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Specific Heats of Saturated and Compressed Liquid Propane*

Robert D. Goodwin

Center for Mechanical Engineering and Process Technology National Bureau of Standards, Boulder, Colorado 80303

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Experimental specific heats for saturated liquid propane, along the coexistence path, have been determined from the triple-point temperature (~ 85 K) to 289 K. Specific heats for the compressed liquid at constant molal volume have been determined along isochores at nine different densities ranging from near the triple-point liquid density to about twice the critical-point density (at pressures up to 300 bar). Comparisons with previous experimental- and/or derived-data show agreement within combined uncertainties of about three percent.

Key words: Constant volume; heat capacities; liquid; propane; saturated liquid; specific heats.

List of Symbols

Subscript c refers to the critical point

$C_o(T)$	heat capacity of the empty calorimeter, J/K
$C_\sigma(T)$	specific heat for saturated liquid, J/mol/K
$C_v{}^o(T)$	specific heat in ideal gas states, J/mol/K
$C_v(\rho, T)$	isochoric specific heat, J/mol/K
$C_p(\rho, T)$	isobaric specific heat, J/mol/K
J	the joule, 1 $N-m$
L	the liter, $10^{-3}\ m^3$
mol	44.09721 grams of propane (C^{12} scale)
$\bar{N}$	total moles of fluid in bomb plus capillary
$\bar{N}_b$	moles of fluid in the calorimeter (bomb)
P	pressure in bars, 1 bar ≡ $10^5\ N/m^2$ (1 atm = 1.01325 bar)
Q	calorimetric heat input, J
$Q/\Delta T$	gross heat capacity (bomb + sample), J/K
R	the gas constant, 8.31434 (J/mol)/K
ρ	density, mol/L
T	temperature, K (1968)
ΔT	calorimeter temperature increment, K
$V_b(T, P)$	volume of the calorimeter, cm^3

1. Introduction

In a recent report on the thermodynamic properties of propane, we indicated the desirability for more accurate data for virtually all physical and thermal properties [8].[1] The present specific heat measurements serve to broaden the experimental data base and to confirm the work in [8] to within combined uncertainties of about three percent in specific heat data. They serve also in comparisons utilizing an equation of state for interpolations. It is anticipated that the present measurements will be incorporated with other new properties measurements in a revision of the thermodynamic tables in [8].

Symbols and units are given in a list. Fixed-point constants, used in computations, are given in table 1. Figure 1 shows the densities, and temperature ranges of the nine experimental runs.

TABLE 1. *Fixed-points used for propane*

	Triple Point	Boiling Point	Critical Point
Temperature, K	85.47	231.0679	369.80
Pressure, bar	$1.6609 \cdot 10^{-9}$	1.01325	42.3974
Density, mol/L			
Vapor	$2.3373 \cdot 10^{-10}$	0.05479	4.96
Liquid	16.620	13.1687	4.96

2. Experimental

Apparatus, technique, and computational procedures have been fully described so often, in work on other substances, that we refer the reader to these publications, to avoid unnecessary repetition [4, 5, 6, 7, 11, 12, 14, 15, 16].

In [5], for example, we gave an accounting of sources of uncertainty. For the present work we have considered only the sources of gross uncertainties, concluding that total uncertainty in each specific heat measurement must be set at about two percent. Nearly all comparisons, reported below, fall well within this figure.

For the present work on propane we have employed the same apparatus, methods, and computational procedures described in detail by Roder in his prior work on ethane [12], except for replacing the platinum resistance thermometer.

The propane is a commercial "research grade," specified to be 99.99 percent pure, with a trace of ethane. No further analysis was made.

For computation of saturated liquid specific heats, from observations on a two-phase sample at constant volume, it is

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[1] Figures in brackets indicate the literature references at the end of the paper.

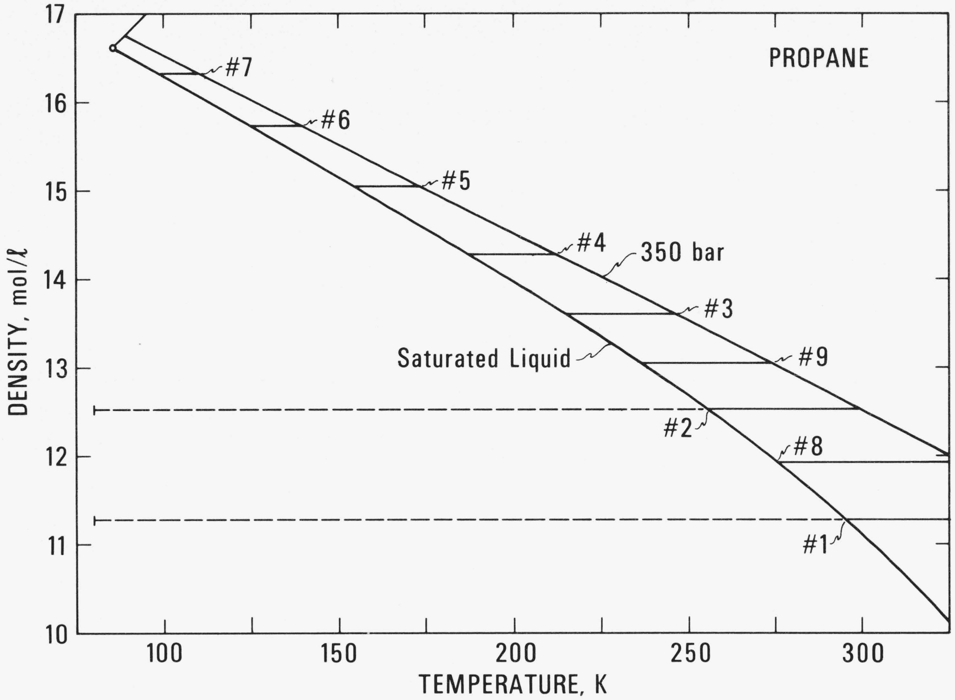

FIGURE 1. *The ρ-T loci of experimental runs.*

Table 2. Heat capacity of the empty calorimeter

Run no.	T_{av}, K	ΔT, K	Power, watt	Time, sec	Heat, joule	Heat Capy., J/K, Exptl.	Heat Capy., J/K, Calcd.	Diff., %
701	80.338	2.556	.16301	606.59	98.88	38.677	38.664	.03
702	82.844	2.455	.16261	605.95	98.53	40.138	40.146	-.02
101	83.566	3.759	.25234	604.15	152.45	40.559	40.564	-.01
703	85.555	2.972	.20591	601.68	123.89	41.685	41.692	-.02
102	87.228	3.580	.25197	605.37	152.53	42.603	42.617	-.03
704	88.798	3.524	.25418	602.72	153.20	43.471	43.465	.01
103	91.529	5.042	.37435	604.78	226.40	44.901	44.899	0.00
705	92.988	4.871	.36651	606.73	222.37	45.650	45.643	.02
104	97.307	6.539	.51730	603.62	312.26	47.752	47.759	-.01
706	98.526	6.230	.49924	603.32	301.20	48.344	48.334	.02
105	103.637	6.170	.51713	604.19	312.44	50.640	50.641	0.00
801	105.231	5.851	.49698	604.37	300.36	51.331	51.327	.01
106	109.624	5.859	.51672	602.45	311.30	53.132	53.140	-.02
802	111.358	6.458	.57453	605.22	347.71	53.846	53.826	.04
107	115.329	5.621	.51600	602.68	310.98	55.323	55.334	-.02
803	117.650	6.186	.57406	605.50	347.60	56.189	56.177	.02
108	120.821	5.441	.51562	604.71	311.80	57.308	57.285	.04
804	123.681	5.945	.57394	603.57	346.41	58.268	58.242	.04
201	127.052	5.236	.51380	604.54	310.61	59.318	59.322	-.01
805	129.504	5.771	.57352	604.76	346.91	60.108	60.076	.05
202	132.158	5.077	.51313	602.00	308.91	60.848	60.863	-.03
806	135.156	5.615	.57339	604.48	346.60	61.725	61.719	.01
203	137.118	4.955	.51256	601.46	308.35	62.232	62.259	-.04
807	140.655	5.481	.57314	604.37	346.39	63.194	63.198	-.01
204	141.960	4.848	.51196	601.05	307.72	63.477	63.533	-.09
808	146.029	5.379	.57288	606.25	347.31	64.564	64.541	.03
205	146.696	4.759	.51189	601.15	307.72	64.666	64.701	-.05
206	151.345	4.680	.51149	601.59	307.71	65.744	65.779	-.05
901	155.708	7.479	.82540	604.43	498.90	66.704	66.733	-.04
207	155.924	4.637	.51113	605.41	309.44	66.740	66.779	-.06
208	161.159	6.001	.67697	601.59	407.26	67.867	67.853	.02
902	163.013	7.288	.82402	603.21	497.06	68.205	68.216	-.02
209	167.036	5.933	.67651	604.96	409.26	68.977	68.979	0.00
903	170.156	7.169	.82288	606.18	498.81	69.575	69.545	.04
301	175.056	5.811	.67894	602.19	408.85	70.355	70.394	-.05
904	177.155	7.006	.82346	601.90	495.64	70.749	70.743	.01
302	181.421	7.166	.85042	601.72	511.71	71.413	71.428	-.02
905	184.033	6.955	.82342	606.98	499.80	71.863	71.833	.04
303	188.400	7.051	.84965	601.40	510.98	72.471	72.484	-.02
906	190.824	6.851	.82311	606.56	499.26	72.871	72.833	.05
304	195.261	6.975	.84912	603.09	512.10	73.423	73.450	-.04
907	197.541	6.816	.82945	606.54	503.09	73.814	73.756	.08
305	202.027	6.871	.84849	602.03	510.82	74.344	74.340	.01
908	204.197	6.734	.82923	606.28	502.75	74.657	74.614	.06
401	210.602	6.700	.83869	602.26	505.11	75.385	75.390	-.01
909	210.749	6.651	.82845	605.75	501.83	75.458	75.408	.07
402	217.173	6.808	.86062	602.82	518.80	76.210	76.143	.09
1001	217.761	6.601	.82893	606.95	503.12	76.213	76.208	.01
403	223.805	6.841	.87126	603.18	525.53	76.824	76.862	-.05
1002	224.611	7.303	.92427	607.84	561.81	76.928	76.947	-.02
404	230.399	6.766	.87076	602.42	524.56	77.534	77.540	-.01
1003	231.761	7.202	.92299	606.18	559.50	77.690	77.675	.02
405	236.925	6.702	.87011	602.12	523.91	78.167	78.178	-.01
1004	238.818	7.131	.92259	605.94	559.03	78.390	78.357	.04
406	243.368	6.649	.86944	602.18	523.56	78.742	78.779	-.05
1005	245.800	7.059	.92145	605.37	557.81	79.022	78.998	.03
407	249.749	6.588	.86869	601.46	522.48	79.313	79.348	-.04
1006	252.712	7.002	.92116	605.91	558.14	79.710	79.604	.13
408	256.060	6.547	.86835	602.43	523.12	79.902	79.888	.02
1007	259.571	6.952	.92034	606.06	557.78	80.228	80.179	.06
409	262.315	6.495	.86799	602.34	522.83	80.498	80.402	.12
1008	266.382	6.902	.91995	605.97	557.46	80.771	80.726	.06
410	268.499	6.464	.86746	603.34	523.37	80.967	80.891	.09
1101	271.535	6.878	.92054	605.61	557.49	81.051	81.125	-.09
501	274.806	6.438	.86515	606.30	524.54	81.476	81.372	.13
1102	278.340	6.822	.91902	605.91	556.85	81.619	81.634	-.02
502	280.917	6.366	.86434	602.10	520.42	81.748	81.823	-.09
1103	285.105	6.771	.91753	605.82	555.86	82.093	82.123	-.04
503	286.958	6.315	.86384	601.14	519.29	82.224	82.253	-.04
1104	291.872	6.829	.92910	606.76	563.74	82.556	82.594	-.05
504	292.930	6.272	.86347	600.25	518.30	82.633	82.666	-.04
1105	298.640	6.788	.92785	607.05	563.25	82.979	83.049	-.08
505	298.868	6.244	.86290	600.99	518.59	83.052	83.064	-.02
601	299.023	7.821	1.07086	605.85	648.78	82.951	83.075	-.15
506	304.748	6.213	.86255	601.32	518.67	83.476	83.448	.03
1106	305.362	6.742	.92764	606.38	562.51	83.433	83.487	-.06
602	306.746	7.721	1.06883	602.60	644.07	83.422	83.575	-.18
1107	312.788	8.200	1.13382	606.91	688.12	83.916	83.955	-.05
603	313.758	6.412	.88694	606.46	537.89	83.889	84.015	-.15
604	320.100	6.375	.88655	605.95	537.20	84.269	84.400	-.16
1108	320.907	8.126	1.13317	605.79	686.46	84.477	84.449	.03
605	326.414	6.350	.88603	606.14	537.06	84.578	84.774	-.23
1109	328.976	8.077	1.13242	606.02	686.27	84.969	84.923	.05
606	332.705	6.317	.88560	606.68	537.27	85.049	85.137	-.10
1201	335.011	6.544	.92627	603.17	558.70	85.369	85.267	.12
607	339.007	6.274	.88521	606.58	536.95	85.578	85.491	.10
1202	341.557	6.533	.92553	605.75	560.64	85.821	85.631	.22
608	345.347	6.228	.88462	606.32	536.36	86.115	85.838	.32

NP = 88, RMSPCT = .078

necessary to have accurate formulations of the vapor pressures, and of the saturated liquid densities. Because experimental specific heats at constant pressure are available from another source [13], comparisons with our results demand use of an equation of state. The equation of state used here [9] is a slight modification of that reported in [8], obtained by use of the new vapor pressures below the boiling point, derived at the end of that report.

3. Heat Capacity of the Empty Calorimeter

The heat capacity of the empty calorimeter must be subtracted from all observations on a sample. Data on the empty calorimeter are presented in table 2, because they indicate the precision obtained over the very long temperature range of the propane measurements. A new formulation for these data has been developed, and a "best" value has been selected for the number of terms, in the expression

$$100/C_o = \sum_{i=1}^{n} A_i \cdot x^{(i-1)},\ n = 6, \qquad (1)$$

where $x \equiv 100/T$, and—

$A_1 = 0.8179\ 0976 \qquad A_4 = 4.5047\ 9912$
$A_2 = 1.7893\ 2156 \qquad A_5 = -2.5192\ 8428$
$A_3 = -3.1476\ 2021 \qquad A_6 = 0.5950\ 2531$

This formula yields a constant for C_o at very high temperatures, and a behavior approaching T^5 as $T \rightarrow 0$.

4. Results for Saturated Liquid

The calorimeter (T, P) loading conditions for the sample in each experimental run are presented in table 3. The density is obtained from the equation of state given in [9]. The total amount of sample, $\bar{N}$, includes the relatively small amount residing in the capillary tube. The equation of state originates on the saturated liquid boundary, and is extrapolated at temperatures below 170 K where no P-ρ-T compressibility data exist. In this region the density is relatively insensitive to pressure, but derivatives of the $P(\rho,T)$ surface, used to intercompare C_v with C_p data, must become increasingly uncertain with diminishing temperature.

Results for specific heats of saturated liquid propane (C_σ) in experimental runs numbers 1 and 2 are presented in table 4 and in figure 2. Pressures here are the vapor pressures. The corrections in columns 10 and 11 are: A, for work done in expanding the calorimeter and in pumping fluid into the capillary tube and B, for the heat of vaporization and heat absorbed by the vapor [5]. Column 12 gives the experimental results. The "calculated" value in column 13 is from a formulation of older experimental and recently derived data in [8]. The last two columns give C_v and C_p derived from the C_σ data of column 12 by methods of [8] with the equation of state of [9].

In the present work we did not succeed in freezing the sample at temperatures below the reported triple point of 85.47 K, due possibly to the viscous behavior of the fluid, the small temperature difference of only 5 K below the triple-point, and a time of no more than six hours at this temperature. Deviations in column 14 of table 4 are within our anticipated uncertainties.

The following fitting function for $C_\sigma(T)$ was developed for all available data ($x \equiv T/T_c$),

$$C_\sigma(T) = A_1 \cdot x/(1-x)^\epsilon + \sum_{i=2}^{n} A_i \cdot x^{i-2} \qquad (2)$$

in which $\epsilon = 0.7$, and $n = 5$. In table 5, however, we apply it only to our results, finding—

$A_1 = -1.77942 \qquad A_4 = -100.24355$
$A_2 = 77.12878 \qquad A_5 = 135.42504$
$A_3 = 48.01034$

TABLE 3. *Loading conditions for the samples*

Run	T, K	P, bar	ρ, mol/L	V_b, cm^3	$\bar{N}$, mol	Coexistence Conditions[a] T, K	Coexistence Conditions[a] ρ, mol/L
1	294.976	11.442	11.292	73.324	0.8288	294.150	11.303
2	254.544	15.372	12.577	73.196	0.9213	252.415	12.591
3	214.940	16.541	13.620	73.071	0.9960	212.889	13.635
4	187.209	18.600	14.302	72.988	1.0447	185.051	14.318
5	155.086	20.047	15.051	72.896	1.0980	153.309	15.067
6	125.098	19.598	15.736	72.814	1.1467	123.602	15.752
7	99.123	19.463	16.325	72.753	1.1885	97.825	16.340
8	275.574	14.372	11.954	73.263	0.8766	273.712	11.967
9	236.045	10.535	13.064	73.131	0.9562	234.541	13.077

[a] For calorimeter full of liquid.

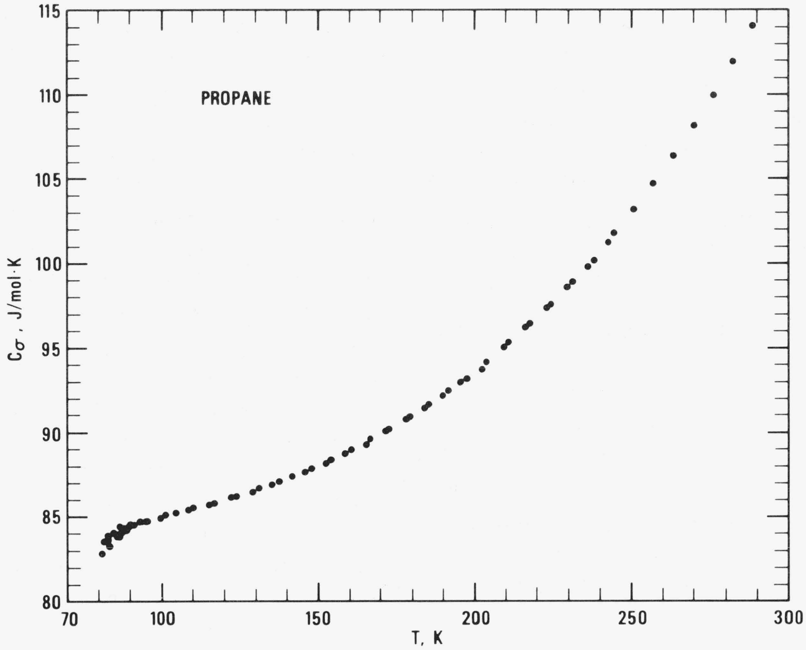

FIGURE 2. *Specific heats for saturated liquid.*

The rms relative deviation for our selected 76 data points is 0.13%. Because A_1 is negative, this formulation should not be extrapolated above 290 K.

In table 6, we give all available data for equation (2). These include: ID = 1, Dana [2]; ID = 2, Kemp [10]; ID = 8, Cutler [1]; and ID = 30 for data derived from C_p data of Yesavage [13] via our equation of state in [8]. The coefficients for this extended data set are—

$$A_1 = 6.63584 \qquad A_4 = -19.92150$$
$$A_2 = 80.76732 \qquad A_5 = 51.18785$$
$$A_3 = 8.27472$$

The rms relative deviation for 133 selected data is 0.29 percent. In tables 5 and 6 the column "Wt." gives the least-squares weighting for that point.

5. Results for Compressed Liquid

Table 7 presents results in column 11 for the single-phase specific heats $C_v(\rho, T)$ of propane in nine experimental runs. These are shown in figure 3. The smooth curve corresponds to extrapolation to the coexistence boundary. As the derivative $(\partial P/\partial \rho)_T$ for compressed liquid is large, the estimated pressures in column 4 become increasingly uncertain with decreasing temperatures. The correction in column 10 is for work done in expanding the calorimeter. The "calculated" value in column 12 is from the specific heats C_p of Yesavage [13] via our equation of state [9] by the methods of [8]. Deviations in the last column fall within our estimate of combined uncertainties of about 3 percent. Our anticipated

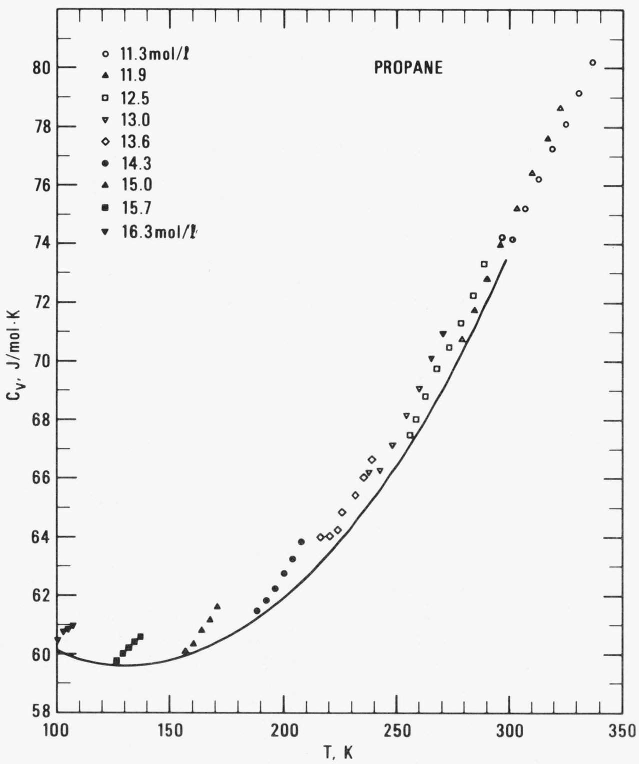

FIGURE 3. *Specific heats for compressed liquid.*

increase of deviations at the lowest temperatures is seen at the bottom of table 7.

Table 8 serves as an extension of table 7 to give "experimental" $C_p(\rho, T)$ data computed from the $C_v(\rho, T)$ data of table 7, column 11, by means of the equation of state [9]. The "calculated" results in table 8 again are from Yesavage $C_p(\rho, T)$ data [13], interpolated by means of the equation of state [9].

6. Behavior of Reduced C_v Data

Diller has presented an examination of the behavior of available C_v data for many substances, in a search for criteria of consistency [3]. In particular, he extrapolated data to the coexistence boundary and plotted reduced specific heats $[C_v - C_v^o]/R$ vs. reduced density. Additional data for various substances subsequently were plotted in these coordinates by Younglove [16].

As a consistency test for present results on propane we present the reduced specific heats in table 9. Ideal gas specific heats C_v^o are from the formulation in [8]. The first line for each run in table 9 gives results extrapolated to the coexistence boundary.

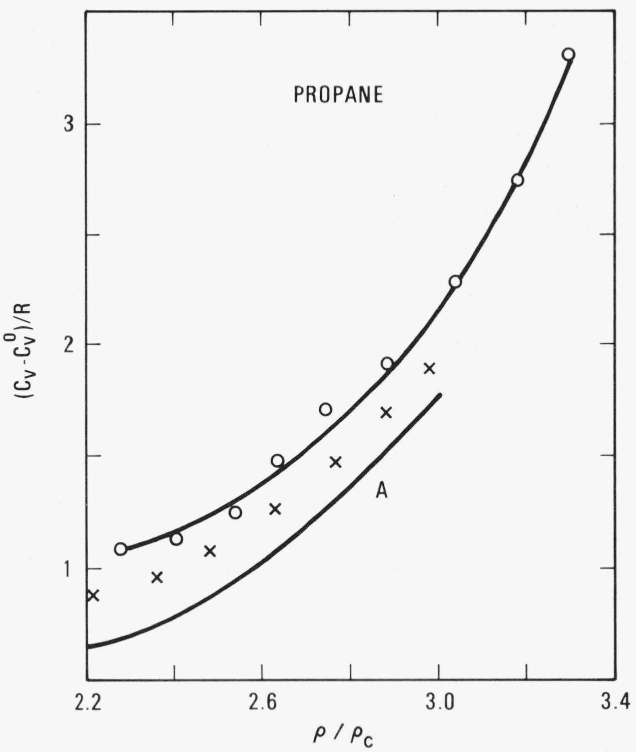

FIGURE 4. *Reduced specific heats at coexistence.*

Figure 4 shows present results. Open circles and the upper curve are for propane. The lower curve, marked A, is taken from figure 6 by Younglove [16]. It represents data for argon, krypton, oxygen, fluorine, and methane within experimental uncertainties. The points symbolized by x are for ethane, as computed but not published by Roder [12]. At a reduced density near 3.0 (run number 5), the difference of about 0.5 in $(C_v - C_v^o)/R$ between propane and curve A corresponds to 4 J/mol/K, or a difference of about 7% in the value $C_v = 59.78$ J/mol/K for propane (run number 5) in table 9. As our comparisons with Yesavage C_p data [13] are much closer than 7%, the higher values for propane in figure 4 probably are real.

The uniform increase of these residual specific heats with increasing asymmetry of molecular shape, from methane through propane, suggests hindered rotation of the asymmetric molecules in the dense (and viscous) liquid at low temperatures.

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Table 4. Experimental data for saturated liquid

Run no.	T_{av}, K	ρ_ℓ, mol/L	P, bar	$\overline{N}_b$, mol	V_b, cm^3	ΔT, K	$Q/\Delta T$, J/K	C_o, J/K	Corr., J/mol/K, A	Corr., J/mol/K, B	C_σ, J/mol/K, Exptl.	C_σ, J/mol/K, Calcd.	Diff., %	C_v J/mol/K	C_p J/mol/K
101	81.053	16.720	0.000	.8288	72.702	.486	107.756	39.092	0.000	0.000	82.85	83.82	-1.17	58.76	82.85
102	81.756	16.704	0.000	.8288	72.703	.930	108.802	39.509	0.000	0.000	83.61	83.86	-.30	59.45	83.61
103	82.677	16.683	0.000	.8288	72.705	.923	109.372	40.049	0.000	0.000	83.65	83.90	-.31	59.40	83.65
104	83.593	16.663	0.000	.8288	72.707	.920	109.621	40.579	0.000	0.000	83.31	83.95	-.77	58.98	83.31
105	84.568	16.640	0.000	.8288	72.708	1.039	110.624	41.136	0.000	0.000	83.84	84.00	-.18	59.43	83.84
106	85.598	16.617	0.000	.8288	72.710	1.033	111.290	41.716	0.000	0.000	83.95	84.05	-.12	59.44	83.95
107	86.622	16.594	0.000	.8288	72.712	1.024	112.143	42.284	0.000	0.000	84.29	84.10	.23	59.70	84.29
108	86.836	16.589	0.000	.8288	72.713	1.030	111.863	42.402	0.000	0.000	83.81	84.11	-.36	59.20	83.81
109	87.856	16.566	0.000	.8288	72.715	1.022	112.699	42.959	0.000	0.000	84.15	84.16	-.02	59.45	84.15
110	88.871	16.543	0.000	.8288	72.716	1.016	113.262	43.505	0.000	0.000	84.17	84.22	-.05	59.38	84.17
111	89.879	16.520	0.000	.8288	72.718	1.008	114.052	44.039	0.000	0.000	84.48	84.27	.25	59.60	84.48
112	91.366	16.486	0.000	.8288	72.721	1.970	114.875	44.815	0.000	0.000	84.54	84.34	.23	59.54	84.54
113	93.321	16.442	0.000	.8288	72.725	1.950	116.033	45.811	0.000	0.000	84.73	84.45	.34	59.58	84.73
114	95.750	16.387	0.000	.8288	72.730	3.708	117.236	47.011	0.000	0.000	84.73	84.57	.19	59.39	84.73
115	99.797	16.295	0.000	.8288	72.739	4.400	119.322	48.923	0.000	0.000	84.94	84.79	.18	59.30	84.94
116	104.646	16.185	0.000	.8288	72.749	5.317	121.726	51.076	0.000	0.000	85.25	85.06	.22	59.26	85.25
117	110.300	16.056	0.000	.8288	72.762	6.008	124.296	53.409	0.000	0.000	85.53	85.39	.17	59.18	85.53
118	116.889	15.905	0.000	.8288	72.777	7.194	127.025	55.904	0.000	0.000	85.81	85.79	.03	59.06	85.81
119	124.009	15.742	0.000	.8288	72.795	7.084	129.793	58.349	0.000	-.001	86.20	86.25	-.05	59.04	86.20
120	131.003	15.582	0.000	.8288	72.812	6.947	132.369	60.524	0.000	-.001	86.69	86.73	-.05	59.15	86.69
121	137.870	15.424	.001	.8288	72.830	6.830	134.681	62.463	0.000	-.003	87.14	87.23	-.11	59.25	87.14
122	145.757	15.242	.002	.8288	72.851	6.679	137.151	64.476	0.000	-.007	87.68	87.85	-.19	59.41	87.68
123	152.350	15.089	.004	.8288	72.869	6.569	139.075	66.004	0.000	-.013	88.16	88.41	-.29	59.57	88.16
124	158.858	14.937	.008	.8288	72.888	6.524	140.980	67.389	0.000	-.022	88.77	89.00	-.25	59.83	88.77
125	165.298	14.786	.014	.8288	72.906	6.440	142.693	68.654	0.000	-.034	89.30	89.62	-.35	60.10	89.30
126	171.647	14.637	.025	.8288	72.924	6.356	144.530	69.808	0.000	-.051	90.11	90.27	-.18	60.60	90.11
127	179.354	14.454	.048	.8288	72.947	6.273	146.499	71.100	-.001	-.076	90.90	91.13	-.25	61.01	90.91
128	185.534	14.306	.077	.8288	72.965	6.203	148.120	72.060	-.001	-.101	91.67	91.86	-.21	61.46	91.68
129	191.643	14.159	.117	.8288	72.983	6.132	149.703	72.949	-.001	-.129	92.48	92.64	-.17	61.93	92.50
130	197.686	14.012	.174	.8288	73.001	6.076	151.161	73.775	-.002	-.159	93.21	93.46	-.26	62.31	93.24
131	204.154	13.853	.258	.8288	73.021	7.001	152.785	74.608	-.002	-.192	94.13	94.39	-.27	62.83	94.17
132	211.041	13.681	.380	.8288	73.042	6.923	154.688	75.442	-.003	-.226	95.39	95.45	-.06	63.62	95.45
133	217.854	13.510	.543	.8288	73.064	6.859	156.350	76.219	-.004	-.255	96.43	96.58	-.16	64.16	96.51
134	224.592	13.337	.754	.8288	73.085	6.787	158.027	76.945	-.005	-.274	97.55	97.77	-.22	64.75	97.67
135	231.245	13.164	1.021	.8288	73.106	6.693	159.827	77.624	-.007	-.281	98.90	99.04	-.14	65.52	99.06
136	238.095	12.983	1.368	.8288	73.128	6.615	161.527	78.289	-.009	-.268	100.16	100.43	-.27	66.12	100.37
137	244.560	12.808	1.773	.8288	73.149	6.510	163.412	78.887	-.011	-.232	101.75	101.84	-.10	67.03	102.03
138	250.946	12.632	2.257	.8288	73.170	6.443	165.130	79.452	-.014	-.168	103.20	103.33	-.13	67.74	103.57
139	257.248	12.454	2.828	.8288	73.191	6.366	166.868	79.987	-.016	-.068	104.75	104.91	-.15	68.49	105.22
140	263.551	12.271	3.502	.8288	73.212	6.491	168.526	80.501	-.020	.075	106.27	106.59	-.31	69.13	106.87
141	269.931	12.082	4.300	.8288	73.234	6.499	170.427	81.002	-.024	.274	108.15	108.42	-.25	70.02	108.92
142	276.292	11.887	5.224	.8288	73.255	6.457	172.202	81.483	-.028	.540	109.98	110.38	-.37	70.75	110.95
143	282.595	11.688	6.278	.8288	73.277	6.377	174.026	81.944	-.033	.865	111.96	112.48	-.46	71.53	113.19
144	288.813	11.484	7.464	.8287	73.299	6.300	175.873	82.383	-.039	1.322	114.09	114.71	-.55	72.33	115.63
236	83.132	16.673	0.000	.9213	72.706	1.056	117.630	40.313	0.000	0.000	83.92	83.93	-.01	59.63	83.92
237	83.995	16.653	0.000	.9213	72.707	.678	118.126	40.809	0.000	0.000	83.92	83.97	-.06	59.56	83.92
238	84.860	16.634	0.000	.9213	72.709	1.057	118.728	41.301	0.000	0.000	84.04	84.01	.03	59.60	84.04
239	85.723	16.614	0.000	.9213	72.711	.679	119.024	41.786	0.000	0.000	83.83	84.06	-.27	59.32	83.83
240	86.395	16.599	0.000	.9213	72.712	.675	119.482	42.159	0.000	0.000	83.93	84.09	-.20	59.35	83.93
201	86.763	16.591	0.000	.9213	72.712	2.941	120.048	42.362	0.000	0.000	84.32	84.11	.25	59.71	84.32
241	87.064	16.584	0.000	.9213	72.713	.670	119.955	42.527	0.000	0.000	84.04	84.12	-.10	59.40	84.04
242	87.870	16.566	0.000	.9213	72.715	.950	120.662	42.966	0.000	0.000	84.33	84.16	.20	59.63	84.33
243	88.931	16.542	0.000	.9213	72.717	1.178	121.183	43.537	0.000	0.000	84.28	84.22	.07	59.48	84.28
202	90.366	16.509	0.000	.9213	72.719	4.280	122.177	44.295	0.000	0.000	84.53	84.29	.28	59.62	84.53
203	95.166	16.400	0.000	.9213	72.729	5.333	124.834	46.726	0.000	0.000	84.78	84.54	.28	59.48	84.78
204	101.406	16.258	0.000	.9213	72.742	7.163	128.059	49.654	0.000	0.000	85.10	84.88	.26	59.34	85.10
205	108.461	16.098	0.000	.9213	72.758	6.966	131.385	52.671	0.000	0.000	85.43	85.28	.18	59.20	85.43
206	115.393	15.939	0.000	.9213	72.774	6.823	134.400	55.358	0.000	0.000	85.79	85.70	.11	59.12	85.79
207	122.132	15.785	0.000	.9213	72.790	6.683	137.126	57.728	0.000	0.000	86.18	86.12	.06	59.12	86.18
208	128.738	15.634	0.000	.9213	72.807	6.566	139.549	59.843	0.000	-.001	86.51	86.57	-.07	59.09	86.51
209	135.238	15.485	0.000	.9213	72.823	6.479	141.825	61.741	0.000	-.001	86.92	87.03	-.13	59.17	86.92
210	141.629	15.337	.001	.9213	72.840	6.352	143.934	63.449	0.000	-.003	87.35	87.52	-.19	59.28	87.35
211	147.902	15.192	.002	.9213	72.857	6.256	145.949	64.987	0.000	-.005	87.87	88.03	-.18	59.50	87.87
212	154.093	15.048	.005	.9213	72.874	6.190	147.768	66.386	0.000	-.009	88.32	88.56	-.27	59.66	88.32
213	160.343	14.902	.009	.9213	72.892	6.108	149.670	67.690	0.000	-.013	88.97	89.14	-.19	60.00	88.97
214	166.378	14.761	.016	.9213	72.909	6.042	151.409	68.856	0.000	-.020	89.58	89.73	-.16	60.33	89.58
215	172.363	14.620	.027	.9213	72.926	6.011	153.069	69.933	0.000	-.027	90.21	90.35	-.16	60.67	90.21
216	178.276	14.480	.044	.9213	72.943	5.914	154.638	70.926	0.000	-.035	90.82	91.00	-.20	60.99	90.83
217	184.114	14.340	.069	.9213	72.961	5.861	156.153	71.845	-.001	-.044	91.46	91.69	-.25	61.32	91.47
218	189.882	14.201	.104	.9213	72.978	5.790	157.688	72.698	-.001	-.052	92.19	92.41	-.24	61.74	92.21
219	195.603	14.062	.153	.9213	72.995	5.767	159.243	73.496	-.001	-.059	93.01	93.17	-.17	62.23	93.03
220	202.405	13.896	.233	.9213	73.016	7.003	160.816	74.388	-.002	-.063	93.74	94.13	-.41	62.55	93.78
221	209.358	13.723	.347	.9213	73.037	6.971	162.868	75.243	-.003	-.061	95.04	95.18	-.15	63.39	95.10
222	216.234	13.551	.500	.9213	73.059	6.845	164.767	76.038	-.003	-.048	96.25	96.30	-.05	64.11	96.33
223	222.998	13.378	.699	.9213	73.080	6.752	166.481	76.777	-.005	-.021	97.34	97.48	-.15	64.67	97.45
224	229.651	13.206	.951	.9213	73.101	6.626	168.233	77.464	-.006	.023	98.54	98.73	-.19	65.30	98.68
225	236.231	13.032	1.266	.9213	73.122	6.614	169.990	78.111	-.007	.089	99.81	100.04	-.24	65.95	100.00
226	242.764	12.857	1.652	.9213	73.143	6.534	171.848	78.723	-.009	.183	101.25	101.44	-.19	66.73	101.51

Table 5. Representation of present C_σ data

Run	Wt.	T,K	J/mol/K	Calcd.	Pcnt.
101	0.000	81.053	82.850	83.798	-1.13
102	1.000	81.756	83.610	83.838	-.27
103	1.000	82.677	83.650	83.890	-.29
236	1.000	83.132	83.920	83.916	.00
104	0.000	83.593	83.310	83.942	-.75
237	1.000	83.995	83.920	83.965	-.05
105	1.000	84.568	83.840	83.997	-.19
238	1.000	84.860	84.040	84.014	.03
106	1.000	85.598	83.950	84.055	-.13
239	1.000	85.723	83.830	84.062	-.28
240	1.000	86.395	83.930	84.100	-.20
107	1.000	86.622	84.290	84.113	.21
201	1.000	86.763	84.320	84.121	.24
108	1.000	86.636	83.810	84.125	-.37
241	1.000	87.064	84.040	84.137	-.12
109	1.000	87.856	84.150	84.182	-.04
242	1.000	87.870	84.330	84.183	.18
110	1.000	88.871	84.170	84.238	-.08
243	1.000	88.931	84.280	84.242	.05
111	1.000	89.879	84.480	84.295	.22
202	1.000	90.366	84.530	84.322	.25
112	1.000	91.366	84.540	84.378	.19
113	1.000	93.321	84.730	84.487	.29
203	1.000	95.166	84.780	84.589	.23
114	1.000	95.750	84.730	84.622	.13
115	1.000	99.797	84.940	84.848	.11
204	1.000	101.406	85.100	84.938	.19
116	1.000	104.646	85.250	85.121	.15
205	1.000	108.461	85.430	85.338	.11
117	1.000	110.300	85.530	85.444	.10
206	1.000	115.393	85.790	85.743	.06
118	1.000	116.889	85.810	85.832	-.03
207	1.000	122.132	86.180	86.151	.03
119	1.000	124.009	86.200	86.269	-.08
208	1.000	128.738	86.510	86.572	-.07
120	1.000	131.003	86.690	86.721	-.04
209	1.000	135.236	86.920	87.008	-.10
121	1.000	137.870	87.140	87.193	-.06
210	1.000	141.629	87.350	87.465	-.13
122	1.000	145.757	87.680	87.775	-.11
211	1.000	147.902	87.870	87.942	-.08
123	1.000	152.350	88.160	88.300	-.16
212	1.000	154.093	88.320	88.446	-.14
124	1.000	158.858	88.770	88.858	-.10
213	1.000	160.343	88.970	88.990	-.02
125	1.000	165.298	89.300	89.451	-.17
214	1.000	166.378	89.580	89.555	.03
126	1.000	171.647	90.110	90.081	.03
215	1.000	172.363	90.210	90.155	.06
216	1.000	178.276	90.820	90.790	.03
127	1.000	179.354	90.900	90.911	-.01
217	1.000	184.114	91.460	91.462	-.00
128	1.000	185.534	91.670	91.632	.04
218	1.000	189.882	92.190	92.172	.02
129	1.000	191.643	92.480	92.398	.09
219	1.000	195.603	93.010	92.924	.09
130	1.000	197.686	93.210	93.211	-.00
220	1.000	202.405	93.740	93.885	-.15
131	1.000	204.154	94.130	94.144	-.02
221	1.000	209.358	95.040	94.946	.10
132	1.000	211.041	95.390	95.215	.18
222	1.000	216.234	96.250	96.078	.18
133	1.000	217.854	96.430	96.357	.08
223	1.000	222.998	97.340	97.275	.07
134	1.000	224.592	97.550	97.570	-.02
224	1.000	229.651	98.540	98.539	.00
135	1.000	231.245	98.900	98.855	.05
225	1.000	236.231	99.810	99.875	-.07
136	1.000	238.095	100.160	100.270	-.11
226	1.000	242.764	101.250	101.291	-.04
137	1.000	244.560	101.750	101.696	.05
138	1.000	250.946	103.200	103.193	.01
139	1.000	257.248	104.750	104.759	-.01
140	1.000	263.551	106.270	106.415	-.14
141	1.000	269.931	108.150	108.184	-.03
142	1.000	276.292	109.980	110.042	-.06
143	1.000	282.595	111.960	111.975	-.01
144	1.000	288.613	114.090	113.970	.11

NP = 78, RMSPCT = .13

Table 6. Representation of all C_σ data

Run	Wt.	T,K	J/mol/K	Calcd.	Pcnt.
101	0.000	81.053	82.850	83.892	-1.24
102	1.000	81.756	83.610	83.924	-.37
103	1.000	82.677	83.650	83.965	-.37
236	1.000	83.132	83.920	83.985	-.08
104	0.000	83.593	83.310	84.006	-.83
237	1.000	83.995	83.920	84.024	-.12
105	1.000	84.568	83.840	84.050	-.25
238	1.000	84.860	84.040	84.063	-.03
106	1.000	85.598	83.950	84.097	-.17
239	1.000	85.723	83.830	84.103	-.32
240	1.000	86.395	83.930	84.134	-.24
107	1.000	86.622	84.290	84.144	.17
201	1.000	86.763	84.320	84.151	.20
108	1.000	86.836	83.810	84.154	-.41
241	1.000	87.064	84.040	84.165	-.15
109	1.000	87.856	84.150	84.201	-.06
242	1.000	87.870	84.330	84.202	.15
110	1.000	88.871	84.170	84.249	-.09
243	1.000	88.931	84.280	84.252	.03
2	1.000	89.720	84.547	84.289	.31
111	1.000	89.879	84.480	84.297	.22
30	1.000	90.000	84.040	84.302	-.31
202	1.000	90.366	84.530	84.320	.25
8	1.000	91.060	83.973	84.353	-.45
112	1.000	91.366	84.540	84.367	.20
113	1.000	93.321	84.730	84.462	.32
8	1.000	93.430	84.224	84.467	-.29
203	1.000	95.166	84.780	84.553	.27
2	1.000	95.530	84.756	84.571	.22
114	1.000	95.750	84.730	84.582	.17
8	1.000	95.760	84.475	84.582	-.13
8	1.000	98.060	84.140	84.698	-.66
115	1.000	99.797	84.940	84.787	.18
30	1.000	100.000	84.860	84.798	.07
8	1.000	100.330	84.057	84.815	-.89
204	1.000	101.406	85.100	84.871	.27
2	1.000	101.960	85.091	84.900	.22
8	1.000	102.570	84.726	84.933	-.24
116	1.000	104.646	85.250	85.044	.24
8	1.000	104.780	85.061	85.051	.01
205	1.000	108.461	85.430	85.254	.21
2	1.000	108.500	85.426	85.256	.20
30	1.000	110.000	85.850	85.341	.60
117	1.000	110.300	85.530	85.358	.20
2	1.000	115.160	85.803	85.641	.19
206	1.000	115.393	85.790	85.655	.16
118	1.000	116.889	85.810	85.746	.08
30	1.000	120.000	86.720	85.938	.91
2	1.000	121.970	86.179	86.062	.14
207	1.000	122.132	86.180	86.073	.12
119	1.000	124.009	86.200	86.194	.01
208	1.000	128.738	86.510	86.510	-.00
2	1.000	128.900	86.556	86.521	.04
30	1.000	130.000	87.420	86.597	.95
120	1.000	131.003	86.690	86.667	.03
209	1.000	135.238	86.920	86.970	-.06
2	1.000	135.950	87.226	87.022	.23
121	1.000	137.870	87.140	87.165	-.03
30	1.000	140.000	88.040	87.327	.82
210	1.000	141.629	87.350	87.453	-.12
2	1.000	142.790	87.435	87.545	-.13
122	1.000	145.757	87.680	87.783	-.12
211	1.000	147.9[illegible]2	87.870	87.960	-.10
2	1.000	149.740	88.147	88.114	.04
30	1.000	150.000	88.670	88.136	.61
123	1.000	152.350	88.160	88.339	-.20
212	1.000	154.093	88.320	88.492	-.19
2	1.000	156.850	88.691	88.741	-.06
124	1.000	158.858	88.770	88.926	-.18
30	1.000	160.000	89.380	89.034	.39
213	1.000	160.343	88.970	89.066	-.11
2	1.000	164.390	89.360	89.458	-.11
125	1.000	165.298	89.300	89.548	-.28
214	1.000	166.378	89.580	89.656	-.08
30	1.000	170.000	90.240	90.028	.24
126	1.000	171.647	90.110	90.202	-.10
2	1.000	172.020	89.863	90.242	-.42
215	1.000	172.363	90.210	90.278	-.08
216	1.000	178.276	90.820	90.932	-.12
2	1.000	179.090	90.742	91.025	-.31
127	1.000	179.354	90.900	91.056	-.17
30	1.000	180.000	91.260	91.130	.14
217	1.000	184.114	91.460	91.617	-.17
128	1.000	185.534	91.670	91.790	-.13
2	1.000	185.900	91.662	91.835	-.19
218	1.000	189.882	92.190	92.336	-.16
30	1.000	190.000	92.460	92.351	.12
129	1.000	191.643	92.480	92.563	-.09
2	1.000	194.280	92.792	92.912	-.13
219	1.000	195.603	93.010	93.091	-.09
130	1.000	197.686	93.210	93.377	-.18
30	1.000	200.000	93.830	93.702	.14
2	1.000	200.940	93.839	93.836	.00
220	1.000	202.405	93.740	94.047	-.33
131	1.000	204.154	94.130	94.304	-.18
2	1.000	207.090	94.257	94.745	-.52
221	1.000	209.358	95.040	95.095	-.06
30	1.000	210.000	95.350	95.196	.16
132	1.000	211.041	95.390	95.360	.03
2	1.000	213.100	95.429	95.691	-.27
222	1.000	216.234	96.250	96.207	.05
133	1.000	217.854	96.430	96.480	-.05
2	1.000	219.250	96.266	96.719	-.47
30	1.000	220.000	97.040	96.849	.20
223	1.000	222.998	97.340	97.378	-.04
134	1.000	224.592	97.550	97.665	-.12
2	1.000	224.960	97.480	97.732	-.26
224	1.000	229.651	98.540	98.610	-.07
2	1.000	229.810	98.275	98.641	-.37
30	1.000	230.000	98.920	98.677	.25
135	1.000	231.245	98.900	98.918	-.02
225	1.000	236.231	99.810	99.914	-.10
136	1.000	238.095	100.160	100.300	-.14
30	1.000	240.000	100.990	100.702	.29
1	0.000	241.760	99.820	101.080	-1.25
226	1.000	242.764	101.250	101.299	-.05
137	1.000	244.560	101.750	101.697	.05
1	0.000	246.880	96.490	102.221	-5.61
30	1.000	250.000	103.310	102.947	.35
138	1.000	253.946	103.200	103.172	.03
1	0.000	252.820	100.550	103.624	-2.97
1	0.000	255.330	100.740	104.244	-3.36
139	1.000	257.248	104.750	104.729	.02
30	1.000	260.000	105.890	105.444	.42
1	0.000	261.550	105.720	105.856	-.13
140	1.000	263.551	106.270	106.398	-.12
1	0.000	264.740	97.790	106.726	-8.37
1	0.000	266.440	106.270	107.203	-.87
1	0.000	269.060	107.200	107.956	-.70
141	1.000	269.931	108.150	108.211	-.06
30	1.000	270.000	108.770	108.232	.50
142	1.000	276.292	109.980	110.158	-.16
1	0.000	276.430	107.010	110.202	-2.90
1	0.000	276.780	111.440	110.314	1.02
30	1.000	280.000	111.980	111.364	.55
143	1.000	282.595	111.960	112.241	-.25
1	0.000	287.550	107.750	114.001	-5.48
144	1.000	288.813	114.090	114.468	-.33
30	1.000	290.000	115.570	114.915	.57
1	0.000	291.590	110.890	115.524	-4.01
30	1.000	300.000	119.600	118.994	.51
30	1.000	310.000	124.220	123.774	.36
30	1.000	320.000	129.700	129.545	.12
30	1.000	330.000	136.630	136.853	-.16
30	1.000	340.000	146.280	146.884	-.41
30	1.000	350.000	162.170	162.894	-.44
30	1.000	360.000	199.630	199.194	.22

NP = 147, RMSPCT = .29

Table 7. Experimental data for compressed liquid

Run no.	T_{av}, K	ρ, mol/L	P, bar	$\overline{N}_b$, mol	V_b, cm^3	ΔT, K	$Q/\Delta T$, J/K	C_o, J/K	Corr., J/mol/K	C_v, J/mol/K Exptl.	Calcd.	Diff. %
145	296.740	11.290	20.564	.8280	73.340	3.531	145.85	82.92	-1.75	74.25	74.16	.12
146	301.507	11.283	45.144	.8280	73.385	6.057	146.14	83.24	-1.76	74.20	74.94	-1.00
147	307.514	11.274	75.945	.8280	73.441	6.022	147.44	83.62	-1.79	75.28	75.94	-.87
148	313.479	11.265	106.338	.8280	73.497	5.959	148.65	84.00	-1.82	76.27	76.96	-.91
149	319.395	11.257	136.292	.8280	73.553	5.914	149.90	84.36	-1.85	77.31	77.99	-.89
150	325.273	11.248	165.870	.8280	73.609	5.857	150.96	84.71	-1.88	78.14	79.03	-1.14
151	331.118	11.239	195.101	.8279	73.665	5.814	152.22	85.05	-1.91	79.22	80.08	-1.09
152	336.944	11.231	224.054	.8279	73.721	5.750	153.45	85.38	-1.94	80.26	81.13	-1.08
801	278.582	11.949	33.044	.8758	73.294	6.106	145.44	81.65	-2.05	70.78	71.51	-1.03
802	284.558	11.938	69.935	.8758	73.356	6.045	146.75	82.08	-2.09	71.75	72.40	-.90
803	290.462	11.928	106.244	.8758	73.418	5.995	148.13	82.50	-2.12	72.82	73.31	-.68
804	296.874	11.917	145.139	.8757	73.485	7.017	149.61	82.93	-2.16	73.98	74.33	-.48
805	303.743	11.905	186.599	.8757	73.557	6.929	151.19	83.38	-2.20	75.23	75.46	-.30
806	310.524	11.894	227.186	.8757	73.629	6.867	152.74	83.81	-2.24	76.47	76.60	-.18
807	317.249	11.882	267.113	.8757	73.701	6.796	154.24	84.23	-2.28	77.67	77.77	-.13
808	322.550	11.873	298.351	.8757	73.757	4.008	155.49	84.55	-2.32	78.69	78.71	-.02
228	256.127	12.573	27.046	.9205	73.214	2.809	144.21	79.89	-2.36	67.50	68.52	-1.52
229	258.863	12.568	47.300	.9205	73.245	2.793	144.95	80.12	-2.38	68.04	68.88	-1.23
230	262.933	12.560	76.936	.9205	73.292	5.389	146.02	80.45	-2.40	68.83	69.42	-.86
231	268.252	12.549	115.610	.9205	73.353	5.336	147.34	80.87	-2.44	69.77	70.15	-.54
232	273.524	12.539	153.660	.9205	73.414	5.301	148.46	81.28	-2.48	70.50	70.89	-.55
233	278.769	12.528	191.247	.9205	73.475	5.267	149.64	81.67	-2.52	71.33	71.66	-.46
234	283.978	12.518	228.306	.9205	73.535	5.237	150.91	82.04	-2.55	72.26	72.44	-.25
235	289.142	12.507	264.777	.9205	73.596	5.195	152.30	82.41	-2.59	73.34	73.24	.13
901	238.172	13.059	28.490	.9554	73.158	4.296	144.06	78.30	-2.61	66.22	66.41	-.29
902	242.633	13.449	67.640	.9554	73.215	5.194	144.57	78.73	-2.64	66.28	66.95	-1.02
903	248.402	13.036	114.066	.9554	73.284	6.120	145.97	79.23	-2.69	67.18	67.63	-.67
904	254.481	13.023	163.629	.9553	73.359	6.049	147.47	79.75	-2.74	68.15	68.38	-.33
905	260.329	13.010	212.165	.9553	73.433	5.992	148.90	80.24	-2.79	69.08	69.16	-.12
906	265.728	12.997	255.975	.9553	73.501	4.993	150.36	80.67	-2.84	70.11	69.89	.31
907	270.590	12.987	295.110	.9553	73.563	4.932	151.61	81.05	-2.87	70.98	70.57	.57
301	216.834	13.615	35.254	.9952	73.097	3.893	142.73	76.11	-2.92	64.02	64.22	-.31
302	220.658	13.606	72.870	.9952	73.148	3.857	143.21	76.53	-2.96	64.05	64.60	-.86
303	224.436	13.596	109.774	.9952	73.200	3.848	143.87	76.93	-3.00	64.27	64.98	-1.11
304	228.196	13.586	146.288	.9952	73.251	3.833	144.90	77.32	-3.04	64.87	65.38	-.79
305	231.931	13.577	182.282	.9952	73.302	3.791	145.89	77.69	-3.07	65.45	65.79	-.51
306	235.624	13.567	217.041	.9952	73.352	3.758	146.90	78.05	-3.11	66.07	66.20	-.19
307	239.291	13.558	252.530	.9952	73.403	3.734	147.87	78.40	-3.15	66.66	66.62	.05
401	188.876	14.297	40.935	1.0439	73.016	3.751	140.20	72.55	-3.32	61.48	61.89	-.67
402	192.681	14.285	86.602	1.0439	73.073	3.966	141.16	73.09	-3.37	61.84	62.18	-.54
403	196.572	14.273	132.941	1.0438	73.132	3.930	142.15	73.63	-3.41	62.23	62.48	-.40
404	200.428	14.262	178.490	1.0438	73.191	3.899	143.28	74.14	-3.46	62.78	62.80	-.04
405	204.255	14.250	223.308	1.0438	73.250	3.869	144.32	74.62	-3.51	63.27	63.13	.21
406	207.852	14.239	265.092	1.0438	73.305	3.441	145.40	75.06	-3.56	63.83	63.46	.59
501	156.962	15.044	46.349	1.0971	72.928	3.807	137.04	67.00	-3.76	60.08	60.02	.09
502	160.668	15.031	104.699	1.0971	72.992	3.629	138.16	67.76	-3.82	60.36	60.20	.26
503	164.253	15.018	158.389	1.0971	73.054	3.592	139.41	68.46	-3.88	60.80	60.38	.68
504	167.862	15.005	211.015	1.0971	73.115	3.563	140.52	69.12	-3.93	61.15	60.58	.93
505	171.318	14.992	262.630	1.0971	73.177	3.528	141.71	69.75	-3.99	61.60	60.78	1.33
601	126.412	15.731	44.790	1.1458	72.840	2.642	132.33	59.12	-4.12	59.78	59.12	1.11
602	129.030	15.720	94.654	1.1458	72.891	2.621	133.49	59.93	-4.17	60.02	59.16	1.44
603	131.699	15.708	144.995	1.1458	72.942	2.743	134.57	60.73	-4.22	60.22	59.21	1.67
604	134.418	15.697	195.789	1.1458	72.996	2.724	135.64	61.51	-4.28	60.41	59.28	1.88
605	137.115	15.685	245.672	1.1458	73.048	2.701	136.66	62.26	-4.34	60.60	59.35	2.06
701	100.334	16.319	48.227	1.1877	72.779	2.423	126.15	49.17	-4.32	60.49	59.14	2.23
702	102.729	16.307	104.627	1.1876	72.830	2.373	127.62	50.24	-4.39	60.76	59.11	2.73
703	105.095	16.295	159.753	1.1876	72.881	2.365	128.83	51.27	-4.45	60.85	59.08	2.91
704	117.444	16.284	213.892	1.1876	72.932	2.343	130.05	52.25	-4.52	60.99	59.07	3.15

Table 8. Derived experimental and calculated C_p, J/mol/K

Run no.	C_p, J/mol/K Exptl.	Calcd.	Diff., %	Run no.	C_p, J/mol/K Exptl.	Calcd.	Diff., %
145	118.54	118.45	.07	906	100.91	100.69	.21
146	117.12	117.86	-.63	907	101.38	100.97	.40
147	116.63	117.29	-.56	301	95.69	95.89	-.21
148	116.21	116.91	-.60	302	95.38	95.93	-.58
149	115.99	116.68	-.59	303	95.27	95.99	-.75
150	115.68	116.57	-.77	304	95.56	96.08	-.54
151	115.71	116.58	-.74	305	95.85	96.19	-.35
152	115.80	116.66	-.75	306	96.19	96.32	-.13
801	109.57	110.30	-.66	307	96.51	96.48	.04
802	109.43	110.07	-.59	401	91.47	91.88	-.45
803	109.47	109.96	-.45	402	91.56	91.91	-.37
804	109.62	109.97	-.32	403	91.72	91.97	-.27
805	109.88	110.11	-.21	404	92.03	92.05	-.03
806	110.22	110.35	-.12	405	92.29	92.16	.15
807	110.60	110.70	-.09	406	92.65	92.27	.41
808	111.02	111.04	-.02	501	88.58	88.53	.06
228	103.08	104.11	-.99	502	88.70	88.55	.18
229	103.23	104.07	-.81	503	88.99	88.58	.46
230	103.47	104.06	-.57	504	89.19	88.62	.64
231	103.72	104.10	-.36	505	89.51	88.69	.92
232	103.82	104.21	-.38	601	86.90	86.24	.76
233	104.06	104.39	-.32	602	87.10	86.23	.99
234	104.44	104.62	-.17	603	87.24	86.24	1.15
235	105.00	104.90	.09	604	87.38	86.25	1.30
901	99.75	99.95	-.19	605	87.51	86.27	1.42
902	99.28	99.96	-.68	701	86.05	84.70	1.57
903	99.59	100.04	-.45	702	86.35	84.69	1.92
904	99.97	100.20	-.23	703	86.46	84.69	2.05
905	100.35	100.43	-.08	704	86.61	84.69	2.22

Table 9. Reduced specific heats, $(C_v - C_v^o)$, J/mol/K

Run	T,K	ρ, mol/L	C_v	C_v^o	$C_v-C_v^o$	$(C_v-C_v^o)/R$
1	294.150	11.303	73.68	64.68	9.00	1.083
145	296.740	11.290	74.25	65.19	9.06	1.090
146	301.507	11.283	74.20	66.12	8.08	.971
147	307.514	11.274	75.28	67.31	7.97	.958
148	313.479	11.265	76.27	68.49	7.78	.935
149	319.395	11.257	77.31	69.67	7.64	.919
150	325.273	11.248	78.14	70.84	7.30	.878
151	331.118	11.239	79.22	72.01	7.21	.868
152	336.944	11.231	80.26	73.17	7.09	.853
2	252.415	12.591	66.96	56.69	10.27	1.235
228	256.127	12.573	67.50	57.38	10.12	1.217
229	258.683	12.568	68.04	57.90	10.14	1.220
230	262.933	12.560	68.83	58.66	10.17	1.223
231	268.252	12.549	69.77	59.67	10.10	1.215
232	273.524	12.539	70.50	60.67	9.83	1.182
233	278.769	12.528	71.33	61.68	9.65	1.160
234	283.978	12.518	72.26	62.69	9.57	1.151
235	289.142	12.507	73.34	63.70	9.64	1.160
3	212.889	13.635	63.88	49.73	14.15	1.702
301	216.834	13.615	64.02	50.39	13.63	1.639
302	220.658	13.606	64.05	51.04	13.01	1.565
303	224.436	13.596	64.27	51.69	12.58	1.514
304	228.198	13.586	64.87	52.34	12.53	1.507
305	231.931	13.577	65.45	52.99	12.46	1.499
306	235.624	13.567	66.07	53.64	12.43	1.494
307	239.291	13.558	66.66	54.30	12.36	1.487
4	185.051	14.318	61.17	45.33	15.84	1.905
401	188.878	14.297	61.48	45.91	15.57	1.873
402	192.681	14.285	61.84	46.49	15.35	1.846
403	196.572	14.273	62.23	47.10	15.13	1.820
404	200.428	14.262	62.78	47.71	15.07	1.813
405	204.255	14.250	63.27	48.32	14.95	1.798
406	207.852	14.239	63.83	48.90	14.93	1.795
5	153.309	15.067	59.78	40.81	18.97	2.282
501	156.982	15.044	60.08	41.31	18.77	2.257
502	160.668	15.031	60.36	41.82	18.54	2.229
503	164.253	15.018	60.80	42.32	18.48	2.222
504	167.802	15.005	61.15	42.82	18.33	2.204
505	171.318	14.992	61.60	43.32	18.28	2.198
6	123.602	15.752	59.52	36.73	22.79	2.742
601	126.412	15.731	59.78	37.13	22.65	2.725
602	129.030	15.720	60.02	37.49	22.53	2.709
603	131.699	15.708	60.22	37.86	22.36	2.689
604	134.418	15.697	60.41	38.24	22.17	2.667
605	137.115	15.685	60.60	38.61	21.99	2.645
7	97.325	16.340	60.20	32.79	27.40	3.296
701	100.334	16.319	60.49	33.21	27.28	3.282
702	102.729	16.307	60.76	33.59	27.17	3.268
703	105.095	16.295	60.85	33.97	26.88	3.233
704	107.444	16.284	60.99	34.34	26.65	3.206
8	273.712	11.967	69.91	60.71	9.20	1.107
801	278.582	11.949	70.78	61.65	9.13	1.099
802	284.558	11.938	71.75	62.80	8.95	1.076
803	290.482	11.928	72.82	63.96	8.86	1.066
804	296.874	11.917	73.98	65.21	8.77	1.055
805	303.743	11.905	75.23	66.57	8.66	1.042
806	310.524	11.894	76.47	67.91	8.56	1.030
807	317.249	11.882	77.67	69.24	8.43	1.013
808	322.550	11.873	78.69	70.30	8.39	1.009
9	234.541	13.077	65.74	53.45	12.28	1.477
901	238.172	13.059	66.22	54.10	12.12	1.458
902	242.833	13.049	66.28	54.94	11.34	1.364
903	248.402	13.036	67.18	55.95	11.23	1.350
904	254.401	13.023	68.15	57.06	11.09	1.334
905	260.329	13.010	69.08	58.17	10.91	1.313
906	265.728	12.997	70.11	59.19	10.92	1.314
907	270.590	12.987	70.98	60.11	10.87	1.307