International Journal of Thermophysics, Vol. 23, No. 3, May 2002 (© 2002)

Pressure Dependence of the Thermophysical Properties of *n*-Pentadecane and *n*-Heptadecane

J. L. Daridon,[1,2] H. Carrier,[1] and B. Lagourette[1]

Received November 26, 2001

The speed of sound in liquid *n*-pentadecane and *n*-heptadecane was measured using a pulse technique operating at 3 MHz. The measurements were carried out at pressures up to 150 MPa in the temperature range from 293 to 383 K. The experimental results have been used to evaluate various thermophysical properties such as density and isentropic and isothermal compressibilities up to 150 MPa with the help of additional density and heat capacity data at atmospheric pressure.

KEY WORDS: compressibility; density; heptadecane; pentadecane; pressure; speed of sound.

1. INTRODUCTION

A study of the thermophysical properties as a function of pressure and temperature in a homologous series of chemical compounds is of great interest not only for industrial applications (for example, in the petroleum industry), but also for fundamental aspects for understanding the influence of the chain length of the components on the liquid structure and then developing models for an accurate representation of the liquid state. With this aim in mind, a research program of ultrasonic speed measurements under pressure on most paraffins between decane and triacontane was initiated as a part of a CNRS-ECODEV project on crude oil characterization. Measurement of the speed of propagation of ultrasound waves u is of interest from a thermodynamic point of view if it coincides perfectly with the speed of sound within the low frequency limit c. In this case, achieved

---

[1] Laboratoire des Fluides Complexes, Faculté des Sciences et Techniques, Université de Pau, BP 1155, 64013 Pau Cedex, France.

[2] To whom correspondence should be addressed. E-mail: jean-luc.daridon@univ-pau.fr

below 10 MHz for paraffin compounds, speed of sound is a purely thermodynamic property which can be integrated so as to generate other thermophysical properties under pressure, provided that the density and the heat capacity at atmospheric pressure are known.

This paper presents data for several thermophysical properties including density, speed of sound and isothermal and isentropic compressibilities, obtained from ultrasonic measurements in liquid *n*-pentadecane (C_{15}) and *n*-heptadecane (C_{17}) at pressures ranging from 0.1 to 150MPa and temperatures between 293.15 and 383.15K.

2. EXPERIMENTAL

The samples of *n*-pentadecane and *n*-heptadecane were supplied by Fluka with a stated purity higher than 99.8%. They were used without any further treatment.

The speed of sound was measured using a pulse echo technique operating at 3 MHz. The apparatus, which has been described previously in detail [1], is essentially made up of two piezoelectric (PZT) elements placed on the opposite sides of a high pressure vessel, and connected to an ultrasonic pulse generator (PANAMETRICS 5055 PRM). Measurements were performed by direct chronometry [2] of the travelling time of the wave through the sample by means of a numerical oscilloscope with memory storage (GOULD 4090). The temperature and pressure dependence of the path length (fixed at 70 mm) was determined by calibration with water using the data of Del Grosso et al. [3], Wilson [4], and of Petitet et al. [5]. To ensure satisfactory thermal uniformity within the fluid, the vessel was immersed in a bath of heat-carrying fluid agitated and thermo-regulated by a Bioblock thermostat with a stability of 0.02 K. The temperature was recorded by means of a platinum probe (Pt100) placed inside the experimental vessel whereas the pressure was measured by an HBM P3M gauge which is frequently checked against a dead weight tester (Bundenberg) to an accuracy better than 0.02 per cent. The experimental uncertainty of the speed of sound measurements has been estimated to be less than 0.2 per cent over the entire pressure range (0.1 to 150MPa), an estimation confirmed after various tests performed with hexane [6], heptane [7], and octane [2].

3. MEASUREMENTS

The speed of sound c was measured along isotherms spaced at 10 K intervals from 293.15 to 383.15 K in the pressure range from atmospheric pressure to 150 MPa using 10 MPa steps. For the lowest temperatures, the maximum pressure was limited to the melting pressure and measurements were performed every 5 MPa in order to have enough data along these isotherms. The results are listed in Tables I and II for *n*-pentadecane and *n*-heptadecane, respectively. The data, which are plotted on Fig. 1, were smoothed as a function of temperature and pressure using a rational function which correlates $1/c^2$ as a function of pressure and temperature:

$$\frac{1}{c^2} = \frac{A + BP + CP^2 + DP^3}{E + FP} \tag{1}$$

Table I. Speed of Sound c ($\mathrm{m \cdot s^{-1}}$) of *n*-Pentadecane

	T (K)									
P (MPa)	293.15	303.15	313.15	323.15	333.15	343.15	353.15	363.15	373.15	383.15
0.1013	1345.9	1308.1	1270.9	1234.5	1198.3	1163.2	1128.6	1094.8	1061.5	1028.5
5.00	1373.0	1336.0	1299.7							
10.00	1399.2	1362.6	1328.3	1294.1	1260.3	1227.1	1194.9	1164.1	1133.2	1103.2
15.00	1424.6	1389.5	1354.5							
20.00	1448.2	1414.6	1381.1	1348.2	1316.8	1285.7	1255.3	1226.4	1197.2	1169.3
25.00	1472.3	1438.6	1406.0							
30.00	1494.3	1462.4	1429.9	1399.1	1368.3	1338.6	1310.4	1282.5	1255.1	1228.6
35.00		1484.6	1453.7							
39.95		1506.6	1475.7	1446.0	1416.8	1387.9	1360.7	1334.7	1308.3	1282.4
44.95		1527.7	1497.7							
49.95		1548.7	1518.7	1489.8	1461.8	1434.0	1407.4	1382.2	1357.7	1332.7
54.95		1568.8	1539.2							
59.90		1588.4	1559.3	1531.2	1504.2	1477.4	1451.0	1427.2	1402.8	1378.9
64.90		1607.0	1578.7							
69.90		1625.7	1597.8	1570.3	1543.9	1518.3	1493.1	1469.4	1446.0	1422.8
74.85		1643.9	1616.5							
79.85		1661.9	1634.6	1607.8	1581.7	1557.0	1532.2	1509.3	1486.5	1464.2
84.85		1679.3	1652.4							
89.80		1695.2	1669.5	1643.4	1618.3	1593.9	1570.4	1547.4	1525.0	1503.0
94.80		1712.8	1686.5							
99.75			1703.1	1677.7	1653.0	1628.8	1605.9	1583.6	1562.0	1540.4
104.75			1719.5							
109.70			1735.7	1710.3	1685.9	1662.7	1640.6	1618.3	1597.1	1576.0
114.70			1751.2							
119.70			1766.4	1742.3	1718.0	1695.2	1673.2	1651.7	1631.0	1610.4
124.65			1781.5							
129.65			1796.9	1773.3	1749.6	1726.8	1704.8	1683.9	1663.4	1643.3
134.60			1811.1							
139.60			1825.8	1802.3	1778.8	1756.8	1735.7	1714.9	1694.8	1675.0
144.55			1840.0							
149.55			1853.9	1830.7	1807.6	1785.7	1765.3	1745.3	1725.2	1705.7

Table II. Speed of Sound c ($\mathrm{m \cdot s^{-1}}$) of n-Heptadecane

	T (K)								
P (MPa)	303.15	313.15	323.15	333.15	343.15	353.15	363.15	373.15	383.15
0.1013	1331.9	1295.4	1259.3	1223.9	1189.4	1155.2	1122.0	1088.9	1056.2
5.00	1360.2	1323.4	1288.5						
10.00	1385.6	1350.1	1316.7	1283.5	1251.1	1219.4	1188.7	1157.8	1128.4
15.00	1411.1	1377.1	1343.6						
20.00	1435.9	1402.5	1369.8	1338.9	1308.0	1277.9	1248.8	1220.1	1192.0
25.00	1459.5	1426.8	1395.2						
30.00	1482.3	1450.0	1419.3	1388.9	1360.8	1331.2	1303.6	1276.5	1249.8
35.00	1504.0	1473.2	1442.5						
39.95		1495.1	1465.3	1436.5	1408.0	1380.4	1353.7	1328.3	1302.5
44.95		1516.5	1486.9						
49.95		1537.3	1508.1	1480.2	1452.4	1426.6	1401.1	1376.0	1351.0
54.95		1557.3	1528.7						
59.90		1577.0	1549.0	1521.8	1495.2	1469.9	1445.5	1420.7	1397.1
64.90		1596.1	1568.4						
69.90		1614.7	1587.5	1561.0	1535.1	1510.6	1486.5	1463.0	1439.7
74.85		1633.0	1605.9						
79.85		1650.9	1624.0	1598.5	1573.0	1549.3	1525.9	1503.2	1480.5
84.85		1668.3	1641.7						
89.80			1659.3	1634.2	1609.6	1586.2	1563.4	1541.3	1519.3
94.80			1676.4						
99.75			1692.8	1668.5	1644.4	1621.6	1599.3	1577.4	1556.1
104.75			1709.4						
109.70			1725.4	1701.4	1677.6	1655.4	1633.5	1612.3	1591.3
114.70			1741.1						
119.70			1756.2	1732.8	1710.0	1688.0	1666.4	1646.1	1625.1
124.65			1771.8						
129.65			1786.6	1763.4	1741.1	1719.2	1698.2	1677.7	1657.9
134.60			1801.5						
139.60			1817.2	1793.1	1771.1	1749.3	1728.8	1708.6	1688.9
149.55				1821.6	1800.1	1779.4	1758.4	1738.6	1719.4

in which

$$A = A_0 + A_1 T + A_2 T^2 + A_3 T^3 \tag{2}$$

and

$$E = 1 + E_1 T \tag{3}$$

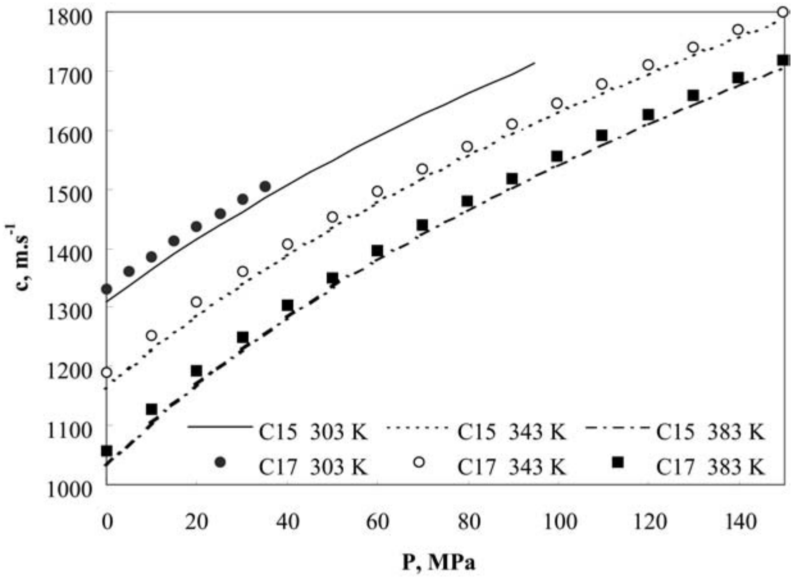

Fig. 1. Speed of sound c in *n*-pentadecane and *n*-heptadecane as a function of pressure.

The coefficients of this equation, obtained by a least squares fit, are given in Table III as well as the statistical information of the fit. Comparisons of the average deviation (AD%) and the average absolute deviation (AAD%) between experimental and smoothed data show that the fitting function does not introduce any systematic error. Moreover, the maximum

Table III. Parameters of Eqs. (1) to (3) with T in K, P in MPa, and c in $\mathrm{m \cdot s^{-1}}$

Parameters			Deviations of c
	n-pentadecane		
$A_0 = 1.55996 \times 10^{-7}$	$A_3 = -4.33400 \times 10^{-15}$	$D = 1.08862 \times 10^{-14}$	AD% $= -4.5 \times 10^{-4}$
$A_1 = -1.96890 \times 10^{-10}$	$B = 1.51289 \times 10^{-9}$	$E_1 = -1.70899 \times 10^{-3}$	AAD% $= 2.3 \times 10^{-2}$
$A_2 = 3.33643 \times 10^{-12}$	$C = -4.97830 \times 10^{-12}$	$F = 6.98722 \times 10^{-3}$	MD% $= 7.3 \times 10^{-2}$
	n-heptadecane		
$A_0 = 1.24603 \times 10^{-7}$	$A_3 = -3.59470 \times 10^{-15}$	$D = 8.01009 \times 10^{-15}$	AD% $= 7.5 \times 10^{-3}$
$A_1 = 8.11198 \times 10^{-11}$	$B = 1.28623 \times 10^{-9}$	$E_1 = -1.70763 \times 10^{-3}$	AAD% $= 2.4 \times 10^{-2}$
$A_2 = 2.42825 \times 10^{-12}$	$C = -3.86900 \times 10^{-12}$	$F = 6.44868 \times 10^{-3}$	MD% $= 1.1 \times 10^{-1}$

deviations (MD%) observed are of the same magnitude as the experimental error. The function then seems appropriate to interpolate the speed-of-sound measurements in both liquids.

The speed of sound in *n*-pentadecane was measured previously as a function of temperature, at atmospheric pressure, by Tardajos et al. [8], Wang et al. [9], Plantier et al. [10] and recently up to 50 MPa by Khasanshin and Shchemelev [11]. Comparison of our data interpolated at atmospheric pressure with a polynomial function of temperature with the one report by Tardajos et al. [8] at 298 K shows good agreement with a deviation of 0.06%. A good fit is also observed with the data of Plantier et al. [10] in the full temperature range with a maximum deviation less than 0.05%. A significant deviation (1% in average) is, however, found with the data reported by Wang et al [9]. Finally, Fig. 3 shows that the data reported by Khasanshin and Shchemelev [11] between atmospheric pressure and 50 MPa are in excellent agreement with the values calculated from Eqs. (1)–(3). A maximum deviation of less than 0.1% is observed in the full common range of investigation.

The speed of sound has been less measured in *n*-heptadecane than in *n*-pentadecane. Thus, the validity of the data for this compound has only been checked by comparison with the atmospheric pressure measurements reported by Plantier et al. [10]. Similar deviations to those observed with *n*-pentadecane were found between the two sets of data.

4. DERIVED THERMOPHYSICAL PROPERTIES

The speed-of-sound data were used to determine the volumetric properties of *n*-pentadecane and *n*-heptadecane as a function of pressure using a modification of Davis and Gordon's procedure [12]. The method rests on the link between the speed of sound c and the isentropic compressibility κ_S and then to the derivative of density ρ with respect to pressure :

$$\left(\frac{\partial \rho}{\partial P}\right)_T = \frac{1}{c^2} + \frac{T\alpha_\mathrm{p}^2}{C_\mathrm{p}} \tag{4}$$

which allows us, by integrating with pressure, to express density versus pressure in terms of speed of sound :

$$\rho(P, T) = \rho_0 + \int_{P\,\text{atmospheric}}^{P} 1/c^2\, dP + T \int_{P\,\text{atmospheric}}^{P} (\alpha_\mathrm{p}^2 / C_\mathrm{p})\, dP$$

where C_p represents the heat capacity at constant pressure and α_p the isobaric expansion coefficient:

$$\alpha_p = -\frac{1}{\rho}\left(\frac{\partial \rho}{\partial T}\right)_P \tag{6}$$

The reference densities $\rho_0(T)$ come from the synthesis of the properties of hydrocarbons at atmospheric pressure performed by the American Petroleum Institute [13]. The data given every 10 K in the temperature range 293 to 383 K for *n*-pentadecane and 303 to 383 for *n*-heptadecane were smoothed as a function of temperature using the following polynomial functions:

$$\rho_0(n\text{-C}_{15}) = 1.0307\times 10^3 - 1.2596T + 1.8186\times 10^{-3}T^2 - 1.9555\text{E}\times 10^{-6}T^3 \tag{7}$$

$$\rho_0(n\text{-C}_{17}) = 1.0415\times 10^3 - 1.2804T + 1.8763\times 10^{-3}T^2 - 1.9619\text{E}\times 10^{-6}T^3 \tag{8}$$

with T in K and ρ in $\text{kg}\cdot\text{m}^{-3}$.

The first integral of Eq. (5), which represents the main contribution to the variation of density with pressure, is determined analytically by integration of Eqs. (1)–(3). The second integral, which can be considered as a perturbation of the first one, is estimated iteratively using a predictor-corrector procedure [1] in which the initialization procedure proposed by Denielou et al. [14] is used. The heat capacities at atmospheric pressure required to initiate the predictor corrector procedure were taken from the compilation of Zabransky et al. [15] and were expressed as a cubic function of temperature in the temperature range investigated:

$$C_{p_0}(n\text{-C}_{15}) = 2.1298\times 10^3 - 1.9230T + 7.3889\times 10^{-3}T^2 \tag{9}$$

$$C_{p_0}(n\text{-C}_{17}) = 1.9194\times 10^3 - 6.4824\times 10^{-1}T + 5.4977\times 10^{-3}T^2 \tag{10}$$

with T in K and C_{p_0} in $\text{J}\cdot\text{K}^{-1}\cdot\text{kg}^{-1}$.

The density data derived from these speed-of-sound measurements are listed in Table IV. The P-V-T data have been fitted to the Tait equation:

$$\frac{1}{\rho} - \frac{1}{\rho_0} = A\ln\left(\left[\frac{P+B}{P_0+B}\right]\right) \tag{11}$$

Table IV. Density ρ ($kg \cdot m^{-3}$) Determined From Speed of Sound

	T (K)									
P (MPa)	293.15	303.15	313.15	323.15	333.15	343.15	353.15	363.15	373.15	383.15
n-pentadecane										
0.1013	768.45	761.48	754.52	747.56	740.58	733.58	726.54	719.44	712.28	705.05
10.00	774.73	768.10	761.49	754.90	748.32	741.74	735.15	728.55	721.91	715.24
20.00	780.60	774.24	767.93	761.65	755.39	749.16	742.93	736.71	730.48	724.25
30.00	786.07	779.94	773.88	767.86	761.88	755.93	750.00	744.09	738.19	732.29
39.95		785.26	779.40	773.60	767.85	762.14	756.46	750.81	745.18	739.56
49.95		790.29	784.62	779.01	773.45	767.95	762.48	757.05	751.65	746.27
59.90		795.02	789.51	784.07	778.69	773.37	768.09	762.84	757.64	752.46
69.90		799.54	794.18	788.89	783.66	778.50	773.38	768.31	763.27	758.26
79.85		803.83	798.60	793.44	788.35	783.33	778.36	773.43	768.54	763.69
89.80		807.93	802.82	797.78	792.82	787.92	783.08	778.28	773.53	768.82
99.75			806.86	801.93	797.08	792.30	787.57	782.90	778.27	773.68
109.70			810.74	805.92	801.17	796.49	791.87	787.30	782.79	778.31
119.70			814.49	809.76	805.11	800.53	796.01	791.54	787.12	782.75
129.65			818.09	813.45	808.88	804.39	799.96	795.59	791.26	786.98
139.60			821.57	817.01	812.52	808.11	803.77	799.48	795.24	791.04
149.55			824.94	820.45	816.04	811.71	807.44	803.23	799.07	794.95
n-heptadecane										
0.1013		771.10	764.28	757.45	750.63	743.78	736.91	729.99	723.03	716.00
10.00		777.47	770.96	764.49	758.03	751.58	745.12	738.65	732.17	725.65
20.00		783.40	777.17	770.99	764.83	758.70	752.58	746.47	740.37	734.25
30.00		788.93	782.93	776.99	771.09	765.23	759.39	753.57	747.77	741.98
39.95			788.29	782.56	776.88	771.24	765.64	760.06	754.52	748.98
49.95			793.36	787.81	782.32	776.88	771.48	766.11	760.78	755.47
59.90			798.13	792.74	787.42	782.14	776.92	771.74	766.59	761.47
69.90			802.69	797.44	792.26	787.14	782.07	777.05	772.07	767.12
79.85			807.01	801.89	796.84	791.85	786.93	782.04	777.21	772.40
89.80				806.13	801.20	796.34	791.54	786.78	782.07	777.40
99.75				810.20	805.38	800.63	795.93	791.29	786.70	782.15
109.70				814.10	809.38	804.73	800.14	795.61	791.12	786.67
119.70				817.88	813.25	808.69	804.19	799.75	795.36	791.02
129.65				821.50	816.95	812.48	808.07	803.72	799.42	795.16
139.60				824.99	820.53	816.13	811.81	807.54	803.32	799.14
149.55					823.99	819.67	815.42	811.22	807.08	802.98

in which A and B are correlated with temperature by means of a second-order polynomial function:

$$A = A_0 + A_1 T + A_2 T^2 \tag{12}$$

$$B = B_0 + B_1 T + B_2 T^2 \tag{13}$$

This equation, with the fitted parameters (Table V), matches the density data within the experimental uncertainty estimated at 0.1% on the basis of comparisons with literature [6] data.

The simultaneous knowledge of c and ρ enables the evaluation of the isentropic compressibility according to the following relation:

$$\kappa_S = \frac{1}{\rho c^2} \tag{14}$$

These data, evaluated with an accuracy of ± 0.3 per cent, are summarized in Table VI. The procedure which is based on the integration (Eq. (5)) gives also access to isothermal compressibility:

$$\kappa_T = \kappa_S + \frac{T\alpha_{\mathrm{p}}^2}{\rho C_{\mathrm{p}}} \tag{15}$$

These last data are listed in Table VII. The isothermal compressibility was also directly derived from the fitted Tait equation. The comparison of the data calculated from Eq. (15) with those obtained by direct derivation of the Tait equation reveals excellent agreement between the two sets of compressibility data with an average absolute deviation less than 0.6%. This deviation is less than the error of the integration procedure which has been estimated on the basis of comparisons [6] with other techniques to be 1%.

Table V. Parameters of the Tait Equation (Eqs. (10)–(12)) with T in K, P in MPa, and ρ in kg·m^{-3}

Parameters			Deviations
	n-pentadecane		
$A_0 = -6.74400 \times 10^{-5}$	$A_2 = 1.14013 \times 10^{-10}$	$B_1 = -1.14226$	AAD% $= 5.8 \times 10^{-3}$
$A_1 = -1.90600 \times 10^{-7}$	$B_0 = 3.56093 \times 10^{2}$	$B_2 = 9.39150 \times 10^{-4}$	MD% $= 1.7 \times 10^{-2}$
	n-heptadecane		
$A_0 = -4.94790 \times 10^{-5}$	$A_2 = 2.45990 \times 10^{-10}$	$B_1 = -1.03326$	AAD% $= 5.4 \times 10^{-3}$
$A_1 = -2.82170 \times 10^{-7}$	$B_0 = 3.42087 \times 10^{2}$	$B_2 = 7.78159 \times 10^{-4}$	MD% $= 1.5 \times 10^{-2}$

Table VI. Isentropic Compressibility κ_S (GPa^{-1}) Determined from Ultrasonic Measurements

	T (K)									
P (MPa)	293.15	303.15	313.15	323.15	333.15	343.15	353.15	363.15	373.15	383.15
n-pentadecane										
0.1013	0.7183	0.7675	0.8206	0.8778	0.9403	1.0075	1.0805	1.1597	1.2460	1.3407
10.00	0.6593	0.7013	0.7443	0.7910	0.8413	0.8954	0.9526	1.0130	1.0787	1.1488
20.00	0.6108	0.6454	0.6827	0.7223	0.7634	0.8074	0.8542	0.9025	0.9550	1.0099
30.00	0.5697	0.5995	0.6320	0.6653	0.7010	0.7383	0.7765	0.8171	0.8599	0.9047
39.95		0.5610	0.5891	0.6183	0.6488	0.6811	0.7140	0.7477	0.7840	0.8222
49.95		0.5276	0.5526	0.5783	0.6051	0.6332	0.6621	0.6914	0.7218	0.7545
59.90		0.4985	0.5209	0.5439	0.5676	0.5924	0.6183	0.6436	0.6707	0.6990
69.90		0.4732	0.4932	0.5141	0.5354	0.5572	0.5800	0.6028	0.6266	0.6514
79.85		0.4504	0.4687	0.4875	0.5070	0.5266	0.5472	0.5676	0.5889	0.6108
89.80		0.4307	0.4469	0.4641	0.4816	0.4996	0.5178	0.5366	0.5559	0.5758
99.75			0.4273	0.4430	0.4592	0.4757	0.4923	0.5093	0.5267	0.5447
109.70			0.4094	0.4242	0.4392	0.4541	0.4692	0.4850	0.5008	0.5173
119.70			0.3935	0.4068	0.4208	0.4347	0.4488	0.4631	0.4776	0.4926
129.65			0.3786	0.3909	0.4039	0.4169	0.4301	0.4433	0.4568	0.4705
139.60			0.3651	0.3768	0.3890	0.4010	0.4130	0.4253	0.4378	0.4506
149.55			0.3527	0.3637	0.3751	0.3863	0.3974	0.4087	0.4205	0.4324
n-heptadecane										
0.1013		0.7310	0.7797	0.8325	0.8893	0.9503	1.0169	1.0882	1.1665	1.2519
10.00		0.6700	0.7116	0.7545	0.8008	0.8500	0.9025	0.9581	1.0188	1.0823
20.00		0.6191	0.6542	0.6913	0.7293	0.7704	0.8136	0.8589	0.9073	0.9586
30.00		0.5769	0.6075	0.6389	0.6723	0.7057	0.7431	0.7809	0.8208	0.8628
39.95			0.5675	0.5952	0.6238	0.6541	0.6854	0.7180	0.7512	0.7870
49.95			0.5334	0.5581	0.5834	0.6102	0.6369	0.6649	0.6942	0.7252
59.90			0.5038	0.5258	0.5484	0.5719	0.5958	0.6201	0.6463	0.6728
69.90			0.4778	0.4976	0.5180	0.5391	0.5603	0.5824	0.6052	0.6289
79.85			0.4546	0.4728	0.4912	0.5104	0.5294	0.5492	0.5694	0.5906
89.80				0.4506	0.4674	0.4847	0.5022	0.5200	0.5383	0.5573
99.75				0.4307	0.4460	0.4619	0.4778	0.4941	0.5109	0.5280
109.70				0.4126	0.4268	0.4415	0.4560	0.4711	0.4863	0.5020
119.70				0.3964	0.4095	0.4229	0.4364	0.4503	0.4640	0.4787
129.65				0.3814	0.3936	0.4060	0.4187	0.4315	0.4444	0.4576
139.60				0.3670	0.3791	0.3906	0.4026	0.4143	0.4264	0.4387
149.55					0.3657	0.3765	0.3873	0.3987	0.4099	0.4212

Table VII. Isothermal Compressibility κ_T (GPa^{-1}) Determined from Acoustic Measurements

	T (K)									
P (MPa)	293.15	303.15	313.15	323.15	333.15	343.15	353.15	363.15	373.15	383.15
					n-pentadecane					
0.1013	0.8611	0.9169	0.9773	1.0425	1.1138	1.1907	1.2744	1.3654	1.4648	1.5740
10.00	0.7864	0.8333	0.8817	0.9341	0.9908	1.0517	1.1164	1.1848	1.2594	1.3390
20.00	0.7253	0.7637	0.8050	0.8489	0.8946	0.9437	0.9958	1.0500	1.1088	1.1703
30.00	0.6740	0.7067	0.7422	0.7788	0.8180	0.8591	0.9014	0.9462	0.9937	1.0434
39.95		0.6590	0.6895	0.7212	0.7544	0.7897	0.8257	0.8627	0.9025	0.9444
49.95		0.6179	0.6448	0.6725	0.7013	0.7318	0.7631	0.7950	0.8281	0.8638
59.90		0.5824	0.6062	0.6307	0.6560	0.6826	0.7105	0.7379	0.7672	0.7978
69.90		0.5514	0.5725	0.5946	0.6172	0.6404	0.6648	0.6893	0.7149	0.7416
79.85		0.5238	0.5428	0.5626	0.5831	0.6038	0.6257	0.6474	0.6702	0.6937
89.80		0.4998	0.5165	0.5345	0.5528	0.5716	0.5909	0.6108	0.6313	0.6525
99.75			0.4930	0.5093	0.5260	0.5433	0.5607	0.5786	0.5970	0.6162
109.70			0.4716	0.4867	0.5021	0.5177	0.5334	0.5500	0.5667	0.5841
119.70			0.4524	0.4660	0.4804	0.4947	0.5093	0.5242	0.5395	0.5553
129.65			0.4347	0.4472	0.4603	0.4737	0.4873	0.5010	0.5151	0.5296
139.60			0.4186	0.4303	0.4427	0.4549	0.4672	0.4800	0.4930	0.5065
149.55			0.4038	0.4148	0.4262	0.4377	0.4490	0.4607	0.4729	0.4854
					n-heptadecane					
0.1013		0.8697	0.9245	0.9841	1.0483	1.1176	1.1933	1.2747	1.3643	1.4622
10.00		0.7933	0.8394	0.8873	0.9390	0.9940	1.0530	1.1156	1.1840	1.2559
20.00		0.7301	0.7686	0.8093	0.8513	0.8968	0.9447	0.9951	1.0490	1.1062
30.00		0.6779	0.7111	0.7452	0.7817	0.8184	0.8592	0.9009	0.9449	0.9913
39.95			0.6622	0.6920	0.7230	0.7557	0.7898	0.8253	0.8617	0.9008
49.95			0.6206	0.6470	0.6740	0.7029	0.7317	0.7620	0.7938	0.8274
59.90			0.5847	0.6079	0.6320	0.6570	0.6826	0.7088	0.7370	0.7656
69.90			0.5533	0.5740	0.5955	0.6178	0.6404	0.6640	0.6883	0.7138
79.85			0.5253	0.5443	0.5634	0.5836	0.6038	0.6247	0.6463	0.6690
89.80				0.5176	0.5351	0.5532	0.5715	0.5904	0.6098	0.6300
99.75				0.4939	0.5097	0.5262	0.5428	0.5599	0.5777	0.5959
109.70				0.4724	0.4870	0.5022	0.5172	0.5329	0.5489	0.5656
119.70				0.4531	0.4665	0.4802	0.4942	0.5086	0.5231	0.5385
129.65				0.4353	0.4477	0.4604	0.4734	0.4867	0.5002	0.5141
139.60				0.4185	0.4306	0.4423	0.4545	0.4667	0.4793	0.4922
149.55					0.4149	0.4258	0.4368	0.4485	0.4602	0.4721

5. CONCLUSION

The data reported here, which cover several thermophysical properties in an extended pressure and temperature domain, represent an original contribution to the chemical compounds under consideration in this study. This information, which complements the data for the compounds n-C_{13} and n-C_{14} [16], n-C_{18} and n-C_{19} [17], could be used to check the relevance of correlation functions with chain length, group contributions or corresponding states principles with respect to substances with many carbon atoms.

REFERENCES

1. J. L. Daridon, A. Lagrabette, and B. Lagourette, *J. Chem. Thermodyn.* **30**:607 (1998).
2. J. L. Daridon, *Acustica* **80**:416 (1994).
3. V. A. Del Grosso and C. W Mader, *J. Acoust. Soc. Am.* **52**:1442 (1972).
4. W. D. Wilson, *J. Acoust. Soc. Am.* **31**:1067 (1959).
5. J. P. Petitet, R. Tufeu, and B. Le Neindre, *Int. J. Thermophys.* **4**:35 (1983).
6. J. L. Daridon, B. Lagourette, and J. P. E. Grolier, *Int. J. Thermophys.* **19**:145 (1998).
7. J. L. Daridon, A. Lagrabette, and B. Lagourette, *Phys. Chem. Liq.* **37**:137 (1999)
8. G. Tardajos, M. Diaz Pena, and E. Aicart, *J. Chem. Thermodyn.* **18**:683 (1986).
9. Z. Wang and A. Nur, *J. Acoust. Soc. Am.* **89**:2725 (1991).
10. F. Plantier, J. L. Daridon, B. Lagourette, and C. Boned, *High Temp.-High Press.* **32**:305 (2000).
11. T. S. Khasanshin, and A. P. Shchemelev, *High Temperature* **39**:60 (2001).
12. L. A. Davis and R. B. Gordon, *J. Chem. Phys.* **46**:2650 (1967).
13. Selected values of thermodynamic properties of hydrocarbons and related compounds, API Research Project 44 (1953).
14. L. Denielou, J. P. Petitet, C. Tequi, and G. Syfosse, *Bull. Minéral.* **106**:139 (1983).
15. M. Zabranski, V. Ruzicka, V. Majer, and E. S. Domalski, *J. Phys. Chem. Ref. Data Monograph* **6** (1996).
16. J. L. Daridon and B. Lagourette*, High Temp.-High Press.* **32**:83 (2000).
17. S. Dutour, J. L. Daridon, and B. Lagourette, *Int. J. Thermophys.* **21**:173 (2000).