24. J. O. Hirschfelder, J. Chem. Phys., 26, No. 2, 274, 282 (1957).
25. N. B. Vargaftik, Handbook of Thermophysical Properties of Gases and Liquids [in Russian], 2nd ed., Nauka, Moscow (1972).
26. C. Mannebek, Physica, 29, No. 7 (1963).
27. L. Monchik, Phys. Fluids, 2, No. 5 (1959).
28. D. L. Timrot, V. V. Marov, and V. I. Sviridenko, Teplofiz. Vys. Temp., 14, No. 1 (1976).
29. B. F. Reutov, Author's Abstract of Candidate's Dissertation Moscow Energy Institite (1976).
30. V. S. Yargin, Physical Constants and Properties of Matter [in Russian], 12th ed., Standartov, Moscow (1978), p. 6.

THERMAL-CONDUCTIVITY COEFFICIENTS OF SIX LIQUID AROMATIC HYDROCARBONS

A. M. Mamedov

UDC 547.53:536.2.08

Using experimental λ and ρ data, equations are developed for six aromatic hydrocarbons which describe λ within the limits of experimental accuracy over the temperature range 298-573°K at pressures up to 500 bar.

On the basis of experimental p, v, T data the authors have established [1] that the equation of state of six aromatic hydrocarbons, benzol, toluol, ethylbenzol, and o-, m-, and n-xylol, can be described with great accuracy over the temperature range 298-673°K at pressures to 500 bar by the formula

$$\frac{pv}{RT} = 1 + B\rho + H\rho^7. \tag{1}$$

In [2-4] it was indicated that the equation of state and transfer properties of liquids can be described by functions having the same form. Therefore, the thermal-conductivity coefficient of the six hydrocarbons referred to above will be described by a function

$$\frac{\lambda}{\lambda_s'} = 1 + B_\lambda\rho + H_\lambda\rho^7, \tag{2}$$

from which it follows that for λ calculations data on λ_s', the thermal-conductivity coefficient of the saturated liquid, will be required. The latter were found for the liquids studied by extrapolation of isotherms in the coordinates λ and p with use of the experimental λ values presented in [5-10]. Then the λ' values thus found were expressed by the single empirical expression

$$\lambda_s' = \frac{T}{a + bT} + c. \tag{3}$$

The values of the constants *a*, b, and c of Eq. (3) for each hydrocarbon are presented in Table 1.

TABLE 1. Values of Constants of Eq. (3) for Six Liquid Aromatic Hydrocarbons

Coefficient	Benzol	Toluol	Ethylbenzol	o-Xylol	m-Xylol	n-Xylol
a	—0,24795	—0,07389	—0,03264	—0,14310	—0,09312	—0,15576
b	—0,0001118	—0,0002759	—0,0002378	—0,0002976	—0,0003007	—0,0003088
c	2486	3203	4149	2569	2914	2466

M. Azizbekov Azerbaidzhan Institute of Petroleum and Chemistry, Baku. Translated from Inzhenerno-Fizicheskii Zhurnal, Vol.34, No. 3, pp. 465-469, March, 1978. Original article submitted February 14, 1977.

 0022-0841/78/3403-0312$07.50

TABLE 2. Comparison of Thermal-Conductivity Coefficient Values, $\lambda'_s \cdot 10^4$ (W/m · deg) for Six Saturated Liquid Aromatic Hydrocarbons Calculated from Eq. (3) with Experimental Data

p, bar	Benzol			Toluol			Ethylbenzol			o-Xylol			m-Xylol			n-Xylol		
	expt.	(3)	%	expt.	(3)	%	expt.	(3)	%	expt.	(3)	%	expt.	(3)	%	expt.	(3)	%
25	1423	1426	+0,21	1294	1294	0,00	1269	1269	0,00	1286	1283	—0,23	1294	1283	—0,85	1270	1263	—0,55
50	1346	1348	+0,15	1224	1221	—0,24	1204	1197	—0,58	1223	1218	—0,41	1224	1216	—0,65	1210	1202	—0,66
75	1272	1272	0,00	1158	1154	—0,34	1139	1133	—0,52	1163	1158	—0,43	1156	1154	—0,17	1149	1144	—0,43
100	1197	1198	+0,08	1094	1093	—0,09	1077	1075	—0,18	1101	1100	—0,09	1096	1097	+0,09	1090	1089	—0,09
125	1124	1124	0,00	1034	1036	+0,19	1021	1022	+0,10	1045	1047	+0,19	1037	1043	+0,58	1032	1037	+0,48
150	1053	1053	0,00	980	983	+0,31	968	974	+0,62	991	996	+0,50	982	994	+1,22	978	989	+1,12
175	984	982	—0,20	930	934	+0,43	921	930	+0,98	941	948	+0,74	936	947	+1,17	930	942	+1,29
200	916	913	—0,33	884	888	+0,45	880	889	+1,02	895	902	+0,78	894	904	+1,12	887	899	+1,35
225	852	845	—0,82	844	846	+0,24	846	852	+0,70	853	859	+0,70	857	863	+0,70	850	857	+0,82
250	790	778	—1,52	808	806	—0,24	817	818	+0,12	816	818	+0,24	825	825	0,00	816	817	+0,12
275	700	713	+1,86	774	768	—0,77	792	786	—0,76	784	779	—0,64	796	789	—0,88	787	780	—0,89
300	—	—	—	733	733	0,00	764	756	—1,05	754	742	—1,59	770	755	—1,95	762	744	—2,36
Mean error			0,43			0,27			0,55			0,54			0,77			0,85

Note. t_{cr} = 289.45°C [11].

As is evident from Table 2, the mean deviation of λ'_s, calculated with Eq. (3) from the values determined by extrapolation comprises 0.57%.

Then, using the linearity of the isotherms

$$\frac{\lambda}{\lambda'_s} - 1/\rho = B_\lambda + H_\lambda \rho^6, \tag{4}$$

obtained from Eq. (2), the method of least squares was used to calculate the values of the temperature-dependent coefficients B_λ and H_λ for all six hydrocarbons considered.

Further studies revealed that these coefficients can be obtained from the following empirical expressions:

$$\lg H_\lambda = a_1 + b_1 T \tag{5}$$

and

$$-\frac{B_\lambda}{H_\lambda} = a_2 + b_2 T, \tag{6}$$

where a_1, b_1 and a_2, b_2 are constant coefficients whose values for the liquids considered are presented in Table 3.

With B_λ, H_λ, and $\lambda_{s'}$ known, the values of the thermal conductivity coefficients λ may now be found from Eq. (2):

$$\lambda = \lambda'_s (1 + B_\lambda \rho + H_\lambda \rho^7). \tag{7}$$

It should be noted that the experimental values of thermal conductivity coefficient λ were determined to an accuracy of 1.6%, with 3.0-3.5% in the critical region.

As is evident from Table 4, the values calculated from Eq. (7) agree quite well with experimental data.

From the above it follows that Eq. (3) may be used to calculate the thermal conductivity coefficients of the six aromatic hydrocarbons referred to above over the temperature range given in Table 2 with a mean deviation of less than 1%, while Eq. (7) for λ gives results within the limits of experimental accuracy over the range of Table 4.

*The linearity of Eq. (4) in this coordinate system was illustrated in [12].

TABLE 3. Values of Constants of Eqs. (5), (6) for Six Liquid Aromatic Hydrocarbons

Coefficient	Benzol	Toluol	Ethylbenzol	o-Xylol	m-Xylol	n-Xylol
a_1	—0,88159	—0,52190	—0,52446	—0,41923	—0,39881	—0,57176
b_1	0,00329676	0,00227124	0,00230109	0,00202860	0,00202344	0,00238434
a_2	—0,51893	—0,44838	—0,40871	—0,43224	—0,41207	—0,39233
b_2	285,738	207,609	246,898	266,562	247,937	236,188

TABLE 4. Comparison of Thermal Conductivity Coefficients $\lambda \cdot 10^4$ (W/m · °K) for Six Aromatic Hydrocarbons Calculated by Eq.(7) with Experimental Data

p, bar	Benzol			Toluol			Ethylbenzol		
	expt.	(7)	%	expt.	(7)	%	expt.	(7)	%
				$t = 25$ °C					
25	1434	1443	—0,63	1304	1301	+0,23	1277	1265	+0,94
100	1468	1473	—0,34	1331	1328	+0,22	1303	1291	+0,92
200	1514	1513	+0,07	1366	1363	+0,22	1337	1326	+0,82
300	1559	1554	+0,32	1402	1398	+0,28	1373	1358	+1,09
				$t = 100$ °C					
25	1210	1207	+0,25	1104	1108	—0,36	1088	1084	+0,87
100	1248	1249	—0,08	1136	1142	—0,53	1120	1115	+0,45
200	1298	1304	—0,46	1180	1185	—0,42	1162	1156	+0,52
300	1348	1358	—0,74	1223	1225	—0,16	1204	1195	+0,75
				$t = 200$° C					
25	925	908	+1,84	895	897	—0,22	893	898	—0,56
100	983	977	+0,61	936	941	—0,53	940	942	—0,21
200	1051	1058	—0,67	988	993	—0,51	999	997	+0,20
300	1112	1135	—2,07	1040	1046	—0,58	1056	1050	+0,57
	$t = 275$ °C					$t = 300$ °C			
25	—	—		—	—		770	770	0
100	826	825	+0,12	824	820	+0,48	836	834	+0,24
200	920	930	—1,09	898	890	+0,89	908	905	+0,33
300	1000	1023	—2,30	956	952	+0,42	972	972	0
				$t = 25$ °C					
25	1295	1275	+1,54	1302	1266	+2,76	1278	1262	+0,31
100	1325	1302	+1,74	1330	1294	+2,71	1301	1292	+0,69
200	1366	1339	+1,98	1368	1330	+2,78	1333	1327	+0,45
300	1407	1375	+2,27	1405	1367	+2,70	1366	1357	+0,66
				$t = 100$ °C					
25	1112	1115	—0,27	1104	1117	—1,18	1099	1102	—0,09
100	1143	1148	—0,44	1134	1148	—1,23	1127	1132	—0,44
200	1186	1191	—0,42	1176	1188	—1,02	1166	1173	—0,51
300	1230	1235	—0,41	1218	1232	—1,15	1207	1208	—0,08
				$t = 200$ °C					
25	908	913	—0,55	909	911	—0,22	900	909	—1,00
100	946	956	—1,06	947	953	—0,63	937	951	—1,49
200	1001	1012	—1,10	995	1005	—1,00	989	1003	—1,42
300	1054	1064	—0,95	1046	1055	—0,86	1041	1052	—1,06
				$t = 300$ °C					
25	764	752	+1,57	777	768	+1,16	767	757	+1,30
100	822	811	+1,34	836	828	+0,96	843	819	+2,85
200	887	880	+0,79	899	892	+0,78	907	888	+2,09
300	952	941	+1,16	959	951	+0,83	967	950	+1,76

Since equation of state (1) allows description of the thermodynamic properties of the six hydrocarbons within the limits of experimental accuracy at pressures to 550 bar, it may be assumed that the proposed Eq. (7) may be extended to the same pressure range. A similar equation proposed for water to 500 bar was proved by the studies of [4] to be valid upon extrapolation to 1400 bar.

In conclusion it should be noted that one of the basic advantages of the proposed method is that it ensures agreement of λ with the thermal data p, v, T.

NOTATION

p	is the pressure;
v	is the specific volume;
T	is the temperature;
R	is the universal gas constant;
ρ	is the density;
ρ_s	is the density of saturated liquid;
B, H, and B_λ, H_λ	are the coefficients of Eqs. (1), (2), temperature-dependent;
λ	is the thermal-conductivity coefficient;
λ'_s	is the thermal-conductivity coefficient of saturated liquid.

LITERATURE CITED

1. A. M. Mamedov, T. S. Akhundov, and F. G. Abdullaev, Inzh.-Fiz. Zh., 30, No. 4 (1976).
2. A. M. Mamedov and T. S. Akhundov, Inzh.-Fiz. Zh., 23, No. 3 (1972).
3. A. M. Mamedov, T. S. Akhundov, and D. S. Ismailov, Teplofiz. Vys. Temp., 10, No. 6 (1972).
4. A. M. Mamedov, Inzh.-Fiz. Zh., 28, No. 2 (1975).
5. T. S. Akhundov and N. E. Gasanova, Izv. Vyssh. Uchebn. Zaved., Neft' Gaz, No. 7 (1969).
6. T. S. Akhundov and N. E. Gasanova, Izv. Vyssh. Uchebn. Zaved., Neft' Gaz, No. 11 (1969).
7. N. E. Gasanova, Author's Abstract of Candidate's Dissertation Azizbekov Azerbaidzhan Institute of Petroleum and Chemistry, Baku (1970).
8. T. S. Akhundov, T. M. Zatulivetrova, and N. E. Gasanova, in: Physical Constants and Properties of Matter [in Russian], 5th ed., Standartov, Moscow (1972).
9. T. S. Akhundov, Izv. Vyssh. Uchebn. Zaved., Neft' Gaz, No. 2 (1974).
10. T. S. Akhundov, Izv. Vyssh. Uchebn. Aved., Neft' Gaz, No. 3 (1974).
11. N. B. Vargaftik, Handbook of Thermophysical Properties of Gases and Liquids [in Russian], Moscow (1972).
12. A. M. Mamedov, Inzh.-Fiz. Zh., 27, No. 5 (1974).

CALCULATING SEMICONDUCTOR PARAMETERS BASED ON MEASURING ELECTRICAL AND THERMOPHYSICAL, GALVANIC AND THERMOMAGNETIC EFFECTS USING THE METHOD OF VARYING THE INFLUENCE FACTORS

I. S. Lisker and M. B. Pevzner

UDC 538.63

The methods and the sequence for calculating the semiconductor parameters using the results of measuring the effects of a single experiment are examined. Algorithms for calculating the primary and secondary semiconductor parameters are proposed.

Lisker [1] proposed experimental investigation methods based on the principle formulated by the author of varying the influence factors in an experiment and demonstrated the feasibility of separate determination in a single experiment of all of the electrical and thermophysical, galvanic and thermomagnetic effects (GTME) in solids, arising under the influence of thermal, electric, and magnetic fields.

The most important consequence of the method of varying the influence factors is the possibility of obtaining the maximum amount of physical data during the course of a single experiment under a given number of

Scientific-Research Institute of Agricultural Physics, Leningrad.

Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 34, No. 3, pp. 470-476, March, 1978. Original article submitted February 25, 1977.

0022-0841/78/3403-0315$07.50