International Journal of Thermophysics, Vol. 11, No. 3, 1990

Thermodynamic Properties of *n*-Pentane

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Received July 17, 1989

Specific volumes and isobaric heat capacity measurements are reported for *n*-pentane. The measurements were made in the liquid and vapor phases at temperatures ranging from the triple point (173 K) to the onset of dissociation temperature (700 K) and pressures up to 100 MPa including a wide region around the critical point. We are able to fit our data, as well as those of a number of other authors, to a single equation of state with 30 constants. This equation yields the density of *n*-pentane in the temperature range from 280 to 650 K at pressures up to 80 MPa and the caloric properties up to 500 K. Additional experimental investigations of the thermodynamic properties are required for temperatures above 500 K. Interpolating equations for the caloric properties on the saturated line and in the critical region are also presented.

KEY WORDS: critical region; equation state; heat capacity; *n*-pentane; saturation properties; sound velocity; thermodynamic properties.

1. INTRODUCTION

N-pentane is conveniently placed between the light *n*-alkanes, which are gases under normal conditions, and the heavier *n*-alkanes, which are liquid or solid under normal conditions; it has a normal boiling temperature of 309.2 K Hence, there exists a considerable interest for investigating thermodynamic properties experimentally. In the 1970s two extensive reviews [1, 2] were prepared dealing with the experimental results available at the time and including equations of state and tables for the thermodynamic properties of *n*-pentane. The first of these reviews covered a wide range of state parameters, namely, temperatures T from 220 to 580 K and pressures

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P up to 40 MPa, while the second review considered only the vapor phase. The equations presented in these reviews were derived from essentially the same experimental data sets [3–8], but at supercritical temperatures the calculated pressures differed by up to 5%. Even greater differences were observed in the derived caloric properties. The years that followed witnessed a series of new investigations on the thermodynamic properties of *n*-pentane, and further attempts were made at unifying the data and obtaining a new accurate equation of state. This situation led to the author's interest in this problem.

2. AVAILABLE EXPERIMENTAL INFORMATION

2.1. Density Data

Besides Refs. 3–8 indicated above, additional density data for *n*-pentane over a wide range of state parameters are also now available [9–12]. In Table I we summarize the data at our disposal. The analysis of the data was carried out with the use of a thermophysical property data handling system described in Ref. 13. The analysis includes testing of the precision and accuracy of the data claimed by the authors and our reassessment when necessary; the elimination of gross errors; checks of the statistical correlation of the data of various authors; and estimation of mutual consistency between different thermodynamic properties. The analysis showed the following.

- The data from Ref. 7, obtained from quasi-isochores, have a large scatter and are in poor agreement with measurements of other authors.
- The results in Refs. 9 and 10 for isochores and isotherms, respectively, give theoretically incorrect slopes and are excluded from our data set.
- The density values selected from acoustic measurements [11, 12] agree with the experimental data of other authors within the estimated error and may be included in the basic data set, especially in view of the limited number of measurements in the liquid phase at high pressures.
- The measurements in Refs. 4–6 and 8 are in excellent agreement; they comprise the basic data set for density.
- The data from Ref. 3 are systematically 0.5–1% lower when compared with the measurements in Refs. 4, 5, 6, and 8 and are therefore excluded from the basic set.

Table I. Experimental Investigations of the Density of *n*-Pentane[a]

Ref.	ΔT (K)	ΔP (MPa)	Number of points	SD (%)[b]
1. Sage and Lacey [3]	311.93	0.1	237	
	510.93	67	21	
2. Genrig and Lentz [7]	295.65	5	272	
	643.15	250		
3. Amirkhanov et al. [9]	473.15	3	90	
	643.15	42		
4. Beattie et al. [5]	473.15	2.5	52	0.51
	573.15	35		
5. Beattie et al. [4]	469.35	3.35	103	
	469.85	3.38		
6. Kiryakov and Melikhov [11]	303.15	10	108	0.31
	393.15	200		
7. Otpushchennikov et al. [12]	303.15	20	36	0.26
	393.15	120		
8. Belinsky and Ikramov [10]	293.15	0.1	48	
	313.15	780		
9. Li and Canjar [6]	373.15	1	120	0.34
	573.15	22		
10. Kratzke et al. [8]	238.37	0.74	119	0.16
	573.15	60.5		

[a] ΔT is the temperature range; ΔP is the pressure range.
[b] See Section 4.1.

The basic set of values obtained as a result of this analysis comprises a relatively small number of experimental points and covers the range of temperatures from 298 to 573 K; it is not possible to obtain a reliable equation of state on the basis of these data in all ranges of the state parameters from the triple point to the onset of dissociation. This circumstance made it necessary to carry out additional detailed investigations of the density of *n*-pentane.

2.2. Caloric Properties

Caloric properties of *n*-pentane, in particular, the isobaric specific heat C_p, have been investigated in detail only in the low-temperature region on the saturation line [14–17]. There exists one work [18] reporting measurements of the heat capacity of liquid *n*-pentane in the temperature range from 333 to 422 K at pressure from 2.76 to 20.4 MPa. Our experimental results for C_p of the saturated liquid agree with the extrapolated values from [18] to within ±1% in the temperature range from 338 to 408 K. However, the deviations have a systematic character: at 338 K the value C_p of Ref. 18 is higher than our data by 1.1%, at 408 K the data are lower by 1%, while at 422 K the value of C_p of Ref. 18 is lower than our data by as much as 8.8%. Measurements in the vapor phase are quite scarce and are limited to atmospheric pressure [19–21]. The measurements of the isochoric heat capacity C_v presented in Ref. 9, which cover a wide range, have a large error; the supercritical region has not been investigated adequately since the experimental data for C_v were obtained with a temperature step of 10 K. Hence, the isobaric heat capacity of *n*-pentane over a wide range of state parameters is not available.

2.3. Sound Velocity

Experimental investigations of ultrasound have been reported in several references [11, 12, 22–26] but almost all measurements have originated from one laboratory [11, 12, 22, 23]; the results cover overlapping regions (Table II). The measurements comprise a comparatively narrow region of the liquid state at 303 K < T < 453 K and

Table II. Experimental Investigations of the Sound Velocity of *n*-Pentane[a]

Ref.	ΔT (K)	ΔP (MPa)	Number of points
1. Kiryakov and Otpushchennikov [22]	303.15 393.15	10 200	57
2. Otpushchennikov et al. [12]	303.15 393.15	0.1 200	110 142
3. Sysoyev [23]	293.15 453.15	10 500	216
4. Ismagilov and Ermakov [24]	378 437	0.5 2.5	26
5. Kling et al. [25]	293.15 433.15	0.1 20	13
6. Richardson and Tait [26]	288.15 317.15	35 550	44

[a] ΔT is the temperature range; ΔP is the temperature range.

0.1 MPa $< P <$ 500 MPa. Other authors' data are rather few [25, 26]. With the exception of Ref. 26, all the data are in good agreement.

In general, the measurements of the sound velocity are in good agreement with the thermodynamic data as is demonstrated by the satisfactory agreement between experimental density data and those deduced from acoustic measurements (see above). However, the relatively narrow region of states covered by the data and the small number of measurements (considering the overlapping results) do not make it possible to derive an accurate representation of the sound velocity over a wide region of state parameters.

3. RESULTS

The density, ρ, of *n*-pentane was measured in the temperature range from 173 to 658 K and at pressures up to 100 MPa with the aid of a spherical constant-volume piezometer. The isobaric heat capacity, C_p, was measured in the temperature range from 290 to 700 K and at pressures up to 60 MPa in an adiabatic flow calorimeter. A detailed discussion of the apparatus and the technique employed is given in Refs. 27–29.

The sample of *n*-pentane used had a purity of 99.9 mass%, the impurities being the isomers of pentane (0.1%). The sample properties were checked by absorption chromotography before and after every run.

The temperature was measured with an accuracy of 0.025 K on IPTS-68. The pressure measurements were accurate to 2.5×10^{-4} MPa and 5.5×10^{-4} MPa for ρ and C_p, respectively. The total measurement error for density was in the range of 0.05–0.07% at $\rho > 2\rho_c$, 0.07–0.1% at $2\rho_c > \rho > 0.8\rho_c$, and 0.1–0.2% at $\rho < 0.8\rho_c$, while the error for the isobaric heat capacity was ± 0.3% on a relative basis (without taking into account temperature errors and pressure errors). The temperature in the liquid thermostat was kept to within $\pm$2–3 mK of the design temperature.

More than 450 densities and 500 isobaric heat capacities were obtained for the vapor and liquid phases, close to the saturation line and over a wide region around the critical point. In the liquid and vapor phases the density was measured along isotherms. The investigation of the region close to the critical point was carried out along isochores. The isobaric heat capacity was measured along 25 isobars. The experimental results have been reported previously [29–37]. In Table III we give additional experimental values for the isobaric heat capacity of *n*-pentane in the critical region which were not published earlier.

Table III. Experimental Results for the Isobaric Specific Heat C_p of *n*-Pentane in the Critical Region

T (K)	C_p ($\mathrm{kJ \cdot kg^{-1} \cdot K^{-1}}$)
$P = 3.40$ MPa	
469.748	16.26
469.963	22.69
470.131	43.33
470.173	59.10
470.184	64.82
470.204	74.58
470.226	90.73
470.230	92.76
470.258	120.4
470.278	145.6
470.295	174.2
470.304	190.9
470.305	187.1
470.308	188.7
470.318	189.2
470.325	187.9
470.334	182.7
470.335	181.0
470.366	149.4
470.392	120.1
470.394	119.8
470.409	103.5
470.448	78.42
470.500	52.85
470.514	51.39
470.538	46.24
470.615	36.12
470.616	37.01
470.704	28.82
470.819	22.20
470.952	18.89

Table III. *(Continued)*

T (K)	C_p ($kJ \cdot kg^{-1} \cdot K^{-1}$)
$P = 3.45$ MPa	
469.754	9.466
470.452	14.13
470.788	22.36
470.962	32.15
471.085	49.81
471.153	63.96
471.170	70.96
471.178	76.68
471.198	88.27
471.245	89.94
471.256	89.36
471.289	87.57
471.418	61.53
471.542	41.04
471.769	26.60
472.144	17.40
$P = 3.50$ MPa	
471.023	11.95
471.372	15.41
471.698	23.02
471.931	32.59
472.022	42.72
472.087	47.78
472.097	50.80
472.157	54.33
472.200	55.81
472.207	55.48
472.230	55.27
472.295	54.03
472.325	52.97
472.388	48.35
472.393	49.08
472.502	40.24
472.511	39.60
472.595	33.86
472.695	27.60
473.053	19.71

Table III. *(Continued)*

T (K)	C_p ($kJ \cdot kg^{-1} \cdot K^{-1}$)
$P = 3.70$ MPa	
474.271	11.26
474.880	14.65
475.228	17.46
475.511	19.70
475.933	21.67
476.003	21.65
476.014	21.62
476.122	21.53
476.190	21.21
476.294	20.66
476.552	19.16
476.905	16.70
477.352	14.06
477.792	12.10
478.165	10.76
479.065	8.707
$P = 4.00$ MPa	
479.27	9.400
480.13	10.83
480.87	11.62
481.32	11.83
481.72	11.75
482.09	11.52
482.50	11.11
483.06	10.39
483.95	9.252
486.21	7.115
$P = 4.50$ MPa	
483.29	5.876
484.22	6.202
487.14	7.115
489.05	7.470
489.68	7.539
490.03	7.546
490.97	7.526
492.15	7.173
493.21	6.881
494.84	6.389
496.97	5.814
501.11	4.961
508.39	4.185

Table III. *(Continued)*

T (K)	C_p (kJ · kg^{-1} · K^{-1})
$P = 5.00$ MPa	
482.63	4.516
484.39	4.701
489.81	5.312
492.72	5.662
496.21	5.938
500.04	5.917
502.37	5.637
505.39	5.288
510.49	4.726
517.65	4.155

4. ANALYSIS OF EXPERIMENTAL DATA

4.1. Equation of State for *n*-pentane

A single equation of state for *n*-pentane in the vapor and liquid phases was formulated in the well-known form of a double polynomial in reduced density and temperature [38]

$$Z = 1 + \sum_{i=1}^{r} \sum_{j=0}^{s_i} b_{ij} \omega^i \theta^j \tag{1}$$

where $Z = P/\rho RT$ is the compressibility factor, $\omega = \rho/\rho_c$ is the reduced density, and $\theta = T_c/T$ is the reciprocal reduced temperature; ρ_c and T_c are the critical density and temperature, respectively. The critical constants were taken as $T_c = 469.55$ K, $P_c = 3.363$ MPa, and $\rho_c = 237$ kg · m^{-3} (see Section 4.2). The basic set of data used for the analysis of the equation includes the following:

density [4–8, 30–34];
heat capacity [16, 21–23, 29, 35–37, and 18] (in the temperature range 333–408 K at pressure 2.76–20.4 MPa); and
ultrasonic velocity [11, 12, 22–25].

The coefficients of Eq. (1) were determined by a stepwise least-squares technique with the aid of the procedure mentioned above [13]. A series of equation variants was obtained differing in choice of weights of experimental data, summation indexes in Eq. (1), and other parameters. The parameters of the final equation of state selected for *n*-pentane are given in Table IV.

The average standard deviation of the densities calculated from Eq. (1) is 0.15% over a wide range of state parameters and 0.91% in the region close to critical point (the average standard deviations for the data of various authors are presented in Table I). This equation may be used for

Table IV. Coefficients in Eq. (1)

Coefficients b_{ij}
$b_{10} = 27.53151$
$b_{11} = -120.7786$
$b_{12} = 210.8933$
$b_{13} = -191.0789$
$b_{14} = 92.92840$
$b_{15} = -22.46610$
$b_{16} = 1.705720$
$b_{20} = -11.05275$
$b_{21} = 20.45554$
$b_{22} = 11.62958$
$b_{23} = -35.13687$
$b_{24} = 14.30141$
$b_{30} = 5.962246$
$b_{31} = -1.208945$
$b_{32} = -31.26607$
$b_{33} = 2.329524$
$b_{34} = -5.500349$
$b_{40} = -1.974794$
$b_{41} = -2.478634$
$b_{42} = 18.46306$
$b_{43} = -14.84170$
$b_{50} = 7.846522 \times 10^{-1}$
$b_{51} = -1.106778$
$b_{52} = -1.862774$
$b_{53} = 2.327909$
$b_{55} = 6.259703 \times 10^{-2}$
$b_{60} = 1.474421 \times 10^{-2}$
$b_{80} = 3.301670 \times 10^{-3}$
$b_{83} = -4.696141 \times 10^{-3}$
$b_{86} = -1.428093 \times 10^{-3}$

the calculation of density of *n*-pentane in the temperature range 200–650 K and pressures up to 80 MPa.

For the calculation of the saturation pressure P_s as a function of temperature, the following equation was adopted:

$$\ln P_s = \sum_{i=-1}^{3} a_i \left(\frac{T}{100}\right)^i \tag{2}$$

with $a_{-1} = -48.86226$, $a_0 = 26.28697$, $a_1 = -5.52557$, $a_2 = 0.83821$, $a_3 = -0.047386$. These coefficients were obtained by fitting experimental data in the temperature range 313–469.15 K and the data of Refs. 15 and 39 to Eq. (2). The standard deviation of the calculated saturation pressures from the experimental values is 0.3% in the temperature range from the triple point to the critical point.

For temperatures above 500 K the isobaric heat capacity calculated from Eq. (1) deviates from the experimental data by up to 10%. Because of the absence of any experimental information from other authors, we are not able to evaluate credibly the reason for these deviations and therefore are unable to present detailed tables of the properties of *n*-pentane in the whole range of state parameters from the triple point to the temperature at which dissociations begins. Investigations in this region will continue so as to obtain additional data for *n*-pentane at temperatures above 520 K.

4.2. Thermodynamic Properties

4.2.1. Isobaric Heat Capacity in the Ideal Gas State

The values for the isobaric heat capacity C_p^o in the ideal gas state for *n*-pentane were obtained by extrapolation of the experimental isotherms in the vapor phase to the pressure $P = 0$ at temperatures from 450 to 700 K. These results and the data of Stull et al. [40] at temperatures from 298.15 to 500 K are represented by an equation of the form

$$C_p^o = \left(\sum_{i=0}^{1} a_i T^i\right) \Big/ \left(1 + \sum_{j=1}^{2} b_j T^j\right) \tag{3}$$

with $a_0 = 2.175445 \times 10^{-1}$, $a_1 = 4.98925522 \times 10^{-3}$, $b_1 = -1.8050676 \times 10^{-5}$, $b_2 = 3.2700109 \times 10^{-7}$, T in K, and C_p^o in $\text{kJ} \cdot \text{kg}^{-1} \cdot \text{K}^{-1}$.

The standard deviation of our experimental C_p^o data and those from Ref. 40 is $\sigma = 0.07\%$ and the maximum deviation is 0.15%.

4.2.2. Thermodynamic Properties at Saturation

The values for the isobaric heat capacities C_p' and C_p'' of the saturated liquid and vapor were determined from an extrapolation of the experimental isobars to the coexistence boundary; the parameters of the phase boundary were calculated from Eq. (2).

The values of C'_p and C''_p for *n*-pentane along the coexistence curve which we determined and the data of Messerly et al. [16] were approximated by an interpolating equation of the form

$$\frac{C_\mathrm{p}}{T}=\sum_{i=0}^{4} a_i \left|\frac{T-T_\mathrm{c}}{T}\right|^i + a_5 \left|\frac{T-T_\mathrm{c}}{T_\mathrm{c}}\right|^n \qquad (\text{for } C'_\mathrm{p} \text{ and } C''_\mathrm{p}) \tag{4}$$

The coefficients of Eq. (4) for C'_p/T and C''_p/T, the temperature range of validity, and standard deviations are given in Table V. The value $C''_\mathrm{p} = 1.704\ \mathrm{kJ\cdot kg^{-1}\cdot K^{-1}}$ at $T = 298.15$ K determined with the C°_p from Ref. 40 and with the pressure corrections determined as described by Edmister et al. [41]. In Table V we also give the coefficients of Eq. (4), the temperatures range and the standard deviation for the enthalpy H' and the entropy S' of the saturated liquid.

4.2.3. Location of the Maxima of the Isobaric Heat Capacity in the Supercritical Region

To determine the critical parameters of *n*-pentane from the experimental data of the isobaric heat capacity and to analyze the data in the critical region, we considered the locations of the maxima for C_p on the isobars $(C^P_\mathrm{pm}, T^P_\mathrm{m})$ and the isotherms $(C^T_\mathrm{pm}, P^T_\mathrm{m})$. The values C^P_pm and C^T_pm were also approximated by Eq. (4), with coefficients, ranges of parameters, and standard deviations given in Table V.

Table V. Coefficients in the Equations for the Caloric Properties of *n*-Pentane

	C'_p/T	$-C''_\mathrm{p}/T$	C^P_pm/T	C^T_pm/T	H'	S'
a_0	7.69275×10^{-3}	5.58201×10^{-3}	4.65671×10^{-3}	4.21013×10^{-3}	1118.12	6.3127
a_1	-1.32672×10^{-2}	-2.79053×10^{-3}	-3.78055×10^{-3}	7.78892×10^{-3}	−1516.45	−4.13922
a_2	7.2235×10^{-2}	6.28477×10^{-3}	2.05477×10^{-2}	4.20009×10^{-2}	889.041	3.11928
a_3	−0.144832	0	0	8.83689×10^{-2}	−417.006	−4.26186
a_4	0.123643	0	0	-6.76152×10^{-2}	0	0
a_5	4.75415×10^{-5}	9.7611×10^{-5}	3.05695×10^{-4}	3.35656×10^{-4}	−140.947	−1.35992
n	−1.190	−1.151	−1.140	−1.124	0.150	0.001
Temperature range (K)[a]	T_tr–T_c	298.15–T_c	T_c–$1.19T_\mathrm{c}$	T_c–$1.49T_\mathrm{c}$	T_tr–T_c	T_tr–T_c
(SD) (%)	0.283	0.317	0.635	0.283	0.027	0.140

[a] T_tr and T_c are the triple-point and critical-point temperatures, respectively.

From the location of the maxima of C_p on the isobars with 3.4, 3.45, and 3.5 MPa, we obtained the critical parameters: $T_c = 469.55 \pm 0.06$ K and $P_c = 3.360 \pm 0.004$ MPa. These agree, within the estimated error, with the most reliable data of *n*-pentane from the optical and P, V, T measurements [4, 5, 8, 10, 34]. The locations of the C_p maxima were represented by the equations:

$$P_m^P - P_c = \sum_{i=1}^{4} a_i \left(\frac{T - T_c}{T_c} \right)^i \tag{5}$$

with $a_1 = 24.8924$, $a_2 = -20.6726$, $a_3 = 1246.78$, $a_4 = -4611.54$, T in K, and P in MPa, and

$$\ln P_m^T = \sum_{i=0}^{5} a_i \left(\frac{T - T_c}{T_c} \right)^i \tag{6}$$

with $a_0 = 1.21011$, $a_1 = 7.36396$, $a_2 = -28.0379$, $a_3 = 101.854$, $a_4 = -183.747$, $a_5 = 124.449$, T in K, and P_m^T in MPa.

4.2.4. Thermodynamic Properties in the Critical Region

An equation of state was obtained from the linear-model scaled equation [42–44] including the Wegner corrections:

$$\begin{aligned} \frac{\rho C_p}{T} = \frac{P_c}{T_c^2} \Biggl[& akr^{-\alpha} \frac{\gamma(\gamma-1)}{2B^2\alpha} - ckr^{-\alpha+\Delta} \frac{\gamma+\Delta}{2B^2[1-(1-2\beta)B^2\theta^2]} \\ & + (1+kr^{\beta}\theta)^{-2} \Biggl\{ akr^{1-\alpha}(s_0(\theta)+\gamma\theta^2) + ar^{\beta\delta-1}\gamma\theta \\ & + cr^{\beta\delta-1+\Delta} \frac{(\gamma+\Delta)\theta}{1-(1-2\beta)B^2\theta^2} \\ & + ckr^{1-\alpha+\Delta} \left[\frac{(\gamma+\Delta)\theta^2}{1-(1-2\beta)B^2\theta^2} - \frac{\gamma+\Delta}{2B^2(1-\alpha+\Delta)} \right] - f'(\tau) \Biggr\}^2 \\ & \times kr^{-\gamma} \Biggl\{ a \left(1 + \frac{2\beta\delta-3}{1-2\beta} \theta^2 \right) \\ & + cr^{\Delta} \left[1 + \frac{2(\gamma+\Delta)B^2\theta^2}{1-(1-2\beta)B^2\theta^2} \right] \Biggr\}^{-1} \\ & - (1+kr^{\beta}\theta)\,\mu''(\rho_c, \tau) - f''(\tau) \Biggr] \end{aligned} \tag{7}$$

Table VI. Coefficients of Eq. (7) and Standard Deviation σ of the Experimental Data on the Isobars

				P (MPa)	σ (%)
T_c (K)	469.45	a	14.785		
P_c (MPa)	3.355	c	-0.0241	3.40	4.5
ρ_c ($\mathrm{kg \cdot m^{-3}}$)	237.3	k	1.3368	3.45	6.6
α	0.108	f_1	-5.886	3.50	4.4
β	0.339	f_2	8.5185	3.70	2.6
γ	1.214	f_3	6.6926	4.0	2.1
δ	4.581	m_0	-92.8	4.5	1.9
Δ	0.5	m_1	254.09	5.0	1.0

where $f(\tau)$, $f'(\tau)$, and $f''(\tau)$ are a temperature function and its temperature derivatives,

$$\mu''(\rho_c, \tau) = \frac{T_c^2 \rho_c}{P_c} \frac{d^2}{dT^2} [\mu(\rho_c, T)]$$

$$s_0(\theta) = s_{00} + s_{02}\theta^2$$

$$s_{00} = \frac{\beta(\delta - 3) - B^2 \alpha\gamma}{2B^4(1-\alpha)\alpha}, \qquad s_{02} = -\frac{\gamma(1-2\beta)}{2\alpha}$$

Here α, β, γ, δ, and Δ are critical exponents; a, k, and c are system-dependent constants; and $\tau = (T - T_c)/T_c$.

According to the recommendations of Ref. 43, we used the values $\alpha = 0.108$ and $\beta = 0.339$; the other exponents were calculated from the scaling relations [43, 44]. The exponent Δ was taken as 0.5. The remaining system-dependent parameters were determined from our (C_p, P, T), (P, V, T) data and the data of Ref. 45 also. In Table VI we give the parameters of the scaled equation state (7) and the standard deviations of the experimental data (see Table III).

Using the parameters of the scaled equation of state (Table VI) and the hypothesis of two-scale factor universality [46], we determined the value for the critical amplitude ξ_0 of the correlation length on the critical isochore. For the calculation we used the amplitude ratio from Refs. 47 and 48

$$R \equiv \xi_0 (B^2 P_c / \Gamma k_B T_c)^{1/3}$$

where k_B is Boltzmann's constant; P_c and T_c are the critical pressure and temperature; B is the amplitude of the power law $\Delta\tilde{\rho} = B\,|\tau|^{\beta}$ for the coexistence curve; Γ and ξ_0 are the amplitudes for the power laws $(\partial\tilde{\rho}/\partial\tilde{\mu})_T = \Gamma|\tau|^{-\gamma}$ and $\xi = \xi_0|\tau|^{-\nu}$ of the compressibility and correlation length on the critical isochore; and $\Delta\tilde{\rho} = [(\rho/\rho_c) - 1]$ and $\tilde{\mu} = (\mu P_c/\rho_c)$ are the reduced density and chemical potential, respectively. According to Refs. 47 and 48, $R = 0.69$. Using this value we obtained $\xi_0 = 2.54 \times 10^{-10}$ m, which agrees with the experimental light-scattering data of Alekhin and Krupsky [49].

ACKNOWLEDGMENTS

In preparing this review the first author has benefited from stimulating discussions with Professor J. V. Sengers. The research was supported by the Division of Science and Technology of the Ministry of Petroleum-Refining Industry and by the Grozneftechim Company, USSR. B. A. Grigoryev was supported by a scholarship from the International Research and Exchanges Board (IREX).

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