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EXPERIMENTAL INVESTIGATION OF THE THERMAL CONDUCTIVITY OF DIBUTYL- AND DIISOBUTYL SEBACATES AT HIGH TEMPERATURES AND PRESSURES

É. M. Godzhaev, É. A. Mamedov, É. G. Kerimov, and M. A. Guseinov

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Results of experimental investigation of the thermal conductivity of dibutyl- and diisobutyl sebacates in the interval of temperatures 308.1–641.3 K and pressures (0.1–40.0) MPa are given.

Esters of sebacic acid are used as plastifiers, polymer materials, and lubricating oils. Investigation of the thermophysical properties and, in particular, the thermal conductivity of sebacates is an important problem of thermal and molecular physics, which is of great scientific and applied significance.

Despite the wide practical use of sebacates, their thermophysical properties are not understood, in practice.

We have investigated experimentally for the first time the thermal conductivity of sebacates in the liquid phase as a function of temperature and pressure [1, 2].

The thermal conductivity was measured by the monotone-heating method, which is based on the nonlinear theory of heat conduction. The theory of the method, the measurement procedure, the structure of the device, and the characteristic corrections involved in the calculation equation have been presented in detail in [3].

The temperature difference in the liquid layer and the heating rate were measured by an R-345 potentiometer (class 0.001) and an electronic stopwatch with an accuracy of 0.01 sec. We employed an MP-2500 dead-weight pressure gauge (class 0.05) and a set of standard pressure gauges to produce and measure the pressure.

In measurements in the region of high temperatures, we concentrated our attention on the stability of the composition of a substance. The absence of thermal decomposition was monitored by a second chromatographic analysis of the product after the experiments and by the reproducibility of the results of second measurements at relatively low temperatures after the investigation in the region of high temperatures. The reproducibility of the experimental data obtained under identical conditions was within $\pm 1\%$. The standard error of measurement amounted to $\pm 2.2\%$.

To check the correctness of the setup of the experiment we performed check measurements of the thermal conductivity (λ) of liquid toluene at temperatures of 300–650 K and pressures of 0.1–40 MPa (see Table 1). The results obtained are in agreement with the data of [4, 5] within experimental error.

The purity of the investigated reagents was no lower than 99.81% of the weight composition of the basic substance (Tsvet-4 chromatograph). The measurements have been performed along the isobars with a temperature step of 22–25 K and a pressure step of 10 MPa in the interval of temperatures 308.1–641.3 K and pressures 0.1–40 MPa. The results obtained on the thermal conductivity of dibutyl- and diisobutyl sebacates in the liquid phases are given in Table 1.

The coefficient of thermal conductivity of dibutyl- and diisobutyl sebacates in the liquid phase decreases with temperature throughout the investigated range of pressures. The most significant change in λ as a function of the temperature is observed at low pressures, and a weaker dependence of λ on the temperature is observed with further increase in the pressure.

As is clear from Table 1, the thermal conductivity of diisobutyl sebacate in the liquid phase is lower than λ of dibutyl sebacate. This is, apparently, due to the fact that in iso-compounds, the average intermolecular distance is approximately 0.38 Å larger than the distance between the molecules of normal esters [6], which decreases somewhat the interaction energy and the thermal conductivity of iso-compounds [7].

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TABLE 1. Experimental Values of the Thermal Conductivity $\lambda \cdot 10^3$ of Liquid Toluene, Dibutyl Sebacate, and Diisobutyl Sebacate as Functions of Temperature and Pressure

T, K	*P*, MPa				
	0.1	10	20	30	40
			Toluene		
300.4	133	136	139	142	145
329.9	124	129	131	136	139
355.1	117	123	124	131	134
379.2	111	117	121	125	129
403.9		112	114	122	125
428.0		107	109	116	120
453.2		101	104	112	115
478.1		96.1	100	107	111
515.3		88.2	95.7	100	105
551.1		83.4	92.8	96.5	102
576.2		81.2	90.6	93.9	101
625.3		79.8	88.9	92.5	101
640.1		78.3	86.5	92.4	101
660.8		77.5	86.2	92.1	101
			Dibutyl sebacate		
308.1	163	169	174	179	184
332.3	160	164	169	175	180
357.2	154	160	165	170	175
382.1	148	155	160	165	170
407.2	143	149	155	160	166
432.1	138	144	150	156	160
457.2	132	140	145	151	156
482.4	128	135	141	146	151
507.5	122	129	136	142	147
531.7	116	124	131	137	143
556.1	111	119	126	133	138
580.3	105	114	121	127	133
604.3	100	110	117	123	128
629.1		105	112	118	124
641.3		101	109	116	121
			Diisobutyl sebacate		
308.1	148	152	157	162	167
332.3	143	148	153	157	162
357.2	137	144	149	153	157
382.1	138	139	144	148	153
407.2	127	134	139	144	149
432.1	123	129	134	139	144
457.2	117	124	130	135	140
482.4	112	120	125	130	135
507.5	107	115	121	126	131
531.7	103	110	118	122	127
556.1	98.1	105	112	117	123
580.3	93.7	102	108	113	118
604.3		96.5	103	109	114
629.1		91.8	98.5	104	110
641.3		89.3	96.1	102	108

NOTATION

P, pressure, MPa; λ, thermal-conductivity coefficient, W/(m·K); *T*, absolute temperature, K.

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