. Both the heats of vaporization and velocity of sound data

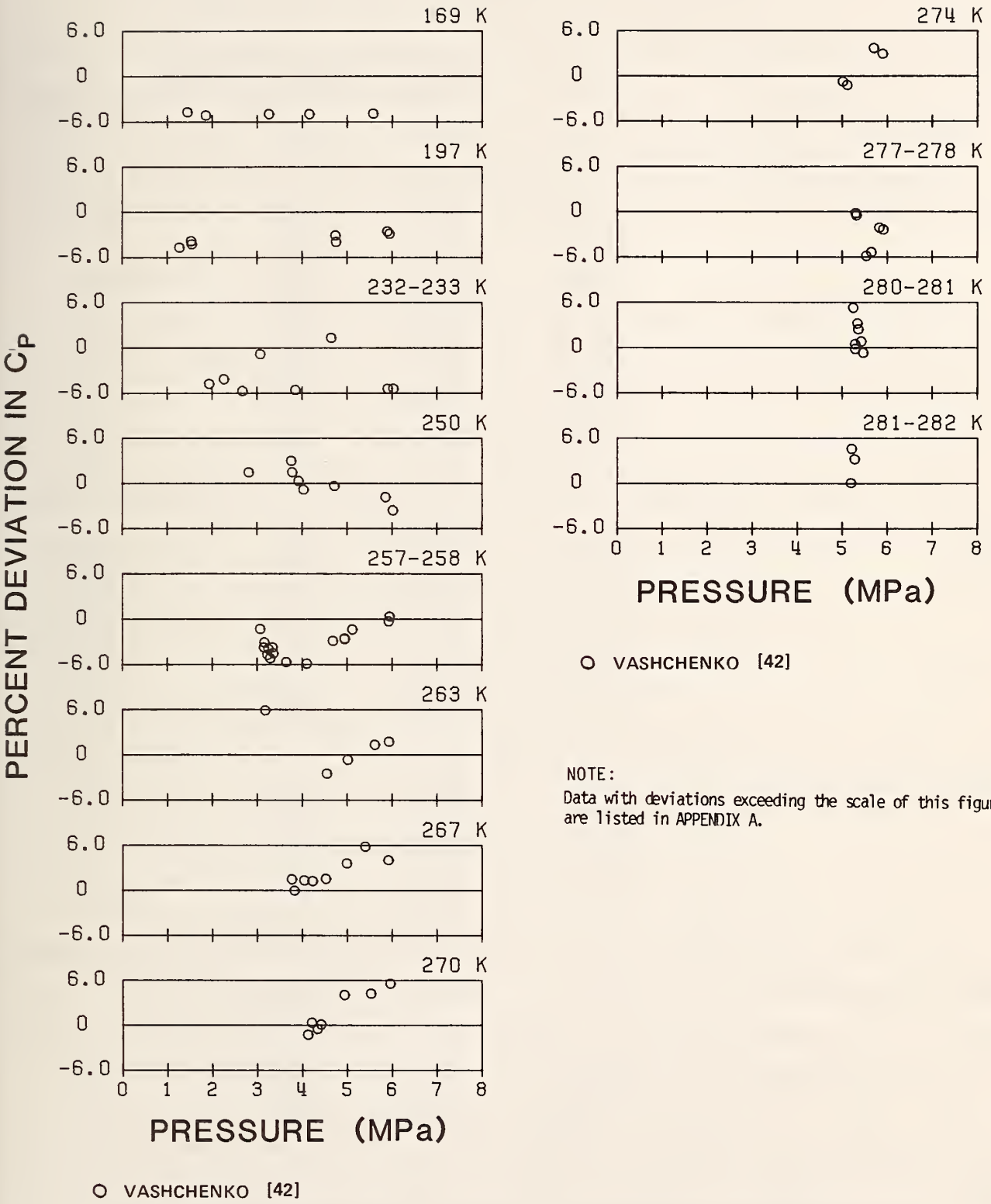
[16] Data taken as a part of this project.





NOTE:
Data with deviations exceeding the scale of this figure are listed in APPENDIX A.

Figure 12. Comparisons of Calculated Values of C_P with Data



NOTE:
Data with deviations exceeding the scale of this figure are listed in APPENDIX A.

Figure 12. Comparisons of Calculated Values of C_P with Data (Continued)

Table 11. Comparison of Calculated and Experimental Data for the Enthalpy of Vaporization

	$\frac{T}{K}$	$\frac{\Delta H_{data}}{J/mol^{-1}}$	$\frac{\Delta H_{eq\ (2)}}{J/mol^{-1}}$	$\frac{\Delta H_{data}-\Delta H_{eq\ (2)}}{J/mol^{-1}}$
Kozlov [20]	150.04	14668	14288	380
	159.87	14223	13918	308
	169.95	13817	13516	301
	179.94	13359	13090	269
	190.12	12933	12622	311
	200.15	12400	12121	279
	219.89	11274	10976	298
	229.89	10515	10286	229
	239.61	9763	9515	248
	273.14	5216	5211	4
	273.49	5153	5134	19
Douslin and Harrison [6][17]	238.15	9635	9638	- 2.7
	243.15	9202	9203	- 0.2
	248.15	8724	8727	- 2.4
	253.15	8197	8201	- 3.0
	258.15	7610	7615	- 4.3
	263.15	6946	6948	- 1.7
	268.15	6164	6168	- 3.5
	273.15	5194	5209	- 14.7
Clusius and Konnertz [5]	143.4	14327	14529	-202
	169.5	13394	13534	-140
	191.9	12523	12536	- 13
	209.8	11661	11591	70
	236.0	9678	9815	-137
	254.0	7854	8106	-252
Egan and Kemp [8]	169.4	13544	13539	5
Tully and Edmister [41]	244.1	9371	9115	256
	245.1	9041	9022	19
	270.9	5601	5670	- 69

[17] Data were derived by the authors from their PVT measurements.

have been received from the USSR. As shown in table 11, the heats of vaporization from Kozlov [20] do not agree with the present correlation and are believed to be incorrect. These heats of vaporization were not used in the fit of eq (1). The velocity of sound data of Dregulyas and Stavtzev [7] are in good agreement with those of Gammon [9] and proved to be of considerable value in the correlation as they provided information in the compressed liquid region where no other velocity of sound measurements exist. The velocity of sound data of Dregulyas and Stavtzev [7] were used in the fit of eq (1).

10. Estimated Accuracy of the Equation of State

The equation of state presented here may be used to calculate properties of ethylene for liquid and vapor states from the triple point temperature to 450 K with pressures to 40 MPa. Based upon the deviations of calculated values from data values, the accuracy of the equation of state is estimated as $\pm$ 0.20 percent in density for most of both liquid and vapor regions of the surface. At the highest temperatures, i.e., above 400 K, the uncertainty is estimated as $\pm$ 0.3 percent in density. The equation is not valid near the critical point and should not be used for states within 30 percent of the critical density at temperatures within 5 percent of the critical temperature. The formulation should be considered accurate to within $\pm$ 2.5 percent for the calculation of heat capacity values, and within about $\pm$ 1 percent for the calculation of velocity of sound except in the critical region, and at (and near) the saturated liquid and saturated vapor states where the deviations may be larger. A possible additional source of error when calculating thermodynamic properties using any equation of state, no matter how accurate that equation of state might be, is the error resulting from errors in the input variables. This error is especially important in the case of custody transfer when the equation of state together with a measured pressure and temperature is used as a means of determining the total mass. Figure 13, reproduced from Thomas, et al. [37], illustrates the resulting errors in density due to errors in the input pressure and temperature. The chart has been constructed for an assumed error in measurement of temperature of 0.5 K and an assumed error in pressure of 0.5 percent. Except for the liquid region where the errors in density are almost entirely the result of the assumed error in temperature, the resulting error in density as shown in figure 13, is divided about equally between the assumed errors in pressure and temperature. The chart may be used for other assumed errors in pressure and temperature by a linear

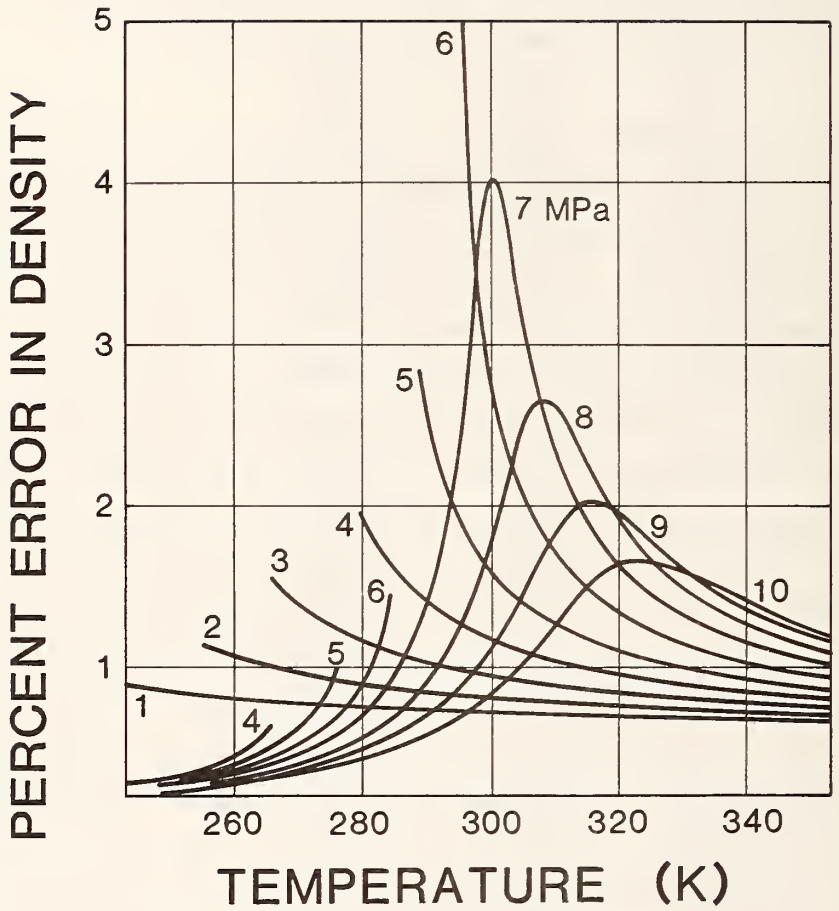


Figure 13. Accuracy of the Equation of State for Assumed Errors in Temperature and Pressure (0.5 K, 0.5% P) from Thomas et. al [37]

translation; for example, if the assumed errors in pressure and temperature are doubled, the resulting error in density is doubled. Figure 13 is intended as a general guide, and for a more accurate assessment of these errors the equation

$$\Delta\rho = \left(\frac{\partial\rho}{\partial T}\right)_P \Delta T + \left(\frac{\partial\rho}{\partial P}\right)_T \Delta P \qquad (13)$$

should be used. The $\left(\frac{\partial\rho}{\partial T}\right)_P$ and $\left(\frac{\partial\rho}{\partial P}\right)_T$ may be obtained from the tables in Appendix B by

$$\left(\frac{\partial\rho}{\partial T}\right)_P = -\left(\frac{\partial P}{\partial T}\right)_\rho \left(\frac{\partial P}{\partial\rho}\right)_T^{-1} \qquad (14)$$

and

$$\left(\frac{\partial\rho}{\partial P}\right)_T = \left(\frac{\partial P}{\partial\rho}\right)_T^{-1} \qquad (15)$$

11. Conclusion

At the beginning of this project, the goal was to provide a mathematical model of the thermodynamic surface of ethylene and new property tables more accurate than those of prior formulations. It was expected that these results would be accurate to within $\pm$ 0.1 percent in density and within $\pm$ 1 percent in derived properties such as C_v. In addition to the general accuracy statement above, the model was to include the critical region by using a switching function as the critical region is encountered. This would accomplish the merger of the critical region model of Hastings, et al. [14] with this formulation. The merger of the two equations was not accomplished and the reader who wishes to make calculations in the critical region ($\rho_c \pm .3\ \rho_c$ for temperature of $T_c \pm .05\ T_c$) should use the equation of state in Hastings, et al. [14].

Although a substantial improvement has been made over the equations and tables available six years ago, the accuracy goal has probably not been achieved. Unfortunately the two major sets of P-ρ-T data used in the development of the model, i.e., Straty [33] and Douslin and Harrison [6], disagree by as much as 0.2 percent in regions common to the two data sets. A good deal of effort, including additional experimental work and alternate methods of data analysis, was expended

in trying to resolve this disagreement without success. At the start of this work, the discrepancy between the two data sets was as large as 0.25 percent. This disagreement was resolved in part by Straty when he verified that some adsorption had taken place in his early experiments. He built a new cell, and repeated the experiment. The data from the second experiment agreed more closely with those of Douslin and Harrison [6], but a 0.2 percent disagreement persists. Impurities do not seem to be a possible cause of the discrepancy as ultra-pure samples were used in both Straty's and Douslin's experiments. Straty repeated some of his experiments with ethylene which had substantial amounts of known impurities, with very little change in the results.

A similar situation exists in the C_v data of Weber [47], but in this case the disagreement is in a single source. There are apparent inconsistencies among the various isochores. As a consequence, only a portion of the data were used in determining the coefficients for the equation of state as outlined in section 4.

In view of the above mentioned discrepancies, and others, it was decided that until these discrepancies are resolved either by experimentation or by additional data analysis, further work on the development of the equation of state is not warranted. Any improvements in the model using the available data would require new methods of correlation or new techniques of data analysis.

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Nomenclature

Symbol	Physical Quantity	Unit Symbol
T	Temperature	K
P	Pressure	MPa
ρ	Density	mol/dm^3
v	specific volume	dm^3/mol
U	Internal energy	J/mol
G	Gibbs function (Gibbs free energy)	J/mol
H	Enthalpy	J/mol
S	Entropy	J/(mol·K)
C_p	Isobaric heat capacity	J/(mol·K)
C_v	Isochoric heat capacity	J/(mol·K)
W	Velocity of sound	m/s
L	Latent heat	J/mol
B(T)	Second virial coefficient	dm^3/mol
$(\partial P/\partial \rho)_T$	Isotherm derivative	$dm^3/MPa/mol$
$(\partial P/\partial T)_\rho$	Isochore derivative	MPa/K

Superscript

o	Ideal gas property

Subscripts

o	Reference state property
c	Critical point property
σ	Property at saturation
tp	Triple point property
eqn	Calculated using an equation
data	Experimental value
nbp	Normal boiling point
satv	Saturated vapor
satl	Saturated liquid
tpv	Triple point (vapor)
tpl	Triple point (liquid)

Molecular weight of ethylene, 28.054.

Gas constant, R = 8.31434 J/(mol·K).

Nomenclature

Symbol	Fixed Points	Value
T_c	Critical temperature	282.3428 K
P_c	Critical pressure	5.0403 MPa
ρ_c	Critical density	7.6340 mol/dm^3
T_{tp}	Triple point temperature	103.986 K
P_{tp}	Triple point pressure	1.213 x 10^{-4} MPa
ρ_{tpv}	Triple point density (vapor)	1.42546 x 10^{-4} mol/dm^3
ρ_{tpl}	Triple point density (liquid)	23.343 mol/dm^3
T_{nbt}	Normal boiling point temperature	169.41 K
P_{nbp}	Normal boiling point pressure	0.101325 MPa
ρ_{nbpv}	Normal boiling density (vapor)	0.07445 mol/dm^3
ρ_{nbpl}	Normal boiling density (liquid)	20.24 mol/dm^3

APPENDIX A. Comparisons to Available Data Sets Including Those Used in the Determination of the Coefficients of the Equation of State (1).

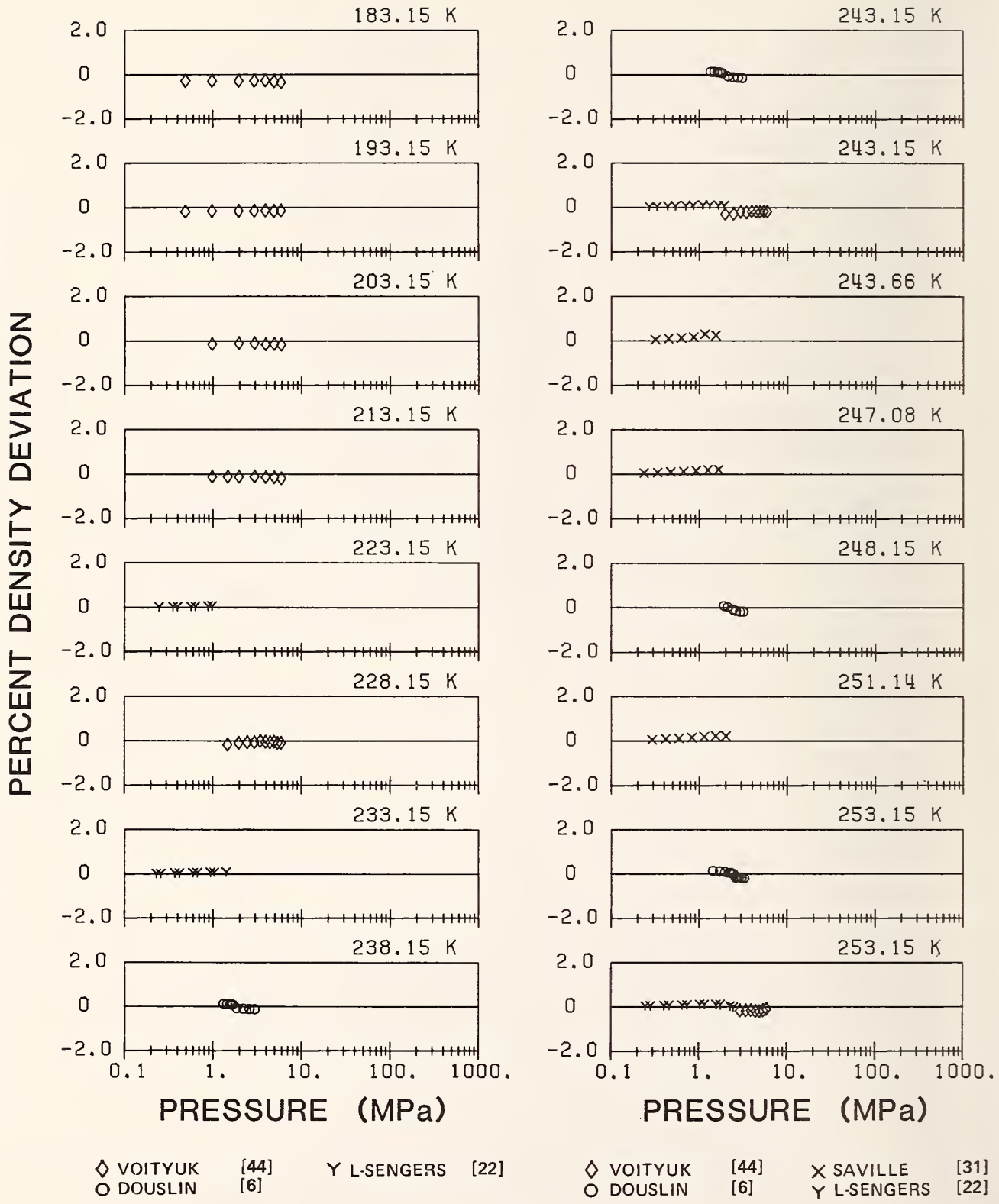
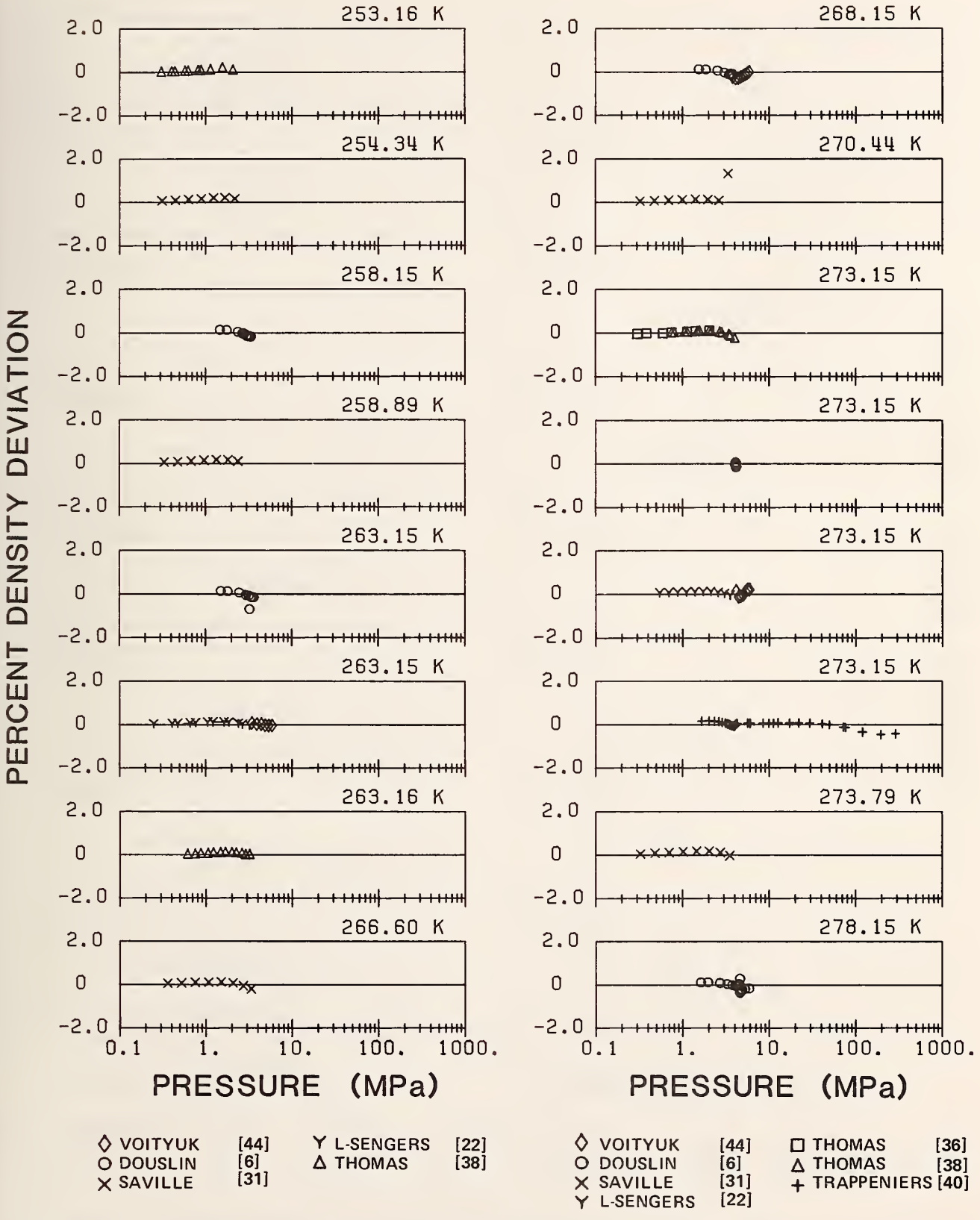


Figure A-1. Comparisons to PVT Data



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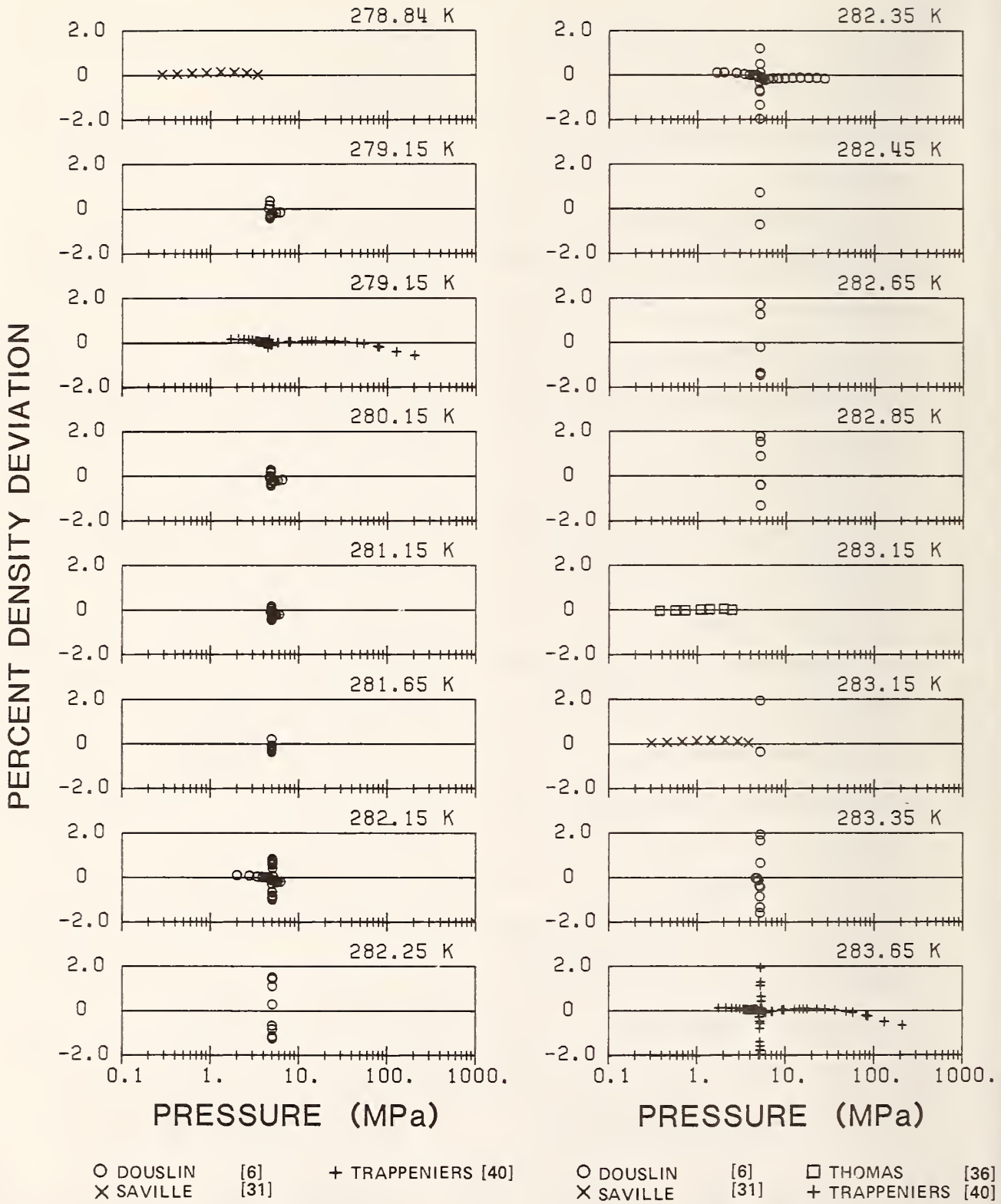

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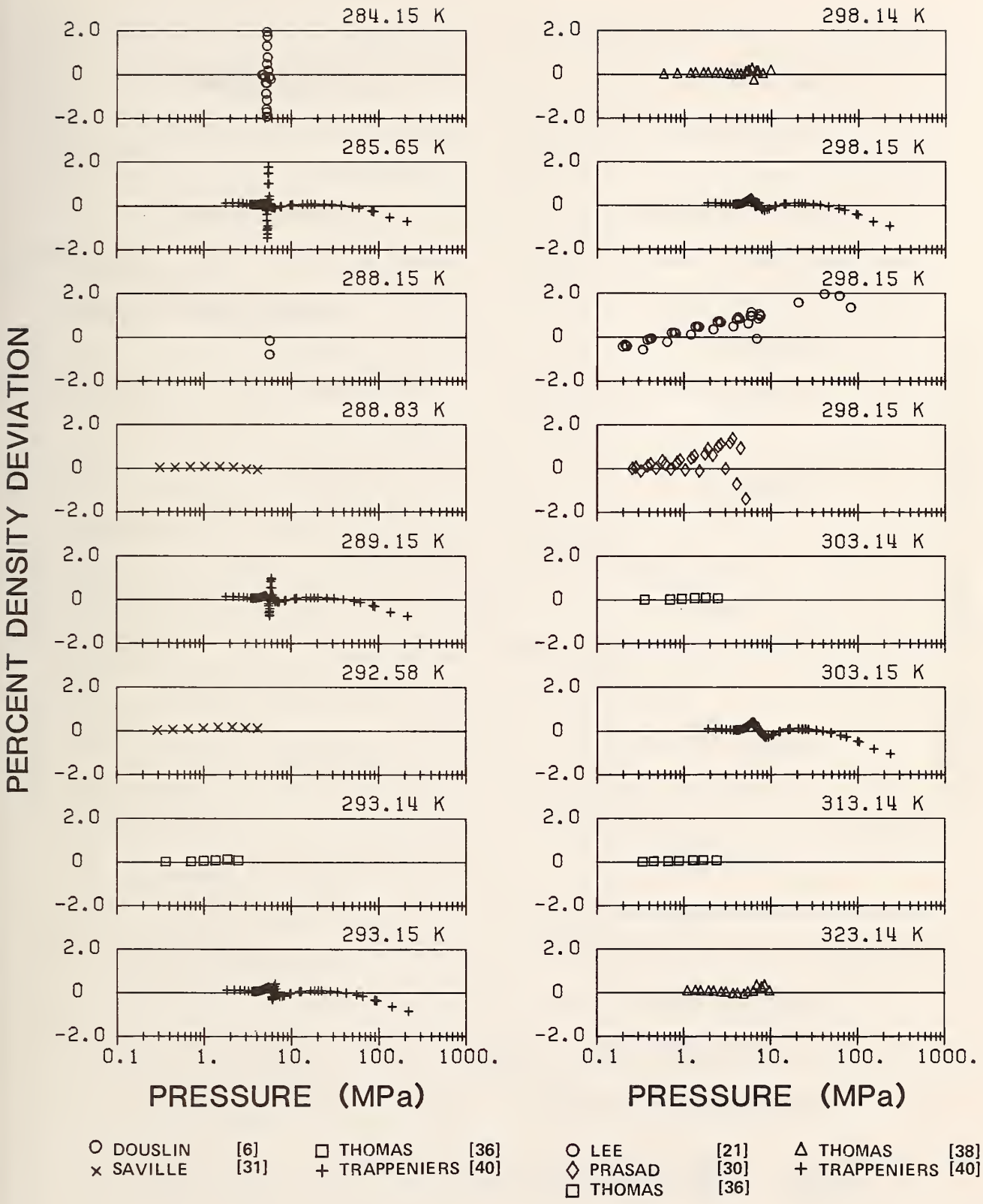

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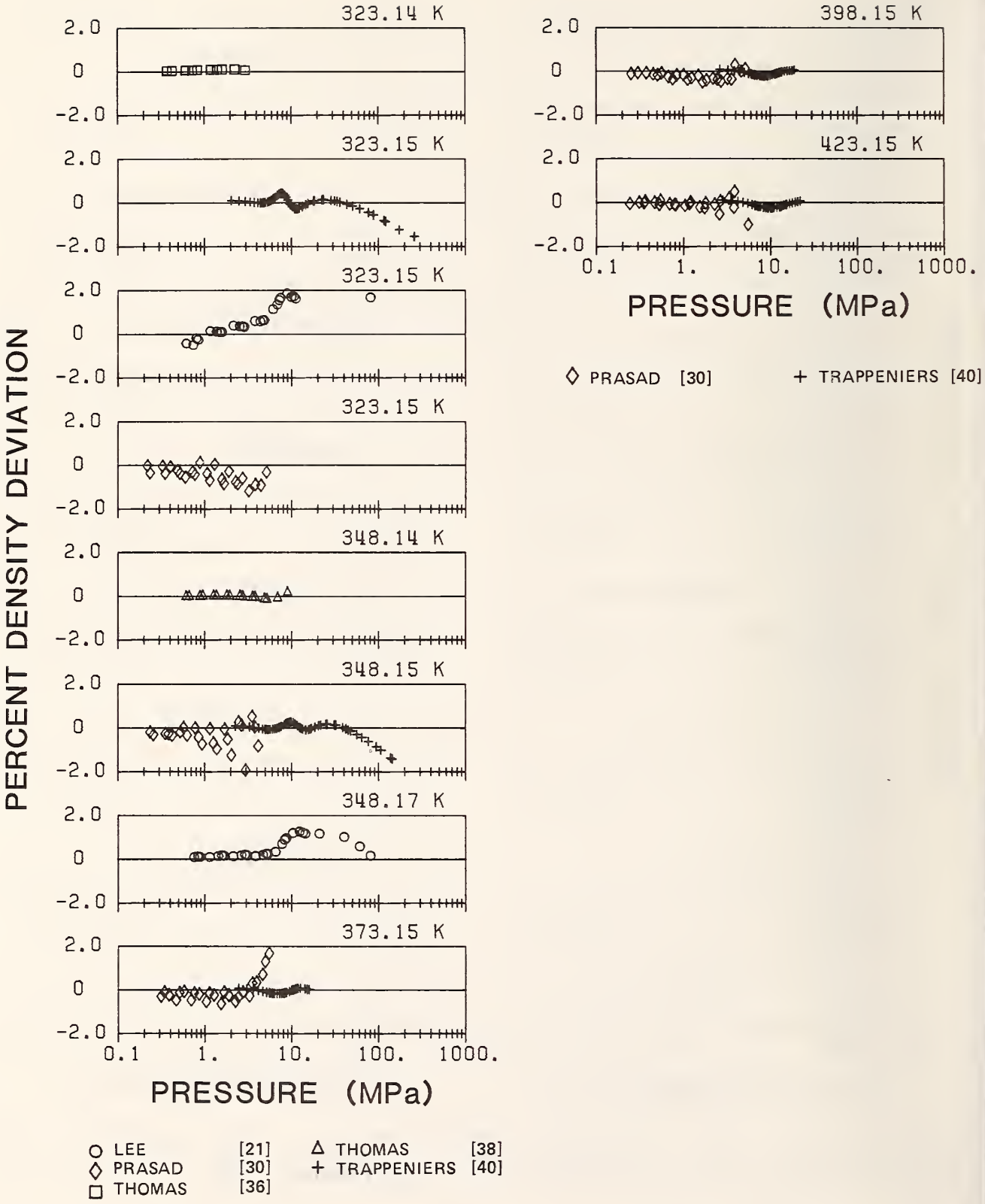

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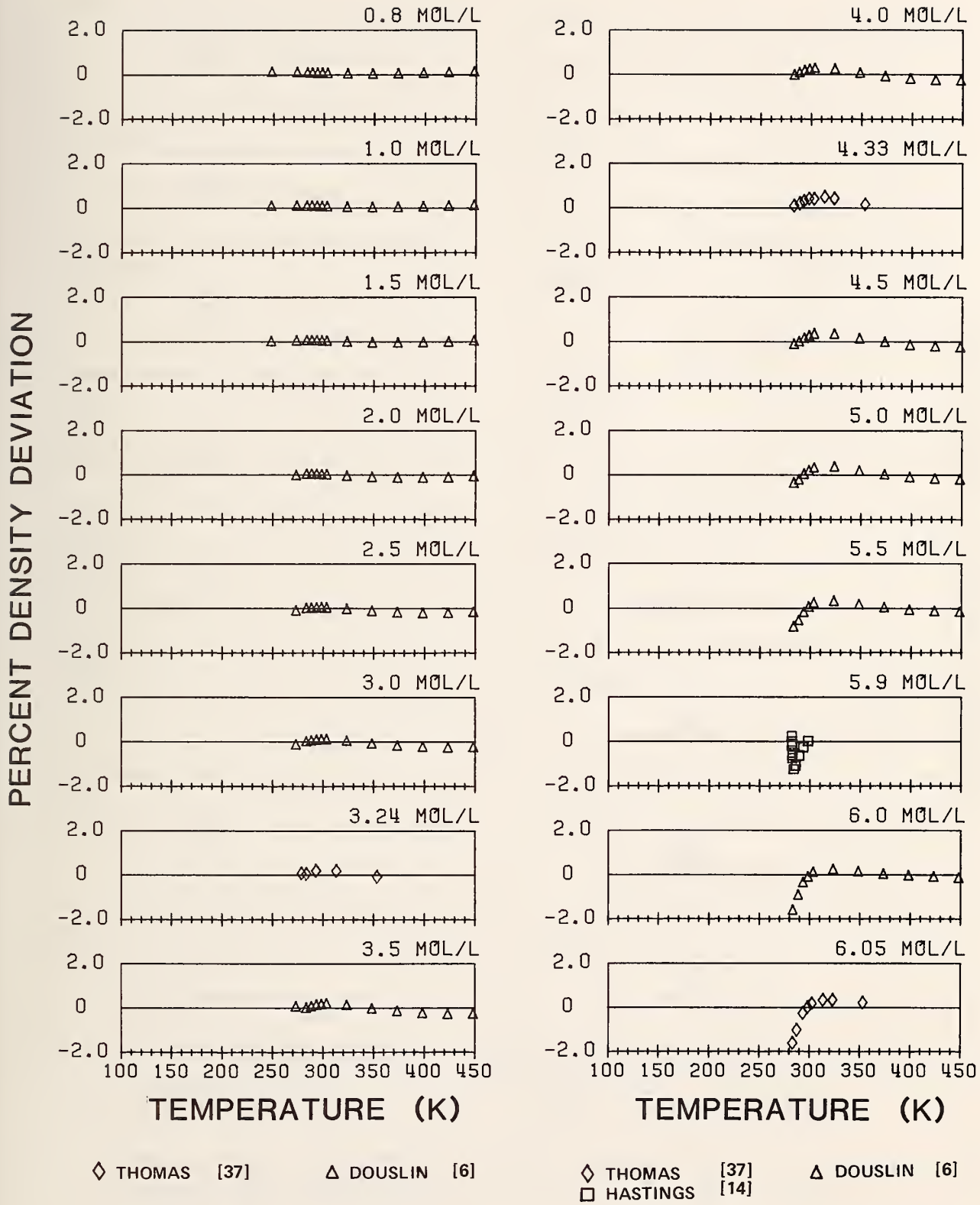

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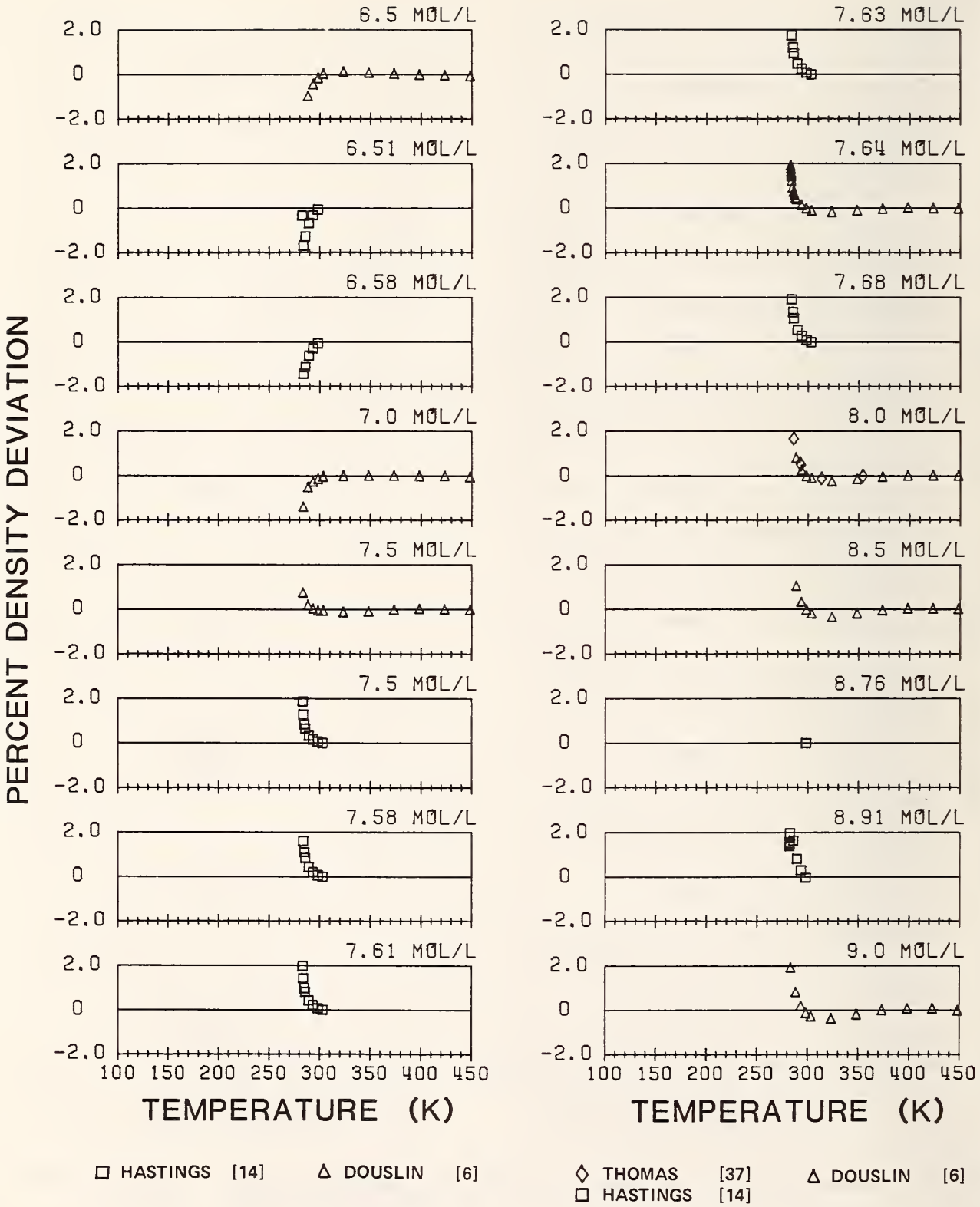

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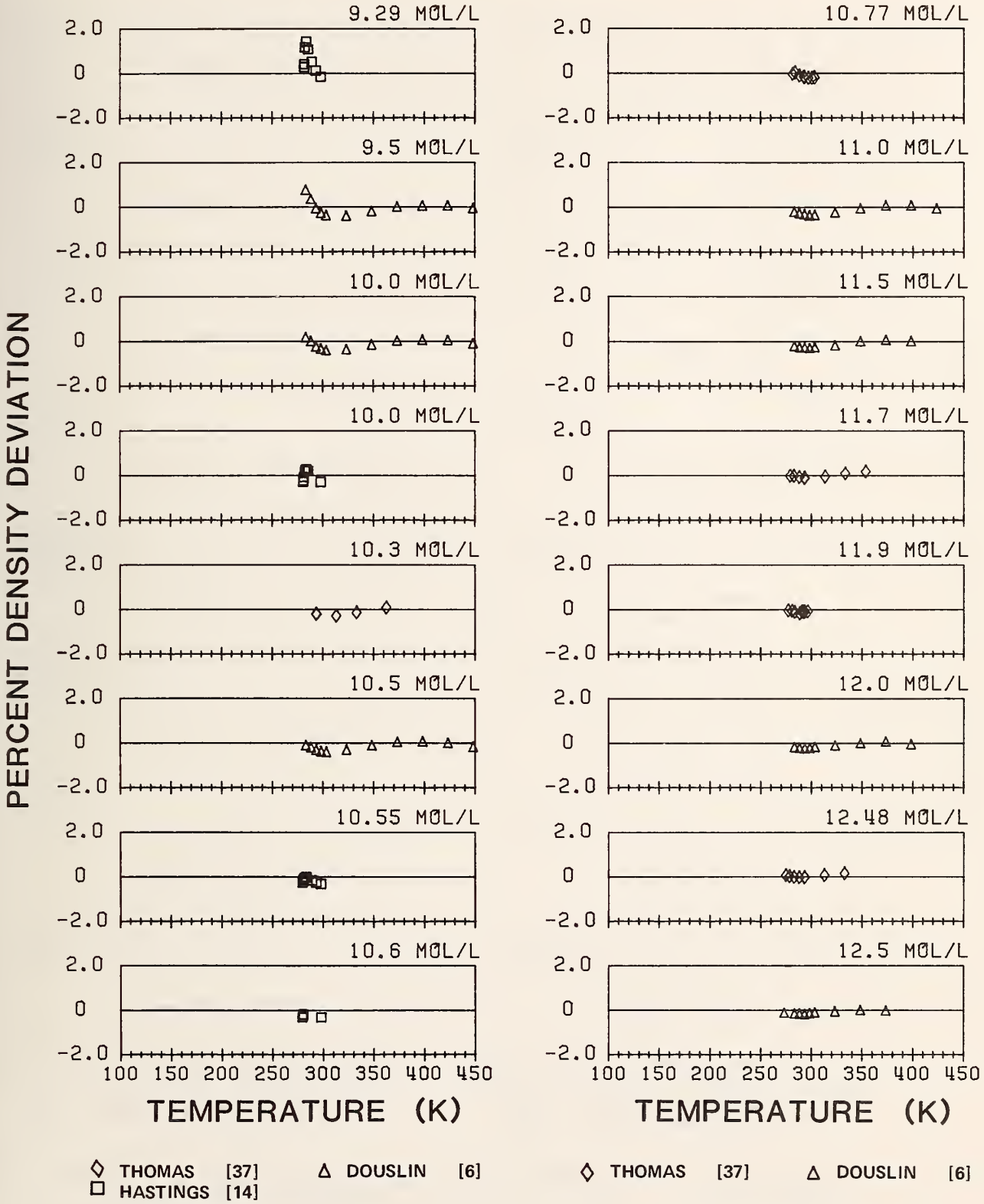
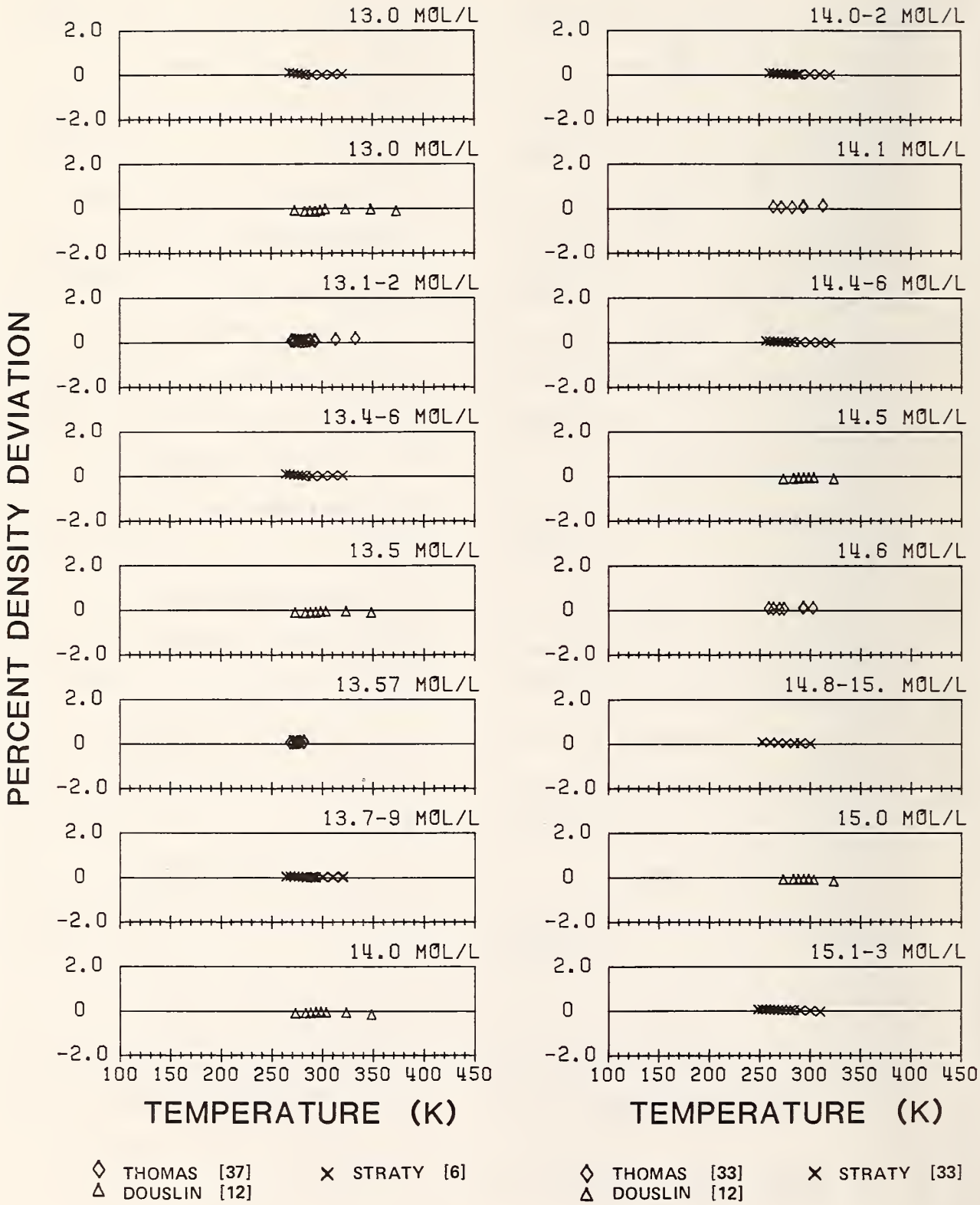


Figure A-1. Comparisons to PVT Data (Continued)



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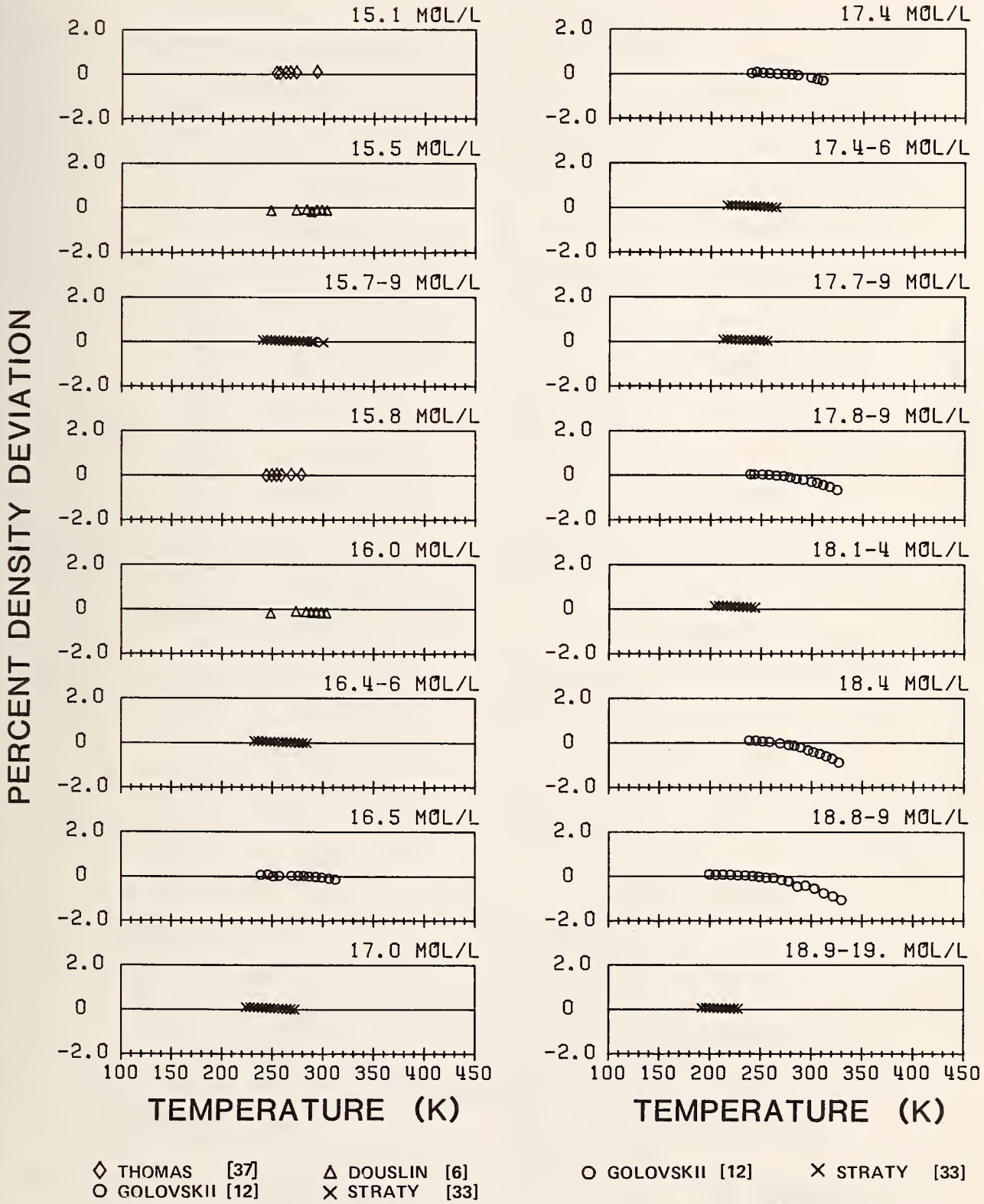

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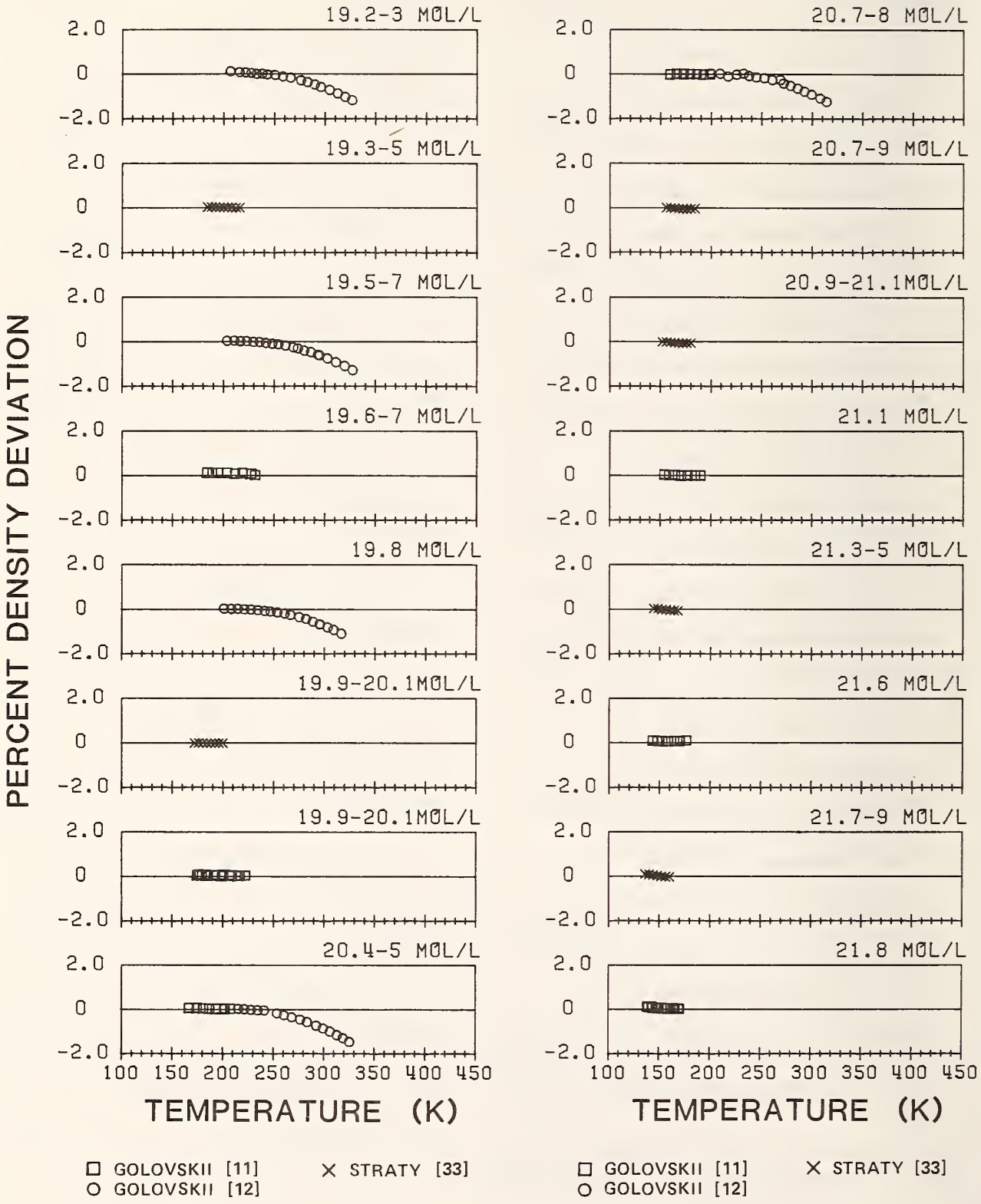

Figure A-1. Comparisons to PVT Data (Continued)

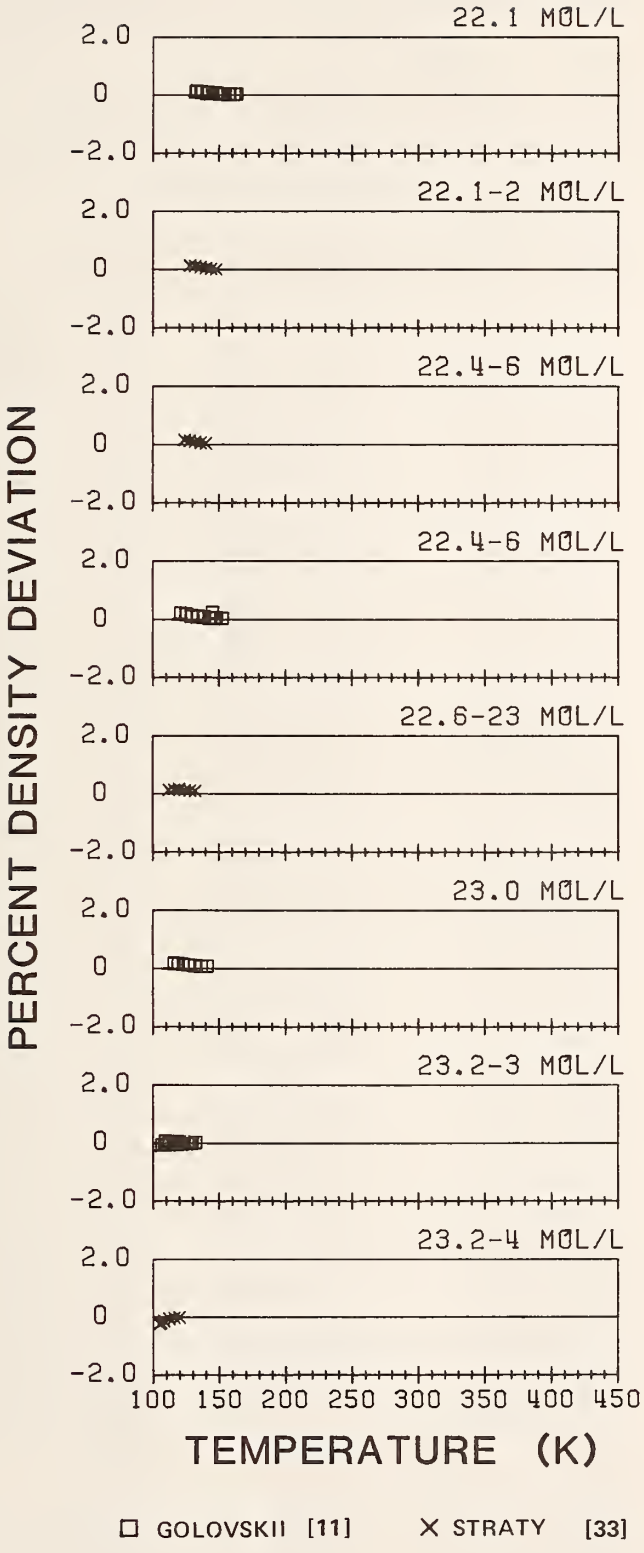

Figure A-1. Comparisons to PVT Data (Continued)

Table A-1. Data Points With Deviations Exceeding the Scale of Figure A-1.

(ISOTHERMAL DATA)

Temperature K	Pressure MPa	Density mol/dm^3	Density Deviation Percent	Author
282.35	5.04	8.50	2.32	Douslin [6]
282.35	5.04	7.75	7.44	Douslin [6]
282.35	5.04	7.50	4.94	Douslin [6]
282.35	5.04	7.25	2.29	Douslin [6]
282.40	5.05	7.65	5.72	Douslin [6]
282.40	5.05	7.60	5.45	Douslin [6]
282.45	5.05	8.00	6.61	Douslin [6]
282.45	5.05	7.75	4.96	Douslin [6]
282.45	5.05	7.65	4.57	Douslin [6]
282.45	5.05	7.60	3.94	Douslin [6]
282.45	5.05	7.50	2.99	Douslin [6]
282.55	5.06	7.65	3.01	Douslin [6]
282.55	5.06	7.60	2.51	Douslin [6]
282.65	5.08	8.50	3.59	Douslin [6]
282.65	5.08	8.00	3.87	Douslin [6]
282.65	5.08	7.75	2.80	Douslin [6]
282.65	5.08	7.65	2.30	Douslin [6]
282.65	5.08	7.60	2.08	Douslin [6]
282.65	5.07	6.75	- 2.03	Douslin [6]
282.65	5.07	6.50	- 2.07	Douslin [6]
282.85	5.10	8.00	3.37	Douslin [6]
282.85	5.10	7.75	2.20	Douslin [6]
283.15	5.12	6.75	- 2.02	Douslin [6]
283.35	5.17	8.50	2.99	Douslin [6]
283.35	5.16	8.00	2.57	Douslin [6]
283.35	5.14	6.75	- 2.00	Douslin [6]
283.35	5.14	6.50	- 2.14	Douslin [6]
283.65	5.20	8.10	2.26	Trappeniers [40]
283.65	5.21	8.71	2.71	Trappeniers [40]
284.15	5.27	8.50	2.46	Douslin [6]
323.15	61.52	17.01	2.02	Lee [21]
323.15	39.64	15.55	2.20	Lee [21]
323.15	19.79	12.93	2.33	Lee [21]
323.15	2.43	1.0	4.50	Prasad [30]
348.15	5.64	2.52	2.14	Prasad [30]

Table A-1. (Continued)
(ISOCHORIC DATA)

Temperature K	Pressure MPa	Density mol/dm^3	Density Deviation Percent	Author
283.15	5.12	6.50	- 2.19	Douslin [6]
282.65	5.07	7.51	3.98	Hastings [14]
282.34	5.04	7.51	9.72	Hastings [14]
283.15	5.13	7.59	2.25	Hastings [14]
282.65	5.07	7.59	4.49	Hastings [14]
282.34	5.04	7.59	10.48	Hastings [14]
282.65	5.08	7.61	3.89	Hastings [14]
282.55	5.06	7.61	4.96	Hastings [14]
282.45	5.05	7.61	7.07	Hastings [14]
282.34	5.04	7.61	9.90	Hastings [14]
283.15	5.13	7.63	2.43	Hastings [14]
282.65	5.07	7.63	4.79	Hastings [14]
282.34	5.04	7.63	11.19	Hastings [14]
282.36	5.04	7.64	7.58	Douslin [6]
282.37	5.04	7.64	6.95	Douslin [6]
282.38	5.05	7.64	6.40	Douslin [6]
282.39	5.05	7.64	6.58	Douslin [6]
282.40	5.05	7.64	5.68	Douslin [6]
282.41	5.05	7.64	5.54	Douslin [6]
282.42	5.05	7.64	4.58	Douslin [6]
282.43	5.05	7.64	4.87	Douslin [6]
282.45	5.05	7.64	3.69	Douslin [6]
282.55	5.06	7.64	2.71	Douslin [6]
282.65	5.08	7.64	2.22	Douslin [6]
283.15	5.13	7.68	2.60	Hastings [14]
282.65	5.08	7.68	5.11	Hastings [14]
282.50	5.06	7.68	7.55	Hastings [14]
282.34	5.04	7.68	11.52	Hastings [14]
283.15	5.14	8.00	2.88	Douslin [6]
283.15	5.14	8.50	3.24	Douslin [6]
282.37	5.05	8.76	3.15	Hastings [14]
282.34	5.04	8.76	3.08	Hastings [14]
282.21	5.03	8.76	2.30	Hastings [14]
282.19	5.02	8.76	2.08	Hastings [14]
283.65	5.21	8.76	2.83	Hastings [14]
282.34	5.04	8.76	3.64	Hastings [14]
282.22	5.03	8.76	3.21	Hastings [14]
282.19	5.02	8.76	2.93	Hastings [14]
282.19	5.02	8.76	2.81	Hastings [14]
282.19	5.02	8.76	2.98	Hastings [14]
282.19	5.02	8.76	2.93	Hastings [14]
282.17	5.02	8.76	2.29	Hastings [14]
283.65	5.22	8.92	2.43	Hastings [14]
282.34	5.04	8.92	2.44	Hastings [14]

Table A-2. Heat Capacity Data With Deviations Exceeding the Scales of Figures 9 and 12.

Temperature K	Pressure MPa	C_v J/(mol K)	C_v Deviations Percent
C_v Data Points of Weber [47] With Deviations Exceeding 5 percent			
297.3	5.9	47.94	6.0
291.3	5.5	51.23	10.0
285.9	5.1	59.07	21.1
289.8	5.8	54.88	10.5
294.8	6.3	50.85	5.3
C_v Data Points of Gammon [9] With Deviations Exceeding 5 percent			
288.2	5.7	52.11	5.0
284.2	5.2	52.79	7.3
284.2	5.2	52.67	10.6
284.2	5.2	58.44	14.0
284.2	5.2	60.89	17.2
284.2	5.2	61.08	17.6
284.2	5.3	59.91	16.3
284.2	5.3	59.54	16.2
284.2	5.3	57.04	13.6
284.2	5.3	53.76	9.9

Table A-2. (Continued)

Temperature K	Pressure MPa	C_p J/(mol K)	C_p Deviations Percent
C_p Data Points of Hejmadi and Powers [16] With Deviations Exceeding 6 percent			
292.0	6.2	479.7	8.3
292.1	6.21	479.9	8.4
299.0	6.21	180.7	- 7.3
300.4	6.21	153.1	-12.0
C_p Data Points of Vaschenko [42] With Deviations Exceeding 6 percent			
168.9	0.5	62.28	- 8.9
249.6	3.1	110.1	17.6
262.7	3.4	106.7	- 6.1
262.7	3.9	101.2	- 6.5
270.3	5.7	117.0	8.0
273.8	4.1	147.3	-21.2
273.8	4.2	143.1	-19.8
273.6	4.5	137.5	- 9.3
273.6	4.7	131.9	- 6.8
273.7	5.2	157.0	20.1
277.7	5.0	148.8	-15.3
277.4	5.0	142.6	-14.5
277.6	5.1	141.7	-14.0
280.4	5.9	184.2	21.1
280.3	5.9	174.7	17.0
281.6	5.2	302.5	10.6
281.4	5.2	233.0	- 7.4
281.3	5.2	249.1	6.2
282.1	5.2	358.2	12.3

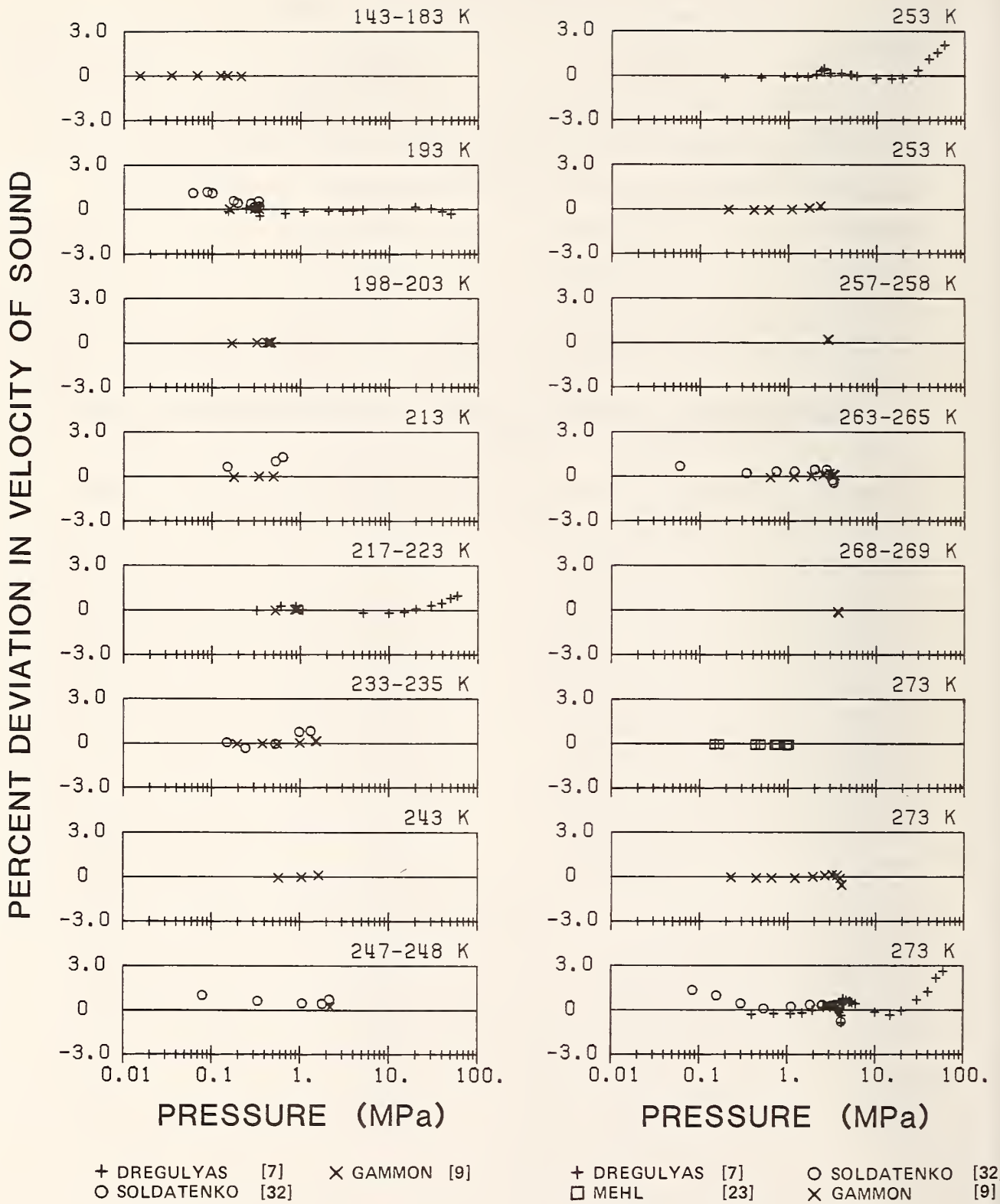

Figure A-2. Comparisons to Velocity of Sound Data

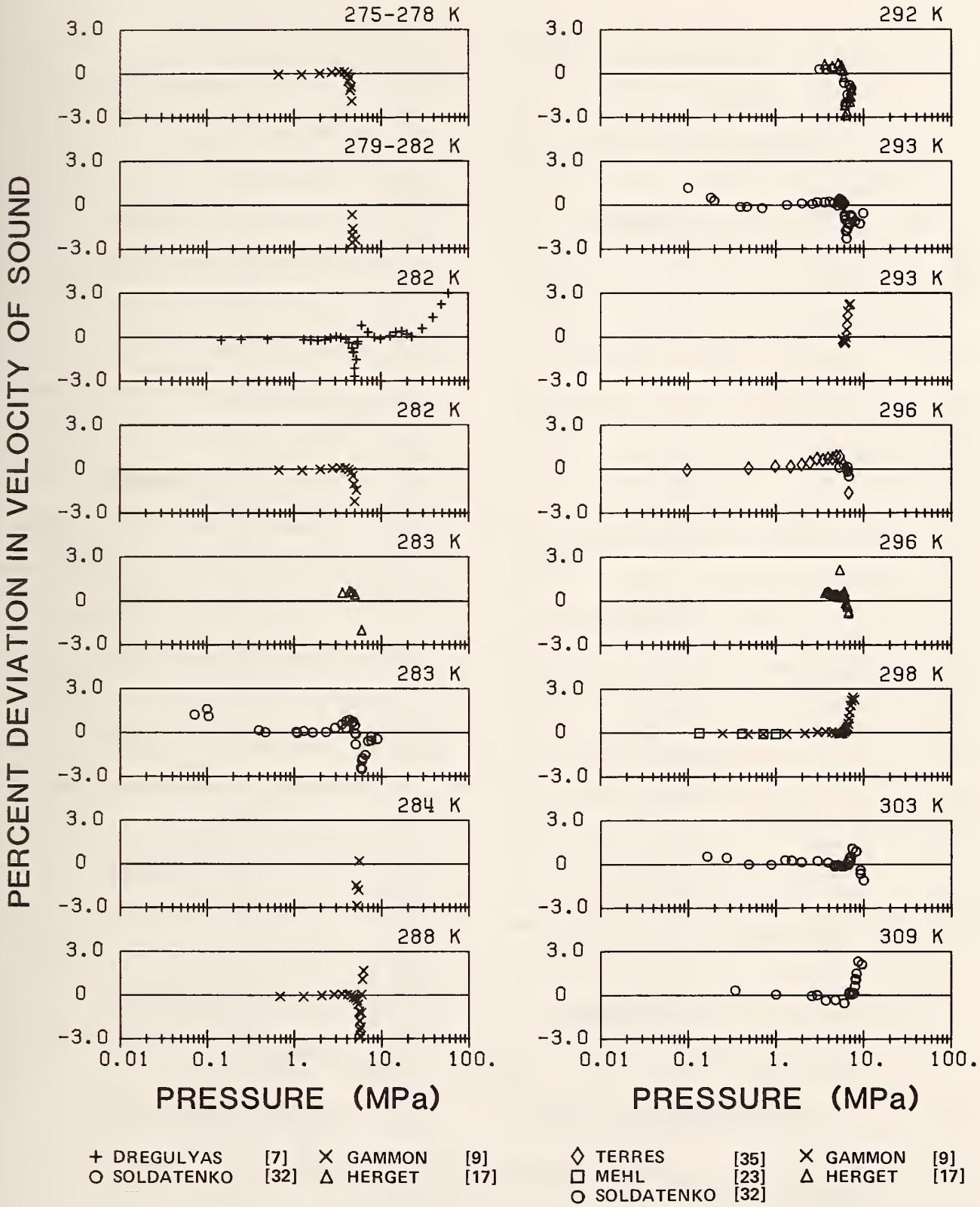

Figure A-2. Comparisons to Velocity of Sound Data (Continued)

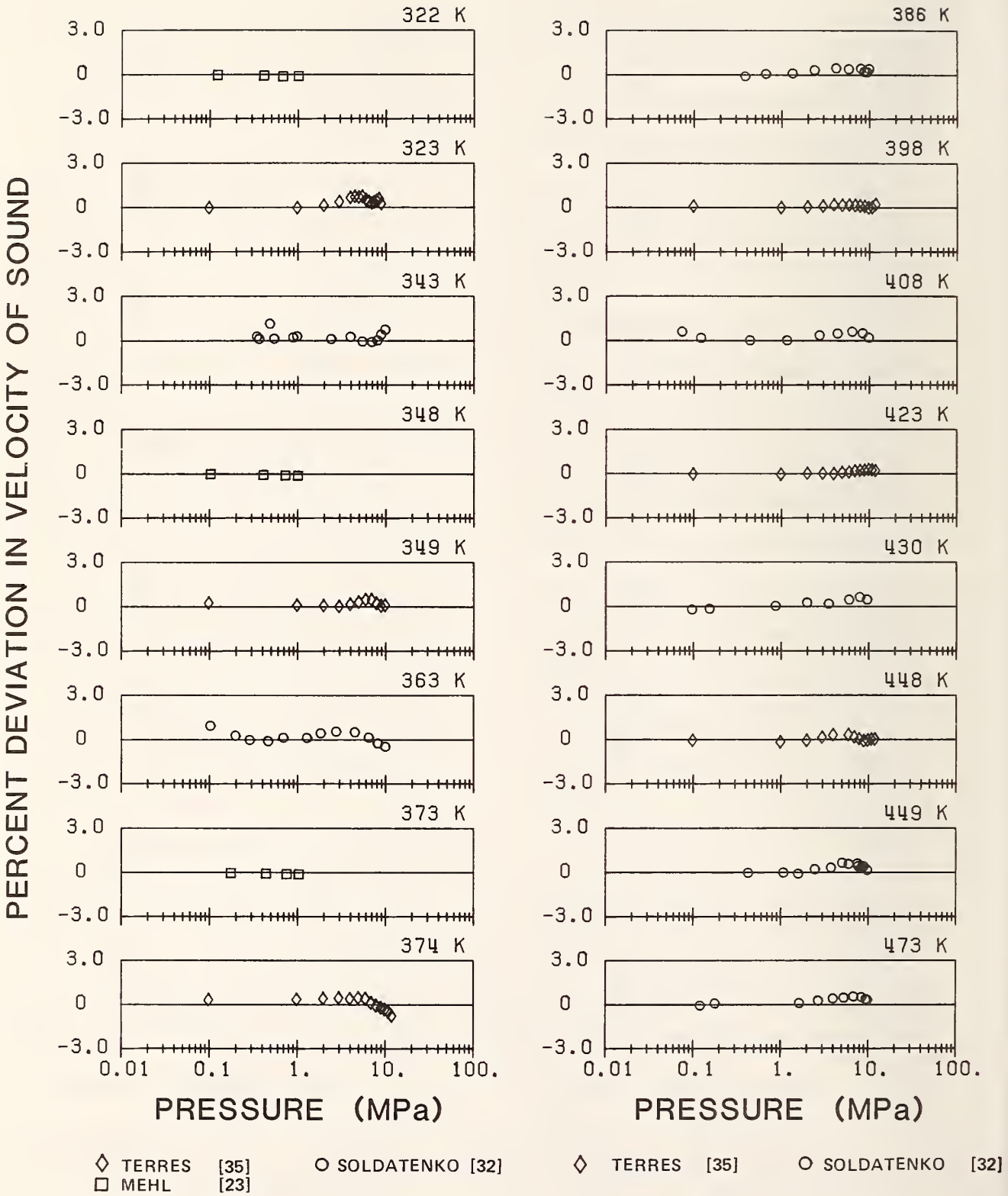

Figure A-2. Comparisons to Velocity of Sound Data (Continued)

Table A-3. Velocity of Sound Data With Deviations Exceeding the Scale of Figure A-2.

Temperature K	Pressure MPa	Velocity of Sound m/s	Velocity of Sound Deviation Percent	Author
280.15	4.80	208.1	- 3.60	Gammon [9]
280.15	4.82	252.5	- 5.38	Gammon [9]
281.15	4.91	224.9	- 9.40	Gammon [9]
281.15	4.99	261.2	- 3.13	Gammon [9]
281.15	4.88	210.4	- 3.01	Gammon [9]
281.15	4.91	201.6	- 6.06	Gammon [9]
281.65	4.95	201.9	- 5.92	Gammon [9]
281.65	4.96	195.6	- 8.71	Gammon [9]
281.65	4.99	231.0	- 7.12	Gammon [9]
282.22	5.02	200.7	- 5.81	Dregulyas [7]
282.22	5.03	185.1	-13.96	Dregulyas [7]
282.22	5.03	182.2	-15.75	Dregulyas [7]
282.22	5.04	196.5	-16.94	Dregulyas [7]
282.22	5.06	219.8	-10.28	Dregulyas [7]
282.22	5.07	226.1	- 9.23	Dregulyas [7]
282.22	5.14	253.3	- 4.67	Dregulyas [7]
282.35	5.04	163.5	-29.12	Gammon [9]
282.35	5.04	172.3	-22.48	Gammon [9]
282.35	5.04	175.0	-20.77	Gammon [9]
282.35	5.01	205.5	- 4.63	Gammon [9]
282.35	5.10	238.2	- 4.95	Gammon [9]
282.35	5.04	185.5	-19.85	Gammon [9]
282.35	5.04	170.0	-24.24	Gammon [9]
282.35	5.06	210.1	-10.98	Gammon [9]
282.35	5.03	194.1	- 9.53	Gammon [9]
282.85	5.13	202.8	-16.35	Herget [17]
282.85	5.14	193.0	-24.45	Herget [17]
282.85	5.17	160.0	-54.64	Herget [17]
282.85	5.17	162.0	-54.18	Herget [17]
282.85	5.17	165.0	-51.38	Herget [17]
282.85	5.24	225.0	-17.85	Herget [17]
282.85	5.37	263.0	-10.11	Herget [17]
282.85	5.41	280.8	- 5.71	Herget [17]
282.85	5.47	290.0	- 5.22	Herget [17]
282.85	5.53	298.6	- 5.00	Herget [17]
282.85	5.60	309.0	- 4.33	Herget [17]
282.85	5.77	318.0	- 7.18	Herget [17]
283.32	5.16	205.6	- 7.09	Soldatenko [32]
283.32	5.20	189.4	-25.44	Soldatenko [32]
283.32	5.21	188.5	-28.14	Soldatenko [32]
283.32	5.23	203.3	-21.85	Soldatenko [32]
283.32	5.26	211.8	-20.16	Soldatenko [32]
283.32	5.29	228.1	-14.53	Soldatenko [32]
283.32	5.29	231.5	-12.94	Soldatenko [32]
283.32	5.34	241.1	-12.62	Soldatenko [32]
283.32	5.45	271.2	- 7.45	Soldatenko [32]
283.32	5.49	283.7	- 4.86	Soldatenko [32]
283.32	5.50	282.2	- 5.94	Soldatenko [32]
283.32	9.94	517.5	- 6.00	Soldatenko [32]

Table A-3. (Continued)

Temperature K	Pressure MPa	Velocity of Sound m/s	Velocity of Sound Deviation Percent	Author
284.15	5.25	196.0	-10.74	Gammon [9]
284.15	5.32	228.8	- 4.59	Gammon [9]
284.15	5.24	196.3	- 9.66	Gammon [9]
284.15	5.28	211.7	- 7.73	Gammon [9]
284.15	5.22	200.2	- 7.42	Gammon [9]
284.15	5.26	200.9	-10.04	Gammon [9]
284.15	5.20	205.8	- 4.94	Gammon [9]
291.85	6.23	234.1	- 3.13	Herget [17]
291.85	6.30	240.4	- 3.28	Herget [17]
291.85	6.37	246.5	- 3.01	Herget [17]
291.85	6.87	300.3	- 5.49	Herget [17]
308.67	9.05	326.0	4.10	Soldatenko [32]
448.15	4.90	332.9	-14.55	Terres [35]

APPENDIX B

Thermodynamic Properties of Fluid Ethylene

Table B-1. Thermodynamic Properties of Saturated Ethylene

Temp. K	Pressure MPa	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of sound m/s
103.986	.00012	23.389	46.008	2.908	6614.68	6614.68	84.4	39.48	74.41	1758.
		.000140	.864	.000	21685.64	22550.01	237.7	24.99	33.31	203.
104.	.00012	23.389	46.027	2.907	6615.72	6615.72	84.4	39.49	74.39	1758.
		.000141	.864	.000	21685.99	22550.48	237.7	24.99	33.31	203.
105.	.00014	23.327	47.235	2.842	6689.42	6689.43	85.1	40.07	73.08	1752.
		.000166	.873	.000	21710.87	22583.64	236.5	24.99	33.32	204.
106.	.00017	23.268	48.189	2.783	6761.97	6761.98	85.8	40.60	72.07	1746.
		.000195	.881	.000	21735.74	22616.78	235.4	25.00	33.33	205.
107.	.00020	23.211	48.934	2.728	6833.64	6833.65	86.5	41.08	71.29	1740.
		.000229	.889	.000	21760.59	22649.91	234.3	25.00	33.34	206.
108.	.00024	23.156	49.506	2.678	6904.61	6904.62	87.1	41.50	70.67	1734.
		.000267	.897	.000	21785.44	22683.03	233.2	25.01	33.34	206.
109.	.00028	23.103	49.933	2.631	6975.02	6975.03	87.8	41.86	70.17	1727.
		.000311	.905	.000	21810.27	22716.12	232.2	25.02	33.35	207.
110.	.00033	23.051	50.237	2.586	7044.97	7044.98	88.4	42.18	69.75	1721.
		.000361	.914	.000	21835.09	22749.20	231.2	25.02	33.36	208.
111.	.00039	23.000	50.436	2.545	7114.54	7114.55	89.0	42.46	69.40	1714.
		.000418	.922	.000	21859.90	22782.25	230.2	25.03	33.37	209.
112.	.00045	22.950	50.545	2.506	7183.79	7183.81	89.7	42.69	69.11	1708.
		.000482	.930	.000	21884.69	22815.29	229.2	25.04	33.38	210.
113.	.00052	22.901	50.576	2.469	7252.77	7252.79	90.3	42.89	68.85	1701.
		.000555	.938	.000	21909.46	22848.29	228.3	25.04	33.39	211.
114.	.00060	22.852	50.538	2.434	7321.51	7321.53	90.9	43.05	68.63	1695.
		.000636	.946	.000	21934.21	22881.27	227.4	25.05	33.41	212.
115.	.00070	22.805	50.442	2.401	7390.04	7390.07	91.5	43.17	68.44	1688.
		.000728	.954	.000	21958.94	22914.22	226.5	25.06	33.42	213.
116.	.00080	22.757	50.294	2.369	7458.39	7458.42	92.1	43.27	68.26	1682.
		.000830	.963	.000	21983.65	22947.13	225.6	25.07	33.43	214.
117.	.00092	22.710	50.100	2.339	7526.57	7526.61	92.7	43.34	68.11	1675.
		.000945	.971	.000	22008.33	22980.01	224.7	25.08	33.45	215.
118.	.00105	22.664	49.867	2.310	7594.60	7594.65	93.2	43.38	67.96	1669.
		.001072	.979	.000	22032.99	23012.86	223.9	25.09	33.47	216.
119.	.00120	22.618	49.599	2.282	7662.50	7662.55	93.8	43.41	67.83	1662.
		.001213	.987	.000	22057.62	23045.67	223.1	25.10	33.48	217.
120.	.00136	22.572	49.299	2.256	7730.27	7730.33	94.4	43.41	67.71	1656.
		.001370	.995	.000	22082.23	23078.44	222.3	25.11	33.50	217.
121.	.00155	22.526	48.973	2.230	7797.93	7797.99	94.9	43.39	67.61	1649.
		.001543	1.003	.000	22106.80	23111.16	221.5	25.13	33.52	218.
122.	.00176	22.481	48.622	2.205	7865.48	7865.56	95.5	43.36	67.50	1643.
		.001735	1.011	.000	22131.34	23143.84	220.7	25.14	33.54	219.
123.	.00199	22.435	48.250	2.181	7932.93	7933.02	96.0	43.32	67.41	1636.
		.001946	1.019	.000	22155.85	23176.47	220.0	25.16	33.57	220.

Table B-1. (Continued)

Temp. K	Pressure MPa	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p	Velocity of sound m/s
124.	.00224	22.390	47.860	2.158	8000.30	8000.40	96.6	43.26	67.32	1629.
		.002177	1.026	.000	22180.33	23209.04	219.2	25.17	33.59	221.
125.	.00252	22.345	47.453	2.136	8067.58	8067.69	97.1	43.19	67.25	1623.
		.002431	1.034	.000	22204.76	23241.57	218.5	25.19	33.61	222.
126.	.00283	22.300	47.031	2.114	8134.78	8134.91	97.7	43.10	67.17	1616.
		.002710	1.042	.000	22229.16	23274.04	217.8	25.20	33.64	223.
127.	.00317	22.255	46.597	2.092	8201.92	8202.06	98.2	43.01	67.11	1610.
		.003014	1.050	.000	22253.52	23306.45	217.1	25.22	33.67	224.
128.	.00355	22.210	46.152	2.072	8268.99	8269.15	98.7	42.92	67.04	1603.
		.003345	1.058	.000	22277.84	23338.80	216.5	25.24	33.70	224.
129.	.00396	22.166	45.698	2.051	8336.00	8336.18	99.2	42.81	66.99	1596.
		.003706	1.065	.000	22302.12	23371.09	215.8	25.26	33.73	225.
130.	.00441	22.121	45.235	2.031	8402.95	8403.15	99.8	42.70	66.94	1590.
		.004099	1.073	.000	22326.35	23403.30	215.1	25.28	33.77	226.
131.	.00491	22.076	44.765	2.012	8469.86	8470.09	100.3	42.59	66.89	1583.
		.004525	1.081	.000	22350.53	23435.45	214.5	25.31	33.80	227.
132.	.00545	22.031	44.289	1.993	8536.73	8536.98	100.8	42.47	66.85	1576.
		.004986	1.088	.000	22374.67	23467.53	213.9	25.33	33.84	228.
133.	.00604	21.986	43.808	1.974	8603.56	8603.83	101.3	42.34	66.82	1570.
		.005485	1.096	.000	22398.75	23499.53	213.3	25.36	33.88	228.
134.	.00668	21.941	43.324	1.956	8670.35	8670.66	101.8	42.22	66.79	1563.
		.006025	1.103	.000	22422.78	23531.45	212.7	25.38	33.92	229.
135.	.00738	21.896	42.835	1.937	8737.12	8737.46	102.3	42.09	66.76	1556.
		.006606	1.111	.000	22446.76	23563.29	212.1	25.41	33.96	230.
136.	.00813	21.850	42.345	1.920	8803.86	8804.24	102.8	41.96	66.74	1550.
		.007232	1.118	.000	22470.68	23595.05	211.5	25.44	34.01	231.
137.	.00895	21.805	41.852	1.902	8870.59	8871.00	103.3	41.83	66.73	1543.
		.007905	1.125	.000	22494.55	23626.72	211.0	25.47	34.05	232.
138.	.00983	21.759	41.359	1.884	8937.30	8937.75	103.8	41.69	66.72	1536.
		.008628	1.132	.000	22518.36	23658.30	210.4	25.50	34.10	232.
139.	.01079	21.714	40.865	1.867	9004.00	9004.49	104.2	41.56	66.71	1529.
		.009403	1.140	.000	22542.10	23689.78	209.9	25.53	34.15	233.
140.	.01182	21.668	40.370	1.850	9070.69	9071.23	104.7	41.43	66.71	1522.
		.010233	1.147	.000	22565.78	23721.17	209.4	25.56	34.21	234.
141.	.01293	21.622	39.877	1.833	9137.38	9137.98	105.2	41.29	66.71	1515.
		.011120	1.154	.000	22589.40	23752.47	208.8	25.60	34.26	235.
142.	.01413	21.576	39.383	1.816	9204.07	9204.73	105.7	41.16	66.71	1508.
		.012069	1.161	.000	22612.95	23783.66	208.3	25.63	34.32	235.
143.	.01541	21.530	38.892	1.800	9270.77	9271.48	106.1	41.03	66.72	1501.
		.013080	1.168	.000	22636.44	23814.74	207.8	25.67	34.38	236.
144.	.01679	21.484	38.401	1.783	9337.47	9338.25	106.6	40.90	66.73	1494.
		.014159	1.174	.000	22659.85	23845.72	207.3	25.71	34.44	237.
145.	.01827	21.437	37.913	1.767	9404.19	9405.04	107.1	40.77	66.75	1487.
		.015306	1.181	.000	22683.19	23876.58	206.9	25.75	34.51	238.

Table B-1. (Continued)

Temp. K	Pressure MPa	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p	Velocity of sound m/s
146.	.01985	21.391	37.427	1.751	9470.92	9471.85	107.5	40.64	66.77	1480.
		.016527	1.188	.000	22706.46	23907.33	206.4	25.79	34.58	238.
147.	.02154	21.344	36.944	1.734	9537.67	9538.68	108.0	40.51	66.79	1473.
		.017823	1.194	.000	22729.65	23937.96	205.9	25.83	34.64	239.
148.	.02334	21.297	36.463	1.718	9604.45	9605.54	108.4	40.39	66.82	1466.
		.019198	1.201	.000	22752.77	23968.48	205.5	25.87	34.72	240.
149.	.02526	21.250	35.985	1.703	9671.24	9672.43	108.9	40.26	66.84	1459.
		.020656	1.207	.000	22775.81	23998.87	205.0	25.92	34.79	240.
150.	.02731	21.202	35.511	1.687	9738.07	9739.36	109.3	40.14	66.88	1452.
		.022200	1.214	.000	22798.77	24029.13	204.6	25.97	34.87	241.
151.	.02950	21.155	35.040	1.671	9804.92	9806.32	109.8	40.02	66.91	1445.
		.023833	1.220	.000	22821.64	24059.26	204.2	26.01	34.95	242.
152.	.03182	21.107	34.572	1.655	9871.81	9873.32	110.2	39.91	66.95	1438.
		.025558	1.226	.000	22844.44	24089.26	203.7	26.06	35.03	242.
153.	.03428	21.059	34.108	1.640	9938.73	9940.36	110.6	39.79	66.99	1431.
		.027380	1.232	.000	22867.14	24119.13	203.3	26.11	35.11	243.
154.	.03689	21.011	33.649	1.624	10005.69	10007.45	111.1	39.68	67.03	1423.
		.029302	1.238	.000	22889.76	24148.85	202.9	26.16	35.20	244.
155.	.03967	20.963	33.193	1.609	10072.69	10074.58	111.5	39.56	67.07	1416.
		.031328	1.243	.000	22912.29	24178.44	202.5	26.22	35.29	244.
156.	.04260	20.914	32.741	1.594	10139.73	10141.77	111.9	39.46	67.12	1409.
		.033461	1.249	.000	22934.73	24207.87	202.1	26.27	35.38	245.
157.	.04571	20.866	32.293	1.578	10206.81	10209.00	112.4	39.35	67.17	1402.
		.035705	1.255	.000	22957.08	24237.16	201.7	26.33	35.48	245.
158.	.04899	20.817	31.849	1.563	10273.94	10276.30	112.8	39.24	67.22	1394.
		.038065	1.260	.000	22979.34	24266.30	201.4	26.38	35.57	246.
159.	.05246	20.768	31.410	1.548	10341.12	10343.64	113.2	39.14	67.27	1387.
		.040544	1.265	.000	23001.49	24295.28	201.0	26.44	35.67	247.
160.	.05611	20.718	30.975	1.533	10408.34	10411.05	113.6	39.04	67.32	1380.
		.043146	1.271	.000	23023.55	24324.11	200.6	26.50	35.78	247.
161.	.05997	20.669	30.545	1.518	10475.61	10478.52	114.1	38.95	67.38	1372.
		.045876	1.276	.000	23045.51	24352.77	200.3	26.56	35.88	248.
162.	.06404	20.619	30.118	1.503	10542.94	10546.05	114.5	38.85	67.44	1365.
		.048737	1.281	.000	23067.37	24381.27	199.9	26.62	35.99	248.
163.	.06831	20.569	29.697	1.488	10610.32	10613.64	114.9	38.76	67.50	1358.
		.051733	1.285	.000	23089.12	24409.60	199.5	26.69	36.10	249.
164.	.07281	20.519	29.279	1.474	10677.75	10681.30	115.3	38.67	67.56	1350.
		.054870	1.290	.000	23110.77	24437.76	199.2	26.75	36.22	250.
165.	.07754	20.469	28.866	1.459	10745.24	10749.03	115.7	38.58	67.62	1343.
		.058150	1.295	.001	23132.32	24465.75	198.9	26.82	36.33	250.
166.	.08250	20.419	28.457	1.444	10812.79	10816.83	116.1	38.49	67.69	1336.
		.061579	1.299	.001	23153.75	24493.56	198.5	26.89	36.46	251.
167.	.08772	20.368	28.053	1.430	10880.39	10884.70	116.5	38.41	67.75	1328.
		.065162	1.303	.001	23175.07	24521.18	198.2	26.95	36.58	251.

Table B-1. (Continued)

Temp. K	Pressure MPa	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of sound m/s
168.	.09318	20.317	27.653	1.416	10948.05	10952.64	116.9	38.33	67.82	1321.
		.068902	1.308	.001	23196.28	24548.63	197.9	27.02	36.70	252.
169.	.09890	20.266	27.257	1.401	11015.78	11020.66	117.3	38.25	67.89	1313.
		.072804	1.312	.001	23217.38	24575.88	197.6	27.10	36.83	252.
170.	.10490	20.215	26.865	1.387	11083.56	11088.75	117.7	38.18	67.96	1306.
		.076872	1.315	.001	23238.35	24602.95	197.2	27.17	36.97	253.
171.	.11117	20.163	26.478	1.373	11151.41	11156.93	118.1	38.10	68.03	1298.
		.081112	1.319	.001	23259.21	24629.81	196.9	27.24	37.10	253.
172.	.11773	20.111	26.095	1.359	11219.33	11225.18	118.5	38.03	68.11	1291.
		.085529	1.323	.001	23279.95	24656.48	196.6	27.32	37.24	254.
173.	.12459	20.059	25.716	1.344	11287.30	11293.51	118.9	37.96	68.19	1283.
		.090126	1.326	.001	23300.57	24682.95	196.3	27.39	37.39	254.
174.	.13175	20.007	25.341	1.331	11355.35	11361.93	119.3	37.90	68.26	1276.
		.094910	1.329	.001	23321.06	24709.22	196.0	27.47	37.53	254.
175.	.13922	19.955	24.969	1.317	11423.46	11430.44	119.7	37.83	68.34	1268.
		.099884	1.332	.001	23341.42	24735.27	195.8	27.55	37.68	255.
176.	.14702	19.903	24.602	1.303	11491.64	11499.03	120.1	37.77	68.42	1260.
		.10505	1.335	.001	23361.66	24761.11	195.5	27.63	37.83	255.
177.	.15515	19.850	24.239	1.289	11559.90	11567.71	120.5	37.71	68.51	1253.
		.11043	1.338	.001	23381.76	24786.74	195.2	27.71	37.99	256.
178.	.16361	19.797	23.879	1.275	11628.22	11636.48	120.9	37.65	68.59	1245.
		.11600	1.340	.001	23401.73	24812.14	194.9	27.80	38.15	256.
179.	.17243	19.744	23.523	1.262	11696.62	11705.35	121.2	37.60	68.68	1238.
		.12179	1.343	.001	23421.56	24837.32	194.6	27.88	38.31	256.
180.	.18160	19.690	23.171	1.248	11765.09	11774.31	121.6	37.54	68.77	1230.
		.12780	1.345	.001	23441.26	24862.28	194.4	27.97	38.48	257.
181.	.19115	19.637	22.822	1.235	11833.64	11843.37	122.0	37.49	68.86	1222.
		.13403	1.347	.001	23460.81	24887.00	194.1	28.05	38.65	257.
182.	.20107	19.583	22.476	1.222	11902.26	11912.53	122.4	37.44	68.95	1215.
		.14048	1.349	.001	23480.22	24911.48	193.8	28.14	38.83	258.
183.	.21137	19.529	22.134	1.208	11970.97	11981.79	122.8	37.40	69.05	1207.
		.14717	1.350	.001	23499.49	24935.73	193.6	28.23	39.00	258.
184.	.22208	19.475	21.795	1.195	12039.75	12051.15	123.1	37.35	69.15	1199.
		.15410	1.352	.001	23518.60	24959.73	193.3	28.32	39.19	258.
185.	.23319	19.420	21.460	1.182	12108.62	12120.63	123.5	37.31	69.25	1192.
		.16127	1.353	.001	23537.57	24983.49	193.1	28.41	39.37	259.
186.	.24471	19.366	21.127	1.169	12177.57	12190.21	123.9	37.27	69.35	1184.
		.16870	1.354	.002	23556.38	25006.99	192.8	28.51	39.57	259.
187.	.25667	19.311	20.798	1.156	12246.61	12259.90	124.3	37.23	69.46	1176.
		.17638	1.355	.002	23575.03	25030.23	192.6	28.60	39.76	259.
188.	.26905	19.256	20.472	1.143	12315.74	12329.71	124.6	37.19	69.57	1168.
		.18432	1.355	.002	23593.53	25053.22	192.3	28.70	39.96	259.
189.	.28189	19.200	20.148	1.131	12384.95	12399.64	125.0	37.16	69.68	1161.
		.19253	1.356	.002	23611.86	25075.93	192.1	28.79	40.17	260.

Table B-1. (Continued)

Temp. K	Pressure MPa	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p	Velocity of sound m/s
190.	.29517	19.145	19.828	1.118	12454.27	12469.68	125.4	37.13	69.80	1153.
		.20102	1.356	.002	23630.02	25098.38	191.8	28.89	40.38	260.
191.	.30893	19.089	19.510	1.105	12523.67	12539.86	125.7	37.09	69.92	1145.
		.20979	1.356	.002	23648.02	25120.56	191.6	28.99	40.59	260.
192.	.32315	19.033	19.195	1.093	12593.18	12610.15	126.1	37.07	70.04	1137.
		.21885	1.356	.002	23665.85	25142.45	191.4	29.09	40.81	260.
193.	.33787	18.976	18.882	1.080	12662.78	12680.59	126.4	37.04	70.17	1129.
		.22820	1.355	.002	23683.50	25164.06	191.1	29.19	41.03	261.
194.	.35308	18.920	18.572	1.068	12732.49	12751.15	126.8	37.01	70.30	1121.
		.23786	1.355	.002	23700.98	25185.38	190.9	29.30	41.26	261.
195.	.36879	18.863	18.265	1.056	12802.30	12821.86	127.2	36.99	70.43	1113.
		.24782	1.354	.002	23718.27	25206.40	190.7	29.40	41.50	261.
196.	.38502	18.806	17.960	1.044	12872.23	12892.70	127.5	36.97	70.57	1105.
		.25810	1.353	.002	23735.37	25227.13	190.5	29.51	41.74	261.
197.	.40178	18.749	17.658	1.031	12942.26	12963.69	127.9	36.95	70.72	1098.
		.26870	1.351	.002	23752.29	25247.55	190.3	29.61	41.98	261.
198.	.41907	18.691	17.357	1.019	13012.42	13034.84	128.2	36.93	70.86	1090.
		.27964	1.350	.003	23769.02	25267.66	190.0	29.72	42.23	261.
199.	.43691	18.633	17.059	1.007	13082.69	13106.14	128.6	36.92	71.02	1082.
		.29091	1.348	.003	23785.55	25287.45	189.8	29.83	42.49	262.
200.	.45531	18.575	16.764	.996	13153.08	13177.59	128.9	36.90	71.18	1074.
		.30252	1.346	.003	23801.88	25306.92	189.6	29.94	42.75	262.
201.	.47428	18.517	16.470	.984	13223.60	13249.21	129.3	36.89	71.34	1066.
		.31449	1.344	.003	23818.00	25326.07	189.4	30.06	43.02	262.
202.	.49382	18.458	16.179	.972	13294.25	13321.01	129.6	36.88	71.51	1057.
		.32683	1.341	.003	23833.92	25344.88	189.2	30.17	43.30	262.
203.	.51395	18.399	15.890	.960	13365.04	13392.97	130.0	36.87	71.68	1049.
		.33953	1.338	.003	23849.62	25363.35	189.0	30.28	43.58	262.
204.	.53469	18.340	15.602	.949	13435.96	13465.11	130.3	36.87	71.86	1041.
		.35261	1.335	.003	23865.11	25381.47	188.8	30.40	43.87	262.
205.	.55603	18.280	15.317	.937	13507.03	13537.44	130.7	36.86	72.05	1033.
		.36608	1.332	.003	23880.37	25399.24	188.6	30.52	44.17	262.
206.	.57800	18.220	15.034	.926	13578.24	13609.96	131.0	36.86	72.24	1025.
		.37995	1.328	.004	23895.41	25416.65	188.4	30.64	44.47	262.
207.	.60059	18.160	14.752	.915	13649.61	13682.68	131.4	36.86	72.45	1017.
		.39422	1.325	.004	23910.21	25433.70	188.2	30.76	44.79	262.
208.	.62383	18.099	14.473	.903	13721.13	13755.60	131.7	36.86	72.65	1008.
		.40891	1.321	.004	23924.78	25450.37	188.0	30.88	45.11	262.
209.	.64772	18.038	14.196	.892	13792.81	13828.72	132.1	36.86	72.87	1000.
		.42403	1.316	.004	23939.10	25466.66	187.8	31.01	45.43	262.
210.	.67228	17.977	13.920	.881	13864.67	13902.06	132.4	36.86	73.09	992.
		.43958	1.312	.004	23953.18	25482.56	187.6	31.13	45.77	262.
211.	.69751	17.915	13.646	.870	13936.69	13975.62	132.8	36.87	73.32	984.
		.45557	1.307	.004	23967.00	25498.06	187.4	31.26	46.12	262.

Table B-1. (Continued)

Temp. K	Pressure MPa	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of sound m/s
212.	.72343	17.853	13.374	.859	14008.89	14049.41	133.1	36.88	73.56	975.
		.47203	1.302	.005	23980.57	25513.16	187.2	31.39	46.47	262.
213.	.75004	17.791	13.104	.848	14081.28	14123.44	133.4	36.89	73.80	967.
		.48895	1.296	.005	23993.87	25527.85	187.0	31.52	46.84	262.
214.	.77736	17.728	12.836	.837	14153.86	14197.71	133.8	36.90	74.06	958.
		.50635	1.291	.005	24006.89	25542.11	186.8	31.65	47.22	262.
215.	.80540	17.665	12.569	.826	14226.63	14272.23	134.1	36.91	74.32	950.
		.52425	1.285	.005	24019.64	25555.95	186.6	31.78	47.60	262.
216.	.83417	17.601	12.304	.815	14299.61	14347.00	134.5	36.92	74.60	941.
		.54264	1.278	.005	24032.10	25569.34	186.4	31.92	48.00	262.
217.	.86368	17.537	12.041	.805	14372.80	14422.05	134.8	36.94	74.88	933.
		.56156	1.272	.005	24044.27	25582.29	186.2	32.05	48.41	262.
218.	.89395	17.472	11.780	.794	14446.20	14497.36	135.1	36.96	75.18	924.
		.58100	1.265	.006	24056.15	25594.77	186.1	32.19	48.83	262.
219.	.92497	17.407	11.521	.783	14519.83	14572.97	135.5	36.98	75.49	916.
		.60099	1.258	.006	24067.71	25606.79	185.9	32.33	49.26	261.
220.	.95678	17.342	11.263	.773	14593.69	14648.86	135.8	37.00	75.80	907.
		.62154	1.250	.006	24078.96	25618.33	185.7	32.47	49.71	261.
221.	.98937	17.276	11.007	.762	14667.79	14725.06	136.2	37.02	76.13	898.
		.64266	1.242	.006	24089.88	25629.37	185.5	32.61	50.17	261.
222.	1.0228	17.209	10.753	.752	14742.13	14801.56	136.5	37.05	76.47	890.
		.66436	1.234	.007	24100.47	25639.91	185.3	32.76	50.65	261.
223.	1.0569	17.142	10.501	.742	14816.73	14878.39	136.8	37.07	76.83	881.
		.68668	1.226	.007	24110.72	25649.94	185.1	32.91	51.14	261.
224.	1.0920	17.075	10.251	.731	14891.60	14955.55	137.2	37.10	77.20	872.
		.70961	1.217	.007	24120.61	25659.44	185.0	33.06	51.64	260.
225.	1.1278	17.006	10.002	.721	14966.74	15033.05	137.5	37.13	77.58	863.
		.73318	1.208	.007	24130.15	25668.40	184.8	33.21	52.16	260.
226.	1.1645	16.938	9.756	.711	15042.16	15110.91	137.8	37.17	77.98	854.
		.75741	1.199	.008	24139.31	25676.80	184.6	33.36	52.70	260.
227.	1.2021	16.868	9.511	.701	15117.87	15189.13	138.2	37.20	78.39	845.
		.78231	1.189	.008	24148.10	25684.64	184.4	33.51	53.26	260.
228.	1.2405	16.798	9.268	.691	15193.88	15267.73	138.5	37.24	78.82	836.
		.80791	1.179	.008	24156.48	25691.89	184.2	33.67	53.84	259.
229.	1.2798	16.728	9.027	.681	15270.21	15346.72	138.8	37.28	79.26	827.
		.83422	1.169	.009	24164.47	25698.55	184.0	33.83	54.44	259.
230.	1.3199	16.656	8.788	.670	15346.86	15426.11	139.2	37.32	79.73	818.
		.86127	1.158	.009	24172.03	25704.59	183.9	33.99	55.06	259.
231.	1.3610	16.584	8.551	.660	15423.84	15505.91	139.5	37.36	80.21	809.
		.88908	1.147	.009	24179.16	25710.00	183.7	34.15	55.70	258.
232.	1.4030	16.512	8.316	.651	15501.17	15586.14	139.9	37.40	80.71	800.
		.91767	1.136	.010	24185.85	25714.76	183.5	34.32	56.37	258.
233.	1.4460	16.438	8.084	.641	15578.86	15666.82	140.2	37.45	81.23	791.
		.94707	1.124	.010	24192.08	25718.85	183.3	34.49	57.07	257.

Table B-1. (Continued)

Temp. K	Pressure MPa	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of sound m/s
234.	1.4898	16.364	7.853	.631	15656.92	15747.96	140.5	37.50	81.77	781.
		.97731	1.112	.010	24197.83	25722.26	183.1	34.66	57.79	257.
235.	1.5347	16.289	7.624	.621	15735.36	15829.57	140.9	37.55	82.34	772.
		1.0084	1.100	.011	24203.10	25724.96	183.0	34.83	58.54	257.
236.	1.5804	16.213	7.398	.611	15814.19	15911.68	141.2	37.61	82.93	763.
		1.0404	1.087	.011	24207.85	25726.92	182.8	35.01	59.32	256.
237.	1.6272	16.136	7.173	.601	15893.44	15994.29	141.5	37.66	83.55	753.
		1.0733	1.074	.011	24212.08	25728.14	182.6	35.18	60.14	256.
238.	1.6750	16.058	6.951	.592	15973.12	16077.42	141.9	37.72	84.19	744.
		1.1072	1.060	.012	24215.77	25728.59	182.4	35.36	60.99	255.
239.	1.7237	15.980	6.731	.582	16053.24	16161.11	142.2	37.78	84.86	734.
		1.1420	1.046	.012	24218.89	25728.23	182.2	35.55	61.87	255.
240.	1.7735	15.900	6.514	.572	16133.81	16245.35	142.5	37.85	85.57	725.
		1.1779	1.032	.013	24221.43	25727.05	182.1	35.73	62.80	254.
241.	1.8243	15.819	6.299	.563	16214.86	16330.18	142.9	37.91	86.30	715.
		1.2149	1.018	.013	24223.36	25725.01	181.9	35.92	63.77	254.
242.	1.8761	15.738	6.086	.553	16296.40	16415.62	143.2	37.98	87.07	705.
		1.2529	1.003	.014	24224.66	25722.08	181.7	36.12	64.79	253.
243.	1.9290	15.655	5.876	.543	16378.46	16501.68	143.6	38.05	87.87	695.
		1.2921	.987	.014	24225.31	25718.25	181.5	36.31	65.86	253.
244.	1.9830	15.571	5.668	.534	16461.05	16588.40	143.9	38.13	88.72	686.
		1.3325	.971	.015	24225.27	25713.46	181.3	36.51	66.98	252.
245.	2.0380	15.486	5.463	.524	16544.19	16675.79	144.3	38.21	89.60	676.
		1.3741	.955	.015	24224.52	25707.69	181.1	36.71	68.16	251.
246.	2.0942	15.399	5.260	.515	16627.90	16763.89	144.6	38.29	90.53	666.
		1.4170	.939	.016	24223.03	25700.89	180.9	36.92	69.40	251.
247.	2.1514	15.312	5.060	.505	16712.21	16852.72	144.9	38.38	91.51	656.
		1.4613	.922	.016	24220.77	25693.03	180.7	37.13	70.71	250.
248.	2.2098	15.222	4.863	.496	16797.14	16942.31	145.3	38.46	92.54	646.
		1.5070	.905	.017	24217.70	25684.07	180.5	37.35	72.10	250.
249.	2.2694	15.132	4.668	.486	16882.73	17032.70	145.6	38.56	93.63	636.
		1.5542	.887	.018	24213.78	25673.96	180.3	37.56	73.56	249.
250.	2.3300	15.040	4.476	.477	16968.99	17123.91	146.0	38.65	94.78	625.
		1.6029	.869	.018	24208.98	25662.64	180.1	37.79	75.12	248.
251.	2.3919	14.946	4.287	.467	17055.95	17215.99	146.3	38.75	95.99	615.
		1.6532	.850	.019	24203.25	25650.08	179.9	38.01	76.77	247.
252.	2.4549	14.851	4.101	.458	17143.66	17308.96	146.7	38.86	97.27	605.
		1.7052	.831	.020	24196.55	25636.20	179.7	38.25	78.52	247.
253.	2.5192	14.754	3.917	.448	17232.13	17402.88	147.0	38.97	98.64	595.
		1.7590	.812	.020	24188.82	25620.95	179.5	38.48	80.39	246.
254.	2.5846	14.655	3.737	.439	17321.42	17497.78	147.4	39.08	100.09	584.
		1.8147	.792	.021	24180.01	25604.26	179.3	38.72	82.39	245.
255.	2.6513	14.554	3.559	.430	17411.56	17593.72	147.8	39.20	101.63	574.
		1.8724	.772	.022	24170.07	25586.06	179.1	38.97	84.53	244.

Table B-1. (Continued)

Temp. K	Pressure MPa	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of sound m/s
256.	2.7192	14.451	3.385	.420	17502.59	17690.75	148.1	39.32	103.28	563.
		1.9322	.751	.023	24158.92	25566.26	178.9	39.22	86.83	243.
257.	2.7884	14.346	3.214	.411	17594.55	17788.92	148.5	39.45	105.05	552.
		1.9942	.730	.024	24146.50	25544.80	178.7	39.48	89.31	243.
258.	2.8589	14.239	3.045	.401	17687.52	17888.30	148.9	39.59	106.94	542.
		2.0585	.709	.025	24132.73	25521.55	178.4	39.75	91.98	242.
259.	2.9307	14.129	2.880	.392	17781.53	17988.95	149.2	39.73	108.98	531.
		2.1254	.687	.026	24117.53	25496.44	178.2	40.02	94.87	241.
260.	3.0039	14.017	2.718	.383	17876.65	18090.95	149.6	39.88	111.19	520.
		2.1949	.664	.027	24100.79	25469.33	178.0	40.29	98.02	240.
261.	3.0783	13.902	2.559	.373	17972.96	18194.39	150.0	40.03	113.59	509.
		2.2673	.642	.028	24082.42	25440.10	177.7	40.58	101.45	239.
262.	3.1542	13.784	2.403	.364	18070.53	18299.35	150.4	40.19	116.19	498.
		2.3428	.618	.029	24062.30	25408.61	177.5	40.87	105.21	238.
263.	3.2314	13.663	2.250	.354	18169.45	18405.96	150.7	40.37	119.05	486.
		2.4216	.594	.030	24040.29	25374.70	177.2	41.18	109.35	237.
264.	3.3100	13.538	2.101	.345	18269.82	18514.31	151.1	40.54	122.19	475.
		2.5039	.570	.031	24016.25	25338.18	177.0	41.49	113.92	236.
265.	3.3900	13.410	1.954	.336	18371.76	18624.56	151.5	40.73	125.67	464.
		2.5901	.545	.033	23990.01	25298.84	176.7	41.81	119.01	235.
5.	3.4715	13.277	1.811	.326	18475.40	18736.87	151.9	40.93	129.54	452.
		2.6806	.520	.034	23961.37	25256.45	176.4	42.14	124.70	234.
7.	3.5545	13.140	1.672	.317	18580.90	18851.41	152.3	41.14	133.88	440.
		2.7756	.494	.036	23930.10	25210.73	176.1	42.48	131.11	233.
3.	3.6390	12.998	1.535	.307	18688.45	18968.41	152.7	41.37	138.80	428.
		2.8758	.468	.037	23895.95	25161.35	175.8	42.83	138.39	232.
).	3.7250	12.851	1.402	.297	18798.26	19088.13	153.2	41.61	144.42	416.
		2.9816	.441	.039	23858.58	25107.93	175.5	43.20	146.73	231.
).	3.8126	12.697	1.272	.288	18910.61	19210.87	153.6	41.86	150.91	404.
		3.0937	.413	.041	23817.64	25050.01	175.2	43.57	156.39	230.
.	3.9018	12.537	1.145	.278	19025.82	19337.04	154.0	42.13	158.51	392.
		3.2130	.385	.043	23772.66	24987.03	174.9	43.97	167.71	229.
.	3.9926	12.369	1.022	.268	19144.30	19467.10	154.5	42.42	167.54	379.
		3.3405	.356	.045	23723.08	24918.29	174.5	44.38	181.16	228.
.	4.0850	12.191	.902	.258	19266.59	19601.67	155.0	42.73	178.47	367.
		3.4774	.326	.047	23668.17	24842.90	174.1	44.81	197.44	226.
.	4.1792	12.002	.786	.248	19393.37	19741.56	155.4	43.07	192.01	353.
		3.6255	.296	.049	23607.02	24759.75	173.7	45.26	217.56	225.
.	4.2751	11.801	.673	.238	19525.57	19887.84	155.9	43.44	209.24	340.
		3.7869	.264	.052	23538.38	24667.29	173.3	45.74	243.07	224.
.	4.3728	11.582	.564	.227	19664.49	20042.02	156.5	43.85	231.97	326.
		3.9648	.232	.055	23460.55	24563.45	172.8	46.25	276.56	222.
.	4.4724	11.343	.459	.216	19812.04	20206.32	157.0	44.30	263.38	312.
		4.1638	.199	.059	23371.06	24445.17	172.3	46.79	322.52	221.

Table B-1. (Continued)

Temp. K	Pressure MPa	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of sound m/s
278.	4.5739	11.076	.358	.205	19971.24	20384.20	157.6	44.83	309.74	297.
		4.3907	.164	.062	23266.09	24307.81	171.8	47.37	389.63	219.
279.	4.6774	10.768	.262	.192	20147.21	20581.61	158.3	45.44	385.16	282.
		4.6574	.128	.067	23139.26	24143.55	171.1	48.01	497.11	218.
280.	4.7831	10.394	.172	.179	20350.16	20810.31	159.1	46.19	529.36	265.
		4.9869	.091	.073	22978.35	23937.47	170.3	48.72	697.18	216.
281.	4.8910	9.895	.088	.163	20606.09	21100.40	160.1	47.20	911.93	247.
		5.4348	.053	.080	22754.05	23653.99	169.2	49.55	1197.30	214.
282.	5.0017	8.956	.016	.139	21049.80	21608.28	161.9	48.99	4431.04	224.
		6.2349	.015	.093	22347.15	23149.35	167.3	50.55	4272.17	212.

Table B-2. Thermodynamic Properties of Ethylene

.05 megapascal Isobar

Temp.	Density	Isotherm Derivative	Isochore Derivative	Internal Energy	Enthalpy	Entropy	C_v	C_p	Velocity of Sound
K	mol/dm^3	dm^3-MPa/mol	MPa/K	J/mol	J/mol	J/(mol•K)	J/(mol•K)		m/s
*103.993	23.390	45.998	2.908	6614.60	6616.74	84.4	39.49	74.43	1758.
110.0	23.052	50.235	2.587	7044.44	7046.61	88.4	42.19	69.76	1721.
120.0	22.573	49.309	2.256	7729.74	7731.96	94.4	43.41	67.72	1656.
130.0	22.122	45.249	2.032	8402.41	8404.67	99.8	42.71	66.94	1590.
140.0	21.669	40.384	1.850	9070.17	9072.48	104.7	41.43	66.70	1522.
150.0	21.203	35.520	1.687	9737.71	9740.07	109.3	40.14	66.87	1452.
*158.297	20.802	31.719	1.559	10293.90	10296.30	112.9	39.21	67.23	1392.
*158.297	.038789	1.262	.000332	22985.93	24274.96	201.2	26.40	35.60	246.
160.0	.038347	1.277	.000328	23031.63	24335.51	201.6	26.39	35.56	248.
170.0	.035953	1.368	.000305	23299.50	24690.19	203.8	26.45	35.41	256.
180.0	.033859	1.457	.000286	23567.72	25044.41	205.8	26.63	35.46	263.
190.0	.032007	1.545	.000270	23837.72	25399.86	207.7	26.92	35.65	270.
200.0	.030355	1.631	.000255	24110.70	25757.85	209.6	27.31	35.97	277.
210.0	.028871	1.718	.000242	24387.68	26119.54	211.3	27.78	36.39	283.
220.0	.027528	1.803	.000231	24669.55	26485.87	213.0	28.34	36.90	289.
230.0	.026308	1.889	.000220	24957.12	26857.71	214.7	28.96	37.49	295.
240.0	.025193	1.974	.000211	25251.09	27235.81	216.3	29.65	38.15	301.
245.0	.024670	2.016	.000206	25400.69	27427.42	217.1	30.01	38.50	304.
250.0	.024170	2.059	.000202	25552.12	27620.84	217.9	30.39	38.87	306.
256.0	.023595	2.110	.000197	25736.37	27855.43	218.8	30.87	39.33	310.
258.0	.023410	2.127	.000196	25798.41	27934.26	219.1	31.03	39.49	311.
260.0	.023227	2.144	.000194	25860.78	28013.40	219.4	31.19	39.65	312.
262.0	.023048	2.160	.000192	25923.47	28092.85	219.7	31.36	39.81	313.
264.0	.022871	2.177	.000191	25986.49	28172.64	220.0	31.52	39.98	314.
266.0	.022697	2.194	.000189	26049.84	28252.77	220.3	31.69	40.14	315.
268.0	.022526	2.211	.000188	26113.53	28333.22	220.6	31.86	40.31	316.
270.0	.022357	2.228	.000187	26177.56	28414.01	220.9	32.04	40.48	317.
275.0	.021946	2.270	.000183	26339.14	28617.48	221.7	32.47	40.91	319.
280.0	.021550	2.312	.000180	26502.91	28823.12	222.4	32.92	41.35	322.
285.0	.021168	2.355	.000177	26668.92	29030.98	223.1	33.37	41.80	324.
290.0	.020800	2.397	.000174	26837.21	29241.11	223.9	33.83	42.25	327.
295.0	.020444	2.439	.000171	27007.81	29453.54	224.6	34.30	42.72	329.
300.0	.020100	2.481	.000168	27180.76	29668.31	225.3	34.78	43.19	331.
305.0	.019768	2.523	.000165	27356.10	29885.45	226.0	35.26	43.67	334.
310.0	.019447	2.565	.000162	27533.83	30104.99	226.7	35.75	44.15	336.
320.0	.018834	2.649	.000157	27896.62	30551.34	228.2	36.73	45.13	341.
330.0	.018260	2.733	.000152	28269.27	31007.53	229.6	37.72	46.11	345.
340.0	.017719	2.817	.000148	28651.90	31473.67	231.0	38.73	47.11	349.
350.0	.017210	2.900	.000143	29044.55	31949.81	232.3	39.74	48.12	354.
360.0	.016730	2.984	.000139	29447.27	32435.98	233.7	40.74	49.12	358.
370.0	.016275	3.068	.000136	29860.05	32932.20	235.1	41.75	50.12	362.
380.0	.015845	3.152	.000132	30282.84	33438.41	236.4	42.75	51.12	367.
390.0	.015437	3.235	.000129	30715.61	33954.58	237.8	43.75	52.11	371.
400.0	.015050	3.319	.000125	31158.28	34480.64	239.1	44.74	53.10	375.
425.0	.014161	3.528	.000118	32307.75	35838.52	242.4	47.17	55.52	385.
450.0	.013372	3.737	.000111	33517.26	37256.37	245.6	49.55	57.90	395.

* Saturated state

Table B-2. (Continued)

.10 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*104.000	23.391	45.989	2.907	6614.52	6618.80	84.4	39.51	74.45	1758.
110.0	23.053	50.232	2.587	7043.90	7048.24	88.4	42.20	69.77	1721.
120.0	22.574	49.318	2.256	7729.21	7733.64	94.4	43.42	67.72	1656.
130.0	22.123	45.264	2.032	8401.81	8406.33	99.8	42.71	66.93	1590.
140.0	21.670	40.403	1.850	9069.49	9074.10	104.7	41.43	66.70	1523.
150.0	21.204	35.540	1.687	9736.92	9741.63	109.3	40.15	66.87	1453.
160.0	20.720	30.994	1.533	10407.53	10412.36	113.6	39.04	67.32	1380.
*169.186	20.256	27.184	1.399	11028.38	11033.31	117.4	38.24	67.90	1312.
*169.186	.073548	1.312	.000640	23221.29	24580.95	197.5	27.11	36.86	252.
170.0	.073154	1.320	.000636	23243.94	24610.92	197.7	27.10	36.82	253.
180.0	.068674	1.416	.000591	23521.24	24977.38	199.8	27.11	36.52	261.
190.0	.064764	1.508	.000553	23798.09	25342.17	201.7	27.28	36.47	268.
200.0	.061308	1.599	.000521	24076.35	25707.46	203.6	27.58	36.61	275.
210.0	.058226	1.689	.000493	24357.47	26074.93	205.4	28.00	36.90	282.
220.0	.055454	1.777	.000468	24642.64	26445.94	207.1	28.50	37.32	288.
230.0	.052945	1.865	.000446	24932.88	26821.62	208.8	29.09	37.83	294.
240.0	.050662	1.952	.000426	25229.04	27202.92	210.4	29.75	38.44	300.
245.0	.049595	1.996	.000417	25379.58	27395.94	211.2	30.10	38.77	303.
250.0	.048573	2.039	.000408	25531.88	27590.65	212.0	30.47	39.12	305.
256.0	.047402	2.091	.000398	25717.07	27826.67	212.9	30.94	39.56	309.
258.0	.047025	2.108	.000394	25779.41	27905.94	213.3	31.10	39.71	310.
260.0	.046654	2.125	.000391	25842.06	27985.51	213.6	31.26	39.86	311.
262.0	.046288	2.142	.000388	25905.03	28065.39	213.9	31.42	40.02	312.
264.0	.045929	2.160	.000385	25968.31	28145.59	214.2	31.58	40.18	313.
266.0	.045575	2.177	.000382	26031.93	28226.11	214.5	31.75	40.34	314.
268.0	.045227	2.194	.000379	26095.87	28306.94	214.8	31.92	40.50	315.
270.0	.044884	2.211	.000376	26160.14	28388.11	215.1	32.09	40.66	316.
275.0	.044050	2.254	.000369	26322.29	28592.45	215.8	32.52	41.08	319.
280.0	.043246	2.297	.000362	26486.60	28798.95	216.6	32.96	41.51	321.
285.0	.042472	2.339	.000356	26653.11	29007.60	217.3	33.41	41.95	324.
290.0	.041726	2.382	.000349	26821.86	29218.46	218.0	33.87	42.40	326.
295.0	.041005	2.425	.000343	26992.90	29431.59	218.8	34.34	42.85	328.
300.0	.040310	2.467	.000337	27166.26	29647.02	219.5	34.81	43.32	331.
305.0	.039638	2.510	.000332	27341.97	29864.79	220.2	35.29	43.79	333.
310.0	.038989	2.552	.000326	27520.07	30084.91	220.9	35.77	44.26	336.
320.0	.037752	2.637	.000316	27883.52	30532.36	222.4	36.75	45.23	340.
330.0	.036593	2.722	.000306	28256.78	30989.55	223.8	37.74	46.21	345.
340.0	.035503	2.806	.000297	28639.94	31456.59	225.2	38.74	47.20	349.
350.0	.034477	2.891	.000288	29033.10	31933.57	226.5	39.75	48.20	353.
360.0	.033509	2.975	.000280	29436.27	32420.52	227.9	40.76	49.19	358.
370.0	.032595	3.060	.000272	29849.46	32917.45	229.3	41.76	50.19	362.
380.0	.031729	3.144	.000265	30272.65	33424.33	230.6	42.76	51.18	366.
390.0	.030909	3.228	.000258	30705.78	33941.13	232.0	43.76	52.17	370.
400.0	.030130	3.312	.000251	31148.79	34467.77	233.3	44.74	53.15	375.
425.0	.028345	3.522	.000236	32299.03	35826.97	236.6	47.18	55.57	385.
450.0	.026761	3.732	.000223	33509.22	37245.98	239.8	49.55	57.94	394.

* Saturated state

Table B-2. (Continued)

.101325 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*104.000	23.391	45.988	2.907	6614.52	6618.85	84.4	39.51	74.45	1758.
110.0	23.053	50.232	2.587	7043.89	7048.28	88.4	42.20	69.77	1721.
120.0	22.574	49.318	2.256	7729.19	7733.68	94.4	43.42	67.72	1656.
130.0	22.123	45.264	2.032	8401.80	8406.38	99.8	42.71	66.93	1590.
140.0	21.670	40.403	1.850	9069.47	9074.14	104.7	41.43	66.70	1523.
150.0	21.204	35.540	1.687	9736.90	9741.67	109.3	40.15	66.87	1453.
160.0	20.720	30.994	1.533	10407.51	10412.40	113.6	39.05	67.32	1380.
*169.409	20.245	27.096	1.395	11043.53	11048.54	117.5	38.22	67.92	1310.
*169.409	.074448	1.313	.000648	23225.98	24587.00	197.4	27.13	36.89	252.
170.0	.074159	1.319	.000645	23242.44	24608.76	197.6	27.12	36.86	253.
180.0	.069611	1.414	.000599	23519.98	24975.57	199.7	27.13	36.55	261.
190.0	.065642	1.507	.000561	23797.03	25340.62	201.6	27.29	36.49	268.
200.0	.062137	1.598	.000528	24075.43	25706.11	203.5	27.59	36.63	275.
210.0	.059010	1.688	.000500	24356.66	26073.74	205.3	28.00	36.92	282.
220.0	.056200	1.777	.000474	24641.93	26444.88	207.0	28.51	37.33	288.
230.0	.053656	1.865	.000452	24932.23	26820.66	208.7	29.09	37.84	294.
240.0	.051340	1.952	.000432	25228.45	27202.04	210.3	29.75	38.45	300.
245.0	.050259	1.995	.000422	25379.02	27395.10	211.1	30.11	38.78	303.
250.0	.049223	2.038	.000413	25531.34	27589.85	211.9	30.48	39.13	305.
256.0	.048036	2.090	.000403	25716.56	27825.90	212.8	30.94	39.56	309.
258.0	.047654	2.107	.000400	25778.90	27905.18	213.1	31.10	39.72	310.
260.0	.047277	2.125	.000397	25841.56	27984.77	213.5	31.26	39.87	311.
262.0	.046907	2.142	.000393	25904.54	28064.66	213.8	31.42	40.02	312.
264.0	.046543	2.159	.000390	25967.83	28144.87	214.1	31.59	40.18	313.
266.0	.046184	2.176	.000387	26031.45	28225.40	214.4	31.75	40.34	314.
268.0	.045831	2.193	.000384	26095.40	28306.24	214.7	31.92	40.50	315.
270.0	.045483	2.211	.000381	26159.67	28387.42	215.0	32.09	40.67	316.
275.0	.044638	2.253	.000374	26321.84	28591.78	215.7	32.52	41.09	319.
280.0	.043823	2.296	.000367	26486.17	28798.30	216.5	32.96	41.52	321.
285.0	.043038	2.339	.000360	26652.69	29006.97	217.2	33.41	41.95	324.
290.0	.042282	2.382	.000354	26821.45	29217.86	217.9	33.87	42.40	326.
295.0	.041552	2.424	.000348	26992.50	29431.01	218.7	34.34	42.86	328.
300.0	.040847	2.467	.000342	27165.87	29646.46	219.4	34.81	43.32	331.
305.0	.040166	2.509	.000336	27341.60	29864.24	220.1	35.29	43.79	333.
310.0	.039508	2.552	.000330	27519.71	30084.38	220.8	35.77	44.27	336.
320.0	.038255	2.637	.000320	27883.18	30531.86	222.2	36.75	45.23	340.
330.0	.037080	2.722	.000310	28256.45	30989.07	223.7	37.74	46.21	345.
340.0	.035975	2.806	.000301	28639.63	31456.14	225.0	38.74	47.20	349.
350.0	.034936	2.891	.000292	29032.79	31933.14	226.4	39.75	48.20	353.
360.0	.033955	2.975	.000284	29435.98	32420.11	227.8	40.76	49.20	358.
370.0	.033028	3.059	.000276	29849.18	32917.06	229.2	41.76	50.19	362.
380.0	.032151	3.144	.000268	30272.38	33423.96	230.5	42.76	51.19	366.
390.0	.031319	3.228	.000261	30705.52	33940.77	231.9	43.76	52.17	370.
400.0	.030530	3.312	.000255	31148.54	34467.43	233.2	44.75	53.16	375.
425.0	.028721	3.522	.000240	32298.80	35826.67	236.5	47.18	55.57	385.
450.0	.027116	3.732	.000226	33509.00	37245.70	239.7	49.55	57.94	394.

* Saturated state

Table B-2. (Continued)

.20 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*104.014	23.392	45.970	2.907	6614.37	6622.92	84.4	39.54	74.49	1757.
110.0	23.055	50.227	2.587	7042.84	7051.51	88.4	42.21	69.79	1720.
120.0	22.576	49.337	2.256	7728.13	7736.99	94.4	43.43	67.72	1656.
130.0	22.125	45.294	2.032	8400.62	8409.66	99.7	42.72	66.93	1590.
140.0	21.673	40.439	1.851	9068.12	9077.35	104.7	41.44	66.69	1523.
150.0	21.207	35.580	1.688	9735.33	9744.77	109.3	40.15	66.85	1453.
160.0	20.723	31.035	1.534	10405.69	10415.34	113.6	39.05	67.30	1381.
170.0	20.218	26.906	1.388	11081.54	11091.43	117.7	38.18	67.94	1306.
180.0	19.691	23.179	1.248	11764.63	11774.79	121.6	37.54	68.76	1230.
*181.894	19.589	22.513	1.223	11894.97	11905.18	122.3	37.45	68.94	1215.
*181.894	.13979	1.348	.00124	23478.18	24908.91	193.9	28.13	38.81	257.
190.0	.13277	1.433	.00117	23714.87	25221.28	195.5	28.07	38.31	264.
200.0	.12516	1.533	.00109	24004.87	25602.77	197.5	28.17	38.04	272.
210.0	.11849	1.630	.00102	24295.05	25982.91	199.3	28.44	38.03	279.
220.0	.11257	1.724	.00097	24587.35	26364.01	201.1	28.85	38.22	285.
230.0	.10726	1.817	.00092	24883.29	26747.89	202.8	29.36	38.58	292.
240.0	.10247	1.908	.00087	25184.09	27135.95	204.5	29.96	39.06	298.
245.0	.10024	1.954	.00085	25336.63	27331.92	205.3	30.29	39.34	301.
250.0	.098107	1.999	.000832	25490.75	27529.34	206.1	30.64	39.64	304.
256.0	.095675	2.052	.000810	25677.91	27768.33	207.0	31.08	40.03	307.
258.0	.094892	2.070	.000803	25740.87	27848.53	207.3	31.24	40.17	308.
260.0	.094122	2.088	.000796	25804.11	27929.00	207.7	31.39	40.31	309.
262.0	.093366	2.106	.000790	25867.65	28009.76	208.0	31.55	40.45	310.
264.0	.092622	2.124	.000783	25931.49	28090.80	208.3	31.71	40.60	311.
266.0	.091891	2.141	.000777	25995.64	28172.14	208.6	31.87	40.74	312.
268.0	.091171	2.159	.000770	26060.10	28253.78	208.9	32.03	40.89	313.
270.0	.090463	2.177	.000764	26124.88	28335.72	209.2	32.20	41.05	315.
275.0	.088743	2.221	.000749	26288.23	28541.93	209.9	32.62	41.44	317.
280.0	.087089	2.265	.000735	26453.65	28750.14	210.7	33.05	41.85	320.
285.0	.085498	2.309	.000721	26621.18	28960.41	211.4	33.49	42.26	322.
290.0	.083966	2.353	.000707	26790.89	29172.80	212.2	33.94	42.69	325.
295.0	.082490	2.396	.000695	26962.83	29387.36	212.9	34.40	43.13	327.
300.0	.081067	2.440	.000682	27137.03	29604.14	213.6	34.87	43.58	330.
305.0	.079693	2.483	.000671	27313.54	29823.18	214.4	35.34	44.04	332.
310.0	.078366	2.527	.000659	27492.38	30044.51	215.1	35.82	44.50	335.
320.0	.075844	2.613	.000637	27857.19	30494.18	216.5	36.79	45.44	339.
330.0	.073483	2.700	.000617	28231.67	30953.39	217.9	37.78	46.40	344.
340.0	.071267	2.786	.000598	28615.94	31422.30	219.3	38.78	47.38	348.
350.0	.069183	2.872	.000580	29010.10	31900.97	220.7	39.78	48.36	353.
360.0	.067220	2.957	.000564	29414.19	32389.48	222.1	40.78	49.34	357.
370.0	.065368	3.043	.000548	29828.24	32887.86	223.5	41.78	50.33	361.
380.0	.063616	3.128	.000533	30252.21	33396.09	224.8	42.78	51.32	366.
390.0	.061957	3.214	.000519	30686.08	33914.15	226.2	43.78	52.30	370.
400.0	.060383	3.299	.000506	31129.78	34441.97	227.5	44.76	53.27	374.
425.0	.056782	3.511	.000475	32281.56	35803.84	230.8	47.19	55.67	384.
450.0	.053590	3.723	.000448	33493.11	37225.16	234.0	49.57	58.03	394.

* Saturated state

Table B-2. (Continued)

.40 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*104.042	23.395	45.932	2.906	6614.06	6631.16	84.4	39.60	74.56	1756.
110.0	23.059	50.216	2.587	7040.71	7058.06	88.4	42.24	69.82	1720.
120.0	22.580	49.374	2.256	7725.98	7743.70	94.3	43.45	67.72	1656.
130.0	22.129	45.354	2.033	8398.25	8416.32	99.7	42.73	66.92	1591.
140.0	21.678	40.512	1.852	9065.40	9083.85	104.7	41.45	66.67	1524.
150.0	21.213	35.659	1.689	9732.18	9751.03	109.3	40.16	66.83	1454.
160.0	20.729	31.119	1.535	10402.02	10421.31	113.6	39.06	67.27	1382.
170.0	20.226	26.992	1.389	11077.28	11097.05	117.7	38.19	67.90	1308.
180.0	19.700	23.268	1.250	11759.64	11779.95	121.6	37.56	68.71	1232.
190.0	19.150	19.876	1.119	12451.21	12472.10	125.3	37.13	69.77	1154.
*196.895	18.755	17.690	1.033	12934.90	12956.23	127.8	36.95	70.70	1098.
*196.895	.26758	1.351	.00246	23750.53	25245.43	190.3	29.60	41.96	261.
200.0	.26207	1.389	.00240	23848.75	25375.06	190.9	29.52	41.56	264.
210.0	.24615	1.504	.00221	24161.01	25785.99	192.9	29.45	40.71	272.
220.0	.23246	1.612	.00206	24470.15	26190.88	194.8	29.61	40.33	280.
230.0	.22047	1.717	.00193	24779.24	26593.58	196.6	29.95	40.26	287.
240.0	.20983	1.818	.00183	25090.51	26996.86	198.3	30.42	40.43	293.
245.0	.20493	1.867	.00178	25247.52	27199.38	199.2	30.70	40.59	297.
250.0	.20029	1.916	.00173	25405.67	27402.78	200.0	31.00	40.78	300.
256.0	.19502	1.974	.00168	25597.20	27648.27	200.9	31.40	41.06	303.
258.0	.19333	1.993	.00167	25661.50	27730.49	201.3	31.54	41.16	305.
260.0	.19167	2.012	.00165	25726.04	27812.92	201.6	31.68	41.27	306.
262.0	.19005	2.031	.00164	25790.84	27895.57	201.9	31.82	41.38	307.
264.0	.18845	2.050	.00162	25855.89	27978.45	202.2	31.97	41.50	308.
266.0	.18688	2.069	.00161	25921.21	28061.57	202.5	32.12	41.62	309.
268.0	.18535	2.088	.00159	25986.80	28144.93	202.8	32.27	41.74	310.
270.0	.18383	2.107	.00158	26052.66	28228.54	203.2	32.43	41.87	311.
275.0	.18017	2.154	.00154	26218.59	28438.71	203.9	32.82	42.20	314.
280.0	.17666	2.201	.00151	26386.38	28650.61	204.7	33.24	42.56	317.
285.0	.17330	2.247	.00148	26556.12	28864.32	205.4	33.66	42.93	320.
290.0	.17006	2.293	.00145	26727.88	29079.93	206.2	34.09	43.32	322.
295.0	.16696	2.339	.00142	26901.72	29297.50	206.9	34.54	43.72	325.
300.0	.16397	2.385	.00140	27077.70	29517.12	207.7	34.99	44.13	327.
305.0	.16110	2.430	.00137	27255.87	29738.83	208.4	35.46	44.55	330.
310.0	.15833	2.476	.00135	27436.27	29962.68	209.1	35.93	44.99	332.
320.0	.15308	2.566	.00130	27803.94	30417.02	210.6	36.88	45.88	337.
330.0	.14818	2.655	.00126	28180.96	30880.42	212.0	37.86	46.80	342.
340.0	.14360	2.744	.00122	28567.52	31353.12	213.4	38.84	47.74	347.
350.0	.13930	2.833	.00118	28963.76	31835.27	214.8	39.84	48.69	351.
360.0	.13526	2.921	.00114	29369.75	32326.99	216.2	40.83	49.65	356.
370.0	.13146	3.009	.00111	29785.54	32828.32	217.6	41.83	50.62	360.
380.0	.12787	3.097	.00108	30211.13	33339.31	218.9	42.83	51.58	365.
390.0	.12448	3.184	.00105	30646.49	33859.92	220.3	43.82	52.54	369.
400.0	.12127	3.271	.00102	31091.59	34390.15	221.6	44.80	53.50	373.
425.0	.11393	3.488	.00096	32246.53	35757.40	224.9	47.22	55.87	384.
450.0	.10745	3.704	.00090	33460.82	37183.41	228.2	49.60	58.20	394.

* Saturated state

Table B-2. (Continued)

.60 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*104.070	23.397	45.894	2.906	6613.76	6639.40	84.4	39.66	74.63	1755.
110.0	23.063	50.205	2.588	7038.58	7064.60	88.4	42.27	69.86	1720.
120.0	22.584	49.411	2.257	7723.83	7750.40	94.3	43.47	67.72	1657.
130.0	22.134	45.415	2.033	8395.87	8422.98	99.7	42.75	66.91	1592.
140.0	21.683	40.585	1.853	9062.68	9090.35	104.7	41.47	66.65	1525.
150.0	21.218	35.739	1.690	9729.03	9757.31	109.3	40.18	66.80	1455.
160.0	20.736	31.203	1.537	10398.35	10427.29	113.6	39.07	67.23	1383.
170.0	20.233	27.078	1.391	11073.03	11102.68	117.7	38.20	67.86	1309.
180.0	19.708	23.356	1.252	11754.68	11785.12	121.6	37.57	68.67	1234.
190.0	19.160	19.968	1.121	12445.40	12476.72	125.3	37.14	69.70	1156.
200.0	18.584	16.834	.997	13148.12	13180.41	128.9	36.91	71.11	1075.
*206.974	18.162	14.760	.915	13647.72	13680.76	131.4	36.86	72.44	1017.
*206.974	.39385	1.325	.00373	23909.83	25433.26	188.2	30.76	44.78	262.
210.0	.38558	1.365	.00362	24011.78	25567.88	188.8	30.64	44.22	265.
220.0	.36131	1.492	.00332	24342.43	26003.05	190.8	30.49	42.94	274.
230.0	.34070	1.610	.00308	24667.66	26428.74	192.7	30.61	42.28	282.
240.0	.32282	1.722	.00288	24991.42	26850.02	194.5	30.93	42.03	289.
245.0	.31471	1.777	.00280	25153.64	27060.15	195.4	31.15	42.03	292.
250.0	.30707	1.830	.00272	25316.46	27270.40	196.2	31.40	42.08	296.
256.0	.29846	1.893	.00263	25512.96	27523.27	197.2	31.74	42.22	300.
258.0	.29572	1.914	.00260	25578.79	27607.77	197.6	31.86	42.28	301.
260.0	.29303	1.934	.00257	25644.81	27692.39	197.9	31.99	42.35	302.
262.0	.29040	1.955	.00255	25711.02	27777.16	198.2	32.12	42.42	303.
264.0	.28782	1.975	.00252	25777.43	27862.09	198.5	32.25	42.50	305.
266.0	.28529	1.995	.00250	25844.06	27947.18	198.9	32.39	42.59	306.
268.0	.28281	2.016	.00247	25910.91	28032.44	199.2	32.53	42.68	307.
270.0	.28039	2.036	.00245	25977.99	28117.90	199.5	32.67	42.78	308.
275.0	.27452	2.086	.00239	26146.78	28332.44	200.3	33.04	43.04	311.
280.0	.26892	2.135	.00234	26317.19	28548.36	201.1	33.43	43.33	314.
285.0	.26357	2.184	.00229	26489.35	28765.80	201.8	33.84	43.65	317.
290.0	.25845	2.233	.00224	26663.33	28984.88	202.6	34.26	43.99	320.
295.0	.25354	2.281	.00219	26839.24	29205.70	203.4	34.69	44.34	322.
300.0	.24884	2.329	.00215	27017.13	29428.35	204.1	35.13	44.72	325.
305.0	.24432	2.376	.00211	27197.09	29652.90	204.8	35.58	45.11	328.
310.0	.23997	2.424	.00207	27379.16	29879.43	205.6	36.04	45.51	330.
320.0	.23177	2.517	.00199	27749.86	30338.67	207.0	36.97	46.35	335.
330.0	.22414	2.610	.00192	28129.57	30806.47	208.5	37.93	47.22	340.
340.0	.21703	2.703	.00186	28518.54	31283.14	209.9	38.91	48.12	345.
350.0	.21038	2.794	.00180	28916.95	31768.90	211.3	39.89	49.04	350.
360.0	.20415	2.885	.00174	29324.92	32263.93	212.7	40.88	49.97	355.
370.0	.19829	2.975	.00169	29742.51	32768.31	214.1	41.88	50.91	359.
380.0	.19278	3.065	.00164	30169.76	33282.11	215.5	42.87	51.85	364.
390.0	.18758	3.155	.00160	30606.67	33805.35	216.8	43.85	52.80	368.
400.0	.18266	3.244	.00155	31053.21	34338.02	218.2	44.84	53.74	372.
425.0	.17146	3.465	.00145	32211.35	35710.75	221.5	47.26	56.08	383.
450.0	.16159	3.685	.00137	33428.43	37141.50	224.8	49.63	58.38	393.

* Saturated state

Table B-2. (Continued)

.80 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*104.098	23.400	45.856	2.905	6613.45	6647.64	84.4	39.72	74.70	1753.
110.0	23.067	50.194	2.588	7036.45	7071.14	88.3	42.30	69.90	1719.
120.0	22.588	49.448	2.257	7721.69	7757.11	94.3	43.49	67.73	1657.
130.0	22.138	45.475	2.034	8393.50	8429.64	99.7	42.76	66.89	1592.
140.0	21.688	40.657	1.854	9059.97	9096.86	104.6	41.48	66.63	1526.
150.0	21.224	35.819	1.691	9725.89	9763.58	109.2	40.19	66.77	1457.
160.0	20.742	31.286	1.538	10394.70	10433.27	113.6	39.08	67.20	1385.
170.0	20.240	27.165	1.392	11068.75	11108.28	117.6	38.22	67.82	1311.
180.0	19.717	23.445	1.254	11749.73	11790.31	121.5	37.58	68.62	1235.
190.0	19.170	20.061	1.123	12439.62	12481.35	125.3	37.15	69.64	1158.
200.0	18.596	16.931	.999	13141.30	13184.32	129.9	36.92	71.03	1078.
210.0	17.986	13.986	.882	13859.44	13903.92	132.4	36.87	73.01	994.
*214.809	17.677	12.620	.828	14212.70	14257.96	134.1	36.91	74.27	951.
*214.809	.52080	1.286	.00506	24017.23	25553.35	186.7	31.76	47.53	262.
220.0	.50148	1.362	.00480	24201.43	25796.70	187.8	31.53	46.30	267.
230.0	.46942	1.497	.00438	24547.00	26251.22	189.8	31.37	44.75	276.
240.0	.44240	1.623	.00406	24885.86	26694.17	191.7	31.50	43.93	284.
245.0	.43035	1.683	.00392	25054.25	26913.22	192.6	31.65	43.71	288.
250.0	.41909	1.741	.00379	25222.52	27131.41	193.5	31.84	43.58	291.
256.0	.40651	1.809	.00365	25424.77	27392.72	194.5	32.11	43.54	296.
258.0	.40252	1.832	.00361	25492.35	27479.81	194.8	32.22	43.55	297.
260.0	.39863	1.854	.00357	25560.03	27566.92	195.2	32.33	43.56	298.
262.0	.39482	1.876	.00353	25627.85	27654.07	195.5	32.44	43.59	300.
264.0	.39110	1.898	.00349	25695.80	27741.29	195.8	32.56	43.63	301.
266.0	.38747	1.919	.00345	25763.90	27828.58	196.2	32.68	43.67	302.
268.0	.38391	1.941	.00341	25832.17	27915.98	196.5	32.81	43.72	304.
270.0	.38043	1.962	.00338	25900.62	28003.48	196.8	32.94	43.78	305.
275.0	.37205	2.016	.00329	26072.59	28222.83	197.6	33.28	43.96	308.
280.0	.36409	2.068	.00321	26245.90	28443.17	198.4	33.65	44.18	311.
285.0	.35651	2.120	.00314	26420.71	28664.68	199.2	34.03	44.43	314.
290.0	.34928	2.171	.00306	26597.13	28887.53	200.0	34.43	44.71	317.
295.0	.34238	2.222	.00300	26775.28	29111.84	200.7	34.84	45.02	320.
300.0	.33578	2.272	.00293	26955.25	29337.73	201.5	35.26	45.35	323.
305.0	.32946	2.322	.00287	27137.13	29565.32	202.3	35.70	45.69	325.
310.0	.32340	2.371	.00282	27320.99	29794.69	203.0	36.15	46.06	328.
320.0	.31199	2.469	.00271	27694.93	30259.11	204.5	37.07	46.83	333.
330.0	.30143	2.565	.00261	28077.48	30731.52	205.9	38.01	47.66	339.
340.0	.29161	2.660	.00252	28468.98	31212.33	207.4	38.98	48.51	344.
350.0	.28247	2.755	.00243	28869.66	31701.85	208.8	39.95	49.39	348.
360.0	.27392	2.849	.00236	29279.68	32200.29	210.2	40.94	50.30	353.
370.0	.26590	2.941	.00228	29699.14	32707.81	211.6	41.92	51.21	358.
380.0	.25837	3.034	.00222	30128.11	33224.50	213.0	42.91	52.13	362.
390.0	.25127	3.125	.00215	30566.61	33750.42	214.3	43.89	53.05	367.
400.0	.24458	3.216	.00209	31014.62	34285.59	215.7	44.87	53.98	371.
425.0	.22937	3.442	.00196	32176.04	35663.89	219.0	47.29	56.28	382.
450.0	.21601	3.665	.00184	33395.95	37099.44	222.3	49.65	58.56	393.

* Saturated state

Table B-2. (Continued)

1.00 megapascal isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*104.127	23.402	45.818	2.904	6613.15	6655.88	84.4	39.78	74.77	1752.
110.0	23.071	50.183	2.589	7034.33	7077.67	88.3	42.33	69.94	1719.
120.0	22.592	49.485	2.258	7719.55	7763.82	94.3	43.51	67.73	1657.
130.0	22.143	45.535	2.035	8391.14	8436.30	99.7	42.78	66.88	1593.
140.0	21.692	40.730	1.854	9057.27	9103.37	104.6	41.49	66.61	1527.
150.0	21.230	35.898	1.692	9722.76	9769.87	109.2	40.20	66.75	1458.
160.0	20.749	31.369	1.539	10391.07	10439.26	113.5	39.10	67.17	1386.
170.0	20.248	27.250	1.394	11064.53	11113.92	117.6	38.23	67.78	1312.
180.0	19.725	23.534	1.255	11744.81	11795.51	121.5	37.59	68.57	1237.
190.0	19.180	20.152	1.125	12433.87	12486.01	125.3	37.16	69.58	1160.
200.0	18.607	17.028	1.001	13134.52	13188.26	128.9	36.93	70.95	1080.
210.0	18.000	14.089	.885	13851.32	13906.87	132.4	36.87	72.89	996.
220.0	17.346	11.287	.774	14591.53	14649.18	135.8	37.00	75.76	908.
*221.321	17.255	10.926	.759	14691.58	14749.54	136.3	37.03	76.24	895.
*221.321	.64956	1.240	.00646	24093.32	25632.81	185.4	32.66	50.32	261.
230.0	.60866	1.376	.00588	24415.07	26058.01	187.3	32.25	47.87	270.
240.0	.56980	1.517	.00537	24772.63	26527.63	189.3	32.15	46.21	279.
245.0	.55282	1.584	.00516	24948.42	26757.34	190.3	32.21	45.70	283.
250.0	.53714	1.648	.00497	25123.13	26984.85	191.2	32.32	45.33	287.
256.0	.51979	1.722	.00477	25332.07	27255.92	192.3	32.53	45.05	292.
258.0	.51433	1.746	.00471	25401.66	27345.96	192.6	32.61	44.99	293.
260.0	.50900	1.770	.00465	25471.27	27435.89	193.0	32.70	44.95	295.
262.0	.50382	1.794	.00459	25540.92	27525.75	193.3	32.79	44.91	296.
264.0	.49877	1.818	.00453	25610.62	27615.56	193.6	32.89	44.89	297.
266.0	.49384	1.841	.00448	25680.40	27705.34	194.0	33.00	44.89	299.
268.0	.48904	1.864	.00443	25750.27	27795.11	194.3	33.11	44.89	300.
270.0	.48434	1.887	.00438	25820.25	27884.91	194.7	33.23	44.90	302.
275.0	.47308	1.944	.00425	25995.79	28109.60	195.5	33.54	44.98	305.
280.0	.46243	1.999	.00414	26172.33	28334.80	196.3	33.87	45.11	308.
285.0	.45234	2.054	.00404	26350.06	28560.77	197.1	34.23	45.28	311.
290.0	.44276	2.108	.00394	26529.15	28787.70	197.9	34.61	45.50	314.
295.0	.43364	2.162	.00385	26709.74	29015.78	198.7	35.00	45.74	317.
300.0	.42495	2.214	.00376	26891.96	29245.17	199.4	35.41	46.02	320.
305.0	.41665	2.266	.00368	27075.92	29476.00	200.2	35.83	46.32	323.
310.0	.40872	2.318	.00360	27261.71	29708.40	201.0	36.27	46.64	326.
320.0	.39382	2.419	.00346	27639.09	30178.29	202.4	37.17	47.35	331.
330.0	.38010	2.519	.00332	28024.66	30655.55	203.9	38.10	48.11	337.
340.0	.36739	2.618	.00320	28418.82	31140.69	205.4	39.05	48.92	342.
350.0	.35559	2.715	.00309	28821.87	31634.10	206.8	40.01	49.77	347.
360.0	.34458	2.812	.00299	29234.03	32136.07	208.2	40.99	50.63	352.
370.0	.33429	2.907	.00290	29655.43	32646.82	209.6	41.97	51.52	357.
380.0	.32464	3.002	.00281	30086.17	33166.48	211.0	42.95	52.42	361.
390.0	.31557	3.096	.00272	30526.30	33695.14	212.4	43.93	53.32	366.
400.0	.30703	3.189	.00265	30975.82	34232.86	213.7	44.91	54.23	370.
425.0	.28767	3.419	.00247	32140.59	35616.82	217.1	47.32	56.49	381.
450.0	.27072	3.646	.00232	33363.37	37057.24	220.4	49.68	58.74	392.

* Saturated state

Table B-2. (Continued)

1.25 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*104.162	23.406	45.771	2.903	6612.77	6666.17	84.4	39.85	74.86	1751.
110.0	23.076	50.168	2.590	7031.67	7085.84	88.3	42.37	69.98	1719.
120.0	22.597	49.531	2.258	7716.88	7772.20	94.3	43.53	67.73	1657.
130.0	22.148	45.610	2.036	8388.19	8444.63	99.6	42.80	66.87	1594.
140.0	21.699	40.821	1.856	9053.90	9111.51	104.6	41.51	66.59	1528.
150.0	21.237	35.998	1.694	9718.86	9777.72	109.2	40.21	66.71	1459.
160.0	20.757	31.474	1.541	10386.53	10446.76	113.5	39.11	67.13	1388.
170.0	20.257	27.358	1.396	11059.26	11120.97	117.6	38.24	67.74	1314.
180.0	19.736	23.644	1.258	11738.68	11802.02	121.5	37.60	68.51	1239.
190.0	19.192	20.267	1.127	12426.72	12491.85	125.2	37.17	69.50	1162.
200.0	18.622	17.148	1.004	13126.10	13193.23	128.8	36.94	70.85	1083.
210.0	18.018	14.218	.888	13841.24	13910.62	132.3	36.88	72.75	1000.
220.0	17.368	11.426	.777	14579.15	14651.12	135.8	37.00	75.54	912.
*228.245	16.781	9.210	.688	15212.48	15286.96	138.6	37.25	78.92	834.
*228.245	.81428	1.177	.00833	24158.48	25693.58	184.2	33.71	53.99	259.
230.0	.80216	1.209	.00814	24229.31	25787.60	184.6	33.57	53.16	261.
240.0	.74263	1.376	.00728	24617.74	26300.95	186.8	33.08	49.83	272.
245.0	.71752	1.453	.00694	24805.20	26547.32	187.8	33.01	48.77	277.
250.0	.69473	1.525	.00664	24989.81	26789.07	188.8	33.01	47.97	281.
256.0	.66992	1.609	.00632	25208.84	27074.72	189.9	33.11	47.29	286.
258.0	.66218	1.636	.00623	25281.43	27169.12	190.3	33.16	47.12	288.
260.0	.65468	1.662	.00614	25353.88	27263.20	190.6	33.22	46.96	289.
262.0	.64741	1.688	.00605	25426.22	27357.00	191.0	33.28	46.84	291.
264.0	.64035	1.714	.00597	25498.48	27450.55	191.3	33.36	46.73	293.
266.0	.63348	1.740	.00588	25570.70	27543.91	191.7	33.44	46.63	294.
268.0	.62681	1.765	.00581	25642.89	27637.10	192.1	33.53	46.56	296.
270.0	.62032	1.790	.00573	25715.08	27730.16	192.4	33.62	46.50	297.
275.0	.60483	1.852	.00556	25895.71	27962.42	193.2	33.89	46.42	301.
280.0	.59028	1.912	.00539	26076.81	28194.45	194.1	34.18	46.41	304.
285.0	.57658	1.971	.00524	26258.65	28426.60	194.9	34.50	46.46	308.
290.0	.56365	2.028	.00510	26441.46	28659.17	195.7	34.85	46.57	311.
295.0	.55140	2.085	.00497	26625.43	28892.41	196.5	35.22	46.73	314.
300.0	.53977	2.141	.00485	26810.74	29126.54	197.3	35.60	46.93	317.
305.0	.52871	2.196	.00474	26997.53	29361.76	198.1	36.01	47.16	320.
310.0	.51818	2.250	.00463	27185.92	29598.23	198.8	36.43	47.43	323.
320.0	.49851	2.357	.00443	27567.95	30075.44	200.4	37.30	48.03	329.
330.0	.48048	2.462	.00425	27957.54	30559.10	201.8	38.20	48.71	334.
340.0	.46388	2.564	.00409	28355.23	31049.92	203.3	39.14	49.46	340.
350.0	.44851	2.666	.00394	28761.41	31548.41	204.8	40.09	50.25	345.
360.0	.43424	2.765	.00381	29176.36	32054.97	206.2	41.06	51.07	350.
370.0	.42093	2.864	.00368	29600.28	32569.89	207.6	42.03	51.92	355.
380.0	.40849	2.962	.00357	30033.32	33093.38	209.0	43.01	52.78	360.
390.0	.39682	3.058	.00346	30475.55	33625.56	210.4	43.98	53.66	365.
400.0	.38586	3.154	.00335	30927.02	34166.53	211.7	44.95	54.54	369.
425.0	.36110	3.390	.00313	32096.07	35557.71	215.1	47.36	56.76	381.
450.0	.33951	3.622	.00293	33322.52	37004.29	218.4	49.72	58.97	391.

* Saturated state

Table B-2. (Continued)

1.50 megapascal Isobar

Temp.	Density	Isotherm Derivative	Isochore Derivative	Internal Energy	Enthalpy	Entropy	C_v	C_p	Velocity of Sound
K	mol/dm^3	dm^3-MPa/mol	MPa/K	J/mol	J/mol	J/(mol·K)	J/(mol·K)		m/s
*104.197	23.409	45.723	2.902	6612.39	6676.47	84.4	39.92	74.95	1749.
110.0	23.081	50.153	2.590	7029.02	7094.01	88.3	42.41	70.03	1718.
120.0	22.602	49.576	2.259	7714.22	7780.58	94.2	43.56	67.74	1658.
130.0	22.154	45.685	2.036	8385.25	8452.96	99.6	42.81	66.86	1595.
140.0	21.705	40.912	1.857	9050.55	9119.66	104.6	41.52	66.56	1529.
150.0	21.243	36.097	1.695	9714.98	9785.59	109.2	40.23	66.68	1460.
160.0	20.765	31.578	1.543	10382.02	10454.26	113.5	39.12	67.09	1389.
170.0	20.266	27.465	1.398	11054.02	11128.04	117.6	38.25	67.69	1316.
180.0	19.747	23.754	1.260	11732.59	11808.55	121.4	37.61	68.45	1241.
190.0	19.205	20.381	1.129	12419.61	12497.72	125.2	37.19	69.43	1165.
200.0	18.637	17.268	1.007	13117.74	13198.23	128.8	36.95	70.75	1086.
210.0	18.036	14.345	.891	13831.26	13914.42	132.3	36.89	72.61	1003.
220.0	17.389	11.564	.780	14566.91	14653.17	135.7	37.01	75.32	916.
230.0	16.677	8.897	.673	15335.63	15425.58	139.1	37.31	79.47	822.
*234.229	16.347	7.801	.629	15674.75	15766.51	140.6	37.51	81.90	779.
*234.229	.98434	1.109	.01033	24199.08	25722.94	183.1	34.70	57.96	257.
240.0	.93513	1.222	.00956	24443.54	26047.59	184.5	34.21	54.75	264.
245.0	.89847	1.311	.00902	24646.66	26316.17	185.6	33.95	52.78	270.
250.0	.86600	1.395	.00856	24844.13	26576.24	186.6	33.81	51.32	275.
256.0	.83137	1.489	.00809	25075.84	26880.09	187.8	33.77	50.04	280.
258.0	.82071	1.519	.00795	25152.14	26979.82	188.2	33.78	49.70	282.
260.0	.81044	1.548	.00781	25228.07	27078.92	188.6	33.80	49.40	284.
262.0	.80052	1.578	.00768	25303.68	27177.46	189.0	33.84	49.14	286.
264.0	.79095	1.606	.00756	25379.03	27275.50	189.4	33.88	48.91	287.
266.0	.78168	1.634	.00745	25454.16	27373.10	189.7	33.93	48.70	289.
268.0	.77272	1.662	.00733	25529.11	27470.32	190.1	33.99	48.52	291.
270.0	.76403	1.690	.00723	25603.92	27567.20	190.4	34.06	48.37	292.
275.0	.74342	1.756	.00698	25790.52	27808.23	191.3	34.27	48.07	296.
280.0	.72423	1.821	.00675	25976.90	28048.07	192.2	34.52	47.88	300.
285.0	.70629	1.885	.00655	26163.44	28287.22	193.0	34.80	47.79	304.
290.0	.68945	1.946	.00636	26350.46	28526.11	193.9	35.11	47.78	307.
295.0	.67359	2.007	.00618	26538.23	28765.09	194.7	35.45	47.83	311.
300.0	.65862	2.066	.00602	26726.97	29004.45	195.5	35.81	47.93	314.
305.0	.64445	2.125	.00586	26916.89	29244.47	196.3	36.19	48.08	317.
310.0	.63099	2.182	.00572	27108.15	29485.35	197.1	36.59	48.28	320.
320.0	.60601	2.294	.00546	27495.24	29970.44	198.6	37.43	48.76	326.
330.0	.58326	2.404	.00523	27889.16	30460.94	200.1	38.32	49.35	332.
340.0	.56240	2.511	.00502	28290.62	30957.76	201.6	39.23	50.02	338.
350.0	.54319	2.616	.00483	28700.10	31461.59	203.1	40.17	50.75	343.
360.0	.52540	2.719	.00466	29118.00	31972.95	204.5	41.13	51.52	348.
370.0	.50888	2.821	.00450	29544.57	32492.20	205.9	42.09	52.33	354.
380.0	.49348	2.921	.00435	29980.00	33019.63	207.3	43.06	53.16	359.
390.0	.47908	3.021	.00421	30424.41	33555.43	208.7	44.03	54.00	363.
400.0	.46557	3.119	.00408	30877.88	34099.75	210.1	45.00	54.86	368.
425.0	.43517	3.361	.00380	32051.33	35498.29	213.5	47.39	57.03	380.
450.0	.40876	3.598	.00355	33281.51	36951.14	216.8	49.75	59.20	391.

* Saturated state

Table B-2. (Continued)

2.00 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*104.267	23.415	45.628	2.901	6611.64	6697.05	84.4	40.06	75.14	1747.
110.0	23.091	50.121	2.592	7023.72	7110.33	88.2	42.48	70.13	1717.
120.0	22.612	49.668	2.260	7708.91	7797.36	94.2	43.61	67.75	1658.
130.0	22.165	45.835	2.038	8379.40	8469.63	99.6	42.85	66.83	1596.
140.0	21.717	41.093	1.859	9043.86	9135.96	104.5	41.55	66.51	1531.
150.0	21.257	36.295	1.698	9707.25	9801.33	109.1	40.26	66.62	1463.
160.0	20.780	31.785	1.546	10373.05	10469.29	113.4	39.15	67.01	1393.
170.0	20.284	27.678	1.401	11043.61	11142.21	117.5	38.28	67.59	1320.
180.0	19.767	23.974	1.264	11720.49	11821.67	121.4	37.64	68.33	1246.
190.0	19.229	20.609	1.134	12405.52	12509.53	125.1	37.21	69.28	1169.
200.0	18.665	17.507	1.012	13101.20	13208.35	128.7	36.97	70.55	1091.
210.0	18.070	14.599	.897	13811.54	13922.22	132.2	36.91	72.33	1010.
220.0	17.432	11.837	.787	14542.85	14657.58	135.6	37.02	74.91	924.
230.0	16.732	9.195	.681	15305.12	15424.65	139.0	37.30	78.78	832.
240.0	15.934	6.663	.577	16115.36	16240.87	142.5	37.83	85.00	731.
*244.311	15.545	5.604	.531	16486.75	16615.42	144.0	38.15	88.98	683.
*244.311	1.3453	.966	.0148	24225.12	25711.77	181.2	36.57	67.34	252.
245.0	1.3349	.984	.0147	24259.62	25757.88	181.4	36.47	66.53	253.
250.0	1.2673	1.100	.0135	24499.77	26077.98	182.7	35.87	61.82	260.
256.0	1.2002	1.225	.0125	24770.37	26436.80	184.1	35.42	58.05	268.
258.0	1.1803	1.264	.0122	24857.49	26551.91	184.6	35.32	57.08	270.
260.0	1.1616	1.302	.0119	24943.39	26665.22	185.0	35.24	56.24	272.
262.0	1.1437	1.338	.0116	25028.24	26776.92	185.5	35.18	55.49	274.
264.0	1.1267	1.374	.0114	25112.15	26887.21	185.9	35.14	54.82	276.
266.0	1.1105	1.409	.0112	25195.25	26996.25	186.3	35.12	54.23	278.
268.0	1.0950	1.443	.0110	25277.64	27104.16	186.7	35.11	53.70	280.
270.0	1.0801	1.476	.0107	25359.41	27211.07	187.1	35.11	53.23	282.
275.0	1.0454	1.556	.0103	25561.61	27474.68	188.1	35.17	52.26	287.
280.0	1.0139	1.633	.0099	25761.43	27734.11	189.0	35.30	51.54	292.
285.0	.98486	1.707	.00950	25959.69	27990.45	189.9	35.48	51.02	296.
290.0	.95807	1.778	.00917	26157.02	28244.56	190.8	35.71	50.65	300.
295.0	.93319	1.846	.00887	26353.94	28497.13	191.7	35.97	50.40	304.
300.0	.90997	1.913	.00859	26550.85	28748.73	192.5	36.27	50.25	307.
305.0	.88822	1.979	.00834	26748.12	28999.82	193.3	36.60	50.19	311.
310.0	.86777	2.043	.00811	26946.02	29250.78	194.1	36.96	50.20	314.
320.0	.83025	2.166	.00769	27344.67	29753.59	195.7	37.72	50.39	321.
330.0	.79653	2.286	.00732	27748.34	30259.22	197.3	38.55	50.76	328.
340.0	.76599	2.402	.00700	28158.13	30769.14	198.8	39.43	51.25	334.
350.0	.73811	2.515	.00671	28574.86	31284.48	200.3	40.34	51.83	339.
360.0	.71252	2.626	.00645	28999.12	31806.06	201.8	41.27	52.49	345.
370.0	.68891	2.734	.00621	29431.36	32334.49	203.2	42.21	53.20	350.
380.0	.66704	2.841	.00599	29871.88	32870.22	204.7	43.17	53.95	356.
390.0	.64669	2.946	.00579	30320.90	33413.59	206.1	44.13	54.73	361.
400.0	.62769	3.049	.00560	30778.58	33964.86	207.5	45.08	55.53	366.
425.0	.58524	3.303	.00519	31961.18	35378.59	210.9	47.47	57.58	378.
450.0	.54867	3.550	.00484	33199.05	36844.23	214.2	49.82	59.67	389.

* Saturated state

Table B-2. (Continued)

2.50 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*104.337	23.422	45.533	2.899	6610.89	6717.63	84.4	40.21	75.32	1744.
110.0	23.101	50.087	2.593	7018.43	7126.65	88.2	42.55	70.23	1717.
120.0	22.622	49.758	2.262	7703.62	7814.13	94.2	43.65	67.76	1659.
130.0	22.175	45.984	2.040	8373.58	8486.31	99.5	42.88	66.81	1598.
140.0	21.729	41.273	1.861	9037.22	9152.27	104.5	41.58	66.47	1534.
150.0	21.271	36.493	1.701	9699.57	9817.10	109.1	40.28	66.56	1466.
160.0	20.796	31.993	1.549	10364.14	10484.36	113.4	39.18	66.93	1396.
170.0	20.302	27.892	1.405	11033.29	11156.43	117.4	38.31	67.50	1324.
180.0	19.788	24.193	1.268	11708.51	11834.85	121.3	37.67	68.22	1250.
190.0	19.253	20.835	1.139	12391.60	12521.44	125.0	37.24	69.14	1174.
200.0	18.694	17.743	1.017	13084.89	13218.62	128.6	37.00	70.36	1097.
210.0	18.104	14.850	.902	13792.17	13930.26	132.1	36.93	72.07	1016.
220.0	17.474	12.106	.794	14519.32	14662.39	135.5	37.02	74.51	932.
230.0	16.785	9.487	.689	15275.51	15424.45	138.9	37.30	78.15	842.
240.0	16.008	6.985	.586	16075.92	16232.10	142.3	37.79	83.84	743.
245.0	15.568	5.778	.534	16500.75	16661.34	144.1	38.15	88.06	690.
250.0	15.077	4.599	.481	16949.61	17115.42	145.9	38.62	93.93	631.
*252.704	14.783	3.972	.451	17205.71	17374.82	146.9	38.93	98.22	598.
*252.704	1.7429	.818	.0202	24191.22	25625.62	179.6	38.41	79.83	246.
256.0	1.6686	.914	.0189	24379.59	25877.83	180.6	37.78	73.58	252.
258.0	1.6292	.968	.0182	24487.57	26022.02	181.1	37.48	70.70	255.
260.0	1.5932	1.019	.0176	24591.82	26160.95	181.7	37.22	68.30	258.
262.0	1.5601	1.067	.0170	24692.95	26295.46	182.2	37.00	66.27	261.
264.0	1.5293	1.113	.0165	24791.45	26426.22	182.7	36.82	64.53	264.
266.0	1.5006	1.158	.0161	24887.71	26553.75	183.2	36.67	63.03	266.
268.0	1.4737	1.201	.0157	24982.03	26678.48	183.6	36.55	61.73	269.
270.0	1.4484	1.242	.0153	25074.68	26800.77	184.1	36.45	60.59	271.
275.0	1.3910	1.340	.0144	25300.36	27097.68	185.2	36.30	58.30	277.
280.0	1.3403	1.432	.0137	25519.52	27384.71	186.2	36.26	56.60	282.
285.0	1.2951	1.519	.0130	25734.01	27664.37	187.2	36.30	55.33	287.
290.0	1.2542	1.601	.0125	25945.17	27938.49	188.2	36.41	54.37	292.
295.0	1.2169	1.680	.0120	26154.04	28208.46	189.1	36.59	53.66	296.
300.0	1.1826	1.756	.0116	26361.39	28475.35	190.0	36.81	53.13	301.
305.0	1.1509	1.829	.0112	26567.85	28740.02	190.9	37.07	52.76	305.
310.0	1.1215	1.900	.0108	26773.93	29003.13	191.7	37.37	52.51	308.
320.0	1.0682	2.037	.0102	27186.50	29526.82	193.4	38.05	52.29	316.
330.0	1.0211	2.167	.0096	27601.59	30049.83	195.0	38.81	52.35	323.
340.0	.97903	2.293	.00916	28020.97	30574.52	196.5	39.64	52.61	329.
350.0	.94101	2.414	.00874	28445.87	31102.61	198.1	40.51	53.02	336.
360.0	.90641	2.532	.00837	28877.22	31635.35	199.6	41.41	53.54	342.
370.0	.87474	2.648	.00804	29315.68	32173.68	201.1	42.34	54.14	347.
380.0	.84558	2.760	.00773	29761.73	32718.28	202.5	43.28	54.79	353.
390.0	.81861	2.871	.00746	30215.71	33269.68	203.9	44.22	55.49	358.
400.0	.79356	2.980	.00720	30677.88	33828.25	205.4	45.17	56.23	364.
425.0	.73797	3.245	.00664	31870.14	35257.80	208.8	47.54	58.15	376.
450.0	.69049	3.502	.00617	33116.00	36736.63	212.2	49.89	60.16	388.

* Saturated state

Table B-2. (Continued)

3.00 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*104.407	23.428	45.438	2.898	6610.15	6738.20	84.3	40.34	75.51	1741.
110.0	23.111	50.052	2.595	7013.14	7142.95	88.1	42.62	70.33	1716.
120.0	22.632	49.847	2.263	7698.35	7830.90	94.1	43.70	67.77	1660.
130.0	22.186	46.132	2.042	8367.78	8503.00	99.5	42.92	66.78	1600.
140.0	21.741	41.454	1.864	9030.62	9168.61	104.4	41.61	66.42	1536.
150.0	21.285	36.691	1.703	9691.95	9832.89	109.0	40.31	66.49	1469.
160.0	20.812	32.200	1.553	10355.31	10499.46	113.3	39.20	66.86	1399.
170.0	20.320	28.104	1.409	11023.06	11170.70	117.4	38.33	67.41	1327.
180.0	19.809	24.411	1.272	11696.66	11848.11	121.2	37.69	68.11	1254.
190.0	19.277	21.060	1.143	12377.83	12533.45	125.0	37.26	69.00	1179.
200.0	18.722	17.979	1.022	13068.79	13229.04	128.5	37.02	70.18	1102.
210.0	18.138	15.099	.908	13773.12	13938.52	132.0	36.95	71.81	1023.
220.0	17.515	12.372	.800	14496.28	14667.57	135.4	37.04	74.14	940.
230.0	16.837	9.775	.696	15246.75	15424.92	138.7	37.30	77.56	851.
240.0	16.078	7.300	.595	16038.11	16224.71	142.1	37.76	82.80	755.
245.0	15.652	6.110	.544	16456.09	16647.76	143.9	38.09	86.59	704.
250.0	15.182	4.952	.493	16895.18	17092.78	145.7	38.52	91.70	648.
256.0	14.532	3.600	.428	17462.09	17668.54	148.0	39.22	101.01	575.
258.0	14.285	3.157	.406	17664.88	17874.89	148.8	39.52	105.51	548.
*259.948	14.023	2.727	.383	17871.46	18085.38	149.6	39.87	111.06	520.
*259.948	2.1912	.666	.0266	24101.71	25470.81	178.0	40.28	97.85	240.
260.0	2.1891	.668	.0266	24105.53	25475.93	178.0	40.26	97.61	240.
262.0	2.1156	.740	.0252	24245.07	25663.12	178.7	39.70	89.97	244.
264.0	2.0519	.806	.0241	24375.01	25837.09	179.4	39.24	84.25	248.
266.0	1.9956	.868	.0231	24497.63	26000.95	180.0	38.85	79.79	252.
268.0	1.9451	.925	.0222	24614.50	26156.81	180.6	38.53	76.20	255.
270.0	1.8994	.979	.0214	24726.70	26306.17	181.1	38.26	73.25	259.
275.0	1.8006	1.104	.0198	24991.76	26657.83	182.4	37.76	67.78	266.
280.0	1.7183	1.217	.0185	25240.92	26986.81	183.6	37.46	64.03	272.
285.0	1.6477	1.320	.0174	25479.17	27299.90	184.7	37.31	61.35	278.
290.0	1.5858	1.416	.0165	25709.70	27601.44	185.8	37.27	59.37	284.
295.0	1.5308	1.507	.0157	25934.68	27894.39	186.8	37.31	57.89	289.
300.0	1.4813	1.594	.0150	26155.70	28180.89	187.7	37.43	56.77	294.
305.0	1.4364	1.676	.0144	26373.90	28462.52	188.7	37.61	55.92	298.
310.0	1.3952	1.755	.0139	26590.19	28740.49	189.6	37.84	55.29	302.
320.0	1.3219	1.906	.0129	27019.68	29289.06	191.3	38.41	54.51	311.
330.0	1.2584	2.048	.0122	27448.28	29832.18	193.0	39.10	54.17	318.
340.0	1.2025	2.184	.0115	27878.71	30373.56	194.6	39.87	54.15	325.
350.0	1.1525	2.314	.0109	28312.88	30915.81	196.2	40.70	54.33	332.
360.0	1.1076	2.440	.0104	28752.13	31460.77	197.7	41.57	54.68	338.
370.0	1.0667	2.562	.0100	29197.43	32009.79	199.2	42.47	55.14	344.
380.0	1.0294	2.681	.0096	29649.48	32563.88	200.7	43.39	55.69	350.
390.0	.99504	2.797	.00922	30108.81	33123.77	202.1	44.32	56.30	356.
400.0	.96331	2.911	.00889	30575.77	33690.02	203.6	45.26	56.96	361.
425.0	.89344	3.188	.00817	31778.20	35136.02	207.1	47.61	58.75	374.
450.0	.83425	3.454	.00756	33032.37	36628.40	210.5	49.95	60.66	387.

* Saturated state

Table B-2. (Continued)

3.50 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*104.477	23.435	45.343	2.897	6609.41	6758.76	84.3	40.48	75.70	1738.
110.0	23.121	50.015	2.597	7007.86	7159.24	88.1	42.69	70.44	1715.
120.0	22.642	49.936	2.264	7693.10	7847.68	94.1	43.74	67.78	1661.
140.0	21.753	41.634	1.866	9024.06	9184.95	104.4	41.64	66.38	1538.
160.0	20.827	32.406	1.556	10346.55	10514.60	113.3	39.23	66.78	1402.
180.0	19.829	24.628	1.276	11684.92	11861.43	121.2	37.72	68.00	1258.
200.0	18.749	18.212	1.027	13052.92	13239.59	128.4	37.04	70.00	1108.
210.0	18.170	15.345	.914	13754.37	13947.00	131.9	36.96	71.57	1029.
220.0	17.555	12.635	.806	14473.72	14673.10	135.3	37.05	73.79	947.
230.0	16.888	10.058	.704	15218.77	15426.02	138.6	37.29	77.00	860.
240.0	16.145	7.608	.604	16001.77	16218.56	142.0	37.73	81.86	767.
245.0	15.732	6.433	.554	16413.57	16636.05	143.7	38.04	85.28	717.
250.0	15.280	5.293	.504	16844.12	17073.18	145.5	38.44	89.79	664.
255.0	14.774	4.187	.452	17299.96	17536.87	147.3	38.94	96.06	607.
260.0	14.187	3.112	.399	17792.43	18039.13	149.3	39.63	105.61	544.
265.0	13.465	2.051	.340	18345.58	18605.52	151.4	40.64	123.08	471.
266.0	13.293	1.837	.327	18468.03	18731.33	151.9	40.91	128.73	454.
*266.345	13.231	1.764	.323	18511.30	18775.83	152.1	41.00	130.95	448.
*266.345	2.7128	.511	.0346	23950.90	25241.07	176.3	42.25	126.82	234.
268.0	2.6114	.586	.0326	24098.55	25438.81	177.1	41.58	113.03	238.
270.0	2.5102	.666	.0307	24258.54	25652.86	177.9	40.92	101.73	243.
272.0	2.4249	.739	.0292	24404.53	25847.91	178.6	40.39	93.72	247.
274.0	2.3510	.805	.0279	24540.34	26029.08	179.3	39.95	87.71	251.
276.0	2.2858	.867	.0267	24668.41	26199.62	179.9	39.58	83.02	255.
277.0	2.2558	.897	.0262	24730.06	26281.63	180.2	39.43	81.03	256.
278.0	2.2273	.926	.0257	24790.36	26361.75	180.5	39.28	79.24	258.
279.0	2.2002	.953	.0252	24849.42	26440.17	180.7	39.15	77.62	260.
279.5	2.1872	.967	.0250	24878.53	26478.78	180.9	39.09	76.86	260.
280.0	2.1744	.981	.0248	24907.37	26517.03	181.0	39.03	76.14	261.
280.5	2.1619	.994	.0246	24935.96	26554.93	181.1	38.97	75.45	262.
280.6	2.1594	.997	.0245	24941.65	26562.46	181.2	38.96	75.31	262.
280.8	2.1545	1.002	.0245	24952.99	26577.50	181.2	38.94	75.05	262.
281.0	2.1496	1.007	.0244	24964.30	26592.48	181.3	38.92	74.78	263.
281.2	2.1448	1.012	.0243	24975.58	26607.41	181.3	38.90	74.53	263.
281.4	2.1400	1.018	.0242	24986.81	26622.29	181.4	38.88	74.28	263.
281.5	2.1377	1.020	.0242	24992.42	26629.71	181.4	38.87	74.15	263.
281.6	2.1353	1.023	.0241	24998.01	26637.12	181.4	38.86	74.03	264.
281.7	2.1330	1.025	.0241	25003.60	26644.52	181.5	38.85	73.90	264.
281.8	2.1306	1.028	.0241	25009.18	26651.90	181.5	38.84	73.78	264.
281.9	2.1283	1.031	.0240	25014.75	26659.28	181.5	38.83	73.66	264.
282.0	2.1259	1.033	.0240	25020.31	26666.64	181.5	38.82	73.54	264.
282.1	2.1236	1.036	.0239	25025.86	26673.99	181.6	38.81	73.42	264.
282.2	2.1213	1.038	.0239	25031.41	26681.32	181.6	38.80	73.31	264.
282.3	2.1190	1.041	.0239	25036.94	26688.65	181.6	38.79	73.19	265.
282.4	2.1167	1.043	.0238	25042.47	26695.96	181.7	38.78	73.08	265.
282.6	2.1122	1.048	.0237	25053.50	26710.55	181.7	38.76	72.85	265.
282.8	2.1077	1.053	.0237	25064.50	26725.10	181.8	38.75	72.62	265.
283.0	2.1032	1.058	.0236	25075.47	26739.60	181.8	38.73	72.40	266.
283.2	2.0988	1.063	.0235	25086.40	26754.06	181.9	38.71	72.18	266.
283.5	2.0922	1.071	.0234	25102.75	26775.67	181.9	38.69	71.86	266.
284.0	2.0813	1.083	.0232	25129.85	26811.47	182.1	38.65	71.35	267.
284.5	2.0707	1.095	.0231	25156.76	26847.01	182.2	38.61	70.85	268.
285.0	2.0603	1.107	.0229	25183.50	26882.32	182.3	38.57	70.37	268.
285.5	2.0500	1.119	.0227	25210.08	26917.39	182.4	38.54	69.91	269.
286.0	2.0399	1.131	.0226	25236.50	26952.23	182.6	38.51	69.46	270.
287.0	2.0203	1.155	.0223	25288.88	27021.26	182.8	38.45	68.62	271.
288.0	2.0014	1.178	.0220	25340.69	27089.49	183.0	38.40	67.83	272.
289.0	1.9830	1.200	.0217	25391.97	27156.95	183.3	38.35	67.10	274.
290.0	1.9653	1.222	.0214	25442.76	27223.70	183.5	38.31	66.42	275.
292.0	1.9313	1.266	.0209	25543.00	27355.27	183.9	38.24	65.17	277.
294.0	1.8992	1.307	.0204	25641.65	27484.50	184.4	38.20	64.08	280.
296.0	1.8689	1.348	.0199	25738.90	27611.67	184.8	38.17	63.11	282.
298.0	1.8401	1.388	.0195	25834.93	27737.01	185.2	38.16	62.25	284.

Table B-2. (Continued)

3.50 megapascal Isobar

Temp.	Density	Isotherm Derivative	Isochore Derivative	Internal Energy	Enthalpy	Entropy	C_v	C_p	Velocity of Sound
K	mol/dm^3	dm^3-MPa/mol	MPa/K	J/mol	J/mol	J/(mol•K)	J/(mol•K)		m/s
300.0	1.8127	1.427	.0191	25929.89	27860.74	185.7	38.17	61.49	286.
302.0	1.7865	1.465	.0187	26023.91	27983.02	186.1	38.19	60.80	288.
304.0	1.7615	1.502	.0184	26117.11	28104.00	186.5	38.22	60.19	290.
310.0	1.6926	1.608	.0174	26392.69	28460.51	187.6	38.38	58.72	296.
315.0	1.6410	1.693	.0167	26618.92	28751.76	188.6	38.57	57.82	301.
320.0	1.5938	1.774	.0161	26843.03	29039.07	189.5	38.81	57.14	305.
325.0	1.5503	1.853	.0155	27065.75	29323.43	190.3	39.09	56.63	309.
330.0	1.5100	1.929	.0150	27287.68	29605.62	191.2	39.41	56.27	313.
335.0	1.4724	2.003	.0145	27509.28	29886.30	192.0	39.75	56.02	317.
340.0	1.4374	2.075	.0141	27730.94	30165.97	192.9	40.11	55.86	321.
350.0	1.3734	2.214	.0133	28175.62	30723.97	194.5	40.89	55.78	328.
360.0	1.3165	2.348	.0127	28623.68	31282.30	196.1	41.73	55.92	335.
370.0	1.2652	2.477	.0121	29076.51	31842.87	197.6	42.60	56.22	341.
380.0	1.2187	2.603	.0116	29535.10	32407.08	199.1	43.50	56.64	348.
390.0	1.1762	2.725	.0111	30000.16	32975.96	200.6	44.42	57.15	353.
400.0	1.1371	2.844	.0107	30472.24	33550.29	202.0	45.35	57.72	359.
425.0	1.0517	3.132	.0098	31685.38	35013.38	205.6	47.68	59.36	373.
450.0	.97999	3.408	.00901	32948.19	36519.68	209.0	50.01	61.16	385.

* Saturated state

Table B-2. (Continued)

4.00 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*104.547	23.441	45.247	2.896	6608.67	6779.31	84.3	40.62	75.88	1736.
110.0	23.131	49.976	2.599	7002.59	7175.52	88.0	42.76	70.55	1714.
120.0	22.652	50.025	2.266	7687.87	7864.45	94.0	43.79	67.79	1661.
140.0	21.765	41.814	1.868	9017.54	9201.32	104.3	41.67	66.33	1540.
160.0	20.842	32.612	1.559	10337.85	10529.77	113.2	39.25	66.71	1406.
180.0	19.849	24.845	1.281	11673.29	11874.81	121.1	37.74	67.89	1262.
200.0	18.777	18.444	1.032	13037.25	13250.28	128.4	37.06	69.83	1113.
210.0	18.203	15.589	.919	13735.93	13955.68	131.8	36.98	71.33	1035.
220.0	17.594	12.895	.813	14451.62	14678.97	135.2	37.06	73.45	954.
230.0	16.937	10.337	.711	15191.52	15427.69	138.5	37.30	76.49	869.
240.0	16.209	7.910	.612	15966.76	16213.53	141.8	37.71	80.99	778.
245.0	15.808	6.749	.563	16372.95	16625.99	143.5	38.00	84.11	730.
250.0	15.371	5.624	.514	16795.94	17056.17	145.3	38.37	88.14	679.
255.0	14.888	4.538	.465	17240.98	17509.65	147.1	38.83	93.55	624.
260.0	14.339	3.488	.413	17716.57	17995.53	149.0	39.44	101.34	565.
265.0	13.686	2.468	.359	18238.73	18530.99	151.0	40.27	114.07	499.
266.0	13.537	2.266	.347	18351.37	18646.85	151.4	40.48	117.74	485.
268.0	13.211	1.861	.323	18588.47	18891.24	152.4	40.97	127.20	454.
270.0	12.835	1.452	.298	18847.16	19158.80	153.3	41.58	141.48	420.
272.0	12.376	1.030	.269	19141.03	19464.24	154.5	42.40	166.86	380.
*272.081	12.356	1.013	.267	19153.64	19477.38	154.5	42.44	168.25	378.
*272.081	3.3512	.353	.0449	23718.83	24912.43	174.5	44.42	182.37	227.
274.0	3.1490	.462	.0410	23950.51	25220.75	175.6	43.28	143.81	234.
276.0	2.9937	.556	.0380	24149.12	25485.27	176.6	42.41	122.57	239.
277.0	2.9288	.598	.0368	24238.31	25604.04	177.0	42.05	115.23	242.
278.0	2.8702	.639	.0357	24322.53	25716.17	177.4	41.74	109.22	244.
279.0	2.8166	.677	.0348	24402.66	25822.82	177.8	41.45	104.20	246.
279.5	2.7914	.695	.0343	24441.40	25874.36	178.0	41.32	101.99	247.
280.0	2.7672	.713	.0339	24479.35	25924.83	178.2	41.19	99.94	248.
280.5	2.7439	.731	.0334	24516.56	25974.32	178.3	41.07	98.03	249.
280.6	2.7394	.734	.0333	24523.92	25984.10	178.4	41.05	97.67	250.
280.8	2.7304	.741	.0332	24538.56	26003.56	178.4	41.00	96.95	250.
281.0	2.7215	.748	.0330	24553.10	26022.88	178.5	40.96	96.26	250.
281.2	2.7127	.755	.0329	24567.53	26042.07	178.6	40.91	95.58	251.
281.4	2.7041	.762	.0327	24581.87	26061.12	178.7	40.87	94.92	251.
281.5	2.6998	.765	.0326	24589.00	26070.59	178.7	40.85	94.60	251.
281.6	2.6955	.769	.0326	24596.11	26080.04	178.7	40.83	94.28	252.
281.7	2.6913	.772	.0325	24603.19	26089.45	178.8	40.81	93.97	252.
281.8	2.6871	.775	.0324	24610.25	26098.83	178.8	40.79	93.66	252.
281.9	2.6830	.779	.0323	24617.29	26108.18	178.8	40.77	93.35	252.
282.0	2.6788	.782	.0323	24624.31	26117.50	178.9	40.75	93.05	252.
282.1	2.6747	.785	.0322	24631.30	26126.79	178.9	40.73	92.75	252.
282.2	2.6706	.788	.0321	24638.27	26136.05	178.9	40.71	92.46	253.
282.3	2.6666	.792	.0320	24645.22	26145.28	179.0	40.69	92.16	253.
282.4	2.6625	.795	.0320	24652.15	26154.48	179.0	40.67	91.88	253.
282.6	2.6545	.802	.0318	24665.95	26172.80	179.1	40.63	91.31	253.
282.8	2.6466	.808	.0317	24679.66	26191.01	179.1	40.59	90.76	254.
283.0	2.6388	.814	.0315	24693.30	26209.11	179.2	40.55	90.23	254.
283.2	2.6311	.821	.0314	24706.85	26227.10	179.2	40.52	89.70	254.
283.5	2.6198	.830	.0312	24727.04	26253.90	179.3	40.46	88.94	255.
284.0	2.6012	.846	.0309	24760.33	26298.06	179.5	40.38	87.72	256.
284.5	2.5832	.861	.0306	24793.18	26341.63	179.6	40.30	86.57	257.
285.0	2.5657	.876	.0303	24825.62	26384.64	179.8	40.22	85.48	258.
285.5	2.5487	.891	.0300	24857.68	26427.12	179.9	40.14	84.45	258.
286.0	2.5321	.906	.0297	24889.36	26469.09	180.1	40.07	83.46	259.
287.0	2.5001	.934	.0291	24951.71	26551.63	180.4	39.94	81.64	261.
288.0	2.4697	.962	.0286	25012.79	26632.43	180.7	39.82	79.99	262.
289.0	2.4406	.990	.0281	25072.72	26711.65	180.9	39.71	78.48	264.
290.0	2.4128	1.016	.0277	25131.61	26789.43	181.2	39.61	77.09	266.
292.0	2.3606	1.068	.0268	25246.60	26941.10	181.7	39.44	74.65	268.
294.0	2.3123	1.117	.0260	25358.35	27088.26	182.2	39.30	72.56	271.
296.0	2.2673	1.165	.0253	25467.34	27231.53	182.7	39.19	70.76	274.
298.0	2.2253	1.211	.0246	25573.97	27371.45	183.2	39.10	69.19	276.
300.0	2.1859	1.255	.0240	25678.55	27508.44	183.6	39.04	67.82	279.

Table B-2. (Continued)

4.00 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
300.0	2.1859	1.255	.0240	25678.55	27508.44	183.6	39.04	67.82	279.
302.0	2.1488	1.298	.0234	25781.35	27642.85	184.1	39.00	66.62	281.
304.0	2.1137	1.340	.0229	25882.60	27775.00	184.5	38.97	65.55	283.
310.0	2.0187	1.460	.0215	26178.80	28160.24	185.8	38.99	63.01	290.
315.0	1.9492	1.554	.0205	26419.08	28471.23	186.8	39.10	61.46	295.
320.0	1.8865	1.643	.0196	26655.12	28775.42	187.7	39.27	60.27	300.
325.0	1.8296	1.729	.0188	26888.14	29074.42	188.7	39.49	59.37	304.
330.0	1.7774	1.811	.0181	27119.03	29369.47	189.6	39.75	58.68	309.
335.0	1.7293	1.891	.0175	27348.53	29661.55	190.4	40.05	58.17	313.
340.0	1.6848	1.968	.0169	27577.20	29951.43	191.3	40.38	57.80	317.
350.0	1.6044	2.117	.0159	28033.83	30526.98	193.0	41.10	57.37	325.
360.0	1.5336	2.258	.0151	28491.74	31099.95	194.6	41.90	57.26	332.
370.0	1.4705	2.394	.0143	28952.84	31673.00	196.2	42.74	57.38	338.
380.0	1.4137	2.526	.0137	29418.52	32248.01	197.7	43.62	57.65	345.
390.0	1.3621	2.654	.0131	29889.77	32826.39	199.2	44.52	58.04	351.
400.0	1.3150	2.778	.0125	30367.29	33409.17	200.7	45.44	58.53	357.
425.0	1.2128	3.077	.0114	31591.71	34889.98	204.3	47.75	59.99	371.
450.0	1.1277	3.363	.0105	32863.49	36410.55	207.7	50.07	61.68	384.

* Saturated state

Table B-2. (Continued)

4.50 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*104.617	23.448	45.152	2.895	6607.94	6799.86	84.3	40.75	76.08	1733.
110.0	23.141	49.935	2.601	6997.32	7191.78	88.0	42.83	70.66	1714.
120.0	22.662	50.112	2.267	7682.66	7881.23	94.0	43.83	67.81	1662.
140.0	21.777	41.993	1.870	9011.06	9217.70	104.3	41.69	66.29	1543.
160.0	20.858	32.818	1.562	10329.22	10544.97	113.1	39.28	66.63	1409.
180.0	19.869	25.061	1.285	11661.78	11888.26	121.1	37.77	67.79	1266.
200.0	18.804	18.674	1.037	13021.79	13261.10	128.3	37.08	69.66	1118.
210.0	18.235	15.831	.925	13717.77	13964.56	131.7	37.00	71.11	1041.
220.0	17.632	13.152	.819	14429.94	14685.15	135.1	37.07	73.13	962.
230.0	16.985	10.612	.718	15164.97	15429.91	138.4	37.30	76.00	878.
240.0	16.271	8.207	.620	15932.96	16209.52	141.7	37.69	80.20	789.
245.0	15.880	7.058	.572	16334.03	16617.40	143.4	37.97	83.06	742.
250.0	15.458	5.947	.524	16750.26	17041.37	145.1	38.31	86.68	693.
255.0	14.994	4.877	.476	17185.93	17486.04	146.8	38.73	91.42	641.
260.0	14.475	3.848	.427	17647.63	17958.51	148.7	39.28	97.96	585.
265.0	13.874	2.857	.375	18146.67	18471.01	150.6	40.00	107.82	524.
266.0	13.740	2.662	.364	18252.63	18580.14	151.0	40.17	110.48	511.
268.0	13.453	2.277	.343	18472.73	18807.22	151.9	40.56	116.90	484.
270.0	13.135	1.894	.320	18706.57	19049.16	152.8	41.03	125.51	454.
272.0	12.772	1.510	.295	18959.46	19311.78	153.8	41.60	137.97	422.
274.0	12.341	1.120	.269	19241.53	19606.17	154.8	42.34	158.36	386.
276.0	11.782	.714	.238	19577.15	19959.08	156.1	43.39	200.99	343.
277.0	11.401	.495	.219	19787.05	20181.74	156.9	44.17	250.73	316.
*277.274	11.275	.432	.213	19853.38	20252.47	157.2	44.44	273.65	308.
*277.274	4.2228	.189	.0595	23344.03	24409.68	172.2	46.94	338.28	220.
278.0	4.0317	.250	.0559	23507.12	24623.27	172.9	46.14	260.06	224.
279.0	3.8416	.320	.0523	23682.49	24853.86	173.8	45.29	207.02	228.
279.5	3.7648	.351	.0509	23757.70	24952.99	174.1	44.94	190.22	230.
280.0	3.6962	.381	.0496	23827.18	25044.66	174.5	44.62	176.94	232.
280.5	3.6341	.408	.0484	23892.06	25130.35	174.8	44.33	166.14	234.
280.6	3.6223	.414	.0482	23904.56	25146.86	174.8	44.27	164.21	234.
280.8	3.5994	.424	.0477	23929.14	25179.34	174.9	44.17	160.56	234.
281.0	3.5773	.435	.0473	23953.17	25211.10	175.1	44.06	157.14	235.
281.2	3.5559	.445	.0469	23976.70	25242.21	175.2	43.96	153.94	236.
281.4	3.5351	.455	.0465	23999.75	25272.69	175.3	43.86	150.94	236.
281.5	3.5250	.460	.0463	24011.11	25287.72	175.3	43.82	149.51	237.
281.6	3.5150	.465	.0461	24022.36	25302.60	175.4	43.77	148.12	237.
281.7	3.5051	.470	.0460	24033.51	25317.34	175.4	43.72	146.77	237.
281.8	3.4954	.475	.0458	24044.55	25331.95	175.5	43.68	145.45	237.
281.9	3.4858	.480	.0456	24055.50	25346.43	175.5	43.63	144.18	238.
282.0	3.4764	.484	.0454	24066.35	25360.79	175.6	43.59	142.94	238.
282.1	3.4671	.489	.0452	24077.11	25375.02	175.6	43.54	141.73	238.
282.2	3.4579	.494	.0451	24087.77	25389.14	175.7	43.50	140.56	239.
282.3	3.4488	.499	.0449	24098.35	25403.13	175.7	43.46	139.41	239.
282.4	3.4399	.503	.0447	24108.84	25417.02	175.8	43.41	138.30	239.
282.6	3.4223	.512	.0444	24129.58	25444.46	175.9	43.33	136.15	240.
282.8	3.4052	.522	.0441	24149.99	25471.49	176.0	43.25	134.11	240.
283.0	3.3885	.531	.0438	24170.10	25498.11	176.1	43.17	132.16	241.
283.2	3.3722	.539	.0435	24189.93	25524.36	176.2	43.10	130.31	241.
283.5	3.3485	.553	.0430	24219.15	25563.05	176.3	42.98	127.68	242.
284.0	3.3106	.574	.0423	24266.59	25625.87	176.5	42.81	123.66	243.
284.5	3.2747	.595	.0416	24312.59	25686.78	176.7	42.64	120.04	244.
285.0	3.2405	.615	.0410	24357.29	25745.97	176.9	42.48	116.76	245.
285.5	3.2079	.634	.0404	24400.80	25803.59	177.1	42.33	113.77	247.
286.0	3.1767	.654	.0398	24443.23	25859.78	177.3	42.19	111.03	248.
287.0	3.1182	.691	.0388	24525.20	25968.32	177.7	41.93	106.18	250.
288.0	3.0642	.726	.0378	24603.80	26072.36	178.1	41.69	102.01	252.
289.0	3.0140	.761	.0369	24679.49	26172.53	178.4	41.48	98.40	254.
290.0	2.9671	.794	.0361	24752.66	26269.31	178.8	41.28	95.23	255.
292.0	2.8815	.857	.0345	24892.59	26454.25	179.4	40.94	89.92	259.
294.0	2.8051	.916	.0332	25025.47	26629.68	180.0	40.66	85.65	262.
296.0	2.7361	.973	.0320	25152.66	26797.36	180.6	40.43	82.14	265.
298.0	2.6730	1.027	.0310	25275.14	26958.61	181.1	40.24	79.20	268.

Table B-2. (Continued)

4.50 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
300.0	2.6151	1.078	.0300	25393.70	27114.47	181.6	40.08	76.72	271.
302.0	2.5615	1.128	.0291	25508.94	27265.71	182.1	39.96	74.58	274.
304.0	2.5116	1.176	.0283	25621.33	27412.99	182.6	39.86	72.74	277.
310.0	2.3800	1.310	.0262	25945.09	27835.84	184.0	39.71	68.48	284.
315.0	2.2863	1.414	.0248	26203.40	28171.62	185.1	39.70	65.96	289.
320.0	2.2036	1.513	.0236	26454.32	28496.42	186.1	39.78	64.05	295.
325.0	2.1296	1.606	.0225	26699.86	28812.89	187.1	39.92	62.60	300.
330.0	2.0628	1.695	.0216	26941.46	29122.99	188.0	40.13	61.49	304.
335.0	2.0018	1.781	.0208	27180.23	29428.19	188.9	40.37	60.63	309.
340.0	1.9458	1.863	.0200	27417.03	29729.64	189.8	40.66	59.98	313.
350.0	1.8461	2.021	.0187	27887.27	30324.78	191.6	41.32	59.13	321.
360.0	1.7595	2.171	.0176	28356.16	30913.78	193.2	42.07	58.72	329.
370.0	1.6829	2.314	.0167	28826.37	31500.27	194.8	42.88	58.62	336.
380.0	1.6146	2.452	.0159	29299.75	32086.80	196.4	43.74	58.72	343.
390.0	1.5530	2.585	.0152	29777.63	32675.21	197.9	44.62	58.98	349.
400.0	1.4971	2.714	.0145	30260.95	33266.83	199.4	45.52	59.36	355.
425.0	1.3767	3.024	.0131	31497.22	34765.99	203.1	47.82	60.64	370.
450.0	1.2774	3.319	.0121	32778.29	36301.15	206.6	50.13	62.21	383.

* Saturated state

Table B-2. (Continued)

5.00 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*104.687	23.455	45.056	2.895	6607.22	6820.39	84.3	40.88	76.27	1731.
110.0	23.151	49.892	2.603	6992.06	7208.03	87.9	42.90	70.77	1713.
120.0	22.672	50.199	2.269	7677.47	7898.01	93.9	43.88	67.82	1663.
140.0	21.789	42.172	1.873	9004.61	9234.09	104.2	41.72	66.25	1545.
160.0	20.873	33.024	1.566	10320.66	10560.20	113.1	39.30	66.56	1412.
180.0	19.889	25.276	1.289	11650.38	11901.77	121.0	37.79	67.69	1270.
200.0	18.830	18.903	1.042	13006.52	13272.05	128.2	37.11	69.50	1123.
210.0	18.266	16.071	.930	13699.89	13973.63	131.6	37.02	70.89	1047.
220.0	17.670	13.406	.825	14408.67	14691.63	135.0	37.09	72.82	969.
230.0	17.031	10.883	.724	15139.06	15432.64	138.3	37.30	75.54	886.
240.0	16.331	8.498	.628	15900.28	16206.44	141.6	37.68	79.47	799.
245.0	15.949	7.360	.581	16296.64	16610.13	143.2	37.94	82.10	753.
250.0	15.540	6.262	.534	16706.77	17028.53	144.9	38.26	85.38	706.
255.0	15.094	5.206	.487	17134.22	17465.48	146.6	38.65	89.58	656.
260.0	14.600	4.193	.439	17584.20	17926.67	148.4	39.15	95.18	603.
265.0	14.039	3.225	.390	18065.05	18421.21	150.3	39.78	103.16	546.
266.0	13.916	3.036	.380	18166.07	18525.37	150.7	39.93	105.20	534.
268.0	13.656	2.663	.359	18374.22	18740.36	151.5	40.26	109.95	509.
270.0	13.374	2.295	.338	18592.12	18965.98	152.3	40.64	115.91	483.
272.0	13.064	1.932	.317	18822.48	19205.22	153.2	41.08	123.71	455.
274.0	12.715	1.572	.294	19069.56	19462.81	154.2	41.61	134.55	426.
276.0	12.309	1.211	.269	19340.89	19747.11	155.2	42.27	151.07	393.
277.0	12.074	1.030	.256	19489.88	19903.99	155.8	42.68	163.33	375.
278.0	11.809	.846	.242	19651.99	20075.41	156.4	43.16	180.60	355.
279.0	11.497	.659	.226	19833.36	20268.27	157.1	43.75	207.30	334.
279.5	11.315	.564	.217	19934.77	20376.65	157.5	44.10	227.29	322.
280.0	11.108	.466	.208	20046.80	20496.93	157.9	44.52	255.63	309.
280.5	10.863	.366	.198	20174.55	20634.84	158.4	45.02	299.62	295.
280.6	10.807	.345	.196	20202.74	20665.39	158.5	45.14	311.60	291.
280.8	10.688	.304	.191	20262.67	20730.48	158.7	45.39	340.64	285.
281.0	10.554	.261	.186	20328.55	20802.29	159.0	45.67	379.43	278.
281.2	10.401	.218	.180	20402.60	20883.31	159.3	46.00	434.35	271.
281.4	10.219	.173	.174	20488.70	20977.99	159.6	46.39	519.28	262.
281.5	10.112	.149	.171	20538.45	21032.92	159.8	46.62	582.65	258.
281.6	9.9889	.125	.1666	20594.81	21095.36	160.0	46.88	671.79	253.
281.7	9.8428	.100	.1621	20660.84	21168.82	160.3	47.20	808.18	248.
281.8	9.6592	.074	.1568	20742.70	21260.34	160.6	47.59	1048.43	241.
281.9	9.3998	.046	.1499	20856.62	21388.55	161.1	48.12	1616.21	234.
*281.985	9.036	.020	.141	21014.65	21567.97	161.7	48.84	3563.22	226.
*281.985	6.2159	.015	.0927	22356.77	23161.15	167.4	50.54	4123.33	212.
282.0	6.1370	.019	.0915	22400.93	23215.66	167.6	50.45	3330.40	212.
282.1	5.8227	.039	.0863	22582.43	23441.14	168.4	49.99	1653.44	214.
282.2	5.6395	.054	.0833	22693.01	23579.62	168.8	49.66	1181.33	215.
282.3	5.5052	.068	.0810	22776.61	23684.84	169.2	49.39	945.00	216.
282.4	5.3977	.081	.0791	22845.25	23771.57	169.5	49.15	799.66	217.
282.6	5.2291	.104	.0762	22956.23	23912.43	170.0	48.74	626.60	218.
282.8	5.0975	.125	.0739	23045.95	24026.82	170.4	48.39	525.02	220.
283.0	4.9888	.144	.0719	23122.39	24124.64	170.8	48.09	457.19	221.
283.2	4.8957	.162	.0702	23189.63	24210.94	171.1	47.82	408.22	222.
283.5	4.7766	.187	.0681	23278.23	24325.01	171.5	47.45	355.43	223.
284.0	4.6149	.225	.0651	23403.70	24487.14	172.1	46.92	297.67	226.
284.5	4.4834	.261	.0627	23510.69	24625.93	172.5	46.47	259.81	228.
285.0	4.3720	.293	.0606	23605.11	24748.74	173.0	46.07	232.81	230.
285.5	4.2753	.324	.0588	23690.31	24859.83	173.4	45.71	212.43	232.
286.0	4.1896	.353	.0572	23768.45	24961.89	173.7	45.39	196.42	233.
287.0	4.0426	.407	.0544	23908.89	25145.73	174.4	44.82	172.74	236.
288.0	3.9191	.457	.0521	24033.83	25309.62	174.9	44.34	155.92	239.
289.0	3.8126	.503	.0501	24147.49	25458.94	175.4	43.91	143.27	242.
290.0	3.7187	.547	.0484	24252.51	25597.07	175.9	43.54	133.36	244.
292.0	3.5589	.628	.0454	24443.34	25848.27	176.8	42.91	118.77	249.
294.0	3.4258	.702	.0430	24615.45	26074.96	177.6	42.40	108.46	253.
296.0	3.3117	.770	.0410	24774.05	26283.85	178.3	41.98	100.77	257.
298.0	3.2118	.835	.0392	24922.41	26479.17	178.9	41.63	94.78	260.

Table B-2. (Continued)

5.00 megapascal isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
300.0	3.1230	.895	.0376	25062.75	26663.77	179.5	41.35	89.99	264.
302.0	3.0431	.953	.0362	25196.63	26839.71	180.1	41.11	86.07	267.
304.0	2.9704	1.008	.0350	25325.21	27008.49	180.7	40.91	82.80	270.
310.0	2.7853	1.160	.0319	25687.03	27482.19	182.2	40.52	75.64	278.
315.0	2.6584	1.276	.0299	25968.94	27849.77	183.4	40.38	71.61	284.
320.0	2.5492	1.383	.0282	26238.66	28200.07	184.5	40.35	68.66	290.
325.0	2.4534	1.485	.0268	26499.57	28537.56	185.6	40.41	66.44	295.
330.0	2.3682	1.581	.0255	26754.03	28865.35	186.6	40.54	64.75	300.
335.0	2.2915	1.673	.0244	27003.74	29185.71	187.5	40.73	63.45	305.
340.0	2.2219	1.761	.0234	27249.97	29500.34	188.5	40.97	62.44	309.
350.0	2.0994	1.929	.0218	27735.71	30117.33	190.2	41.56	61.08	318.
360.0	1.9944	2.086	.0204	28216.86	30723.86	192.0	42.26	60.31	326.
370.0	1.9027	2.236	.0192	28697.06	31324.84	193.6	43.03	59.94	333.
380.0	1.8216	2.380	.0182	29178.78	31923.61	195.2	43.86	59.85	340.
390.0	1.7490	2.519	.0174	29663.76	32522.57	196.8	44.72	59.97	347.
400.0	1.6834	2.653	.0166	30153.24	33123.43	198.3	45.61	60.23	353.
425.0	1.5434	2.973	.0150	31401.95	34641.53	202.0	47.89	61.30	368.
450.0	1.4290	3.277	.0137	32692.63	36191.59	205.5	50.19	62.75	382.

* Saturated state

Table B-2. (Continued)

5.20 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*104.715	23.457	45.018	2.894	6606.93	6828.61	84.3	40.93	76.35	1730.
110.0	23.155	49.875	2.604	6989.95	7214.53	87.9	42.93	70.82	1713.
120.0	22.676	50.233	2.270	7675.40	7904.72	93.9	43.90	67.83	1663.
140.0	21.794	42.244	1.874	9002.05	9240.65	104.2	41.73	66.23	1546.
160.0	20.879	33.106	1.567	10317.25	10566.30	113.1	39.31	66.53	1413.
180.0	19.897	25.362	1.290	11645.85	11907.19	121.0	37.80	67.65	1272.
200.0	18.841	18.994	1.044	13000.46	13276.46	128.2	37.12	69.44	1125.
210.0	18.278	16.166	.932	13692.82	13977.31	131.6	37.03	70.80	1050.
220.0	17.685	13.507	.827	14400.27	14694.31	134.9	37.09	72.70	971.
230.0	17.049	10.991	.727	15128.87	15433.86	138.2	37.30	75.37	890.
240.0	16.354	8.613	.631	15887.49	16205.45	141.5	37.68	79.19	803.
245.0	15.976	7.480	.584	16282.08	16607.56	143.2	37.93	81.74	758.
250.0	15.571	6.386	.538	16689.93	17023.88	144.8	38.24	84.90	711.
255.0	15.132	5.335	.491	17114.36	17458.01	146.6	38.62	88.92	662.
260.0	14.647	4.328	.444	17560.14	17915.16	148.3	39.10	94.21	610.
265.0	14.099	3.367	.395	18034.72	18403.53	150.2	39.70	101.60	554.
266.0	13.980	3.180	.386	18134.08	18506.04	150.6	39.85	103.46	543.
268.0	13.729	2.811	.366	18338.34	18717.10	151.4	40.16	107.74	519.
270.0	13.459	2.448	.345	18551.29	18937.66	152.2	40.51	113.01	493.
272.0	13.163	2.091	.324	18775.05	19170.09	153.0	40.92	119.72	467.
274.0	12.836	1.738	.302	19012.89	19418.02	154.0	41.39	128.68	439.
276.0	12.463	1.388	.279	19270.11	19687.35	154.9	41.98	141.51	408.
277.0	12.253	1.213	.267	19408.73	19833.13	155.5	42.32	150.39	392.
278.0	12.021	1.038	.254	19556.48	19989.04	156.0	42.72	162.00	375.
279.0	11.761	.861	.240	19716.43	20158.58	156.6	43.18	178.01	356.
279.5	11.616	.773	.233	19802.49	20250.14	157.0	43.44	188.61	346.
280.0	11.459	.683	.225	19893.83	20347.63	157.3	43.74	201.86	335.
280.5	11.285	.593	.217	19991.86	20452.64	157.7	44.07	218.96	324.
280.6	11.248	.575	.215	20012.44	20474.73	157.8	44.14	223.01	322.
280.8	11.171	.539	.212	20054.74	20520.21	157.9	44.29	231.90	317.
281.0	11.091	.502	.208	20098.72	20567.58	158.1	44.44	242.05	312.
281.2	11.005	.465	.205	20144.63	20617.13	158.3	44.61	253.76	307.
281.4	10.914	.429	.201	20192.78	20669.21	158.5	44.79	267.46	302.
281.5	10.867	.410	.199	20217.82	20696.34	158.5	44.89	275.21	299.
281.6	10.817	.391	.197	20243.57	20724.28	158.6	44.99	283.70	297.
281.7	10.766	.373	.195	20270.11	20753.11	158.8	45.09	293.01	294.
281.8	10.713	.354	.193	20297.51	20782.92	158.9	45.20	303.30	291.
281.9	10.657	.335	.191	20325.86	20813.81	159.0	45.31	314.73	288.
282.0	10.599	.316	.189	20355.28	20845.91	159.1	45.43	327.49	285.
282.1	10.538	.297	.186	20385.89	20879.36	159.2	45.56	341.86	282.
282.2	10.473	.278	.184	20417.84	20914.34	159.3	45.69	358.16	279.
282.3	10.405	.259	.181	20451.33	20951.07	159.5	45.83	376.81	276.
282.4	10.333	.240	.179	20486.57	20989.80	159.6	45.98	398.40	272.
282.6	10.173	.202	.173	20563.56	21074.69	159.9	46.31	453.66	265.
282.8	9.9859	.163	.1675	20652.21	21172.94	160.2	46.69	534.47	258.
283.0	9.7562	.124	.1605	20758.65	21291.64	160.7	47.16	663.72	250.
283.2	9.4554	.086	.1522	20895.42	21445.37	161.2	47.76	900.37	240.
283.5	8.6898	.036	.1343	21238.09	21836.50	162.6	49.13	1931.45	225.
284.0	6.5377	.037	.0976	22285.58	23080.96	167.0	50.31	1777.83	215.
284.5	5.7406	.085	.0845	22748.52	23654.35	169.0	49.30	777.52	218.
285.0	5.3580	.130	.0779	22995.76	23966.27	170.1	48.51	512.45	221.
285.5	5.1053	.171	.0734	23171.17	24189.73	170.9	47.87	394.03	224.
286.0	4.9155	.208	.0700	23310.61	24368.50	171.5	47.34	326.42	226.
287.0	4.6351	.275	.0649	23531.08	24652.96	172.5	46.47	251.13	230.
288.0	4.4280	.334	.0610	23707.22	24881.56	173.3	45.77	209.52	233.
289.0	4.2632	.388	.0580	23857.11	25076.85	174.0	45.19	182.78	237.
290.0	4.1260	.438	.0554	23989.43	25249.73	174.6	44.69	163.98	239.
292.0	3.9053	.529	.0513	24219.17	25550.70	175.6	43.88	139.07	244.
294.0	3.7309	.611	.0481	24418.10	25811.86	176.5	43.23	123.13	249.
296.0	3.5867	.686	.0454	24596.56	26046.37	177.3	42.71	111.98	253.
298.0	3.4636	.755	.0432	24760.35	26261.66	178.0	42.28	103.70	257.
300.0	3.3563	.820	.0413	24913.09	26462.40	178.7	41.92	97.29	260.
302.0	3.2612	.881	.0396	25057.21	26651.69	179.3	41.63	92.19	264.
304.0	3.1759	.940	.0381	25194.41	26831.76	179.9	41.38	88.02	267.

Table B-2. (Continued)

5.20 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
310.0	2.9623	1.100	.0345	25575.67	27331.06	181.5	40.89	79.14	275.
315.0	2.8187	1.220	.0322	25869.09	27713.93	182.7	40.67	74.28	282.
320.0	2.6965	1.332	.0302	26147.72	28076.14	183.9	40.59	70.78	288.
325.0	2.5903	1.437	.0286	26415.76	28423.24	185.0	40.61	68.18	293.
330.0	2.4965	1.536	.0272	26676.08	28758.98	186.0	40.71	66.21	298.
335.0	2.4126	1.631	.0260	26930.69	29086.06	187.0	40.88	64.69	303.
340.0	2.3367	1.721	.0249	27181.11	29406.45	187.9	41.10	63.52	308.
350.0	2.2041	1.893	.0231	27673.63	30032.89	189.7	41.66	61.91	317.
360.0	2.0910	2.053	.0216	28160.07	30646.88	191.5	42.33	60.98	325.
370.0	1.9928	2.206	.0203	28644.53	31253.94	193.1	43.09	60.50	332.
380.0	1.9061	2.352	.0192	29129.79	31857.83	194.7	43.91	60.32	339.
390.0	1.8288	2.493	.0183.	29617.75	32461.15	196.3	44.77	60.37	346.
400.0	1.7591	2.629	.0174	30109.79	33065.81	197.8	45.65	60.58	353.
425.0	1.6109	2.954	.0157	31363.63	34591.65	201.5	47.91	61.57	368.
450.0	1.4902	3.260	.0143	32658.25	36147.75	205.1	50.21	62.96	382.

* Saturated state

Table B-2. (Continued)

5.40 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*104.743	23.460	44.979	2.894	6606.64	6836.82	84.3	40.98	76.42	1729.
110.0	23.159	49.857	2.605	6987.85	7221.02	87.9	42.96	70.86	1712.
120.0	22.680	50.268	2.270	7673.34	7911.43	93.9	43.91	67.83	1664.
140.0	21.798	42.315	1.875	8999.49	9247.21	104.2	41.74	66.21	1547.
160.0	20.885	33.188	1.568	10313.85	10572.41	113.0	39.32	66.51	1415.
180.0	19.905	25.447	1.292	11641.33	11912.62	120.9	37.81	67.61	1274.
200.0	18.851	19.085	1.046	12994.44	13280.89	128.1	37.12	69.37	1128.
210.0	18.291	16.262	.934	13685.78	13981.02	131.6	37.04	70.72	1052.
220.0	17.700	13.608	.829	14391.93	14697.03	134.9	37.10	72.58	974.
230.0	17.067	11.098	.730	15118.77	15435.16	138.2	37.31	75.19	893.
240.0	16.378	8.728	.634	15874.87	16204.59	141.4	37.67	78.92	807.
245.0	16.003	7.598	.588	16267.74	16605.18	143.1	37.92	81.39	762.
250.0	15.602	6.509	.541	16673.39	17019.49	144.8	38.23	84.44	716.
255.0	15.169	5.462	.495	17094.93	17450.92	146.5	38.60	88.29	667.
260.0	14.692	4.461	.448	17536.74	17904.28	148.2	39.06	93.29	616.
265.0	14.158	3.507	.401	18005.51	18386.93	150.1	39.64	100.17	562.
266.0	14.042	3.322	.391	18103.37	18487.94	150.5	39.77	101.88	551.
268.0	13.798	2.956	.371	18304.12	18695.47	151.2	40.06	105.77	527.
270.0	13.538	2.598	.352	18512.67	18911.55	152.0	40.39	110.47	503.
272.0	13.256	2.245	.331	18730.75	19138.13	152.9	40.77	116.33	478.
274.0	12.946	1.899	.310	18960.89	19378.02	153.8	41.21	123.92	451.
276.0	12.599	1.556	.288	19207.00	19635.61	154.7	41.73	134.27	422.
277.0	12.407	1.386	.276	19337.94	19773.18	155.2	42.03	141.09	407.
278.0	12.199	1.217	.264	19475.70	19918.36	155.7	42.37	149.59	391.
279.0	11.971	1.048	.252	19622.07	20073.17	156.3	42.75	160.54	374.
279.5	11.847	.963	.245	19699.28	20155.09	156.6	42.96	167.32	366.
280.0	11.716	.878	.239	19779.77	20240.69	156.9	43.19	175.31	356.
280.5	11.575	.794	.232	19864.14	20330.66	157.2	43.44	184.87	347.
280.6	11.546	.777	.230	19881.54	20349.25	157.3	43.50	187.02	345.
280.8	11.485	.743	.227	19916.95	20387.11	157.4	43.61	191.59	341.
281.0	11.423	.709	.224	19953.19	20425.92	157.5	43.72	196.57	337.
281.2	11.359	.675	.221	19990.36	20465.77	157.7	43.84	202.01	333.
281.4	11.292	.641	.218	20028.54	20506.76	157.8	43.96	208.00	329.
281.5	11.258	.624	.217	20048.04	20527.72	157.9	44.03	211.23	327.
281.6	11.222	.607	.215	20067.83	20549.01	158.0	44.09	214.63	324.
281.7	11.187	.590	.214	20087.93	20570.65	158.0	44.16	218.21	322.
281.8	11.150	.573	.212	20108.35	20592.66	158.1	44.23	221.99	320.
281.9	11.113	.556	.210	20129.12	20615.05	158.2	44.30	225.99	318.
282.0	11.074	.539	.209	20150.25	20637.86	158.3	44.37	230.23	316.
282.1	11.035	.521	.207	20171.76	20661.11	158.4	44.45	234.73	313.
282.2	10.995	.504	.205	20193.68	20684.82	158.4	44.53	239.52	311.
282.3	10.954	.487	.204	20216.04	20709.02	158.5	44.61	244.63	309.
282.4	10.911	.470	.202	20238.86	20733.76	158.6	44.69	250.08	306.
282.6	10.823	.436	.198	20286.02	20784.96	158.8	44.86	262.20	301.
282.8	10.729	.402	.194	20335.47	20838.76	159.0	45.04	276.25	296.
283.0	10.629	.368	.191	20387.58	20895.62	159.2	45.24	292.73	291.
283.2	10.522	.334	.187	20442.83	20956.07	159.4	45.45	312.35	286.
283.5	10.343	.283	.180	20533.01	21055.12	159.8	45.80	349.91	278.
284.0	9.9784	.200	.1681	20711.30	21252.46	160.4	46.52	449.88	262.
284.5	9.4686	.123	.1534	20951.73	21522.04	161.4	47.50	655.57	246.
285.0	8.6606	.066	.1343	21324.34	21947.85	162.9	48.86	1086.03	229.
285.5	7.5411	.051	.1138	21858.90	22574.97	165.1	49.97	1311.70	220.
286.0	6.6107	.067	.0986	22347.50	23164.36	167.2	49.87	1000.96	219.
287.0	5.6580	.134	.0827	22918.20	23872.60	169.6	48.64	506.28	223.
288.0	5.1869	.203	.0744	23241.49	24282.57	171.1	47.58	339.02	227.
289.0	4.8808	.266	.0688	23472.89	24579.27	172.1	46.75	262.51	231.
290.0	4.6543	.324	.0646	23657.97	24818.19	172.9	46.06	218.82	234.
292.0	4.3252	.427	.0585	23953.28	25201.78	174.2	44.98	170.39	240.
294.0	4.0863	.517	.0541	24192.28	25513.78	175.3	44.16	143.83	245.
296.0	3.8985	.599	.0506	24398.24	25783.38	176.2	43.51	126.88	249.
298.0	3.7438	.674	.0478	24582.31	26024.68	177.0	42.98	115.06	254.
300.0	3.6123	.744	.0454	24750.76	26245.64	177.8	42.55	106.30	257.
302.0	3.4980	.809	.0434	24907.47	26451.21	178.4	42.19	99.55	261.
304.0	3.3969	.871	.0416	25055.05	26644.74	179.1	41.89	94.17	264.

Table B-2. (Continued)

5.40 megapascal isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
310.0	3.1493	1.040	.0373	25458.96	27173.61	180.8	41.27	83.11	273.
315.0	2.9864	1.165	.0346	25765.37	27573.59	182.1	40.98	77.24	280.
320.0	2.8496	1.281	.0324	26053.85	27948.88	183.3	40.85	73.10	286.
325.0	2.7318	1.390	.0305	26329.67	28306.38	184.4	40.83	70.05	292.
330.0	2.6286	1.492	.0290	26596.31	28650.63	185.4	40.90	67.76	297.
335.0	2.5368	1.589	.0276	26856.18	28984.83	186.4	41.03	66.00	302.
340.0	2.4543	1.682	.0264	27111.05	29311.30	187.4	41.23	64.64	307.
350.0	2.3108	1.857	.0244	27610.72	29947.60	189.2	41.76	62.77	315.
360.0	2.1892	2.021	.0228	28102.67	30569.32	191.0	42.41	61.67	324.
370.0	2.0841	2.177	.0214	28591.55	31182.66	192.7	43.16	61.07	331.
380.0	1.9916	2.325	.0202	29080.44	31791.77	194.3	43.96	60.80	339.
390.0	1.9094	2.468	.0192	29571.46	32399.55	195.9	44.81	60.79	345.
400.0	1.8355	2.606	.0183	30066.13	33008.07	197.4	45.68	60.94	352.
425.0	1.6788	2.935	.0165	31325.20	34541.74	201.1	47.94	61.85	367.
450.0	1.5517	3.245	.0150	32623.81	36103.92	204.7	50.23	63.18	381.

* Saturated state

Table B-2. (Continued)

5.60 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*104.771	23.463	44.941	2.894	6606.35	6845.03	84.3	41.04	76.50	1728.
110.0	23.163	49.839	2.605	6985.75	7227.51	87.9	42.98	70.91	1712.
120.0	22.684	50.302	2.271	7671.27	7918.14	93.9	43.93	67.84	1664.
140.0	21.803	42.387	1.876	8996.93	9253.78	104.2	41.75	66.20	1548.
160.0	20.891	33.270	1.570	10310.46	10578.52	113.0	39.33	66.48	1416.
180.0	19.913	25.533	1.293	11636.84	11918.06	120.9	37.82	67.57	1275.
200.0	18.862	19.176	1.048	12988.45	13285.35	128.1	37.13	69.31	1130.
210.0	18.303	16.356	.936	13678.79	13984.75	131.5	37.04	70.64	1054.
220.0	17.714	13.708	.832	14383.66	14699.79	134.8	37.11	72.47	977.
230.0	17.085	11.204	.732	15108.77	15436.53	138.1	37.31	75.03	896.
240.0	16.400	8.841	.637	15862.40	16203.86	141.4	37.67	78.66	811.
250.0	15.633	6.631	.545	16657.13	17015.35	144.7	38.21	84.00	721.
255.0	15.205	5.589	.499	17075.90	17444.21	146.4	38.57	87.69	673.
260.0	14.736	4.593	.453	17513.96	17893.97	148.1	39.02	92.44	623.
265.0	14.214	3.645	.406	17977.33	18371.32	150.0	39.57	98.86	570.
270.0	13.613	2.744	.358	18475.99	18887.37	151.9	40.29	108.23	513.
272.0	13.342	2.396	.338	18689.09	19108.83	152.7	40.64	113.41	488.
274.0	13.047	2.054	.317	18912.69	19341.91	153.6	41.04	119.94	463.
276.0	12.721	1.718	.296	19149.75	19589.97	154.5	41.51	128.54	435.
278.0	12.353	1.387	.274	19405.00	19858.34	155.4	42.08	140.57	406.
280.0	11.922	1.060	.250	19686.69	20156.39	156.5	42.78	158.95	375.
281.0	11.673	.897	.237	19842.06	20321.80	157.1	43.20	172.54	357.
282.0	11.390	.736	.224	20011.57	20503.23	157.7	43.70	191.47	339.
283.0	11.059	.575	.209	20201.45	20707.84	158.5	44.30	219.86	319.
284.0	10.651	.417	.192	20423.40	20949.18	159.3	45.07	267.40	297.
285.0	10.105	.265	.173	20703.46	21257.62	160.4	46.10	361.67	272.
285.5	9.7384	.196	.1617	20883.67	21458.72	161.1	46.79	449.57	259.
286.0	9.2629	.137	.1488	21111.23	21715.79	162.0	47.63	588.50	245.
286.2	9.0324	.118	.1432	21220.45	21840.44	162.4	48.01	658.93	240.
286.4	8.7769	.103	.1374	21341.47	21979.51	162.9	48.40	731.36	235.
287.0	7.9115	.082	.1204	21759.64	22467.47	164.6	49.36	863.38	226.
287.5	7.2129	.084	.1084	22117.34	22893.73	166.1	49.63	821.46	223.
287.6	7.0868	.086	.1063	22184.65	22974.85	166.4	49.63	800.45	223.
287.8	6.8517	.092	.1024	22312.81	23130.12	166.9	49.56	750.86	223.
288.0	6.6401	.099	.0989	22431.48	23274.84	167.4	49.44	695.89	223.
288.2	6.4512	.108	.0958	22540.39	23408.45	167.9	49.29	640.50	223.
288.4	6.2829	.117	.0930	22639.94	23531.24	168.3	49.12	588.09	224.
288.6	6.1330	.128	.0905	22730.91	23644.01	168.7	48.93	540.43	224.
288.8	5.9988	.139	.0882	22814.26	23747.77	169.1	48.74	498.10	225.
289.0	5.8782	.150	.0861	22890.92	23843.59	169.4	48.55	460.96	226.
289.5	5.6235	.180	.0817	23058.83	24054.66	170.1	48.09	387.44	227.
290.0	5.4181	.210	.0780	23200.89	24234.46	170.8	47.66	334.56	229.
290.5	5.2474	.239	.0750	23324.29	24391.50	171.3	47.26	295.46	231.
291.0	5.1018	.267	.0723	23433.80	24531.45	171.8	46.90	265.64	232.
291.5	4.9752	.295	.0700	23532.61	24658.20	172.2	46.56	242.24	234.
292.0	4.8633	.322	.0680	23622.97	24774.46	172.6	46.25	223.43	235.
293.0	4.6726	.373	.0644	23784.38	24982.87	173.3	45.69	195.09	238.
294.0	4.5139	.421	.0615	23926.68	25167.28	174.0	45.20	174.76	241.
295.0	4.3783	.467	.0590	24055.00	25334.04	174.5	44.78	159.44	243.
296.0	4.2598	.510	.0568	24172.65	25487.26	175.0	44.39	147.46	246.
297.0	4.1547	.552	.0548	24281.88	25629.75	175.5	44.05	137.84	248.
298.0	4.0603	.592	.0531	24384.30	25763.50	176.0	43.75	129.92	250.
299.0	3.9746	.630	.0515	24481.07	25890.01	176.4	43.47	123.28	252.
300.0	3.8962	.667	.0501	24573.10	26010.39	176.8	43.22	117.63	254.
302.0	3.7570	.736	.0476	24745.58	26236.14	177.5	42.78	108.54	258.
304.0	3.6361	.802	.0454	24905.80	26445.91	178.2	42.42	101.51	262.
306.0	3.5294	.864	.0435	25056.48	26643.15	178.9	42.12	95.93	265.
308.0	3.4339	.923	.0418	25199.52	26830.32	179.5	41.87	91.39	268.
310.0	3.3475	.979	.0403	25336.33	27009.21	180.1	41.67	87.62	271.
312.0	3.2687	1.033	.0390	25467.96	27181.18	180.6	41.50	84.44	274.
314.0	3.1963	1.085	.0378	25595.25	27347.29	181.2	41.36	81.74	276.
315.0	3.1621	1.111	.0372	25657.47	27428.41	181.4	41.31	80.53	278.
316.0	3.1293	1.136	.0366	25718.83	27508.38	181.7	41.25	79.41	279.
320.0	3.0088	1.231	.0347	25956.88	27818.10	182.6	41.11	75.62	284.

Table B-2. (Continued)

5.60 megapascal isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
325.0	2.8782	1.343	.0326	26241.20	28186.86	183.8	41.05	72.06	290.
330.0	2.7647	1.448	.0308	26514.67	28540.24	184.9	41.08	69.41	295.
335.0	2.6643	1.548	.0293	26780.16	28882.00	185.9	41.19	67.39	300.
340.0	2.5746	1.643	.0280	27039.75	29214.87	186.9	41.37	65.83	305.
345.0	2.4934	1.734	.0268	27294.96	29540.85	187.8	41.59	64.62	310.
350.0	2.4195	1.822	.0258	27546.94	29861.48	188.8	41.86	63.67	314.
360.0	2.2889	1.990	.0240	28044.66	30491.20	190.5	42.49	62.38	323.
370.0	2.1766	2.148	.0225	28538.12	31110.99	192.2	43.22	61.65	330.
380.0	2.0782	2.299	.0212	29030.75	31725.45	193.9	44.01	61.29	338.
390.0	1.9909	2.443	.0202	29524.92	32337.76	195.5	44.85	61.21	345.
400.0	1.9126	2.583	.0192	30022.26	32950.21	197.0	45.72	61.31	351.
425.0	1.7472	2.916	.0172	31286.66	34491.79	200.7	47.97	62.12	367.
450.0	1.6135	3.229	.0157	32589.31	36060.10	204.3	50.26	63.40	381.

* Saturated state

Table B-2. (Continued)

5.80 megapascal isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*104.799	23.465	44.902	2.894	6606.06	6853.23	84.3	41.09	76.58	1727.
110.0	23.167	49.820	2.606	6983.65	7234.00	87.8	43.01	70.96	1712.
120.0	22.688	50.336	2.272	7669.21	7924.85	93.9	43.95	67.84	1664.
140.0	21.808	42.458	1.877	8994.39	9260.34	104.2	41.76	66.18	1549.
160.0	20.897	33.352	1.571	10307.09	10584.64	113.0	39.34	66.45	1417.
180.0	19.921	25.618	1.295	11632.36	11923.51	120.9	37.83	67.53	1277.
200.0	18.872	19.267	1.050	12982.48	13289.82	128.1	37.14	69.25	1132.
210.0	18.315	16.451	.938	13671.84	13988.52	131.5	37.05	70.56	1057.
220.0	17.729	13.807	.834	14375.44	14702.59	134.8	37.11	72.36	980.
230.0	17.103	11.310	.735	15098.85	15437.97	138.1	37.31	74.86	899.
240.0	16.423	8.954	.640	15850.08	16203.25	141.3	37.67	78.41	815.
250.0	15.663	6.751	.548	16641.14	17011.45	144.6	38.20	83.58	726.
255.0	15.240	5.714	.503	17057.27	17437.84	146.3	38.55	87.11	678.
260.0	14.779	4.723	.457	17491.77	17884.21	148.1	38.98	91.63	629.
265.0	14.267	3.781	.411	17950.10	18356.62	149.9	39.51	97.65	577.
270.0	13.684	2.887	.364	18441.03	18864.89	151.8	40.19	106.23	521.
272.0	13.423	2.542	.344	18649.72	19081.82	152.6	40.52	110.85	498.
274.0	13.141	2.205	.324	18867.65	19309.02	153.4	40.90	116.57	473.
276.0	12.832	1.875	.304	19097.15	19549.13	154.3	41.33	123.87	448.
278.0	12.489	1.550	.283	19341.72	19806.12	155.2	41.83	133.65	420.
280.0	12.097	1.231	.260	19607.04	20086.48	156.2	42.44	147.64	391.
281.0	11.876	1.074	.248	19750.38	20238.75	156.7	42.80	157.27	375.
282.0	11.633	.918	.236	19903.37	20401.97	157.3	43.21	169.74	358.
283.0	11.359	.763	.223	20069.06	20579.68	157.9	43.68	186.59	341.
284.0	11.043	.612	.209	20252.34	20777.54	158.6	44.24	210.70	322.
285.0	10.666	.464	.194	20461.61	21005.37	159.4	44.92	247.91	302.
285.5	10.444	.392	.186	20580.46	21135.79	159.9	45.33	275.02	291.
286.0	10.191	.324	.177	20712.76	21281.91	160.4	45.79	311.30	280.
286.2	10.078	.298	.173	20770.42	21345.93	160.6	45.99	329.26	276.
286.4	9.9580	.273	.1692	20831.33	21413.78	160.9	46.21	349.66	271.
287.0	9.5427	.204	.1570	21038.00	21645.80	161.7	46.94	428.39	257.
287.5	9.1196	.158	.1460	21244.71	21880.70	162.5	47.63	513.35	247.
287.6	9.0259	.151	.1437	21290.33	21932.93	162.7	47.77	531.24	245.
287.8	8.8297	.138	.1392	21385.81	22042.69	163.1	48.05	565.93	241.
288.0	8.6235	.128	.1347	21486.48	22159.06	163.5	48.32	597.00	238.
288.2	8.4100	.121	.1303	21591.43	22281.08	163.9	48.57	622.03	235.
288.4	8.1926	.116	.1260	21699.40	22407.35	164.3	48.79	639.33	232.
288.6	7.9749	.113	.1219	21808.98	22536.26	164.8	48.97	648.30	230.
288.8	7.7603	.111	.1180	21918.74	22666.13	165.2	49.11	649.18	229.
289.0	7.5516	.112	.1143	22027.39	22795.44	165.7	49.19	642.71	228.
289.5	7.0694	.118	.1061	22287.18	23107.61	166.8	49.22	600.66	227.
290.0	6.6571	.132	.0991	22521.13	23392.38	167.7	49.03	536.36	227.
290.5	6.3158	.151	.0933	22725.06	23643.40	168.6	48.72	468.32	228.
291.0	6.0353	.174	.0885	22901.01	23862.02	169.4	48.36	407.90	229.
291.5	5.8029	.199	.0844	23053.63	24053.13	170.0	47.98	358.31	230.
292.0	5.6073	.225	.0810	23187.64	24222.00	170.6	47.62	318.67	231.
293.0	5.2944	.277	.0753	23414.55	24510.04	171.6	46.95	261.52	234.
294.0	5.0518	.327	.0709	23603.23	24751.34	172.4	46.35	223.46	237.
295.0	4.8550	.376	.0673	23766.04	24960.69	173.1	45.82	196.69	240.
296.0	4.6900	.422	.0643	23910.39	25147.05	173.7	45.36	176.96	242.
297.0	4.5484	.467	.0616	24040.94	25316.13	174.3	44.95	161.83	245.
298.0	4.4244	.509	.0593	24160.83	25471.75	174.8	44.58	149.87	247.
299.0	4.3142	.550	.0573	24272.22	25616.61	175.3	44.24	140.17	249.
300.0	4.2152	.589	.0555	24376.68	25752.66	175.8	43.94	132.16	251.
302.0	4.0430	.663	.0523	24569.25	26003.82	176.6	43.42	119.66	255.
304.0	3.8969	.733	.0497	24745.07	26233.42	177.4	42.99	110.36	259.
306.0	3.7702	.798	.0474	24908.28	26446.67	178.1	42.63	103.17	262.
308.0	3.6583	.860	.0454	25061.64	26647.07	178.7	42.34	97.44	266.
310.0	3.5583	.919	.0436	25207.14	26837.14	179.3	42.09	92.77	269.
312.0	3.4679	.976	.0421	25346.19	27018.69	179.9	41.88	88.90	272.
314.0	3.3854	1.030	.0406	25479.91	27193.13	180.5	41.72	85.63	275.
315.0	3.3468	1.056	.0400	25545.03	27278.04	180.7	41.64	84.19	276.
316.0	3.3097	1.082	.0393	25609.12	27361.55	181.0	41.58	82.85	277.
320.0	3.1746	1.181	.0371	25856.61	27683.60	182.0	41.39	78.38	282.

Table B-2. (Continued)

5.80 megapascal isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
325.0	3.0297	1.297	.0347	26150.23	28064.59	183.2	41.28	74.24	288.
330.0	2.9048	1.405	.0328	26431.07	28427.74	184.3	41.28	71.17	294.
335.0	2.7952	1.508	.0311	26702.58	28777.54	185.4	41.36	68.85	299.
340.0	2.6977	1.605	.0296	26967.18	29117.15	186.4	41.51	67.07	304.
345.0	2.6100	1.698	.0284	27226.65	29448.90	187.3	41.71	65.69	309.
350.0	2.5303	1.788	.0272	27482.30	29774.53	188.3	41.97	64.61	313.
360.0	2.3903	1.959	.0253	27986.03	30412.54	190.1	42.57	63.12	322.
370.0	2.2703	2.119	.0237	28484.23	31038.95	191.8	43.28	62.25	330.
380.0	2.1657	2.272	.0223	28980.73	31658.88	193.4	44.06	61.80	337.
390.0	2.0731	2.419	.0211	29478.11	32275.82	195.0	44.89	61.63	344.
400.0	1.9904	2.561	.0201	29978.20	32892.25	196.6	45.75	61.68	351.
425.0	1.8160	2.897	.0180	31248.02	34441.84	200.4	47.99	62.40	366.
450.0	1.6756	3.214	.0164	32554.76	36016.30	204.0	50.28	63.62	381.

* Saturated state

Table B-2. (Continued)

6.00 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*104.827	23.468	44.864	2.894	6605.77	6861.44	84.3	41.14	76.66	1726.
110.0	23.171	49.801	2.607	6981.55	7240.49	87.8	43.04	71.00	1711.
120.0	22.692	50.370	2.272	7667.15	7931.56	93.8	43.96	67.85	1665.
140.0	21.813	42.530	1.878	8991.84	9266.91	104.1	41.77	66.16	1550.
160.0	20.903	33.433	1.572	10303.72	10590.76	113.0	39.35	66.42	1418.
180.0	19.929	25.704	1.297	11627.89	11928.97	120.9	37.84	67.49	1278.
200.0	18.882	19.357	1.051	12976.55	13294.30	128.0	37.15	69.19	1134.
210.0	18.327	16.545	.940	13664.93	13992.31	131.5	37.06	70.48	1059.
220.0	17.743	13.907	.836	14367.29	14705.44	134.8	37.12	72.24	982.
230.0	17.121	11.415	.737	15089.03	15439.48	138.0	37.32	74.70	903.
240.0	16.445	9.066	.643	15837.91	16202.76	141.3	37.66	78.16	819.
250.0	15.692	6.871	.552	16625.42	17007.78	144.6	38.18	83.17	730.
255.0	15.275	5.838	.507	17039.01	17431.81	146.2	38.53	86.57	684.
260.0	14.821	4.852	.461	17470.12	17874.95	148.0	38.95	90.87	635.
265.0	14.319	3.914	.416	17923.73	18342.74	149.8	39.46	96.53	584.
270.0	13.751	3.027	.369	18407.58	18843.90	151.6	40.11	104.43	530.
272.0	13.499	2.686	.350	18612.33	19056.80	152.4	40.42	108.59	507.
274.0	13.229	2.353	.331	18825.30	19278.87	153.2	40.76	113.65	484.
276.0	12.935	2.026	.311	19048.36	19512.22	154.1	41.16	119.95	459.
278.0	12.612	1.707	.291	19284.17	19759.91	155.0	41.62	128.12	433.
280.0	12.250	1.395	.269	19536.84	20026.65	155.9	42.16	139.25	405.
281.0	12.049	1.241	.258	19671.46	20169.41	156.4	42.47	146.53	391.
282.0	11.832	1.089	.247	19813.18	20320.27	157.0	42.82	155.52	376.
283.0	11.594	.939	.235	19963.77	20481.26	157.5	43.21	166.94	360.
284.0	11.330	.792	.223	20125.75	20655.33	158.2	43.65	181.95	343.
285.0	11.029	.648	.209	20302.97	20847.00	158.8	44.17	202.54	325.
285.5	10.861	.578	.202	20399.07	20951.51	159.2	44.46	215.96	316.
286.0	10.678	.509	.195	20501.53	21063.44	159.6	44.79	232.32	307.
286.2	10.600	.482	.192	20544.60	21110.65	159.7	44.92	239.88	303.
286.4	10.518	.456	.189	20589.01	21159.44	159.9	45.07	248.14	299.
287.0	10.253	.379	.180	20731.63	21316.85	160.5	45.53	277.92	287.
287.5	10.001	.320	.171	20863.55	21463.51	161.0	45.97	309.93	277.
287.6	9.9465	.309	.1697	20891.63	21494.86	161.1	46.07	317.26	275.
287.8	9.8336	.287	.1662	20949.71	21559.86	161.3	46.26	332.93	271.
288.0	9.7145	.266	.1626	21010.49	21628.12	161.5	46.46	349.94	267.
288.2	9.5889	.247	.1590	21074.20	21699.92	161.8	46.67	368.25	263.
288.4	9.4564	.228	.1554	21141.01	21775.50	162.1	46.88	387.71	259.
288.6	9.3168	.212	.1517	21211.06	21855.06	162.3	47.10	408.01	256.
288.8	9.1701	.197	.1479	21284.43	21938.73	162.6	47.32	428.67	252.
289.0	9.0167	.184	.1442	21361.08	22026.51	162.9	47.54	449.04	249.
289.5	8.6081	.160	.1349	21565.64	22262.66	163.7	48.07	493.35	242.
290.0	8.1795	.146	.1261	21783.24	22516.78	164.6	48.50	519.45	236.
290.5	7.7546	.142	.1181	22004.62	22778.35	165.5	48.77	523.21	233.
291.0	7.3538	.145	.1110	22220.80	23036.71	166.4	48.87	507.34	231.
291.5	6.9900	.153	.1047	22424.92	23283.28	167.3	48.81	477.07	231.
292.0	6.6689	.166	.0992	22612.74	23512.44	168.0	48.64	438.75	231.
293.0	6.1492	.202	.0902	22935.57	23911.32	169.4	48.11	360.50	232.
294.0	5.7595	.246	.0833	23197.18	24238.93	170.5	47.50	297.86	234.
295.0	5.4590	.292	.0779	23413.76	24512.86	171.5	46.91	252.51	237.
296.0	5.2187	.339	.0735	23598.43	24748.14	172.3	46.38	219.78	239.
297.0	5.0203	.385	.0699	23760.09	24955.24	173.0	45.89	195.57	242.
298.0	4.8522	.429	.0668	23904.62	25141.19	173.6	45.46	177.12	244.
299.0	4.7067	.472	.0641	24036.03	25310.80	174.1	45.06	162.66	246.
300.0	4.5789	.513	.0617	24157.09	25467.45	174.7	44.71	151.05	249.
302.0	4.3623	.591	.0577	24375.63	25751.04	175.6	44.10	133.60	253.
304.0	4.1835	.664	.0544	24570.93	26005.13	176.4	43.59	121.13	256.
306.0	4.0316	.733	.0517	24749.37	26237.61	177.2	43.17	111.77	260.
308.0	3.8997	.798	.0493	24915.02	26453.60	177.9	42.82	104.50	263.
310.0	3.7832	.860	.0472	25070.66	26656.60	178.6	42.53	98.70	267.
312.0	3.6791	.919	.0454	25218.26	26849.09	179.2	42.28	93.95	270.
314.0	3.5850	.975	.0437	25359.29	27032.93	179.8	42.08	90.01	273.
315.0	3.5411	1.002	.0430	25427.69	27122.06	180.1	42.00	88.28	274.
316.0	3.4992	1.029	.0423	25494.85	27209.53	180.3	41.92	86.68	275.
320.0	3.3476	1.132	.0397	25752.83	27545.17	181.4	41.68	81.40	281.

Table B-2. (Continued)

6.00 megapascal isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
325.0	3.1867	1.251	.0370	26056.63	27939.45	182.6	41.52	76.58	287.
330.0	3.0493	1.363	.0348	26345.44	28313.08	183.8	41.47	73.05	293.
335.0	2.9297	1.468	.0330	26623.39	28671.41	184.8	41.53	70.40	298.
340.0	2.8238	1.568	.0313	26893.33	29018.13	185.9	41.65	68.38	303.
345.0	2.7290	1.663	.0299	27157.28	29355.92	186.8	41.84	66.80	308.
350.0	2.6432	1.755	.0287	27416.78	29686.75	187.8	42.07	65.58	312.
360.0	2.4932	1.928	.0266	27926.77	30333.33	189.6	42.65	63.88	321.
370.0	2.3653	2.092	.0248	28429.89	30966.57	191.4	43.34	62.86	329.
380.0	2.2542	2.247	.0234	28930.37	31592.09	193.0	44.11	62.31	336.
390.0	2.1562	2.396	.0221	29431.06	32213.73	194.6	44.93	62.07	343.
400.0	2.0688	2.539	.0210	29933.95	32834.20	196.2	45.79	62.06	350.
425.0	1.8853	2.879	.0188	31209.28	34391.87	200.0	48.02	62.68	366.
450.0	1.7379	3.199	.0171	32520.15	35972.53	203.6	50.30	63.84	380.

* Saturated state

Table B-2. (Continued)

6.50 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*104.896	23.475	44.768	2.893	6605.06	6831.95	84.3	41.26	76.86	1724.
110.0	23.181	49.752	2.610	6976.30	7256.70	87.8	43.10	71.12	1711.
120.0	22.702	50.454	2.274	7662.02	7948.34	93.8	44.01	67.87	1665.
140.0	21.824	42.708	1.880	8985.52	9283.35	104.1	41.80	66.12	1552.
160.0	20.918	33.638	1.575	10295.35	10606.08	112.9	39.37	66.35	1422.
180.0	19.948	25.917	1.301	11616.80	11942.65	120.8	37.86	67.39	1282.
220.0	17.779	14.153	.842	14347.14	14712.74	134.7	37.13	71.97	989.
230.0	17.164	11.676	.744	15064.85	15443.54	137.9	37.32	74.31	910.
240.0	16.499	9.344	.650	15808.08	16202.04	141.2	37.66	77.57	828.
250.0	15.763	7.167	.560	16587.19	16999.54	144.4	38.16	82.21	742.
255.0	15.358	6.143	.516	16994.85	17418.07	146.1	38.48	85.30	697.
260.0	14.921	5.167	.472	17418.19	17853.82	147.8	38.87	89.14	650.
265.0	14.442	4.242	.427	17861.18	18311.26	149.5	39.34	94.05	601.
270.0	13.908	3.368	.383	18329.66	18797.02	151.3	39.92	100.60	550.
275.0	13.296	2.548	.337	18833.09	19321.95	153.2	40.65	110.00	496.
276.0	13.162	2.390	.328	18939.28	19433.14	153.6	40.82	112.42	484.
278.0	12.877	2.080	.309	19158.63	19663.42	154.5	41.20	118.06	461.
280.0	12.566	1.779	.289	19389.08	19906.35	155.3	41.62	125.15	437.
282.0	12.223	1.487	.270	19633.67	20165.46	156.3	42.11	134.40	411.
284.0	11.836	1.204	.249	19897.01	20446.18	157.3	42.69	147.03	384.
286.0	11.388	.932	.227	20186.60	20757.37	158.4	43.38	165.40	356.
288.0	10.848	.678	.204	20515.43	21114.60	159.6	44.25	194.15	326.
289.0	10.529	.562	.192	20701.35	21318.72	160.3	44.77	215.01	310.
290.0	10.163	.455	.179	20907.11	21546.70	161.1	45.35	242.09	294.
291.0	9.7404	.364	.1652	21137.90	21805.22	162.0	46.00	276.03	279.
292.0	9.2545	.294	.1517	21397.79	22100.15	163.0	46.69	313.87	265.
293.0	8.7140	.248	.1385	21685.16	22431.09	164.1	47.34	345.99	254.
294.0	8.1510	.226	.1265	21988.91	22786.36	165.3	47.82	361.14	247.
295.0	7.6076	.222	.1159	22292.22	23146.63	166.6	48.04	356.30	242.
296.0	7.1152	.232	.1069	22580.21	23493.75	167.7	48.00	335.88	241.
297.0	6.6884	.252	.0992	22843.66	23815.50	168.8	47.77	306.78	240.
298.0	6.3271	.280	.0927	23079.36	24106.69	169.8	47.42	275.72	241.
299.0	6.0236	.314	.0873	23288.67	24367.76	170.7	47.03	247.02	242.
300.0	5.7674	.350	.0826	23475.08	24602.10	171.5	46.62	222.37	244.
301.0	5.5489	.388	.0786	23642.47	24813.88	172.2	46.23	201.85	246.
302.0	5.3601	.427	.0751	23794.33	25006.99	172.8	45.85	184.92	248.
303.0	5.1950	.465	.0721	23933.48	25184.70	173.4	45.50	170.93	250.
304.0	5.0488	.503	.0694	24062.19	25349.62	173.9	45.18	159.27	251.
305.0	4.9181	.540	.0670	24182.22	25503.86	174.4	44.88	149.48	253.
306.0	4.8003	.577	.0648	24294.97	25649.07	174.9	44.60	141.16	255.
308.0	4.5949	.648	.0610	24502.81	25917.43	175.8	44.11	127.85	259.
310.0	4.4206	.715	.0578	24692.19	26162.58	176.6	43.70	117.73	262.
312.0	4.2697	.780	.0550	24867.45	26389.81	177.3	43.35	109.81	265.
314.0	4.1369	.841	.0526	25031.61	26602.84	178.0	43.05	103.45	268.
316.0	4.0185	.900	.0505	25186.84	26804.37	178.6	42.81	98.25	271.
318.0	3.9118	.957	.0486	25334.75	26996.41	179.2	42.60	93.92	274.
320.0	3.8147	1.012	.0469	25476.57	27180.49	179.8	42.43	90.27	277.
322.0	3.7258	1.065	.0454	25613.27	27357.84	180.4	42.29	87.16	280.
325.0	3.6052	1.141	.0433	25810.32	27613.27	181.2	42.14	83.27	283.
330.0	3.4309	1.260	.0404	26122.03	28016.57	182.4	42.00	78.32	289.
335.0	3.2820	1.372	.0380	26413.13	28398.62	183.5	41.97	74.68	295.
340.0	3.1523	1.478	.0359	26702.86	28764.82	184.6	42.03	71.93	300.
345.0	3.0377	1.578	.0342	26979.15	29118.96	185.7	42.16	69.82	305.
350.0	2.9350	1.674	.0326	27249.10	29463.76	186.6	42.35	68.17	310.
355.0	2.8422	1.766	.0313	27514.30	29801.28	187.6	42.59	66.89	314.
360.0	2.7576	1.855	.0300	27775.94	30133.07	188.5	42.86	65.87	319.
370.0	2.6083	2.025	.0279	28292.09	30784.16	190.3	43.51	64.46	327.
380.0	2.4798	2.186	.0262	28803.03	31424.20	192.0	44.24	63.63	335.
390.0	2.3674	2.340	.0247	29312.34	32057.97	193.7	45.04	63.18	342.
400.0	2.2678	2.487	.0234	29822.51	32688.78	195.3	45.88	63.02	349.
425.0	2.0602	2.836	.0208	31112.01	34267.00	199.1	48.08	63.38	365.
450.0	1.8951	3.163	.0188	32433.42	35863.29	202.7	50.35	64.40	380.

* Saturated state

Table B-2. (Continued)

7.00 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*104.966	23.481	44.671	2.893	6604.34	6902.45	84.3	41.39	77.06	1722.
110.0	23.191	49.702	2.612	6971.05	7272.89	87.7	43.17	71.25	1710.
120.0	22.712	50.538	2.276	7656.91	7965.12	93.8	44.05	67.88	1666.
140.0	21.836	42.885	1.882	8979.23	9299.80	104.0	41.82	66.08	1554.
160.0	20.933	33.842	1.579	10287.03	10621.44	112.9	39.40	66.29	1425.
180.0	19.967	26.129	1.305	11605.82	11956.40	120.7	37.89	67.30	1286.
220.0	17.814	14.397	.847	14327.34	14720.29	134.6	37.15	71.72	995.
230.0	17.206	11.934	.750	15041.18	15448.00	137.8	37.33	73.94	918.
240.0	16.552	9.617	.657	15779.08	16201.99	141.0	37.66	77.02	837.
250.0	15.832	7.457	.568	16550.38	16992.53	144.3	38.13	81.34	753.
255.0	15.438	6.442	.525	16952.65	17406.08	145.9	38.44	84.17	709.
260.0	15.015	5.475	.481	17369.05	17835.25	147.6	38.81	87.62	664.
265.0	14.556	4.559	.438	17802.82	18283.73	149.3	39.24	91.94	617.
270.0	14.049	3.697	.395	18258.47	18756.71	151.0	39.76	97.51	568.
275.0	13.480	2.889	.351	18742.83	19262.10	152.9	40.41	105.07	517.
276.0	13.357	2.735	.343	18844.02	19368.09	153.3	40.56	106.94	507.
278.0	13.098	2.432	.325	19051.65	19586.07	154.1	40.88	111.16	485.
280.0	12.822	2.138	.307	19267.31	19813.26	154.9	41.23	116.20	463.
282.0	12.523	1.853	.288	19492.63	20051.61	155.7	41.62	122.36	441.
284.0	12.197	1.578	.270	19729.84	20303.75	156.6	42.07	130.10	417.
286.0	11.836	1.315	.251	19982.12	20573.51	157.6	42.58	140.12	393.
288.0	11.430	1.064	.231	20254.09	20866.51	158.6	43.17	153.57	367.
289.0	11.205	.945	.221	20399.52	21024.24	159.1	43.51	162.12	354.
290.0	10.962	.832	.210	20552.73	21191.29	159.7	43.87	172.28	341.
291.0	10.698	.724	.200	20715.12	21369.44	160.3	44.26	184.37	328.
292.0	10.409	.625	.189	20888.30	21560.78	161.0	44.69	198.70	315.
293.0	10.092	.536	.178	21074.00	21767.61	161.7	45.15	215.34	302.
294.0	9.7442	.459	.1670	21273.68	21992.05	162.4	45.63	233.75	290.
295.0	9.3655	.398	.1562	21487.78	22235.20	163.3	46.12	252.37	278.
296.0	8.9615	.352	.1456	21714.84	22495.95	164.2	46.57	268.45	269.
297.0	8.5435	.323	.1358	21950.92	22770.26	165.1	46.95	279.04	262.
298.0	8.1266	.308	.1268	22190.26	23051.62	166.0	47.22	282.46	256.
299.0	7.7253	.305	.1186	22426.69	23332.80	167.0	47.34	278.80	253.
300.0	7.3506	.310	.1114	22654.98	23607.29	167.9	47.34	269.34	251.
301.0	7.0086	.323	.1049	22871.38	23870.15	168.8	47.23	255.86	250.
302.0	6.7017	.343	.0992	23073.78	24118.30	169.6	47.03	240.23	250.
303.0	6.4287	.367	.0942	23261.57	24350.44	170.3	46.78	224.07	250.
304.0	6.1868	.394	.0897	23435.22	24566.65	171.1	46.51	208.52	251.
305.0	5.9724	.424	.0857	23595.85	24767.90	171.7	46.22	194.20	252.
306.0	5.7817	.456	.0822	23744.84	24955.56	172.3	45.93	181.37	253.
308.0	5.4577	.522	.0761	24013.51	25296.09	173.4	45.38	160.09	256.
310.0	5.1925	.589	.0712	24251.10	25599.21	174.4	44.88	143.74	259.
312.0	4.9702	.655	.0670	24465.12	25873.52	175.3	44.44	131.09	262.
314.0	4.7801	.719	.0635	24660.97	26125.37	176.1	44.06	121.14	265.
316.0	4.6149	.781	.0605	24842.56	26359.40	176.9	43.74	113.18	268.
318.0	4.4691	.841	.0578	25012.74	26579.05	177.5	43.46	106.69	271.
320.0	4.3390	.899	.0554	25173.62	26786.90	178.2	43.22	101.33	274.
322.0	4.2217	.956	.0533	25326.83	26984.94	178.8	43.03	96.83	277.
325.0	4.0652	1.036	.0506	25544.91	27266.86	179.7	42.79	91.33	281.
330.0	3.8440	1.163	.0467	25884.38	27705.39	181.0	42.54	84.49	287.
335.0	3.6592	1.281	.0436	26201.93	28114.90	182.3	42.42	79.57	293.
340.0	3.5010	1.392	.0410	26503.79	28503.22	183.4	42.42	75.93	298.
345.0	3.3629	1.498	.0388	26794.12	28875.62	184.5	42.49	73.16	303.
350.0	3.2407	1.598	.0369	27075.82	29235.82	185.5	42.64	71.01	308.
355.0	3.1313	1.694	.0352	27351.00	29586.53	186.5	42.83	69.34	313.
360.0	3.0322	1.787	.0337	27621.26	29929.79	187.5	43.08	68.02	317.
370.0	2.8591	1.963	.0312	28151.58	30599.91	189.3	43.67	66.15	326.
380.0	2.7116	2.129	.0292	28673.72	31255.22	191.1	44.37	65.01	333.
390.0	2.5836	2.287	.0274	29192.18	31901.61	192.8	45.15	64.34	341.
400.0	2.4708	2.439	.0259	29709.98	32543.11	194.4	45.97	64.01	348.
425.0	2.2378	2.797	.0229	31014.22	34142.33	198.3	48.14	64.10	364.
450.0	2.0540	3.131	.0207	32346.45	35754.42	201.9	50.40	64.95	379.

* Saturated state

Table B-2. (Continued)

7.50 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*105.036	23.488	44.574	2.893	6603.63	6922.95	84.3	41.51	77.26	1720.
110.0	23.201	49.649	2.615	6965.81	7289.07	87.7	43.23	71.37	1709.
120.0	22.722	50.621	2.277	7651.82	7981.89	93.7	44.09	67.90	1667.
140.0	21.848	43.063	1.885	8972.97	9316.26	104.0	41.85	66.04	1556.
160.0	20.947	34.045	1.582	10278.78	10636.82	112.8	39.42	66.22	1428.
180.0	19.986	26.341	1.309	11594.93	11970.19	120.7	37.91	67.20	1290.
200.0	18.959	20.027	1.065	12932.94	13328.54	127.8	37.22	68.76	1148.
220.0	17.848	14.639	.853	14307.87	14728.08	134.5	37.17	71.47	1002.
320.0	4.9289	.801	.0655	24841.84	26363.49	176.5	44.01	114.60	273.
240.0	16.603	9.887	.664	15750.84	16202.56	140.9	37.66	76.50	846.
250.0	15.897	7.742	.576	16514.87	16986.65	144.1	38.11	80.54	764.
255.0	15.514	6.735	.533	16912.20	17395.64	145.7	38.41	83.14	721.
260.0	15.104	5.776	.491	17322.35	17818.92	147.4	38.75	86.27	677.
265.0	14.662	4.868	.449	17748.00	18259.54	149.0	39.16	90.11	632.
270.0	14.179	4.015	.407	18192.72	18721.67	150.8	39.64	94.93	585.
275.0	13.644	3.218	.365	18661.60	19211.28	152.6	40.22	101.22	537.
280.0	13.039	2.478	.322	19162.52	19737.73	154.5	40.93	109.87	487.
282.0	12.770	2.198	.305	19374.55	19961.85	155.3	41.26	114.37	466.
284.0	12.483	1.929	.288	19594.97	20195.80	156.1	41.63	119.74	445.
286.0	12.173	1.670	.270	19825.44	20441.58	157.0	42.03	126.26	423.
288.0	11.834	1.423	.252	20068.13	20701.88	157.9	42.49	134.35	401.
290.0	11.461	1.190	.234	20326.01	20980.39	158.8	43.00	144.57	378.
292.0	11.044	.974	.215	20603.03	21282.11	159.9	43.58	157.70	354.
294.0	10.572	.781	.197	20904.26	21613.66	161.0	44.23	174.50	331.
296.0	10.034	.619	.178	21235.15	21982.62	162.2	44.95	194.96	309.
298.0	9.4257	.498	.1592	21598.53	22394.23	163.6	45.68	216.33	290.
300.0	8.7674	.424	.1420	21988.60	22844.04	165.1	46.31	231.85	275.
302.0	8.1052	.393	.1270	22388.08	23313.42	166.7	46.69	235.30	266.
304.0	7.4893	.394	.1143	22775.59	23777.01	168.2	46.77	226.55	261.
306.0	6.9501	.417	.1037	23135.21	24214.34	169.7	46.58	209.90	259.
308.0	6.4945	.457	.0950	23459.96	24614.80	171.0	46.23	190.45	259.
310.0	6.1147	.508	.0878	23750.21	24976.76	172.1	45.82	171.83	260.
312.0	5.7976	.564	.0818	24010.14	25303.78	173.2	45.39	155.65	262.
314.0	5.5300	.623	.0768	24244.95	25601.18	174.1	44.99	142.18	265.
316.0	5.3012	.682	.0725	24459.37	25874.13	175.0	44.62	131.14	267.
318.0	5.1029	.742	.0688	24657.30	26127.05	175.8	44.29	122.08	270.
320.0	4.9289	.801	.0655	24841.84	26363.49	176.5	44.01	114.60	273.
322.0	4.7743	.858	.0627	25015.38	26586.27	177.2	43.76	108.37	275.
324.0	4.6358	.914	.0601	25179.80	26797.64	177.9	43.55	103.14	278.
326.0	4.5105	.969	.0578	25336.58	26999.36	178.5	43.37	98.70	280.
328.0	4.3964	1.022	.0558	25486.90	27192.86	179.1	43.22	94.89	283.
330.0	4.2917	1.074	.0539	25631.71	27379.28	179.7	43.10	91.61	285.
335.0	4.0631	1.197	.0499	25974.36	27820.24	181.0	42.89	85.13	291.
340.0	3.8708	1.313	.0466	26295.90	28233.46	182.2	42.82	80.39	296.
345.0	3.7055	1.423	.0439	26602.11	28626.13	183.4	42.83	76.84	302.
350.0	3.5608	1.528	.0415	26896.91	29003.19	184.5	42.93	74.11	307.
355.0	3.4324	1.628	.0395	27183.13	29368.20	185.5	43.09	71.98	311.
360.0	3.3172	1.724	.0377	27462.81	29723.76	186.5	43.30	70.31	316.
365.0	3.2129	1.816	.0361	27737.52	30071.88	187.4	43.56	68.99	320.
370.0	3.1177	1.905	.0347	28008.44	30414.09	188.4	43.84	67.94	324.
380.0	2.9494	2.077	.0323	28542.55	31085.41	190.2	44.51	66.44	332.
390.0	2.8045	2.239	.0303	29070.66	31744.90	191.9	45.25	65.53	340.
400.0	2.6777	2.395	.0285	29596.48	32397.41	193.5	46.06	65.02	347.
425.0	2.4178	2.760	.0251	30915.97	34018.02	197.5	48.21	64.83	364.
450.0	2.2145	3.101	.0226	32259.30	35646.06	201.2	50.45	65.52	379.

* Saturated state

Table B-2. (Continued)

8.00 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*105.105	23.495	44.477	2.893	6602.93	6943.43	84.3	41.63	77.47	1718.
110.0	23.211	49.594	2.618	6960.57	7305.23	87.6	43.30	71.50	1709.
120.0	22.732	50.703	2.279	7646.74	7998.67	93.7	44.13	67.92	1668.
140.0	21.859	43.240	1.887	8966.75	9332.73	104.0	41.87	66.01	1559.
160.0	20.962	34.249	1.585	10270.60	10652.24	112.8	39.44	66.15	1431.
180.0	20.005	26.552	1.312	11584.15	11984.04	120.6	37.93	67.11	1294.
200.0	18.983	20.248	1.070	12918.74	13340.16	127.8	37.24	68.62	1153.
220.0	17.882	14.879	.858	14288.72	14736.09	134.4	37.18	71.23	1008.
320.0	5.5864	.726	.0772	24483.55	25915.60	174.8	44.69	128.90	273.
240.0	16.653	10.153	.671	15723.33	16203.72	140.8	37.66	76.02	855.
250.0	15.961	8.022	.584	16480.55	16981.78	144.0	38.10	79.79	774.
255.0	15.586	7.022	.541	16873.33	17386.60	145.6	38.38	82.20	732.
260.0	15.188	6.070	.500	17277.82	17804.54	147.2	38.71	85.06	690.
265.0	14.761	5.170	.458	17696.25	18238.20	148.8	39.09	88.51	646.
270.0	14.299	4.324	.417	18131.49	18690.97	150.5	39.53	92.75	601.
275.0	13.792	3.535	.377	18587.47	19167.50	152.3	40.06	98.09	555.
280.0	13.228	2.803	.336	19069.83	19674.60	154.1	40.69	105.10	508.
282.0	12.982	2.528	.320	19271.97	19888.20	154.9	40.98	108.58	489.
284.0	12.722	2.262	.303	19480.45	20109.29	155.6	41.29	112.60	469.
286.0	12.445	2.007	.287	19696.22	20339.05	156.5	41.63	117.28	449.
288.0	12.149	1.762	.270	19920.50	20578.98	157.3	42.00	122.81	429.
290.0	11.831	1.530	.253	20154.81	20831.02	158.2	42.41	129.43	408.
292.0	11.485	1.311	.237	20401.04	21097.62	159.1	42.86	137.42	387.
294.0	11.107	1.109	.220	20661.55	21381.84	160.0	43.36	147.11	366.
296.0	10.690	.927	.203	20939.00	21687.35	161.1	43.90	158.72	346.
298.0	10.231	.771	.186	21235.93	22017.89	162.2	44.47	172.05	326.
300.0	9.7267	.646	.1694	21553.47	22375.94	163.4	45.05	185.91	308.
302.0	9.1866	.557	.1539	21889.31	22760.15	164.7	45.59	197.67	293.
304.0	8.6305	.503	.1397	22236.15	23163.09	166.0	46.01	204.19	282.
306.0	8.0861	.480	.1272	22582.93	23572.28	167.3	46.24	203.85	275.
308.0	7.5781	.481	.1163	22918.61	23974.29	168.7	46.28	197.27	270.
310.0	7.1214	.499	.1071	23235.15	24358.53	169.9	46.16	186.45	268.
312.0	6.7207	.532	.0991	23528.45	24718.80	171.1	45.92	173.67	268.
314.0	6.3736	.573	.0924	23797.92	25053.10	172.1	45.62	160.72	268.
316.0	6.0736	.621	.0866	24045.14	25362.32	173.1	45.30	148.71	270.
318.0	5.8135	.673	.0816	24272.74	25648.86	174.0	44.99	138.08	271.
320.0	5.5864	.726	.0772	24483.55	25915.60	174.8	44.69	128.90	273.
322.0	5.3864	.781	.0734	24680.15	26165.36	175.6	44.42	121.07	275.
324.0	5.2098	.836	.0701	24864.79	26400.64	176.3	44.18	114.39	278.
326.0	5.0498	.890	.0671	25039.35	26623.58	177.0	43.97	108.69	280.
328.0	4.9062	.943	.0644	25205.36	26835.95	177.7	43.79	103.80	282.
330.0	4.7757	.996	.0620	25364.09	27039.23	178.3	43.64	99.59	285.
335.0	4.4948	1.122	.0570	25735.44	27515.28	179.7	43.36	91.30	290.
340.0	4.2626	1.242	.0529	26079.23	27956.04	181.0	43.22	85.31	296.
345.0	4.0656	1.355	.0495	26403.19	28370.91	182.3	43.18	80.85	301.
350.0	3.8953	1.463	.0466	26712.51	28766.27	183.4	43.23	77.45	306.
355.0	3.7456	1.567	.0441	27010.81	29146.66	184.5	43.35	74.81	310.
360.0	3.6124	1.666	.0420	27300.74	29515.36	185.5	43.52	72.75	315.
365.0	3.4925	1.761	.0401	27584.25	29874.85	186.5	43.75	71.11	319.
370.0	3.3833	1.853	.0385	27862.83	30227.03	187.5	44.02	69.81	324.
380.0	3.1931	2.029	.0356	28409.65	30915.06	189.3	44.64	67.94	332.
390.0	3.0301	2.195	.0333	28947.92	31588.10	191.0	45.36	66.76	339.
400.0	2.8883	2.354	.0313	29482.10	32251.89	192.7	46.14	66.06	347.
425.0	2.6000	2.727	.0274	30817.37	33894.25	196.7	48.27	65.56	363.
450.0	2.3765	3.073	.0245	32172.03	35538.33	200.5	50.50	66.08	379.

* Saturated state

Table B-2. (Continued)

8.50 megapascal Isobar

Temp. K	Density mol/dm³	Isotherm Derivative dm³-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*105.175	23.501	44.380	2.894	6602.22	6963.90	84.3	41.75	77.67	1716.
110.0	23.221	49.537	2.620	6955.33	7321.38	87.6	43.36	71.64	1708.
120.0	22.742	50.784	2.281	7641.68	8015.45	93.6	44.17	67.94	1669.
140.0	21.871	43.417	1.890	8960.57	9349.22	103.9	41.90	65.97	1561.
160.0	20.977	34.452	1.588	10262.46	10667.68	112.7	39.46	66.09	1434.
180.0	20.024	26.763	1.316	11573.45	11997.95	120.5	37.95	67.02	1298.
200.0	19.008	20.468	1.074	12904.71	13351.89	127.7	37.26	68.49	1158.
220.0	17.915	15.117	.863	14269.87	14744.32	134.3	37.20	71.00	1014.
320.0	6.2963	.690	.0905	24110.16	25460.16	173.2	45.18	141.12	277.
240.0	16.702	10.415	.677	15696.49	16205.42	140.7	37.66	75.56	863.
250.0	16.022	8.298	.591	16447.34	16977.85	143.8	38.09	79.11	784.
255.0	15.656	7.305	.549	16835.91	17378.82	145.4	38.36	81.34	743.
260.0	15.269	6.359	.508	17235.22	17791.92	147.0	38.67	83.97	702.
265.0	14.855	5.465	.468	17647.16	18219.34	148.6	39.03	87.09	659.
270.0	14.411	4.626	.428	18074.09	18663.92	150.3	39.44	90.86	616.
275.0	13.928	3.842	.388	18519.07	19129.35	152.0	39.93	95.48	572.
280.0	13.397	3.118	.349	18986.31	19620.77	153.8	40.50	101.33	527.
282.0	13.168	2.844	.333	19180.70	19826.19	154.5	40.75	104.14	509.
284.0	12.928	2.581	.317	19380.11	20037.57	155.3	41.03	107.30	491.
286.0	12.676	2.328	.302	19585.13	20255.68	156.0	41.32	110.88	472.
288.0	12.410	2.085	.286	19796.50	20481.45	156.8	41.64	114.98	453.
290.0	12.127	1.854	.270	20015.09	20716.02	157.6	41.98	119.70	434.
292.0	11.825	1.634	.255	20241.96	20960.75	158.5	42.35	125.18	415.
294.0	11.503	1.428	.239	20478.36	21217.32	159.3	42.75	131.56	396.
296.0	11.155	1.238	.223	20725.69	21487.67	160.3	43.18	138.96	377.
298.0	10.780	1.066	.208	20985.41	21773.89	161.2	43.64	147.43	358.
300.0	10.375	.916	.192	21258.72	22077.98	162.2	44.11	156.76	341.
302.0	9.9404	.791	.1775	21545.99	22401.09	163.3	44.59	166.30	324.
304.0	9.4801	.695	.1633	21845.93	22742.54	164.4	45.04	174.85	310.
306.0	9.0046	.627	.1500	22154.84	23098.81	165.6	45.43	180.87	298.
308.0	8.5288	.587	.1380	22466.87	23463.49	166.8	45.71	183.14	290.
310.0	8.0690	.569	.1273	22775.22	23828.64	168.0	45.86	181.36	283.
312.0	7.6382	.571	.1179	23073.78	24186.61	169.1	45.88	176.11	279.
314.0	7.2443	.586	.1096	23358.13	24531.46	170.2	45.79	168.43	277.
316.0	6.8904	.613	.1024	23625.86	24859.46	171.3	45.63	159.44	276.
318.0	6.5755	.648	.0961	23876.32	25169.01	172.2	45.41	150.12	276.
320.0	6.2963	.690	.0905	24110.16	25460.16	173.2	45.18	141.12	277.
322.0	6.0489	.735	.0857	24328.74	25733.97	174.0	44.94	132.82	278.
324.0	5.8287	.783	.0814	24533.73	25992.02	174.8	44.71	125.38	280.
326.0	5.6319	.833	.0776	24726.80	26236.05	175.6	44.49	118.79	282.
328.0	5.4550	.883	.0742	24909.53	26467.72	176.3	44.30	113.01	283.
330.0	5.2950	.934	.0712	25083.31	26688.58	176.9	44.13	107.96	285.
335.0	4.9539	1.059	.0648	25486.05	27201.86	178.5	43.80	97.90	290.
340.0	4.6759	1.180	.0597	25854.31	27672.13	179.9	43.60	90.58	296.
345.0	4.4432	1.295	.0555	26197.74	28110.79	181.2	43.51	85.14	301.
350.0	4.2440	1.406	.0521	26522.88	28525.71	182.4	43.52	81.01	305.
355.0	4.0706	1.512	.0491	26834.29	28922.44	183.5	43.60	77.82	310.
360.0	3.9175	1.613	.0466	27135.25	29305.02	184.5	43.75	75.32	315.
365.0	3.7807	1.711	.0444	27428.18	29676.47	185.6	43.95	73.34	319.
370.0	3.6573	1.805	.0424	27714.92	30039.07	186.6	44.19	71.76	323.
380.0	3.4423	1.985	.0391	28275.17	30744.45	188.4	44.78	69.48	331.
390.0	3.2600	2.155	.0364	28824.10	31431.45	190.2	45.47	68.03	339.
400.0	3.1024	2.318	.0341	29366.96	32106.79	191.9	46.23	67.12	346.
425.0	2.7844	2.697	.0297	30718.49	33771.19	196.0	48.33	66.30	363.
450.0	2.5399	3.049	.0265	32084.70	35431.36	199.8	50.55	66.64	379.

* Saturated state

Table B-2. (Continued)

9.00 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*105.244	23.508	44.282	2.894	6601.52	6984.36	84.3	41.86	77.88	1714.
110.0	23.231	49.477	2.623	6950.10	7337.50	87.5	43.42	71.77	1707.
120.0	22.751	50.865	2.283	7636.64	8032.22	93.6	44.20	67.96	1670.
140.0	21.882	43.593	1.892	8954.42	9365.72	103.9	41.92	65.93	1563.
160.0	20.991	34.654	1.592	10254.39	10683.14	112.7	39.48	66.02	1437.
180.0	20.042	26.973	1.320	11562.86	12011.90	120.5	37.98	66.93	1302.
200.0	19.032	20.687	1.079	12890.83	13363.71	127.6	37.29	68.36	1163.
220.0	17.948	15.353	.869	14251.32	14752.76	134.2	37.22	70.78	1020.
230.0	17.367	12.938	.773	14951.18	15469.40	137.4	37.38	72.64	947.
240.0	16.749	10.675	.684	15670.29	16207.63	140.6	37.67	75.13	871.
250.0	16.081	8.570	.598	16415.14	16974.79	143.7	38.08	78.47	793.
260.0	15.346	6.643	.517	17194.37	17780.85	146.8	38.64	82.98	713.
265.0	14.945	5.755	.477	17600.44	18202.66	148.4	38.98	85.83	672.
270.0	14.516	4.920	.437	18019.97	18639.99	150.1	39.37	89.20	630.
275.0	14.053	4.142	.399	18455.43	19095.84	151.8	39.82	93.27	588.
280.0	13.550	3.422	.361	18910.01	19574.21	153.5	40.34	98.26	545.
285.0	12.996	2.762	.323	19388.09	20080.62	155.3	40.94	104.57	501.
290.0	12.376	2.165	.285	19895.89	20623.10	157.2	41.65	112.82	457.
295.0	11.670	1.638	.248	20442.42	21213.63	159.2	42.48	123.96	413.
300.0	10.851	1.199	.212	21039.70	21869.10	161.4	43.43	138.86	370.
305.0	9.9016	.879	.1774	21697.31	22606.25	163.8	44.44	155.88	331.
310.0	8.8628	.705	.1472	22401.97	23417.45	166.5	45.25	166.55	304.
315.0	7.8638	.660	.1231	23101.93	24246.41	169.1	45.56	162.55	290.
316.0	7.6807	.662	.1190	23236.03	24407.80	169.6	45.55	160.16	288.
317.0	7.5045	.668	.1152	23367.33	24566.61	170.1	45.53	157.40	287.
318.0	7.3357	.676	.1116	23495.63	24722.50	170.6	45.49	154.35	286.
320.0	7.0206	.699	.1050	23742.68	25024.63	171.6	45.37	147.69	285.
322.0	6.7348	.730	.0991	23976.70	25313.04	172.5	45.22	140.71	285.
324.0	6.4768	.766	.0939	24197.97	25587.54	173.3	45.05	133.83	285.
326.0	6.2440	.807	.0892	24407.23	25848.62	174.1	44.87	127.31	286.
328.0	6.0336	.850	.0850	24605.50	26097.14	174.9	44.69	121.29	287.
330.0	5.8431	.895	.0813	24793.88	26334.16	175.6	44.53	115.83	288.
332.0	5.6698	.942	.0779	24973.45	26560.81	176.3	44.38	110.91	290.
334.0	5.5116	.989	.0748	25145.22	26778.16	176.9	44.25	106.52	291.
336.0	5.3665	1.036	.0721	25310.12	26987.20	177.6	44.14	102.60	293.
338.0	5.2329	1.083	.0695	25468.95	27188.85	178.2	44.04	99.11	295.
340.0	5.1093	1.130	.0672	25622.43	27383.91	178.7	43.96	96.00	297.
345.0	4.8371	1.245	.0622	25986.56	27847.19	180.1	43.84	89.61	301.
350.0	4.6062	1.357	.0580	26328.59	28282.48	181.3	43.80	84.72	306.
355.0	4.4068	1.464	.0545	26653.97	28696.28	182.5	43.85	80.95	310.
360.0	4.2320	1.568	.0515	26966.67	29093.34	183.6	43.97	77.99	315.
365.0	4.0768	1.667	.0489	27269.60	29477.23	184.7	44.14	75.65	319.
370.0	3.9376	1.763	.0466	27564.95	29850.63	185.7	44.36	73.78	323.
375.0	3.8116	1.856	.0446	27854.41	30215.65	186.7	44.62	72.28	327.
380.0	3.6967	1.947	.0428	28139.30	30573.92	187.6	44.91	71.07	331.
390.0	3.4939	2.120	.0397	28699.33	31275.22	189.4	45.58	69.31	339.
400.0	3.3197	2.285	.0371	29251.21	31962.32	191.2	46.32	68.19	346.
425.0	2.9707	2.671	.0322	30619.43	33648.98	195.3	48.38	67.05	363.
450.0	2.7044	3.028	.0286	31997.40	35325.27	199.1	50.60	67.21	379.

* Saturated state

Table B-2. (Continued)

9.50 megapascal isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*105.314	23.515	44.184	2.894	6600.81	7004.81	84.2	41.98	78.09	1712.
110.0	23.241	49.416	2.626	6944.86	7353.61	87.5	43.48	71.91	1707.
120.0	22.761	50.945	2.285	7631.62	8048.99	93.5	44.24	67.99	1670.
140.0	21.894	43.769	1.895	8948.31	9382.23	103.8	41.94	65.89	1566.
160.0	21.006	34.856	1.595	10246.38	10698.64	112.6	39.50	65.96	1440.
180.0	20.061	27.182	1.324	11552.35	12025.91	120.4	38.00	66.85	1306.
200.0	19.056	20.905	1.083	12877.11	13375.63	127.5	37.31	68.23	1167.
220.0	17.981	15.587	.874	14233.05	14761.40	134.1	37.24	70.57	1026.
230.0	17.406	13.183	.779	14929.74	15475.54	137.3	37.40	72.35	953.
240.0	16.796	10.931	.690	15644.69	16210.32	140.4	37.68	74.72	879.
250.0	16.139	8.838	.605	16383.88	16972.52	143.5	38.08	77.87	803.
260.0	15.419	6.922	.524	17155.08	17771.19	146.7	38.61	82.07	724.
265.0	15.029	6.039	.485	17555.81	18187.90	148.3	38.94	84.68	684.
270.0	14.614	5.208	.447	17968.72	18618.76	149.9	39.31	87.74	644.
275.0	14.170	4.434	.409	18395.81	19066.24	151.5	39.73	91.36	603.
280.0	13.690	3.718	.372	18839.59	19533.51	153.2	40.21	95.69	562.
285.0	13.168	3.061	.335	19303.28	20024.74	154.9	40.76	100.99	520.
290.0	12.592	2.466	.299	19791.25	20545.68	156.8	41.39	107.65	478.
295.0	11.950	1.936	.263	20309.37	21104.32	158.7	42.11	116.17	436.
300.0	11.225	1.483	.229	20865.12	21711.40	160.7	42.92	127.08	396.
305.0	10.404	1.126	.196	21465.32	22378.45	162.9	43.80	139.90	358.
310.0	9.4961	.888	.1658	22107.45	23107.86	165.3	44.61	151.08	327.
315.0	8.5669	.773	.1403	22766.85	23875.76	167.7	45.15	154.36	307.
316.0	8.3872	.763	.1358	22897.18	24029.86	168.2	45.21	153.76	304.
317.0	8.2113	.757	.1315	23026.20	24183.14	168.7	45.26	152.75	302.
318.0	8.0397	.754	.1275	23153.61	24335.24	169.2	45.28	151.39	300.
320.0	7.7117	.756	.1200	23402.64	24634.54	170.1	45.29	147.73	296.
322.0	7.4056	.768	.1132	23642.72	24925.53	171.0	45.24	143.14	294.
324.0	7.1226	.789	.1071	23872.94	25206.72	171.9	45.16	137.98	293.
326.0	6.8625	.816	.1016	24092.98	25477.31	172.7	45.05	132.59	293.
328.0	6.6243	.849	.0967	24302.97	25737.08	173.5	44.93	127.21	293.
330.0	6.4064	.885	.0922	24503.37	25986.26	174.3	44.80	122.01	293.
332.0	6.2070	.924	.0881	24694.81	26225.34	175.0	44.68	117.12	294.
334.0	6.0243	.966	.0845	24878.04	26454.99	175.7	44.56	112.59	295.
336.0	5.8565	1.008	.0812	25053.81	26675.95	176.4	44.45	108.44	296.
338.0	5.7019	1.052	.0781	25222.86	26888.98	177.0	44.35	104.66	297.
340.0	5.5590	1.097	.0753	25385.88	27094.81	177.6	44.27	101.23	299.
345.0	5.2451	1.208	.0693	25771.04	27582.27	179.0	44.13	94.05	303.
350.0	4.9803	1.318	.0644	26130.53	28038.04	180.3	44.07	88.49	307.
355.0	4.7531	1.425	.0603	26470.50	28469.20	181.6	44.09	84.15	311.
360.0	4.5550	1.529	.0568	26795.47	28881.08	182.7	44.18	80.73	316.
365.0	4.3802	1.630	.0537	27108.86	29277.71	183.8	44.33	78.02	320.
370.0	4.2241	1.727	.0511	27413.21	29662.20	184.9	44.53	75.85	324.
375.0	4.0835	1.822	.0488	27710.50	30036.94	185.9	44.77	74.11	328.
380.0	3.9558	1.914	.0467	28002.26	30403.81	186.8	45.04	72.69	332.
390.0	3.7315	2.090	.0431	28573.80	31119.67	188.7	45.68	70.62	339.
400.0	3.5399	2.257	.0402	29134.97	31818.70	190.5	46.41	69.28	347.
425.0	3.1588	2.648	.0347	30520.28	33527.78	194.6	48.44	67.79	363.
450.0	2.8701	3.009	.0307	31910.17	35220.17	198.5	50.64	67.77	379.

* Saturated state

Table B-2. (Continued)

10.00 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*105.383	23.522	44.086	2.895	6600.11	7025.26	84.2	42.09	78.30	1710.
110.0	23.252	49.352	2.630	6939.63	7369.71	87.4	43.54	72.05	1706.
120.0	22.771	51.024	2.287	7626.61	8065.76	93.5	44.28	68.01	1671.
140.0	21.905	43.945	1.897	8942.23	9398.75	103.8	41.97	65.86	1568.
160.0	21.020	35.058	1.598	10238.42	10714.16	112.6	39.53	65.90	1443.
180.0	20.079	27.391	1.328	11541.94	12039.96	120.4	38.02	66.76	1309.
200.0	19.080	21.121	1.088	12863.54	13387.64	127.5	37.33	68.11	1172.
220.0	18.012	15.819	.879	14215.06	14770.23	134.0	37.26	70.36	1032.
230.0	17.443	13.425	.785	14908.69	15481.98	137.2	37.41	72.07	960.
240.0	16.841	11.184	.696	15619.67	16213.46	140.3	37.69	74.33	887.
250.0	16.195	9.102	.612	16353.50	16970.99	143.4	38.08	77.31	812.
260.0	15.490	7.197	.532	17117.24	17762.81	146.5	38.59	81.23	735.
265.0	15.110	6.317	.494	17513.06	18174.86	148.1	38.90	83.65	696.
270.0	14.708	5.491	.456	17919.98	18599.89	149.7	39.25	86.43	657.
275.0	14.279	4.720	.418	18339.65	19039.97	151.3	39.65	89.68	617.
280.0	13.820	4.007	.382	18774.05	19497.65	152.9	40.10	93.50	577.
285.0	13.324	3.352	.346	19225.63	19976.18	154.6	40.60	98.05	537.
290.0	12.784	2.757	.311	19697.54	20479.78	156.4	41.17	103.57	497.
295.0	12.191	2.226	.277	20193.78	21014.06	158.2	41.82	110.38	458.
300.0	11.534	1.763	.244	20719.23	21586.21	160.1	42.53	118.76	419.
305.0	10.804	1.382	.212	21278.51	22204.09	162.2	43.30	128.57	383.
310.0	10.002	1.100	.183	21871.98	22871.79	164.4	44.06	138.24	351.
315.0	9.1585	.928	.1568	22488.38	23580.26	166.6	44.68	144.18	327.
316.0	8.9900	.906	.1521	22612.32	23724.67	167.1	44.77	144.58	323.
317.0	8.8229	.888	.1475	22735.92	23869.32	167.5	44.85	144.68	320.
318.0	8.6579	.874	.1432	22858.91	24013.93	168.0	44.92	144.48	316.
320.0	8.3357	.855	.1350	23102.16	24301.82	168.9	45.02	143.22	311.
322.0	8.0272	.848	.1275	23340.35	24586.11	169.8	45.07	140.92	307.
324.0	7.7349	.851	.1207	23572.09	24864.94	170.6	45.08	137.79	305.
326.0	7.4603	.863	.1145	23796.42	25136.85	171.5	45.06	134.05	303.
328.0	7.2042	.882	.1089	24012.79	25400.87	172.3	45.00	129.93	301.
330.0	6.9664	.906	.1037	24220.97	25656.44	173.1	44.93	125.63	301.
332.0	6.7462	.936	.0990	24421.06	25903.39	173.8	44.85	121.32	300.
334.0	6.5425	.969	.0948	24613.35	26141.81	174.5	44.76	117.12	301.
336.0	6.3543	1.004	.0909	24798.27	26372.01	175.2	44.67	113.11	301.
338.0	6.1801	1.042	.0873	24976.33	26594.42	175.9	44.59	109.34	302.
340.0	6.0188	1.082	.0841	25148.07	26809.54	176.5	44.51	105.83	303.
345.0	5.6634	1.185	.0770	25553.28	27319.00	178.0	44.37	98.23	306.
350.0	5.3640	1.291	.0713	25930.07	27794.36	179.4	44.30	92.15	309.
355.0	5.1078	1.396	.0664	26284.77	28242.57	180.6	44.31	87.32	313.
360.0	4.8854	1.499	.0623	26622.31	28669.21	181.8	44.38	83.48	317.
365.0	4.6900	1.600	.0588	26946.45	29078.66	183.0	44.51	80.41	321.
370.0	4.5162	1.698	.0558	27260.08	29474.34	184.0	44.69	77.95	325.
375.0	4.3602	1.793	.0531	27565.45	29858.91	185.1	44.91	75.95	329.
380.0	4.2191	1.886	.0508	27864.30	30234.49	186.1	45.17	74.34	333.
390.0	3.9723	2.064	.0467	28447.69	30965.09	188.0	45.79	71.95	340.
400.0	3.7626	2.234	.0435	29018.39	31676.15	189.8	46.49	70.37	347.
425.0	3.3483	2.629	.0373	30421.14	33407.73	194.0	48.50	68.54	364.
450.0	3.0367	2.994	.0329	31823.09	35116.17	197.9	50.68	68.32	379.

* Saturated state

Table B-2. (Continued)

12.50 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*105.729	23.556	43.589	2.900	6596.63	7127.29	84.2	42.63	79.41	1701.
110.0	23.302	48.998	2.647	6913.46	7449.88	87.2	43.84	72.81	1703.
120.0	22.820	51.405	2.298	7601.82	8149.59	93.3	44.46	68.14	1676.
140.0	21.961	44.818	1.910	8912.35	9481.53	103.6	42.07	65.69	1579.
160.0	21.090	36.063	1.614	10199.45	10792.15	112.3	39.62	65.60	1459.
180.0	20.169	28.427	1.347	11491.18	12110.95	120.1	38.13	66.36	1328.
200.0	19.196	22.190	1.109	12797.83	13449.02	127.1	37.44	67.53	1194.
220.0	18.165	16.953	.903	14128.89	14817.02	133.6	37.36	69.43	1060.
230.0	17.622	14.604	.811	14808.72	15518.08	136.8	37.50	70.84	992.
240.0	17.053	12.411	.724	15502.14	16235.16	139.8	37.75	72.65	923.
250.0	16.451	10.376	.644	16213.00	16972.81	142.8	38.10	74.97	853.
260.0	15.809	8.511	.567	16945.84	17736.53	145.8	38.55	77.88	783.
265.0	15.469	7.649	.531	17322.09	18130.16	147.3	38.81	79.60	748.
270.0	15.115	6.836	.495	17705.80	18532.82	148.8	39.10	81.50	713.
275.0	14.744	6.076	.461	18097.72	18945.52	150.3	39.42	83.61	678.
280.0	14.356	5.369	.427	18498.60	19369.34	151.9	39.77	85.95	643.
285.0	13.948	4.716	.395	18909.23	19805.44	153.4	40.14	88.53	609.
290.0	13.518	4.119	.363	19330.44	20255.12	155.0	40.55	91.39	575.
295.0	13.065	3.577	.333	19763.06	20719.80	156.6	40.99	94.54	542.
300.0	12.587	3.090	.304	20207.91	21201.01	158.2	41.46	98.00	510.
305.0	12.082	2.659	.276	20665.69	21700.30	159.8	41.95	101.76	479.
310.0	11.549	2.286	.249	21136.65	22218.96	161.5	42.46	105.72	450.
315.0	10.992	1.974	.225	21620.17	22757.40	163.2	42.96	109.62	424.
316.0	10.877	1.919	.220	21718.22	22867.38	163.6	43.06	110.35	419.
317.0	10.763	1.867	.215	21816.65	22978.09	163.9	43.16	111.06	414.
318.0	10.647	1.817	.211	21915.44	23089.49	164.3	43.26	111.74	409.
320.0	10.414	1.726	.202	22113.95	23314.25	165.0	43.45	112.99	400.
322.0	10.180	1.645	.193	22313.39	23541.32	165.7	43.63	114.05	392.
324.0	9.9449	1.575	.1849	22513.36	23770.29	166.4	43.79	114.88	384.
326.0	9.7106	1.514	.1770	22713.42	24000.68	167.1	43.95	115.46	377.
328.0	9.4778	1.464	.1695	22913.06	24231.93	167.8	44.10	115.75	370.
330.0	9.2479	1.423	.1624	23111.79	24463.46	168.5	44.23	115.73	364.
332.0	9.0217	1.391	.1557	23309.10	24694.65	169.2	44.34	115.41	359.
334.0	8.8005	1.367	.1493	23504.53	24924.90	169.9	44.44	114.80	355.
336.0	8.5850	1.350	.1433	23697.62	25153.65	170.6	44.53	113.91	351.
338.0	8.3760	1.340	.1377	23888.02	25380.38	171.3	44.60	112.78	348.
340.0	8.1742	1.337	.1324	24075.42	25604.63	171.9	44.67	111.44	345.
345.0	7.7028	1.350	.1206	24529.41	26152.18	173.5	44.78	107.45	340.
350.0	7.2806	1.388	.1106	24961.49	26678.39	175.0	44.87	102.99	337.
355.0	6.9055	1.445	.1020	25371.97	27182.13	176.5	44.95	98.53	336.
360.0	6.5732	1.514	.0947	25762.50	27664.17	177.8	45.04	94.35	336.
365.0	6.2785	1.591	.0884	26135.42	28126.34	179.1	45.16	90.60	337.
370.0	6.0162	1.673	.0829	26493.21	28570.93	180.3	45.32	87.32	339.
375.0	5.7815	1.758	.0782	26838.23	29000.30	181.5	45.50	84.50	341.
380.0	5.5703	1.844	.0740	27172.60	29415.65	182.6	45.72	82.10	344.
390.0	5.2050	2.016	.0671	27816.43	30217.95	184.6	46.25	78.37	349.
400.0	4.8992	2.186	.0615	28435.25	30987.68	186.6	46.88	75.73	355.
425.0	4.3093	2.589	.0515	29928.77	32829.46	191.1	48.77	72.17	370.
450.0	3.8775	2.965	.0446	31392.19	34615.90	195.1	50.90	71.01	384.

* Saturated state

Table B-2. (Continued)

15.00 megapascal isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*106.075	23.590	43.082	2.909	6593.15	7229.00	84.2	43.14	80.58	1694.
110.0	23.354	48.580	2.668	6887.24	7529.53	86.9	44.12	73.67	1700.
120.0	22.868	51.765	2.311	7577.42	8233.35	93.1	44.62	68.29	1680.
140.0	22.017	45.682	1.922	8883.27	9564.57	103.3	42.17	65.53	1591.
160.0	21.159	37.060	1.629	10161.80	10870.74	112.1	39.72	65.32	1474.
180.0	20.255	29.452	1.365	11442.48	12183.03	119.8	38.23	65.98	1346.
200.0	19.306	23.236	1.130	12735.41	13512.38	126.8	37.55	67.02	1216.
220.0	18.308	18.050	.926	14048.36	14867.67	133.2	37.47	68.64	1086.
240.0	17.245	13.581	.751	15395.30	16265.11	139.3	37.83	71.31	955.
260.0	16.083	9.748	.598	16797.35	17730.01	145.2	38.57	75.46	824.
270.0	15.450	8.092	.529	17526.95	18497.82	148.1	39.07	78.18	760.
280.0	14.773	6.630	.464	18279.87	19295.20	151.0	39.65	81.37	696.
290.0	14.047	5.370	.404	19058.87	20126.69	153.9	40.30	85.00	635.
300.0	13.267	4.313	.348	19865.92	20996.53	156.8	41.04	89.03	578.
310.0	12.432	3.452	.298	20701.63	21908.23	159.8	41.83	93.34	524.
320.0	11.546	2.782	.252	21563.87	22863.07	162.9	42.64	97.56	476.
340.0	9.7134	2.004	.1792	23327.97	24872.22	169.0	44.11	101.89	406.
350.0	8.8545	1.864	.1522	24190.49	25884.54	171.9	44.67	100.12	386.
355.0	8.4589	1.841	.1408	24607.65	26380.92	173.3	44.91	98.35	379.
360.0	8.0901	1.842	.1308	25013.32	26867.44	174.7	45.13	96.21	374.
365.0	7.7490	1.862	.1219	25406.94	27342.67	176.0	45.35	93.87	371.
370.0	7.4352	1.898	.1141	25788.57	27806.01	177.2	45.57	91.47	369.
375.0	7.1473	1.945	.1072	26158.81	28257.51	178.4	45.80	89.14	367.
380.0	6.8835	2.001	.1010	26518.53	28697.66	179.6	46.04	86.95	367.
385.0	6.6417	2.063	.0956	26868.80	29127.26	180.7	46.30	84.93	367.
390.0	6.4196	2.130	.0907	27210.71	29547.29	181.8	46.58	83.11	368.
400.0	6.0268	2.273	.0824	27873.72	30362.60	183.9	47.19	80.08	371.
425.0	5.2673	2.647	.0675	29450.95	32298.73	188.6	49.01	75.41	381.
450.0	4.7154	3.015	.0577	30974.28	34155.32	192.8	51.09	73.45	393.

* Saturated state

Table B-2. (Continued)

20.00 megapascal isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*106.761	23.661	42.026	2.936	6586.09	7431.38	84.1	44.03	83.15	1682.
110.0	23.458	47.529	2.719	6834.34	7686.94	86.4	44.65	75.73	1695.
120.0	22.964	52.415	2.339	7529.64	8400.56	92.6	44.92	68.67	1690.
140.0	22.124	47.382	1.949	8827.35	9731.34	102.9	42.33	65.26	1614.
160.0	21.290	39.032	1.661	10090.11	11029.52	111.6	39.88	64.82	1504.
180.0	20.419	31.469	1.400	11350.63	12330.09	119.2	38.42	65.32	1381.
200.0	19.512	25.272	1.168	12619.17	13644.19	126.2	37.77	66.14	1256.
220.0	18.570	20.153	.968	13901.31	14978.33	132.5	37.69	67.37	1133.
240.0	17.586	15.788	.797	15206.19	16343.46	138.4	38.05	69.29	1012.
260.0	16.543	12.048	.651	16547.00	17755.98	144.1	38.74	72.12	894.
270.0	15.992	10.416	.585	17235.29	18485.91	146.9	39.18	73.90	837.
280.0	15.418	8.955	.525	17937.51	19234.66	149.6	39.69	75.88	781.
290.0	14.820	7.670	.468	18654.55	20004.05	152.3	40.25	78.02	728.
300.0	14.197	6.562	.417	19386.59	20795.33	155.0	40.85	80.24	678.
310.0	13.551	5.626	.369	20132.95	21608.86	157.6	41.50	82.46	631.
320.0	12.886	4.851	.327	20891.93	22444.07	160.3	42.18	84.56	589.
340.0	11.524	3.730	.254	22435.42	24170.88	165.5	43.56	87.84	518.
350.0	10.849	3.362	.224	23210.50	25053.92	168.1	44.24	88.65	490.
355.0	10.519	3.221	.211	23596.25	25497.55	169.3	44.58	88.77	478.
360.0	10.196	3.106	.198	23979.73	25941.28	170.6	44.91	88.69	468.
365.0	9.8817	3.015	.1866	24360.17	26384.12	171.8	45.24	88.42	458.
370.0	9.5775	2.947	.1760	24736.93	26825.15	173.0	45.57	87.97	450.
375.0	9.2848	2.899	.1662	25109.46	27263.52	174.2	45.89	87.36	444.
380.0	9.0043	2.868	.1573	25477.40	27698.56	175.3	46.22	86.64	438.
385.0	8.7366	2.853	.1490	25840.53	28129.75	176.5	46.55	85.83	433.
390.0	8.4819	2.851	.1415	26198.78	28556.74	177.6	46.88	84.96	429.
400.0	8.0112	2.879	.1283	26900.96	29397.46	179.7	47.57	83.18	424.
425.0	7.0398	3.073	.1035	28585.36	31426.36	184.6	49.43	79.35	419.
450.0	6.3005	3.352	.0869	30203.21	33377.56	189.1	51.47	77.00	423.

* Saturated state

Table B-2. (Continued)

25.00 megapascal isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*107.443	23.733	40.897	2.976	6578.69	7632.09	84.0	44.79	86.11	1674.
110.0	23.564	46.138	2.785	6780.29	7841.21	85.9	45.13	78.42	1691.
120.0	23.059	52.962	2.373	7483.03	8567.20	92.2	45.17	69.16	1700.
140.0	22.228	49.045	1.977	8774.15	9898.86	102.5	42.47	65.04	1636.
160.0	21.415	40.976	1.691	10022.76	11190.17	111.1	40.03	64.38	1533.
180.0	20.573	33.452	1.434	11265.34	12480.49	118.7	38.60	64.74	1414.
200.0	19.702	27.250	1.204	12512.76	13781.64	125.6	37.98	65.41	1293.
220.0	18.806	22.158	1.006	13769.47	15098.81	131.8	37.93	66.37	1176.
240.0	17.883	17.856	.838	15041.85	16439.79	137.7	38.30	67.83	1062.
260.0	16.925	14.176	.695	16339.05	17816.18	143.2	38.98	69.92	952.
270.0	16.428	12.560	.632	16999.92	18521.70	145.8	39.42	71.21	899.
280.0	15.918	11.096	.573	17670.24	19240.75	148.5	39.91	72.62	848.
290.0	15.395	9.789	.519	18350.51	19974.42	151.0	40.44	74.12	800.
300.0	14.858	8.640	.469	19040.78	20723.37	153.6	41.02	75.67	754.
310.0	14.309	7.645	.424	19740.55	21487.68	156.1	41.63	77.19	711.
320.0	13.751	6.800	.382	20448.75	22266.84	158.6	42.26	78.63	671.
340.0	12.621	5.499	.311	21883.80	23864.70	163.4	43.60	81.03	604.
350.0	12.059	5.020	.280	22606.35	24679.52	165.8	44.29	81.89	575.
355.0	11.781	4.818	.266	22967.80	25089.81	166.9	44.64	82.21	562.
360.0	11.507	4.640	.253	23328.91	25501.52	168.1	44.99	82.46	551.
365.0	11.237	4.483	.240	23689.36	25914.25	169.2	45.34	82.62	540.
370.0	10.971	4.347	.229	24048.84	26327.60	170.3	45.70	82.71	530.
375.0	10.711	4.231	.218	24407.02	26741.17	171.4	46.06	82.71	520.
380.0	10.456	4.133	.208	24763.66	27154.58	172.5	46.41	82.64	512.
385.0	10.209	4.051	.198	25118.51	27567.44	173.6	46.78	82.50	505.
390.0	9.9679	3.986	.1889	25471.38	27979.44	174.7	47.14	82.29	498.
400.0	9.5091	3.896	.1727	26170.69	28799.77	176.8	47.88	81.74	487.
425.0	8.4996	3.854	.1406	27880.63	30821.93	181.7	49.82	80.00	470.
450.0	7.6762	3.977	.1178	29545.49	32802.33	186.2	51.88	78.52	463.

* Saturated state

Table B-2. (Continued)

30.00 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol·K)	C_v J/(mol·K)	C_p J/(mol·K)	Velocity of Sound m/s
*108.120	23.806	39.673	3.029	6570.67	7830.84	83.9	45.45	89.57	1669.
110.0	23.675	44.318	2.868	6724.20	7991.37	85.3	45.58	82.01	1686.
120.0	23.153	53.396	2.412	7437.33	8733.06	91.8	45.39	69.78	1711.
140.0	22.328	50.667	2.005	8723.38	10066.97	102.1	42.59	64.88	1659.
160.0	21.534	42.894	1.721	9959.28	11352.41	110.7	40.16	63.99	1561.
180.0	20.719	35.406	1.466	11185.76	12633.72	118.2	38.77	64.23	1446.
200.0	19.880	29.181	1.239	12414.64	13923.72	125.0	38.19	64.79	1328.
220.0	19.023	24.089	1.042	13649.85	15226.92	131.2	38.18	65.57	1214.
240.0	18.149	19.820	.875	14896.11	16549.10	137.0	38.57	66.72	1105.
260.0	17.254	16.178	.734	16160.30	17898.98	142.4	39.27	68.35	1002.
270.0	16.797	14.570	.672	16801.36	18587.37	145.0	39.71	69.34	952.
280.0	16.332	13.103	.614	17449.35	19286.20	147.5	40.21	70.43	905.
290.0	15.860	11.779	.561	18104.69	19996.30	150.0	40.74	71.59	859.
300.0	15.379	10.598	.513	18767.50	20713.19	152.5	41.31	72.79	816.
310.0	14.892	9.558	.468	19437.53	21452.00	154.9	41.92	73.97	775.
320.0	14.400	8.654	.427	20114.17	22197.46	157.2	42.56	75.11	738.
340.0	13.411	7.217	.356	21483.37	23720.31	161.8	43.89	77.10	672.
350.0	12.920	6.662	.325	22173.47	24495.44	164.1	44.59	77.90	644.
355.0	12.677	6.421	.311	22519.29	24885.82	165.2	44.94	78.24	631.
360.0	12.436	6.201	.298	22865.40	25277.81	166.3	45.30	78.55	619.
365.0	12.197	6.002	.285	23211.61	25671.22	167.4	45.66	78.81	608.
370.0	11.961	5.823	.273	23557.76	26065.83	168.5	46.02	79.03	597.
375.0	11.729	5.663	.261	23903.69	26461.44	169.5	46.39	79.21	587.
380.0	11.500	5.520	.250	24249.24	26857.84	170.6	46.76	79.35	578.
385.0	11.276	5.393	.240	24594.28	27254.83	171.6	47.14	79.44	569.
390.0	11.056	5.281	.230	24938.69	27652.22	172.6	47.51	79.50	561.
400.0	10.630	5.101	.212	25625.19	28447.47	174.6	48.28	79.52	547.
425.0	9.6568	4.852	.1755	27325.43	30432.04	179.5	50.25	79.17	522.
450.0	8.8210	4.811	.1480	29003.85	32404.81	184.0	52.32	78.66	508.

* Saturated state

Table B-2. (Continued)

35.00 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*108.793	23.882	38.327	3.095	6561.73	8027.29	83.7	46.01	93.68	1668.
110.0	23.791	41.943	2.974	6664.85	8136.02	84.7	46.02	87.00	1681.
120.0	23.246	53.702	2.457	7392.31	8897.92	91.4	45.58	70.54	1721.
140.0	22.425	52.246	2.035	8674.80	10235.53	101.7	42.68	64.75	1681.
160.0	21.648	44.785	1.751	9899.26	11516.02	110.2	40.27	63.65	1588.
180.0	20.856	37.334	1.497	11111.22	12789.38	117.7	38.94	63.79	1477.
200.0	20.046	31.075	1.271	12323.64	14069.66	124.5	38.40	64.27	1362.
220.0	19.222	25.962	1.075	13540.34	15361.13	130.6	38.43	64.92	1250.
240.0	18.390	21.702	.909	14765.04	16668.25	136.3	38.86	65.85	1145.
260.0	17.547	18.080	.769	16003.19	17997.89	141.7	39.59	67.18	1046.
270.0	17.119	16.477	.707	16629.14	18673.59	144.2	40.04	67.98	999.
280.0	16.688	15.006	.650	17260.49	19357.76	146.7	40.55	68.87	953.
290.0	16.253	13.668	.598	17897.65	20051.10	149.1	41.09	69.81	910.
300.0	15.814	12.462	.550	18540.81	20754.11	151.5	41.68	70.79	869.
310.0	15.371	11.385	.506	19189.91	21466.98	153.8	42.29	71.78	830.
320.0	14.925	10.434	.465	19844.65	22189.64	156.1	42.94	72.75	794.
340.0	14.034	8.883	.394	21168.78	23662.69	160.6	44.29	74.51	730.
350.0	13.592	8.266	.363	21836.68	24411.68	162.8	45.00	75.27	702.
355.0	13.373	7.993	.349	22171.71	24788.91	163.8	45.36	75.62	689.
360.0	13.156	7.741	.335	22507.34	25167.80	164.9	45.72	75.94	677.
365.0	12.940	7.509	.322	22843.44	25548.22	166.0	46.09	76.23	665.
370.0	12.727	7.297	.310	23179.91	25930.06	167.0	46.46	76.50	654.
375.0	12.516	7.104	.298	23516.67	26313.18	168.0	46.83	76.74	644.
380.0	12.307	6.927	.287	23853.61	26697.45	169.0	47.21	76.96	634.
385.0	12.102	6.766	.276	24190.66	27082.76	170.0	47.59	77.16	625.
390.0	11.900	6.621	.266	24527.73	27468.99	171.0	47.97	77.33	617.
400.0	11.505	6.372	.247	25201.69	28243.75	173.0	48.75	77.61	601.
425.0	10.586	5.957	.207	26883.49	30189.68	177.7	50.75	78.01	571.
450.0	9.7702	5.769	.1762	28560.06	32142.37	182.2	52.82	78.20	552.

* Saturated state

Table B-2. (Continued)

40.00 megapascal Isobar

Temp. K	Density mol/dm^3	Isotherm Derivative dm^3-MPa/mol	Isochore Derivative MPa/K	Internal Energy J/mol	Enthalpy J/mol	Entropy J/(mol•K)	C_v J/(mol•K)	C_p J/(mol•K)	Velocity of Sound m/s
*109.461	23.959	36.826	3.174	6551.52	8221.03	83.6	46.49	98.66	1669.
110.0	23.914	38.807	3.109	6600.33	8272.97	84.1	46.46	94.37	1676.
120.0	23.339	53.866	2.508	7347.72	9061.56	91.0	45.74	71.46	1732.
140.0	22.520	53.782	2.066	8628.18	10404.41	101.3	42.76	64.68	1703.
160.0	21.758	46.650	1.781	9842.36	11680.80	109.8	40.38	63.35	1615.
180.0	20.987	39.239	1.528	11041.17	12947.12	117.3	39.09	63.40	1506.
200.0	20.202	32.938	1.301	12238.86	14218.87	124.0	38.61	63.81	1393.
220.0	19.409	27.789	1.106	13439.40	15500.35	130.1	38.68	64.37	1284.
240.0	18.611	23.519	.940	14645.91	16795.16	135.7	39.15	65.16	1181.
260.0	17.810	19.902	.800	15862.91	18108.85	141.0	39.91	66.27	1085.
270.0	17.407	18.300	.738	16476.93	18774.83	143.5	40.39	66.94	1040.
280.0	17.003	16.825	.682	17095.37	19447.93	146.0	40.91	67.69	996.
290.0	16.596	15.475	.630	17718.63	20128.79	148.3	41.47	68.49	954.
300.0	16.188	14.247	.582	18346.98	20817.90	150.7	42.07	69.33	915.
310.0	15.779	13.140	.539	18980.49	21515.52	153.0	42.70	70.19	877.
320.0	15.369	12.151	.498	19619.05	22221.72	155.2	43.36	71.05	842.
340.0	14.551	10.504	.427	20910.16	23659.11	159.6	44.75	72.66	780.
350.0	14.146	9.833	.396	21561.81	24389.47	161.7	45.47	73.40	752.
355.0	13.945	9.531	.382	21888.93	24757.33	162.7	45.83	73.74	739.
360.0	13.746	9.252	.368	22216.82	25126.87	163.8	46.20	74.07	727.
365.0	13.548	8.992	.355	22545.42	25497.99	164.8	46.57	74.38	715.
370.0	13.351	8.752	.342	22874.66	25870.63	165.8	46.95	74.67	704.
375.0	13.157	8.530	.330	23204.47	26244.69	166.8	47.33	74.95	694.
380.0	12.965	8.325	.318	23534.79	26620.10	167.8	47.71	75.21	684.
385.0	12.775	8.136	.307	23865.58	26996.75	168.8	48.10	75.45	675.
390.0	12.587	7.963	.297	24196.77	27374.59	169.8	48.49	75.68	666.
400.0	12.220	7.659	.277	24860.21	28133.50	171.7	49.27	76.09	649.
425.0	11.354	7.108	.235	26523.55	30046.58	176.3	51.28	76.91	616.
450.0	10.569	6.793	.202	28192.71	31977.52	180.7	53.35	77.55	593.

* Saturated state

APPENDIX C. Guide for Use of Computer Programs for the Calculation of Thermodynamic Properties of Ethylene

This guide contains documentation of computer programs for the calculation of thermodynamic properties of ethylene from the triple point temperature to 450 K with pressures to 40 MPa. These programs are based upon the formulation given in this document. Methods of property calculation used in these programs are discussed, and input and output arguments for each subprogram are given.

Program listings for the calculation of isochoric heat capacity (C_v), isoboric heat capacity (C_p), internal energy (U), enthalpy (H), and entropy (S) are given in section 3.6. Subprograms for the calculation of ideal gas properties, vapor pressure, saturated liquid and vapor densities, melting pressure, and other ancillary quantities are also given.

DESCRIPTIONS AND LISTINGS OF INDEX TO SUBPROGRAMS IN THIS GUIDE

1. Introduction

This package of subprograms was developed for use on a CDC-6600 scientific computer for the calculation of the thermodynamic properties of fluids for which the formulation[1] is based upon the equation of state given in section 4. Although this guide is specifically for use in calculating the thermodynamic properties of ethylene with the formulation of this work, it may be adapted for use in calculating properties of other fluids by making appropriate changes in the subprograms which define the coefficients for the equation of state and ancillary equations. These subprograms may also be modified for use with other pressure explicit equations of state by replacing the routines which define the pressure and the necessary derivatives and integrals.

This package requires that the equation of state used in the formulation be developed to satisfy the Maxwell criterion for phase equilibrium to allow continuous integration along isotherms through the two-phase region. Calculation of liquid properties using an equation of state which does not satisfy this criterion requires the use of the Clapeyron relation with the vapor pressure equation in addition to the methods described here.

The unit system employed in the equation of state for which this package has been developed requires input and output in kelvins, MPa, and mol/dm^3 for the primary arguments temperature, pressure, and density, respectively. Units for derived properties are given in section 3.

2. Methods of Property Calculation

The methods of property calculation described here require the following information.

1. An equation of state

$$P = P(\rho,T) \quad , \tag{C-1}$$

2. A vapor pressure equation for liquid-vapor coexistence states

$$P = P(T) \quad , \tag{C-2}$$

3. An ideal gas heat capacity equation

$$C_p^o = C_p^o(T) \quad , \tag{C-3}$$

---

[1] A thermodynamic formulation is the set of equations used to calculate properties including the equation of state, vapor pressure equation, and other ancillary equations.

4. The reference properties of the ideal gas,

   a. $S^{o}_{T_o}$, the ideal gas entropy at temperature T_o, and .101325 MPa

   b. $H^{o}_{T_o}$, the ideal gas enthalpy at temperature T_o,

   c. T_o, the reference temperature for a and b,

The values used for $S^{o}_{T_o}$, $H^{o}_{T_o}$, and T_o are given in section 7

The equation of state for ethylene was developed to satisfy the Maxwell criterion, so that continuous integration of functions for various properties through the two-phase region is appropriate. The vapor pressure equation is used to calculate the saturation pressure or temperature to define the boundary of the two-phase region.

Equations (7, 8, 9, 10, 11, and 12 in section 7) are used for both the vapor and liquid phases for the calculation of entropy, enthalpy, internal energy, specific heat at constant volume, C_v, and specific heat at constant pressure, C_p, and the velocity of sound, W.

3. Description and Use of Subprograms

A complete listing of all subprograms used for the calculation of the thermodynamic properties of ethylene is given in section 3.7 of this guide. If these subprograms are to be used on a computer with a word length less than 11 significant figures it is necessary that all real variables be converted to double precision and that all functions return double precision values.

The units employed for various quantities in the following routines are:

Temperature--kelvins
Pressure--megapascal
Density--mole/decimeter cubed
Enthalpy--joules/mole
Internal Energy--joules/mole
Entropy--joules/mole-kelvin
Specific Heat at Constant Pressure--joules/mole-kelvin
Specific Heat at Constant Volume--joules/mole-kelvin
Sonic Velocity--meters/second

For input and output arguments in other units, the user must modify the calling program to accommodate the desired units.

The use of the various subprograms in this package is summarized in the subsections below. The groupings of subprograms and entries for the purposes of this section are:

A. Data initialization subprogram,

B. Programs to define the equation of state and derivative and integral functions,

C. Programs to calculate density if temperature and pressure are known,

D. Programs which calculate thermodynamic properties,

E. Programs to define the properties of the coexistence states.

F. Example of use of selected subprograms with sample output for verification purposes.

For convenience, the subprograms in section 3.7 are arranged in alphabetical order.

3.1 Data Initialization Subprogram

The data initialization subprogram in this package is SUBROUTINE DATA C2. The various coefficients and constants in this subprogram are taken from this work. A call to this data initialization routine need be made only once but must precede the call to any other subprogram in this package. A write statement in this program prints a reminder of the range of applicability of the equation of state.

3.2 Programs to Define the Equation of State and Derivative and Integral Functions

The program PROPS is a multiple entry program which calculates the pressure and various derivatives for the calculation of other properties. All entries for this subprogram are for input variables of temperature (TT) and density (DD). All return arguments are given the variable name PP.

Table C-1. SUBROUTINE PROPS and Its Entry Points

Program (Entry) Name and Purpose	Output Variable
SUBROUTINE PROPS defines functions needed to calculate properties of the various entry points and routes the calculation to the proper location.	
ENTRY PRESS calculates the pressure at the input ρ and T.	Pressure (PP)
ENTRY DPDD calculates the value of $(\partial P/\partial \rho)_T$ at the input ρ and T.	$(\partial P/\partial \rho)_T$ (PP)
ENTRY DPDT calculates the value of $(\partial P/\partial T)_\rho$ at the input ρ and T.	$(\partial P/\partial T)_\rho$ (PP)
ENTRY DSDN calculates the terms of the integral $\int[(R/\rho) - (1/\rho^2)\ (\partial P/\partial T)_\rho]\ d\rho$ used in the calculation of enthalpy, internal energy, and entropy. (This may also be expressed as the partial derivative of S with respect to the coefficients G of the equation of state.)	$(\partial S/\partial G_i)_T$ (PP)
ENTRY DUDN calculates the terms of the integral $\int[(P/\rho^2) - (RT/\rho)]\ d\rho$ needed in the calculation of enthalpy and internal energy. (This may also be expressed as the partial derivative of U with respect to the coefficients G of the equation of state.)	$(\partial U/\partial G_i)_T$ (PP)
ENTRY TDSDT calculates the terms of the integral $\int[(T/\rho^2)\ [(\partial^2 P/\partial T^2)_\rho]\ d\rho$ used in the calculation of C_v and C_p.	$T(\partial S/\partial T)_\rho$ (PP)

3.3 Programs to Calculate Density if Temperature and Pressure are Known

The programs listed in Table C-2 perform iterative solutions of the equation of state for known values of temperature and density. The FUNCTION FIND D uses a Newton method iteration which defaults to the Regula-Falsi method in the case of divergence. The Regula-Falsi method is to be avoided whenever possible because it is considerably slower than other methods.

Table C-2. Iterative Solutions for Density

Program (Entry) Name and Purpose	Input Variables	Output Variables
FUNCTION FIND D calculates the density using Newton's method of iteration, defaulting to the Regula-Falsi method. This function generates a trial density internally.	Pressure (P) Temperature (T)	
FUNCTION FIND M calculates the density using Newton's method of iteration. The user must supply a trial density DD.	Pressure (P) Temperature (T) Trial Density (DD)	
SUBROUTINE REGULA calculates the density using the Regula-Falsi method of iteration.	Pressure (PI) Temperature (TT)	Density (DD)

3.4 Programs Which Calculate Thermodynamic Properties

The FUNCTION CPI calculates thermodynamic properties of the ideal gas states. Table C-3 describes this function and its entries. All entries require the input variable temperature (T).

Table C-3. FUNCTION CPI and Its Entry Points

Program (Entry) Name and Purpose
FUNCTION CPI calculates the value of the value of the ideal gas heat capacity C_p^o.
ENTRY SI calculates the value of the integral $\int(C_p^o/T)\,dT$, used in the calculation of entropy differences for ideal gas states.
ENTRY HI calculates the value of the integral $\int C_p^o\,dT$, used in the calculation of enthalpy differences for ideal gas states.

Functions for the calculation of thermodynamic properties of real fluid states are listed in Table C-4.

Table C-4. Functions for Thermodynamic Properties

Program (Entry) Name and Purpose	Input Variables
FUNCTION CP calculates the heat capacity at constant pressure	Temperature (T) Density (D)
FUNCTION CV calculates the heat capacity at constant volume	Temperature (T) Density (D)
FUNCTION ENTHAL calculates the enthalpy	Pressure (P) Temperature (T) Density (D)
FUNCTION ENTROP calculates the entropy	Temperature (T) Density (D)
FUNCTION SOUND calculates the velocity of sound	Temperature (T) Density (D)

3.5 Programs to Define the Properties of the Coexistence States

Table C-5 describes the use of subprograms for the calculation of thermodynamic properties of coexistence states. All subprograms except FUNCTION PMELT are for coexisting liquid and vapor phases. FUNCTION PMELT calculates the freezing line pressure.

Table C-5. Subprograms for Coexistence Properties

Program (Entry) Name and Purpose	Input Variable(s)
FUNCTION DPDTVP calculates the slope (dP/dT) of the vapor pressure equation	Saturation Temperature (TT)
FUNCTION FINDTV calculates the saturation temperature iteratively from the vapor pressure equation	Pressure (POBS)
FUNCTION PMELT calculates the pressure on the freezing line	Temperature (TT)
FUNCTION SATL calculates the density of the saturated liquid using an approximating function	Saturation Temperature (TT)
ENTRY SATV calculates the density of the saturated vapor using an approximating function	Saturation Temperature (TT)
FUNCTION VPN calculates the vapor pressure	Saturation Temperature (TT)

3.6 Example of Use of Selected Subprograms with Sample Output for Verification Purposes

The following program listing illustrates the use of selected subprograms in this package for the calculation of thermodynamic properties of specific fluid state for ethylene. The program output is included for use in verifying the computer programs by the user of this work.

```
      PROGRAM SAMPL(INPUT,OUTPUT)
C     THIS IS A SAMPLE PROGRAM FOR ETHYLENE, IT IS INTENDED TO ILLUSTR-
C     ATE THE USE AND RESULTS OF THE PROGRAM
      CALL DATA C2
  104 FORMAT(1H1)
  103 FORMAT(* *)
  101 FORMAT(*   PRES  DENSITY  TEMP      H          S         CV
     1 CP  SOUND SPD*)
  102 FORMAT(* ETHYLENE PROPERTIES IN MPA,KELVINS,MOLES/DM3,JOULES
     1 AND METERS/SECOND*)
      PRINT 104
      PRINT 102
      PRINT 103
      PRINT 101
      P=10
      DO 10 J=110,400,10
      T=J
      D=FIND D(P,T)
      S=ENTROP(D,T)
      H=ENTHAL(P,D,T)
      CSUBV=CV(D,T)
      CSUBP=CP(D,T)
      W=SOUND(D,T)
   10 PRINT 100,P,D,T,H,S,CSUBV,CSUBP,W
  100 FORMAT(F6.0,F10.4,F6.0,F10.2,F10.3,3F10.2)
      STOP
      END
```

ETHYLENE PROPERTIES IN MPA,KELVINS,MOLES/DM3,JOULES AND METERS/SECOND

PRES	DENSITY	TEMP	H	S	CV	CP	SOUND SPD
10.	23.2516	110.	7369.71	87.438	43.54	72.05	1706.12
10.	22.7710	120.	8065.76	93.497	44.28	68.01	1671.34
10.	22.3347	130.	8737.42	98.874	43.35	66.51	1623.17
10.	21.9051	140.	9398.75	103.775	41.97	65.86	1567.89
10.	21.4687	150.	10056.28	108.312	40.64	65.72	1507.50
10.	21.0198	160.	10714.16	112.558	39.53	65.90	1443.45
10.	20.5568	170.	11374.89	116.563	38.66	66.27	1377.05
10.	20.0793	180.	12039.96	120.364	38.02	66.76	1309.34
10.	19.5872	190.	12710.46	123.990	37.59	67.36	1240.93
10.	19.0802	200.	13387.64	127.463	37.33	68.11	1172.01
10.	18.5564	210.	14073.34	130.808	37.23	69.08	1102.43
10.	18.0125	220.	14770.23	134.050	37.26	70.36	1031.91
10.	17.4432	230.	15481.98	137.213	37.41	72.07	960.11
10.	16.8407	240.	16213.46	140.326	37.69	74.33	886.74
10.	16.1946	250.	16970.99	143.418	38.08	77.31	811.65
10.	15.4902	260.	17762.81	146.523	38.59	81.23	734.84
10.	14.7079	270.	18599.89	149.682	39.25	86.43	656.52
10.	13.8197	280.	19497.65	152.946	40.10	93.50	577.10
10.	12.7838	290.	20479.78	156.391	41.17	103.57	497.24
10.	11.5343	300.	21586.21	160.141	42.53	118.76	418.90
10.	5.3640	350.	27794.36	179.364	44.30	92.15	309.36
10.	3.7626	400.	31676.15	189.761	46.49	70.37	347.16

3.7 Listings of Subprograms for Calculation of Thermodynamic Properties of Ethylene

```
      FUNCTION CP(D,T)
C     CALCULATES SPECIFIC HEAT CAPACITY
C     AT CONSTANT PRESSURE FOR INPUT OF
C     DENSITY AND TEMPERATURE IN MOL/DM3 AND K
C     CP IS IN JOULES/MOL-K
      CVEE=CV(D,T)
      CALL DPDT(DPT,D,T)
      CALL DPDD(DPD,D,T)
      CP=CVEE+(T/(D**2)*(DPT**2)/DPD)*1000.
      RETURN
      END
```

```
      FUNCTION CPI(T)
C     CALCULATES IDEAL GAS THERMO PROPERTIES
C     FOR ALL FLUIDS EXCEPT H2.  INPUT IS IN
C     KELVIN, OUTPUT IS IN JOULES, MOL/DM3 AND K
      COMMON/CPID/G(11)
      K=1
    1 U=G(9)/T
      EU=EXP (U)
      TS=1./T**4
      GO TO (2,3,4),K
    2 CPI=G(8)*U*U*EU/(EU-1.)**2
      DO 10 I=1,7
      TS=TS*T
   10 CPI=CPI+G(I)*TS
      CPI=CPI*8.31434
      RETURN
      ENTRY SI
      K=2
      GO TO 1
    3 CPI=G(8)*(U/(EU-1.)-ALOG(1.-1./EU))
     1-G(1)*TS*T/3.-G(2)*TS*T*T/2.-G(3)/T+G(4)*ALOG(T)+G(5)*T+G(6)*T*T/2
     2.+G(7)*T**3/3.
      CPI=CPI*8.31434+G (11)
      RETURN
      ENTRY HI
      K=3
      GO TO 1
    4 CPI=G(8)*U*T/(EU-1.)-G(1)/(2.*T*T)-G(2)/T+G(3)*ALOG(T)+G(4)*T
     1+G(5)*T*T/2.+G(6)*T**3/3.+G(7)*T**4/4.
      CPI=CPI*8.31434+G(10)
      RETURN
      END
```

```
      FUNCTION CV(D,T)
C     CALCULATES SPECIFIC HEAT CAPACITY
C     AT CONSTANT VOLUME FOR AN INPUT
C     OF DENSITY AND TEMPERATURE IN MOL/DM3 AND K
```

```
      DATA(R=8.31434)
      DD=D
      TT=T
      CALL TDSDT(CD,DD,TT)
      DD=0
      CALL TDSDT(CO,DD,TT)
      CV=CPI(TT)+(CO-CD)*1000.
      CV=CV-R
      RETURN
      END
```

```
      SUBROUTINE DATA C2
C     DATA SUBROUTINE FOR ETHYLENE
      DIMENSION A(20)
      DIMENSION G(32),VP(9),GI(11)
      DIMENSION GV(9),GT(9),FV(4),FT(4),EV(8),ET(4)
      COMMON/CPID/GI
      COMMON/CRIT/ EM, EOK, RM, TC, DC, X , PC, SIG
      COMMON/DATA/G,R,GAMMA,VP,DTP,PCC,PTP,TCC,TTP,TUL,TLL,PUL,DCC
      COMMON/DATA1/GV,GT,FV,FT,EV,ET
      COMMON/PARA/PERCEN
      COMMON/ISP/N
      COMMON/SATC/A,DTPV
      N=0
      GAMMA=-.0172
      R=8.31434E-3
      GI(1)=.5603615762E+6
      GI(2)=-.2141069802E+5
      GI(3)=.2532008897E+3
      GI(4)=.3554495281E+1
      GI(5)=-.9951927478E-2
      GI(6)=.5108931070E-4
      GI(7)=-.1928667482E-7
      GI(8)=-.2061703241E+2
      GI(9)=.3E+4
      GI(10)=GI(11)=0
      TO=298.15
      HO=29610.0
      SO=219.223
      GI(10)=HO-HI(TO)
      GI(11)=SO-SI(TO)
      G( 1)= -.2146684366683E-02
      G( 2)=  .1791433722534E+00
      G( 3)= -.3675315603930E+01
      G( 4)=  .3707178934669E+03
      G( 5)= -.3198282566709E+05
      G( 6)=  .5809379774732E-04
      G( 7)= -.7895570824899E-01
      G( 8)=  .1148620375835E+02
      G( 9)=  .2713774629193E+05
      G(10)= -.8647124319107E-05
      G(11)=  .1617727266385E-01
      G(12)= -.2731527496271E+01
```

```
    G(13)= -.2672283641459E-03
    G(14)= -.4752381331990E-02
    G(15)= -.6255637346217E+01
    G(16)=  .4576234964434E-03
    G(17)= -.7534839269320E-05
    G(18)=  .1638171982209E-01
    G(19)= -.3563090740740E-03
    G(20)= -.1833000783170E+05
    G(21)= -.1805074209985E+07
    G(22)= -.4794587918874E+03
    G(23)=  .3531948274957E+07
    G(24)= -.2562571039155E+01
    G(25)=  .1044308253292E+03
    G(26)= -.1695303363659E-01
    G(27)= -.1710334224958E+03
    G(28)= -.2054114462372E-04
    G(29)=  .6727558766661E-02
    G(30)= -.1557168403328E-06
    G(31)= -.1229814736077E-04
    G(32)=  .4234325938573E-04
    VP(1)=8.209579800
    VP(2)=4.315424145
    VP(3)=-1.692585975
    VP(9)=-.1976495575
    VP(4)=3.446501098
    VP(5)=1.5
    VP(6)=EXP(-9.017286635)
    VP(7)=103.986
    VP(8)=282.3428
    A( 1)=  -.609621515594E+02
    A( 2)=   .203185312702E-01
    A( 3)=  -.925441265813E+00
    A( 4)=   .243630795888E+02
    A( 5)=  -.854745622888E+03
    A( 6)=   .123927868183E+04
    A( 7)=  -.142710711789E+04
    A( 8)=   .837358670405E+03
    A( 9)=   .432203696552E+03
    A(10)=  -.137917541161E+04
    A(11)=   .126858600124E+04
    A(12)=  -.571552321713E+03
    A(13)=   .106012234360E+03
    A(14)=  -.479047060183E+01
    A(15)=   .151381345283E-01
    A(16)=  -.403456079445E+00
    A(17)=   .508683920225E+01
    A(18)=  -.246711997987E+02
    A(19)=   .980030915247E+01
    A(20)=  -.216846516122E+01
    DTP=23.34296694034
    DTPV=.1425455127094E-03
    EM=28.054
    PRINT 100
100 FORMAT(* THE TEMPERATURE RANGE FOR ETHYLENE IS 104 TO 400K*
```

```
     1/* WITH PRESSURES TO 40 MPA*)
      TCC=VP(8)
      PCC=VPN(TCC)
      PTP=VP(6)
      TTP=VP(7)
      TUL=450.
      TLL=TTP
      PUL=40.
      DCC=7.650
      RETURN
      END
```

```
      FUNCTION DPDTVP(TT)
C     CALCULATES THE DERIVATIVE OF PRESSURE
C     WITH RESPECT TO TEMPERATURE AT
C     SATURATION.  INPUT IS TEMP. IN K, OUTPUT IS MPA/K.
      COMMON/DATA/G,R,GAMMA,VP
      DIMENSION G(32),VP(9)
      T=TT
      IF(TT.GT.VP(8))GO TO 1
      X=(1.-VP(7)/T)/(1.-VP(7)/VP(8))
      DXDT=(VP(7)/T**2)/(1.-VP(7)/VP(8))
      DPDT=VP(1)*DXDT+2.*VP(2)*X*DXDT+VP(3)*3.*X**2*DXDT+VP(4)*
     1((1.-X)**VP(5))*DXDT+VP(4)*X*((1.-X)**(VP(5)-1.))*VP(5)*(-DXDT)
      DPDT=DPDT*VPN(T)
      DPDTVP=DPDT
      RETURN
    1 DPDTVP=0
      RETURN
      END
```

```
      FUNCTION ENTHAL(P,D,T)
C     CALCULATES ENTHALPY FOR INPUT OF
C     PRESSURE, DENSITY AND TEMP. IN
C     MPA, MOL/DM3 AND K.  OUTPUT IS IN
C     JOULES/MOL
      R=8.31434E-3
      DD=D
      TT=T
      CALL DSDN(SD,DD,TT)
      CALL DUDN(UD,DD,TT)
      DD=0
      CALL DSDN(SO,DD,TT)
      CALL DUDN(UO,DD,TT)
      ENTHAL=T*(SD-SO)*1000.+(UD-UO)*1000.+HI(T)+(P/D-R*T)*1000.
      RETURN
      END
```

```
      FUNCTION ENTROP(D,T)
C     CALCULATES ENTROPY
C     FOR AN INPUT OF DENSITY AND
```

```
C     TEMP. IN MOL/DM3 AND K.  OUTPUT IS IN
C     JOULES/MOL-K
      R=8.31434E-3
      DD=D
      TT=T
      CALL DSDN(SD,DD,TT)
      DD=0
      CALL DSDN(SO,DD,TT)
      ENTROP=(SD-SO)*1000.-R*ALOG(D*R*T/.101325)*1000.+SI(T)
      RETURN
      END
```

```
      FUNCTION FIND D(P,T)
C     ITTERATES EQUATION OF STATE
C     FOR DENSITY, GIVEN PRESSURE
C     AND TEMP. IN MPA AND KELVIN.  IF
C     ITTERATION FAILS TRY USING
C     FUNCTION CALLED FIND M
      DIMENSION G(32),VP(9)
      COMMON/DATA/G,R,GAMMA,VP,DTP,PCC,PTP,TCC,TTP,TUL,PUL,DCC
      TT=T
      IF(TT.GT.VP(8))GO TO 100
      IF( P.GT.VPN(TT))GO TO 101
      DD=SATV(TT)
      GO TO 102
  100 PC=PCC
      X=(1.1/(9.*PC))*P+.7/9.
      DD=P/(R*T*X)
      IF(P/PC.GT.20..AND.T/VP(8).LT.2.5)DD=DTP
      GO TO 102
  101 DD=SATL(TT)
  102 CONTINUE
      DO 10 I=1,50
      IF(DD.LE.0.0.OR.DD.GT.50.)GO TO 11
      CALL PRESS(PP,DD,TT)
      IF(PP.LE.0.0)GO TO 11
      P2=PP
      IF(ABS (P-P2)-1.E-7*P)20,20,1
    1 CALL DPDD(PP,DD,TT)
      DP=PP
      CORR=(P2-P)/DP
      IF(ABS (CORR)-1.E-7*DD)20,20,10
   10 DD=DD-CORR
   11 CALL REGULA(P,DD,T)
   20 FIND D=DD
      RETURN
      END
```

```
      FUNCTION FIND M(P,T,DD)
C     ALTERNATIVE FOR FIND D, INPUT IS
C     PRESSURE IN MPA, T IN KELVIN AND
C     DENSITY IN MOL/DM3.  INPUT DENSITY
```

```
C     IS A STARTING VALUE FOR ITERATION
C     OF EQUATION OF STATE FOR SOLUTION FOR P AND T
      TT=T
      DO 10 I=1,50
      CALL PRESS(PP,DD,TT)
      P2=PP
      IF(ABS (P-P2)-1.E-7*P)20,20,1
    1 CALL DPDD(PP,DD,TT)
      DP=PP
      CORR=(P2-P)/DP
      D=DD
      IF(ABS (CORR)-1.E-7*D)20,20,10
   10 DD=DD-CORR
      FIND M=0
      RETURN
   20 FIND M=DD
      RETURN
      END
```

```
      FUNCTION FINDTV(POBS)
C     ITTERATES THE VAPOR PRESSURE EQUATION
C     FOR A TEMPERATURE ( IN KELVIN)
C     GIVEN AN INPUT PRESSURE IN MPA
      COMMON/DATA/G,R,GAMMA,VP,DTP
      DIMENSION G(32),VP(9)
      T=VP(8)
      DO 7 I=1,10
      P=VPN(T)
      IF(ABS (P-POBS)-.000001*POBS)8,8,6
    6 CONTINUE
      CORR=(POBS-P)/DPDTVP(T)
    7 T=T+CORR
    8 CONTINUE
      FINDTV=T
      RETURN
      END
```

```
      FUNCTION PMELT(TT)
C     FUNCTION SUBPROGRAM TO CALCULATE MELTING PRESSURE FOR C2H4
      A=.00012
      B=357.924
      C=103.986
      E=2.0645
      TAU=(TT/C)**E
      TAUM1=TAU-1.0
      PMELT=A+B*TAUM1
      RETURN
      END
```

```
      SUBROUTINE PROPS(PP,DD,TT)
      DIMENSION X(33)
```

```
      DIMENSION B(33),G(32)
      EQUIVALENCE (B,X)
      COMMON/DATA/G,R,GAMMA
      COMMON/1/B
      DATA(ID=1)
      DATA(IZ=1)
    1 CONTINUE
      IF(IZ.LE.0)GO TO 2
      IZ=0
    2 CONTINUE
      D=DD
      P=PP
      T=TT
      GM=GAMMA
      D2=D*D
      D3=D2*D
      D4=D3*D
      D5=D4*D
      D6=D5*D
      D7=D6*D
      D8=D7*D
      D9=D8*D
      D10=D9*D
      D11=D10*D
      D12=D11*D
      D13=D12*D
      TS=SQRT (T)
      T2=T*T
      T3=T2*T
      T4=T3*T
      T5=T4*T
      F=EXP (GM*D2)
      GO TO (100,200,300,400,500,600,700),K
      ENTRY PRESS
C     ENTRY FOR PRESSURE, INPUT IS DENSITY
C     AND TEMP. IN MOL/DM3 AND K, OUTPUT IS IN MPA
      K=1
      GO TO 1
  100 CONTINUE
      B( 1)=D2*T
      B( 2)=D2*TS
      B( 3)=D2
      B( 4)=D2/T
      B( 5)=D2/T2
      B( 6)=D3*T
      B( 7)=D3
      B( 8)=D3/T
      B( 9)=D3/T2
      B(10)=D4*T
      B(11)=D4
      B(12)=D4/T
      B(13)=D5
      B(14)=D6/T
      B(15)=D6/T2
```

```
      B(16)=D7/T
      B(17)=D8/T
      B(18)=D8/T2
      B(19)=D9/T2
      B(20)=D3*F/T2
      B(21)=D3*F/T3
      B(22)=D5*F/T2
      B(23)=D5*F/T4
      B(24)=D7*F/T2
      B(25)=D7*F/T3
      B(26)=D9*F/T2
      B(27)=D9*F/T4
      B(28)=D11*F/T2
      B(29)=D11*F/T3
      B(30)=D13*F/T2
      B(31)=D13*F/T3
      B(32)=D13*F/T4
      IF(ID.GT.0)GO TO 102
      B(33)=P-R*D*T
      RETURN
  102 P=0
      M=32
      DO 101 I=1,M
  101 P=P+B(I)*G(I)
      P=P+R*D*T
      PP=P
      RETURN
      ENTRY DPDD
C     PARTIAL OF PRESSURE WITH RESPECT TO
C     DENSITY - SEE PRESSURE
C     ENTRY FOR UNITS
      K=2
      GO TO 1
  200 CONTINUE
      F1=2.00*F*GM*D
      F21=3.000*F*D2 +F1*D3
      F22=5.000*F*D4 +F1*D5
      F23=7.000*F*D6 +F1*D7
      F24=9.000*F*D8 +F1*D9
      F25=11.00*F*D10+F1*D11
      F26=13.00*F*D12+F1*D13
      B( 1)=2.00*D*T
      B( 2)=2.00*D*TS
      B( 3)=2.00*D
      B( 4)=2.00*D/T
      B( 5)=2.00*D/T2
      B( 6)=3.00*D2*T
      B( 7)=3.00*D2
      B( 8)=3.00*D2/T
      B( 9)=3.00*D2/T2
      B(10)=4.00*D3*T
      B(11)=4.00*D3
      B(12)=4.00*D3/T
      B(13)=5.00*D4
```

```
      B(14)=6.00*D5/T
      B(15)=6.00*D5/T2
      B(16)=7.00*D6/T
      B(17)=8.00*D7/T
      B(18)=8.00*D7/T2
      B(19)=9.00*D8/T2
      B(20)=F21/T2
      B(21)=F21/T3
      B(22)=F22/T2
      B(23)=F22/T4
      B(24)=F23/T2
      B(25)=F23/T3
      B(26)=F24/T2
      B(27)=F24/T4
      B(28)=F25/T2
      B(29)=F25/T3
      B(30)=F26/T2
      B(31)=F26/T3
      B(32)=F26/T4
      M=32
      IF(ID.GT.0)GO TO 202
      B(33)=P-R*T
      RETURN
  202 P=0
      DO 201 I=1,M
  201 P=P+B(I)*G(I)
      P=P+R*T
      PP=P
      RETURN
      ENTRY DPDT
C     PARTIAL OF PRESSURE WITH RESPECT
C     TO TEMPERATURE - SEE PRESSURE
C     ENTRY FOR UNITS
      K=3
      GO TO 1
  300 CONTINUE
      X( 1)=D2
      X( 2)=D2/(2.00*TS)
      X( 3)=0
      X( 4)=-D2/T2
      X( 5)=-2.00*D2/T3
      X( 6)=D3
      X( 7)=0
      X( 8)=-D3/T2
      X( 9)=-2.00*D3/T3
      X(10)=D4
      X(11)=0
      X(12)=-D4/T2
      X(13)=0
      X(14)=-D6/T2
      X(15)=-2.00*D6/T3
      X(16)=-D7/T2
      X(17)=-D8/T2
      X(18)=-2.00*D8/T3
```

```
      X(19)=-2.00*D9/T3
      X(20)=-2.00*D3*F/T3
      X(21)=-3.00*D3*F/T4
      X(22)=-2.00*D5*F/T3
      X(23)=-4.00*D5*F/T5
      X(24)=-2.00*D7*F/T3
      X(25)=-3.00*D7*F/T4
      X(26)=-2.00*D9*F/T3
      X(27)=-4.00*D9*F/T5
      X(28)=-2.00*D11*F/T3
      X(29)=-3.00*D11*F/T4
      X(30)=-2.00*D13*F/T3
      X(31)=-3.00*D13*F/T4
      X(32)=-4.00*D13*F/T5
      IF(ID.GT.0)GO TO 302
      X(33)=PP-R*D
      RETURN
  302 P=0
      DO 301 I=1,32
  301 P=P+G(I)*X(I)
      PP=P+R*D
      RETURN
      ENTRY DSDN
C     PARTIAL OF ENTROPY WITH
C     RESPECT TO THE G COEFFICIENTS
      K=4
      GO TO 1
  400 CONTINUE
C     S=SO-R*LOGF(D*R*T/PO)+(DSDN(D)-DSDN(O))*1000. +CPOS(T)
      G1=F/(2.00*GM)
      G2=(F*D2-2.00*G1)/(2.00*GM)
      G3=(F*D4-4.00*G2)/(2.00*GM)
      G4=(F*D6-6.00*G3)/(2.00*GM)
      G5=(F*D8-8.00*G4)/(2.00*GM)
      G6=(F*D10-10.00*G5)/(2.00*GM)
      X( 1)=-D
      X( 2)=-D/(2.00*TS)
      X( 3)=0.D0
      X( 4)=+D/T2
      X( 5)=2.00*D/T3
      X( 6)=-D2/2.00
      X( 7)=0.D0
      X( 8)=D2/(2.00*T2)
      X( 9)=D2/T3
      X(10)=-D3/3.00
      X(11)=0.D0
      X(12)=D3/(3.00*T2)
      X(13)=0.D0
      X(14)=D5/(5.00*T2)
      X(15)= 2.00*D5/(5.00*T3)
      X(16)=D6/(6.00*T2)
      X(17)=D7/(7.00*T2)
      X(18)=2.00*D7/(7.00*T3)
      X(19)=D8/(4.00*T3)
```

```
      X(20)=2.00*G1/T3
      X(21)=3.00*G1/T4
      X(22)=2.00*G2/T3
      X(23)=4.00*G2/T5
      X(24)=2.00*G3/T3
      X(25)=3.00*G3/T4
      X(26)=2.00*G4/T3
      X(27)=4.00*G4/T5
      X(28)=2.00*G5/T3
      X(29)=3.00*G5/T4
      X(30)=2.00*G6/T3
      X(31)=3.00*G6/T4
      X(32)=4.00*G6/T5
      IF(ID.GT.0)GO TO 402
      RETURN
  402 P=0
      DO 401 I=1,32
  401 P=P+G(I)*X(I)
      PP=P
      RETURN
      ENTRY DUDN
C     TERMS NEEDED FOR ENTHALPY CALCULATION
      K=5
      GO TO 1
  500 CONTINUE
C     H=HO+(T*DSDN(D)-DSDN(0))*1000.+(DUDN(D-DUDN(0))*1000.+CPOH(T)
C     +(P/D-R*T)*1000.
      G1=F/(2.00*GM)
      G2=(F*D2-2.00*G1)/(2.00*GM)
      G3=(F*D4-4.00*G2)/(2.00*GM)
      G4=(F*D6-6.00*G3)/(2.00*GM)
      G5=(F*D8-8.00*G4)/(2.00*GM)
      G6=(F*D10-10.00*G5)/(2.00*GM)
      X( 1)=D*T
      X( 2)=D*TS
      X( 3)=D
      X( 4)=D/T
      X( 5)=D/T2
      X( 6)=D2*T/2.00
      X( 7)=D2/2.00
      X( 8)=D2/(2.00*T)
      X( 9)=D2/(2.00*T2)
      X(10)=D3*T/3.00
      X(11)=D3/3.00
      X(12)=D3/(3.00*T)
      X(13)=D4/4.00
      X(14)=D5/(5.00*T)
      X(15)=D5/(5.00*T2)
      X(16)=D6/(6.00*T)
      X(17)=D7/(7.00*T)
      X(18)=D7/(7.00*T2)
      X(19)=D8/(8.00*T2)
      X(20)=G1/T2
      X(21)=G1/T3
```

```
      X(22)=G2/T2
      X(23)=G2/T4
      X(24)=G3/T2
      X(25)=G3/T3
      X(26)=G4/T2
      X(27)=G4/T4
      X(28)=G5/T2
      X(29)=G5/T3
      X(30)=G6/T2
      X(31)=G6/T3
      X(32)=G6/T4
      IF(ID.GT.0)GO TO 502
      RETURN
  502 P=0
      DO 501 I=1,32
  501 P=P+G(I)*X(I)
      PP=P
      RETURN
      ENTRY TDSDT
C     TEMP. TIMES THE PARTIAL OF
C     ENTROPY WITH RESPECT TO TEMP.
      K=6
      GO TO 1
  600 CONTINUE
C     CV=CV0+(TDSDN(/)-TDSDN(D))*1000.
      G1=F/(2.00*GM)
      G2=(F*D2-2.00*G1)/(2.00*GM)
      G3=(F*D4-4.00*G2)/(2.00*GM)
      G4=(F*D6-6.00*G3)/(2.00*GM)
      G5=(F*D8-8.00*G4)/(2.00*GM)
      G6=(F*D10-10.00*G5)/(2.00*GM)
      X(1)=0
      X( 2)=-D/(4.00*TS)
      X(3)=0
      X( 4)=2.00*D/T2
      X( 5)=6.00*D/T3
      X(6)=0
      X(7)=0
      X( 8)=D2/T2
      X( 9)=3.00*D2/T3
      X(10)=0
      X(11)=0
      X(12)=(2.00*D3)/(3.00*T2)
      X(13)=0
      X(14)=(2.00*D5)/(5.00*T2)
      X(15)=(6.00*D5)/(5.00*T3)
      X(16)=D6/(3.00*T2)
      X(17)=(2.00*D7)/(7.00*T2)
      X(18)=(6.00*D7)/(7.00*T3)
      X(19)=(3.00*D8)/(4.00*T3)
      X(20)=6.000*G1/T3
      X(21)=12.00*G1/T4
      X(22)=6.000*G2/T3
      X(23)=20.00*G2/T5
```

```
      X(24)=6.000*G3/T3
      X(25)=12.00*G3/T4
      X(26)=6.000*G4/T3
      X(27)=20.00*G4/T5
      X(28)=6.000*G5/T3
      X(29)=12.00*G5/T4
      X(30)=6.000*G6/T3
      X(31)=12.00*G6/T4
      X(32)=20.00*G6/T5
      IF(ID.GT.0)GO TO 602
      RETURN
  602 P=0
      DO 601 I=1,32
  601 P=P+G(I)*X(I)
      PP=P
      RETURN
      ENTRY DP2D2
C     SECOND PARTIAL OF PRESSURE WITH
C     RESPECT TO DENSITY SQUARED
      K=7
      GO TO 1
  700 CONTINUE
      F1=2.*F*GM*D
      F12=2.*F1*GM*D+2.*F*GM
      F212=3.*F1*D2+3.*2.*D*F+F12*D3+F1*3.*D2
      F222=5.*F1*D4 +5.*4.*D3*F+5.*D4*F1+F12*D5
      F232=7.*F1*D6+7.*6.*D5*F+7.*D6*F1+F12*D7
      F242=9.*F1*D8+9.*8.*D7*F+9.*D8*F1+F12*D9
      F252=11.*F1*D10+10.*11.*D9*F+11.*D10*F1+F12*D11
      F262=13.*F1*D12+13.*12.*D11*F+13.*D12*F1+F12*D13
      B(1)=2.*T  $B(2)=2.*TS  $  B(3)=2.
      B(4)=2./T  $  B(5)=2./T2  $  B(6)=6.*D*T
      B(7)=6.*D  $  B(8)=6.*D/T  $  B(9)=6.*D/T2
      B(10)=12.*D2*T  $  B(11)=12.*D2  $  B(12)=12.*D2/T
      B(13)=20.*D3  $  B(14)=30.*D4/T  $  B(15)=30.*D4/T2
      B(16)=42.*D5/T  $  B(17)=56.*D6/T  $  B(18)=56.*D6/T2
      B(19)=72.*D7/T2  $  B(20)=F212/T2  $  B(21)=F212/T3
      B(22)=F222/T2
      B(23)=F222/T4  $  B(24)=F232/T2  $  B(25)=F232/T3
      B(26)=F242/T2  $  B(27)=F242/T4  $  B(28)=F252/T2
      B(29)=F252/T3  $  B(30)=F262/T2  $  B(31)=F262/T3
      B(32)=F262/T4
      M=32
      IF(ID.GT.0)GO TO 702
      B(33)=PP
      RETURN
  702 P=0
      DO 701 I=1,M
  701 P=P+B(I)*G(I)
      PP=P
      RETURN
      END
```

```
      SUBROUTINE REGULA(PI,DD,TT)
C     ITTERATES EQUATION OF STATE FOR DENSITY WHEN FIND D FAILS
      DIMENSION G(32),VP(9)
      COMMON/DATA/G,R,GAMMA,VP,DTP,PCC,PTP,TCC,TTP,TUL,TLL,PUL,DCC
      T=TT
      P=PI
      D2=0
      IF(T.LT.TCC)GO TO 10
      DO=DCC*TCC/T
      GO TO 20
   10 PP=VPN(T)
      IF(P.GT.PP)GO TO 15
      DO=SATV(T)
      DO 11 I=1,150
      CALL PRESS(PO,DO,T)
      IF(PO.GE.P)GO TO 12
   11 DO=DO+.0001*DO
      GO TO 42
   12 D1=DO
   13 CALL PRESS(P1,D1,T)
      IF(P1.LT.P)GO TO 14
      IF(D1.LE..1*PTP)GO TO 42
      DO=D1
      Z=(P1-P)/P
      IF(Z.LT..1)Z=.1
      IF(Z.GT..9)Z=.9
      D1=D1-Z*D1
      GO TO 13
   14 CALL PRESS(PO,DO,T)
      DO 140 I=1,50
      D=D1
      P3=P1
      IF(ABS(P-P1).LT..00001*P)GO TO 40
      P2=P-P1
      D1=D1+(D1-DO)*P2/(P1-PO)
      IF(ABS(D-D1).LE..00001*D)GO TO 40
      IF(ABS(P-P1).LT..005*P)D2=FIND M(P,T,D1)
      IF(D2.GT.0.0.AND.D2.LT.50.)D1=D2
      D2=0
      CALL PRESS(P1,D1,T)
      IF(PO.GT.P.AND.P1.GT.P)GO TO 120
      IF(PO.LT.P.AND.P1.LT.P)GO TO 120
      GO TO 140
  120 PO=P3
      DO=D
  140 CONTINUE
      GO TO 41
   15 DO=SATL(T)
      DO 16 I=1,10
      CALL PRESS(PO,DO,T)
      IF(PO.LE.P)GO TO 17
   16 DO=DO-.0001*DO
      GO TO 42
   17 D1=DO
```

```
   18 CALL PRESS(P1,D1,T)
      IF(D1.GE.50.)GO TO 42
      IF(P1.GT.P)GO TO 14
      DO=D1
      Z=(P-P1)/P
      Z=Z*10
      IF(T/TCC.LT..6)Z=1.
      IF(Z.LT.1.)Z=1.
      IF(Z.GT.9.)Z=9.
      D1=D1+.01*D1*Z
      GO TO 18
   20 CALL PRESS(PO,DO,T)
      IF(P.LE.PO)GO TO 30
      D1=DO
   21 CALL PRESS(P1,D1,T)
      IF(P1.GE.P)GO TO 14
      IF(D1.GE.50.)GO TO 42
      DO=D1
      Z=(P-P1)/P
      Z=Z*10
      IF(Z.LT.1)Z=1
      IF(Z.GT.9)Z=9
      D1=D1+.1*D1*Z
      GO TO 21
   30 D1=DO
   31 CALL PRESS(P1,D1,T)
      IF(P1.LE.P)GO TO 14
      IF(D1.LE..1*PTP)GO TO 42
      DO=D1
      Z=(P1-P)/P
      Z=Z*10
      IF(Z.LT.1)Z=1
      IF(Z.GT.9)Z=9
      D1=D1-.1*D1*Z
      GO TO 31
   40 DD=D1
      RETURN
   41 PRINT 101,P,T,D
  102 FORMAT(* REGULA FAILED AT P=*,F7.2,* AND T=*,F7.2)
  101 FORMAT(* DENSITY ITTERATION FAILED AT P=*,F7.2,* AND T=*,F7.2,
     1/* DENSITY RETURNED IS*,E17.8)
      RETURN
   42 PRINT 102,P,T
      RETURN
      END
```

```
      FUNCTION SATL(TT)
C     CALCULATES THE DENSITY OF THE
C     SATURATED LIQUID AT TEMP., T IN KELVIN.
C     OUTPUT IS IN MOL/DM3.
      DIMENSION A(20)
      DIMENSION G(32),VP(9)
      COMMON/DATA/G,R,GAMMA,VP,DTP,PCC,PTP,TCC,TTP,TUL,TLL,PUL,DCC
```

```
      COMMON/SATC/A,DTPV
      K=14
      KK=7
      GO TO 10
      ENTRY SATV
      K=1
      KK=13
   10 IF(T.GE.TCC)GO TO 20
      T=TT
      ITT=TCC
      IF(ITT+1-T.LT.1.)T=ITT
      X=(T-TCC)/(TTP-TCC)
      D=A(K)*ALOG(X)
      DO 11 I=2,KK
      K=K+1
      MM=I
      IF(MM.GE.5)MM=MM+1
   11 D=D+A(K)*(1.-X**((MM-5)/3.))
      IF(K.LT.14)GO TO 12
      D=DCC+EXP(D)*(DTP-DCC)
      GO TO 13
   12 D=DCC+EXP(D)*(DTPV-DCC)
   13 SATL=D
      IF(ITT+1-TT.LT.1.)SATL=D-(D-DCC)*(TT-T)
      RETURN
   20 DSATL=DCC
      RETURN
      END
```

```
      FUNCTION SOUND(D,T)
C     CALCULATES THE SPEED OF SOUND
C     FOR AN INPUT OF DENSITY AND TEMP.
C     IN MOL/Dm3 AND KELVIN.  OUTPUT IS IN
C     METERS/SECOND.
      COMMON/CRIT/W
      CALL DPDD(DP,D,T)
      SOUND=((CP(D,T)/CV(D,T))*DP*1.E+6/W)**.5
      RETURN
      END
```

```
      FUNCTION VPN(TT)
C     CALCULATES VAPOR PRESSURE IN MPA
C     FOR AN INPUT TEMPERATURE IN KELVIN
      DIMENSION G(32),VP(9)
      COMMON/DATA/G,R,GAMMA,VP
      T=TT
      X=(1.-VP(7)/T)/(1.-VP(7)/VP(8))
      VPN=VP(6)*EXP (VP(1)*X+VP(2)*X*X+VP(3)*X**3+VP(9)*X**4+VP(4)*X*
     1(1.-X)**VP(5))
      RETURN
      END
```

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☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)

A thermodynamic property formulation for ethylene, developed as a part of a joint industry-government project, is presented. The formulation includes an equation of state, vapor pressure equation, and equation for the ideal gas heat capacity. The coefficients were determined by a least squares fit of selected experimental data. Comparisons of property values calculated using the equation of state with measured values are given. The equation of state is not valid in the critical region ($\rho_c \pm 0.3\ \rho_c$ for temperatures of $T_c \pm 0.05\ T_c$). Errors on the order of 20 percent for derived properties and 10 percent for density may be encountered near the critical point. Tables of the thermodynamic properties of ethylene for the liquid and vapor phases for temperatures from the freezing line to 450 K with pressures to 40 MPa are presented. The equation of state and its derivative and integral functions for calculating thermodynamic properties are included. Estimates of the accuracy of calculated properties are given. A guide for use of computer programs for the calculation of thermodynamic properties of ethylene with listings of subprograms and a sample program to illustrate the use and results of the program are included.

12. KEY WORDS (Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)

Computer programs; equation of state; ethylene thermodynamic properties; tabular values.

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