[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY OF THE UNIVERSITY OF TEXAS]

The Compressibility of Liquid *n*-Octane

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Introduction.—This investigation forms a part of the general program of this Laboratory of determining the pressure–volume–temperature relations for pure hydrocarbons and of their known mixtures, both in the liquid and gaseous state. Reports have been made on some of the isomeric hexanes.[2] In addition to the normal octane here reported, work is in progress on 2,2,4-trimethylpentane and on tetramethylbutane. The results on these octanes and on the remaining hexanes will be reported soon.

This investigation deals with the compressibility of pure *n*-octane at eight temperatures: at 25° intervals beginning with 100° and including 275°. No data over this range were found in the literature; vapor pressure and density data up to critical temperature (t_c = 296.2°) and pressure (p_c = 24.61 atm.) were recorded by Young.[3]

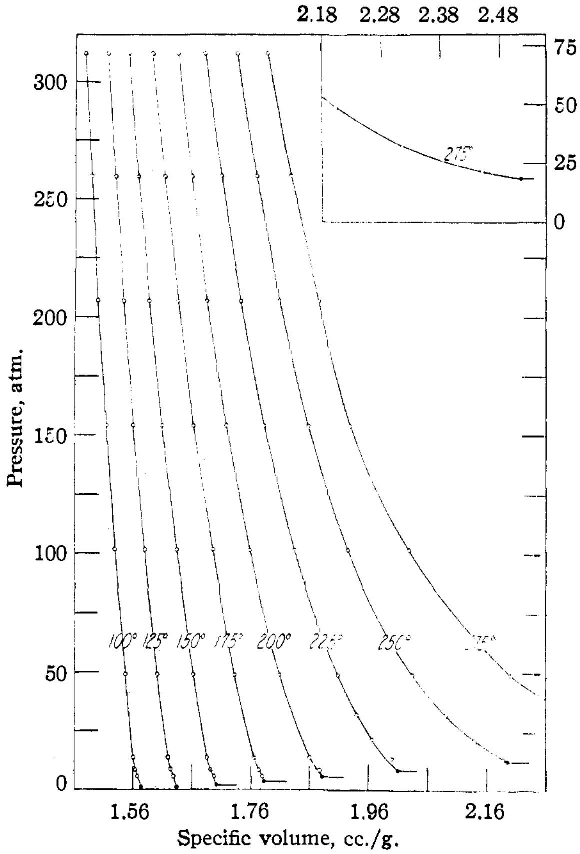

Fig. 1.—Specific volume of liquid *n*-octane as a function of the pressure (solid points from the data of Young[3]).

Method and Apparatus.—The dead-weight piston gage method and apparatus has been described elsewhere.[2,4] Minor improvements in accessory apparatus have been

TABLE I

COMPRESSIBILITY OF LIQUID *n*-OCTANE

Molecular weight, 114.224; pressures are in normal atmospheres and temperatures are on the International Temperature Scale.[a]

Press., atm.	Cc./g. 100.00°	Moles/liter 100.00°	Cc./g. 125.00°	Moles/liter 125.00°	Cc./g. 150.00°	Moles/liter 150.00°
5.0	1.569	5.580	1.629	5.374	1.697	5.159
10.0	1.564	5.598	1.624	5.391	1.690	5.180
15.0	1.561	5.609	1.620	5.404	1.685	5.196
20.0	1.559	5.615	1.617	5.414	1.681	5.208
25.0	1.557	5.623	1.615	5.421	1.678	5.217
30.0	1.555	5.630	1.612	5.431	1.675	5.226
50.0	1.547	5.659	1.602	5.465	1.662	5.268
100.0	1.530	5.722	1.580	5.541	1.634	5.358
150.0	1.514	5.782	1.560	5.612	1.610	5.438
200.0	1.501	5.833	1.544	5.670	1.589	5.510
250.0	1.489	5.880	1.529	1.726	1.571	5.573
300.0	1.477	5.923	1.516	5.775	1.554	5.634
	175.00°		200.00°		225.00°	
5.0	1.780	4.918				
10.0	1.771	4.943	1.870	4.681	2.004	4.369
15.0	1.764	4.963	1.859	4.709	1.987	4.406
20.0	1.759	4.977	1.849	4.735	1.971	4.441
25.0	1.754	4.991	1.841	4.755	1.957	4.473
30.0	1.749	5.005	1.833	4.776	1.946	4.499
50.0	1.732	5.055	1.808	4.842	1.906	4.593
100.0	1.697	5.159	1.760	4.974	1.836	4.768
150.0	1.664	5.261	1.721	5.087	1.786	4.902
200.0	1.638	5.345	1.689	5.183	1.747	5.011
250.0	1.616	5.417	1.663	5.264	1.714	5.108
300.0	1.596	5.485	1.640	5.338	1.686	5.192
	250.00°		275.00°			
5.0						
10.0						
15.0	2.180	4.016				
20.0	2.149	4.074	2.484	3.524		
25.0	2.122	4.125	2.388	3.666		
30.0	2.099	4.171	2.336	3.748		
50.0	2.032	4.308	2.199	3.981		
100.0	1.928	4.541	2.033	4.306		
150.0	1.863	4.699	1.944	4.503		
200.0	1.814	4.826	1.883	4.649		
250.0	1.775	4.932	1.834	4.773		
300.0	1.743	5.023	1.795	4.877		

[a] Burgess, *Bur. Standards J. Research*, **1**, 635 (1928).

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(2) Kelso with Felsing, THIS JOURNAL, **62**, 3132 (1940); *J. Ind. Eng. Chem.*, **34**, 161 (1942).

(3) Young, *J. Chem. Soc.*, **77**, 1145 (1900).

(4) Beattie, *Proc. Am. Acad. Arts Sci.*, **69**, 389 (1934).

made; the most important change was the development of a more convenient contact indicator.

Material Used.—The *n*-octane sample used in this work was prepared under the direction of Professor C. E. Boord of the Department of Chemistry of the Ohio State University as part of the American Petroleum Institute Hydrocarbon Research Project in the Industrial Research Foundation of the University. The material was stated to have the following constants: *d* (g./cc.) at 20° = 0.7019 (0.7019); f. p. = −56.90°; b. p. (normal) = 125.6°; and $n^{20}D$ 1.3976 (1.3975_8); the values in parentheses were obtained by the authors of this paper.

The Data.—The experimental results are presented graphically in the accompanying figure, specific volumes (cc./g.) as functions of the pressure at different temperatures. From such large-scale graphs, the specific volumes at each temperature were read off at rounded pressures; these values, together with the calculated molar densities, are presented in Table I. Specific volumes of the liquid in contact with the saturated vapor at the different temperatures and corresponding vapor pressures are presented in Table II.

TABLE II

SPECIFIC VOLUMES OF LIQUID *n*-OCTANE IN CONTACT WITH ITS SATURATED VAPOR

Temp., °C.	Vapor press., atm.	Cc./g.
100.00	1.00	1.574[a]
125.00	1.00	1.634[a]
150.00	1.88	1.702[b]
175.00	3.30	1.783[b]
200.00	5.40	1.882[b]
225.00	8.44	2.009[b]
250.00	12.63	2.196[b]
275.00	18.34	2.518[b]

[a] Calculated from the equation listed in "I. C. T.," Vol. III, p. 29. [b] "I. C. T.," Vol. III, p. 245, or ref. 3.

Discussion of Results.—The density data are believed to be accurate to 0.10% at the lower pressures and temperatures and to 0.1 to 0.2% at the higher pressures and temperatures. The uncertainty in the measurement of pressures is less than 0.03%, in the determination of mass less than 0.01%, and the measurement of volume from 0.05 to 0.1%. Temperature measurements are correct at least to 0.01°. At 250° and 275°, there was evidence of decomposition; after keeping the octane at these temperatures for twenty-four hours, the densities at the same pressures showed a slight decrease. The density–pressure values listed in the table for these temperatures were determined as rapidly as possible and with the precision indicated. Hence the density data for these temperatures are believed to be accurate to 0.2%. An inspection of the figure reveals that an extrapolation of the data at the different temperatures yields results in splendid agreement with the boiling-point densities recorded by Young.[3]

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Summary

1. The compressibility of liquid *n*-octane has been determined at 25° intervals from 100 to 275° at pressures ranging from the vapor pressures to approximately 300 atmospheres.

2. The data are presented tabularly and graphically, the specific volume being related to the pressure at different temperatures.

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