CALCULATION OF HEAT CONDUCTIVITY OF ORGANIC LIQUIDS AS FUNCTION OF TEMPERATURE

M. M. Safarov and Kh. Khadzhidov

Results of generalization of experimental data on heat conductivity of a series of organic liquids as a function of temperature at atmospheric pressure are presented. The approximation dependence for calculation of heat conductivity of liquid organic compounds as a function of temperature, normal boiling temperature, and molar mass is obtained.

Previously, experimental studies of heat conductivity within the temperature range of 153–573 K at atmospheric pressure were carried out for the following compounds [1, 4, 8, 9]: saturated hydrocarbons (hexane, heptane, octane, nonane, decane, undecane, tetradecane, pentadecone, hexadecane, heptadecane, and nonadecane), unsaturated hydrocarbons and cycloparaffins (hexane-1, heptane-1, octane-1, decene-1, dodecene-1, tetradecene-1, pentyne-1, hexyne-1, heptyne-1, undecyne-5, and dodecyne-6), esters and ethers (domethyl, diethy1, dipropyl, dibutyl, diisony, dihexyl, diheptyl, didecyl, methylpropyl, ethylbutyl, methylamyl, ethylamyl, propylbutyl, ethylhexyl, methylheptyl, ethylheptyl, and ethylloctyl), ketones (dimethyl, diethyl, dipropyl, dibutyl, diisony, dihexyl, methylpropyl, methylbutyl, methylamyl, methylecyl, methylheptyl, methyloctyl, ethylpropyl, ethylbutyl, ethylamyl, ethylhexyl, ethylheptyl, ethylloctyl and others), aldehydes (butyraldehyde, valeraldehyde, caproaldehyde, enantonal, octanal, nonanal, decanal, hendecanal, and dodecanal), saturated monohydric alcohols (methanol, pentanol, hexanol, heptanol, octanol, nonyl alcohol, 1-decanol, undecylic alcohol, dodecyl alcohol, tridecyl alcohol, pentadecyl alcohol, hexadecyl alcohol, heptadecyl alcohol, octadecyl alcohol, and ethanol), and acetates (methyl acetate, ethyl acetate, butyl acetate, isobutyl acetate, amyl acetate, and isoamyl acetate).

The heat conductivity of the above organic liquids was measured on specially designed experimental installations using the method of the heated thread and the cylindric bicalorimeter of the regular thermal regime [5, 6].

To obtain an equation for calculations of heat conductivity of organic liquids as a function of temperature at atmospheric pressure we processed experimental data from [1-4] using the following functional dependence:

$$\frac{\lambda}{\lambda_1} = f \left( \frac{T}{T_1} \right)$$

(1)

where $\lambda$ is the heat conductivity at temperature $T$; $\lambda_1$ is the heat conductivity at temperature $T_1 = 383$ K.

A generalization for the dependence (1) for organic liquids is shown in Fig. 1, from which one can see that the experimental data fit the common curve rather well. We write the equation for this curve:

$$\lambda = \left[ 0.393 \left( \frac{T}{T_1} \right)^2 - 1.432 \frac{T}{T_1} + 2.039 \right] \lambda_1.$$  

(2)

The analysis of the value of $\lambda_1$ for organic liquids has shown that this quantity is a function of the molar weight (Fig. 2). Then the experimental data presented in Fig. 2 were processed in the form of the functional dependence

$$\frac{\lambda_1}{\lambda_{1*}} = f \left( \frac{\mu}{\mu_1} \right).$$

(3)
Fig. 1. Dependence of the relative heat conductivity $\lambda/\lambda_1$ on the relative temperature $T/T_1$ of organic liquids: 
1-10) saturated hydrocarbons; 11-18) cycloparaffins; 19-25) olefin hydrocarbons; 26-30) alcohols; 31-35) ketones; 36-41) ethers; 42-45) aldehydes; 46-50) acetates.

Fig. 2. Dependence of $\lambda_1$ on $\mu$: 
1) olefin hydrocarbons; 2) paraffin hydrocarbons; 3) ethers; 4) ketones; 5) aldehydes; 6) alcohols; 7) butyrates; 8) acetates. $\lambda_1$, W/(cm·K); $\mu$, kg/mole.

TABLE 1. Values of $\mu_1$ and $T_{\text{boil}}$ of Organic Liquids

<table>
<thead>
<tr>
<th>Organic liquid</th>
<th>Amine acetate</th>
<th>Ethyl ether</th>
<th>Dodecene-1</th>
<th>$n$-Dodecane</th>
<th>Diamyl ketone</th>
<th>Dodecanal</th>
<th>Dodecy alcohol</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu_1$, kg/mole</td>
<td>0.136</td>
<td>0.158</td>
<td>0.168</td>
<td>0.170</td>
<td>0.170</td>
<td>0.184</td>
<td>0.186</td>
</tr>
<tr>
<td>$T_{\text{boil}}, \text{K}$</td>
<td>405</td>
<td>464</td>
<td>486</td>
<td>489</td>
<td>499.4</td>
<td>535.2</td>
<td>546.6</td>
</tr>
</tbody>
</table>