



Soviet-era science, translated into English

PHYSICAL CHEMISTRY

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1963

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Figure 1

Figure 1: Figure 1

Abstract**Full Text****PHYSICAL CHEMISTRY**

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GENERALIZATION OF DATA ON THE VISCOSITY OF SATURATED HYDROCARBONS AT VARIOUS TEMPERATURES AND PRESSURES*(Presented by Academician V. A. Kirillin, 20 III 1963)*

A generalization of data on the viscosity of saturated hydrocarbons, as well as of many other gases, was given in ⁽¹⁾. It was established that the most satisfactory generalized dependence is the common curve in the coordinates

$$\left(\frac{\eta_{p,T} - \eta_T}{\eta_{(p,T)_{cr}} - \eta_{T_{cr}}} \right) - \frac{\rho}{\rho_{cr}}.$$

Here: $\eta_{p,T}$ is the viscosity at a given pressure (p , atm) and temperature (T , °K), η_T is the viscosity at atmospheric pressure and the same temperature (T , °K), $\eta_{T_{cr}}$ is the viscosity at atmospheric pressure and the critical temperature (T , °K), $\eta_{(p,T)_{cr}}$ is the viscosity at the critical point (at p_{cr} and T_{cr}).

Fig. 1. Dependence of $(\eta_{p,T} - \eta_T)$ on density according to literature data:

I—for methane, *II*—for ethane, *III*—for propane.

1–12—the numbers correspond to the cited literature; 13—data of Comings ⁽¹⁾, 14—Kuss ⁽¹⁾, 15—Sage and Lacey ⁽¹⁾, 16—Beecher and Katz ⁽¹⁾, 17—Terf and Galkov ⁽¹⁾, 18—Smith and Brown ⁽¹⁾.

In this article we present a generalization in these coordinates of the experimental data on the viscosity of *n*-pentane, *n*-hexane, *n*-heptane, and *n*-octane, published in ^(2–4). In these same papers a treatment of the experimental data in the coordinates $(\eta_{p,T} - \eta_T) - \rho$ was presented, which showed that the experimental data for all four of the listed substances, at all temperatures investigated for a given substance, lie well on one common dependence curve.

In Fig. 1, in addition to what was set forth in ⁽¹⁾, a treatment is given of the existing experimental data in these same coordinates for methane, ethane

[Figure 2 and Figure 3 graphs]

Fig. 2. Dependence of $\eta_{(pT)cr}$ (a) and η_{Tcr} (b) on molecular weight for saturated hydrocarbons $C_1 - C_8$

Fig. 3. Dependence of $\eta_{(pT)cr}/\eta_{Tcr}$ on molecular weight for saturated hydrocarbons $C_1 - C_8$.

and propane using data published recently ⁽³⁻¹³⁾; the density values in this case were taken from the following works: for methane ^(14,15), ethane ^(16,17), propane ^(17,18).

As can be seen, for the generalization, in addition to the values $\eta_{p,T}$ and η_T , it is necessary to know the values of the constants η_{Tcr} , $\eta_{(p,T)cr}$, ρ_{cr} , and the $P - V - T$ data for the substances investigated.

On the basis of our experimental data, using the data given in ^(1,19,20), Table 1 has been compiled.

Table 1

Substance	Mol. wt.	$t_{cr}, ^\circ C$	p_{cr}, atm	$\rho_{cr}, g/cm^3$	$\eta_{Tcr}, 10^{-7} g/cm sec$	$\eta_{(pT)cr}, 10^{-7} g/cm sec$	$\frac{\eta_{(pT)cr}}{\eta_{Tcr}}$
Methane	16.04	-82.50	45.8	0.162	743	1583	2.130
Ethane	30.07	32.37	48.2	0.203	950	2130	2.242
Propane	44.09	96.80	42.01	0.220	1010	2390	2.366
<i>n</i> -Butane	58.12	152.01	37.47	0.228	1080	—	—
<i>n</i> -Pentane	72.14	196.62	33.31	0.232	1073	2650	2.472
<i>n</i> -Hexane	86.17	234.70	29.93	0.234	1090	2720	2.495
<i>n</i> -Heptane	100.19	267.01	27.01	0.235	1071	2711	2.530
<i>n</i> -Octane	114.22	296.20	24.64	0.234	1045	2645	2.531

In Figs. 2 and 3 the dependence of η_{Tcr} and $\eta_{(pT)cr}$, as well as $\eta_{(pT)cr}/\eta_{Tcr}$, on molecular weight is presented.

It is seen from Fig. 2 that the dependence of the indicated quantities on molecular weight is represented in the form of smooth curves which, however, do not have a simple graphical regularity.

Therefore, it appears difficult to carry out extrapolative predictions from these curves of the values of $\eta_{T_{cr}}$ and $\eta_{(pT)_{cr}}$ for paraffin hydrocarbons with molecular weight greater than that of *n*-octane.

Using the data of Table 1, we constructed a generalized plot (Fig. 4), in the coordinates

$$\left(\frac{\eta_{pT} - \eta_T}{\eta_{(pT)_{cr}} - \eta_{T_{cr}}} \right) - \frac{\rho}{\rho_{cr}}$$

for the class of paraffin hydrocarbons from methane to *n*-octane inclusive. As can be seen, the experimental data for all paraffin hydrocarbons are arranged very well on one common curve.

Table 2

$\frac{\rho}{\rho_{cr}}$	$\frac{\eta_{p,T} - \eta_T}{\eta_{(pT)_{cr}} - \eta_{T_{cr}}}$	$\frac{\rho}{\rho_{cr}}$	$\frac{\eta_{p,T} - \eta_T}{\eta_{(pT)_{cr}} - \eta_{T_{cr}}}$
0.005	0	1.500	2.060
0.100	0.040	1.600	2.360
0.200	0.125	1.700	2.700
0.300	0.200	1.800	3.100
0.400	0.275	1.900	3.580
0.500	0.350	2.000	4.500
0.600	0.475	2.200	5.565
0.700	0.600	2.300	6.670
0.800	0.700	2.400	7.875
0.900	0.850	2.500	9.375
1.000	1.000	2.600	11.400
1.100	1.175	2.700	13.900
1.200	1.350	2.800	17.600
1.300	1.575	3.000	30.250
1.400	1.800		

The values

$$\frac{\eta_{pT} - \eta_T}{\eta_{(pT)_{cr}} - \eta_{T_{cr}}},$$

corresponding to the generalized reduced curve for even values of ρ/ρ_{cr} , are summarized in Table 2, which may be

Fig. 4. Dependence of the viscosity of paraffin hydrocarbons in the coordinates

Figure 4: plot of the viscosity dependence of paraffin hydrocarbons in the indicated reduced coordinates.

Figure 2: Figure 4: plot of the viscosity dependence of paraffin hydrocarbons in the indicated reduced coordinates.

$$\left(\frac{\eta_{pT} - \eta_T}{\eta_{(pT)_{cr}} - \eta_{T_{cr}}} \right) - \frac{\rho}{\rho_{cr}};$$

1—methane, 2—ethane, 3—propane, 4—*n*-pentane, 5—*n*-hexane, 6—*n*-heptane, 7—*n*-octane.

used for interpolation and extrapolation calculations.

A generalization is given of experimental data on the viscosity of saturated hydrocarbons from methane to octane inclusive, over wide ranges of temperatures and pressures (densities). The generalization was carried out on the basis of the theory of corresponding states in the coordinates

$$\frac{\eta_{p,T} - \eta_T}{\eta_{(p,T)_{cr}} - \eta_{T_{cr}}} - \frac{\rho}{\rho_{cr}}$$

and a plot of this dependence was constructed.

On the basis of the generalized reduced curve, Table 2 was compiled for the values

$$\left(\frac{\eta_{p,T} - \eta_T}{\eta_{(p,T)_{cr}} - \eta_{T_{cr}}} \right)$$

for values $0 < \frac{\rho}{\rho_{cr}} \leq 3$, which may be used for interpolation and extrapolation calculations.

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Received
19 III 1963

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