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THERMAL CONDUCTIVITY OF CD_3OH, CH_3OH, C_2D_6, C_2H_6 IN THE GASEOUS PHASE

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Results of measurements of the thermal conductivity of CD_3OH, CH_3OH, C_2D_6, and C_2H_6 in the gaseous phase are presented.

The present study is a continuation of a series of experiments on the thermal conductivity of deuterium- and hydrogen-containing isotopic compounds [1-3].

Experimental data are available for the thermal conductivity of methanol CH_3OH and ethane C_2H_6 [4]. It was thus of interest to study the thermal conductivity of CD_3OH and C_2D_6 in the gaseous phase using the same apparatus. The measurements were performed by the heated filament method. The major part of the experimental apparatus consisted of a quartz measurement tube. Tube parameters were: internal diameter D_{in} = 4.07 mm, external diameter D_{ex} = 5.69 mm, platinum wire diameter d = 0.10 mm.

In determining the thermal conductivity coefficient, corrections were considered for radiation from the measurement wire, for temperature drop in the measurement tube wall, and for heat loss from the ends of the apparatus.

TABLE 1. Experimental Data on CH_3OH Thermal Conductivity

T, °K	Q, W	$T_f - T_w$, °K	δT_q, °K	ΔT_g, °K	$\lambda \cdot 10^4$, W/(m·°K)
308,28	0,1464	26,37	0,04	26,33	177
318,89	0,2255	39,56	0,07	39,49	182
342,52	0,3782	58,75	0,11	58,64	206
367,45	0,0707	9,89	0,02	9,87	229
382,99	0,2340	31,03	0,06	30,97	241
436,51	0,3784	39,90	0,10	39,80	300
490,94	0,1365	11,80	0,04	11,76	364
503,25	0,3894	31,83	0,10	31,73	385
516,81	0,6743	52,70	0,17	52,53	402
529,59	0,2634	19,70	0,07	19,63	421
547,79	0,3922	27,52	0,10	27,42	448
558,65	0,3936	27,12	0,10	27,02	454
589,75	0,4108	26,07	0,10	25,74	499

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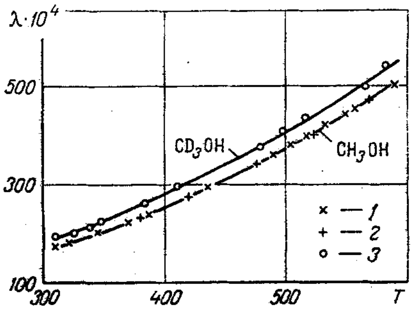

Fig. 1

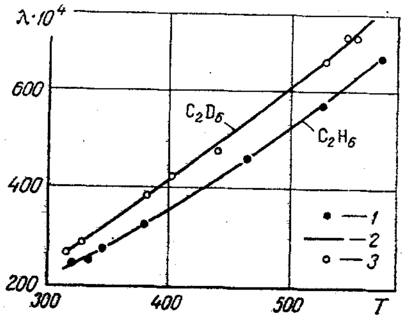

Fig. 2

Fig. 1. Experimentally determined thermal conductivity of CH_3OH: 1) MAI data; 2) [4]; and CD_3OH: 3) MAI data, in gaseous phase versus temperature.

Fig. 2. Experimentally determined thermal conductivity of C_2H_6: 1) MAI data; 2) [4]; and C_2D_6: 3) MAI data, in gaseous phase versus temperature.

TABLE 2. Experimental Data on CD_3OH Thermal Conductivity

T, °K	Q, W	$T_f - T_w$, °K	δT_q, °K	ΔT_g, °K	$\lambda \cdot 10^4$, W/m·°K
306,85	0,1056	17,52	0,03	17,49	193
321,14	0,2223	35,71	0,07	35,64	199
336,21	0,0960	16,86	0,03	16,83	212
349,52	0,2317	32,53	0,07	32,46	228
383,30	0,0490	5,92	0,01	5,91	265
408,45	0,3681	39,46	0,10	39,36	295
483,04	0,0846	7,10	0,02	7,08	376
487,76	0,1784	14,84	0,05	14,79	379
496,97	0,3885	30,01	0,10	29,91	409
517,05	0,7298	53,57	0,19	53,38	430
570,29	0,1904	12,01	0,05	11,96	498
586,96	0,6709	38,31	0,16	38,15	549

TABLE 3. Experimental Data on C_2H_6 Thermal Conductivity

T, °K	Q, W	$T_f - T_w$, °K	δT_q, °K	ΔT_g, °K	$\lambda \cdot 10^4$, W/m·°K
318,8	0,1885	28,46	0,04	28,3	249
327,54	0,1361	19,07	0,04	18,87	258
344,24	0,3340	44,31	0,09	44,06	275
379,6	0,2013	22,75	0,05	22,69	322
462,4	0,3457	28,1	0,09	27,9	460
580,5	0,3494	19,48	0,08	19,81	672
590,2	0,3520	19,88	0,08	20,2	675

To determine the effect of temperature variation, experiments were performed at varying gas pressures close to 1 bar (from 50 to 600 mm Hg). It proved that the temperature change correction was negligibly small (tenths of a percent). The experimental data obtained on thermal conductivity of methanol vapor CH_3OH were in good agreement with the results of [1], with a divergence of less than 1%. The same may be said of the λ data for ethane. The maximum deviation from the results of [2] was 0.5%.

Tables 1, 2 and Fig. 1 present experimental data on the thermal conductivity of conventional methanol CH_3OH and deuterium-bearing CD_3OH in the temperature range (300-690)°K.

Results of λ measurements in conventional ethane C_2H_6 and deuterium-bearing C_2D_6 are shown in Tables 3, 4 and Fig. 2.

It is clear from Figs. 1 and 2 that over the temperature range studied for CH_3OH, CD_3OH, C_2H_6, and C_2D_6 the thermal conductivity of the deuterium-containing compounds is higher than that of the hydrogen-containing compounds.

TABLE 4. Experimental Data on C_2D_6 Thermal Conductivity

T, °K	Q, W	$T_f - T_w$, °K	δT_q, °K	Δ_g, °K	$\lambda \cdot 10^4$, W/m · °K
315,32	0,1840	25,21	0,05	24,96	266
329,12	0,3283	41,82	0,09	41,53	284
381,69	0,3331	31,84	0,09	31,45	388
402,21	0,6487	57,69	0,17	57,22	418
440,67	0,3391	25,99	0,09	26,1	478
531,34	0,3427	19,27	0,08	19,59	663
551,68	0,3436	18,15	0,08	18,37	709
555,13	0,4476	23,47	0,08	23,69	716

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THERMAL CONDUCTIVITY OF CARBON BLACK

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Experimental data are presented on the effective thermal conductivity of carbon black in particle sizes from 0.1 to 0.5 mm in an air medium over the temperature range 350-475°K under pressures of 0.04 to 0.42 MPa.

Various branches of industry make wide use of technical-grade carbon black as a technological ingredient, thermal insulator, thermostable material, etc. The carbon black used in the tire industry is in the form of polydispersed granules 0.2-3.0 mm in size, which are formed in granulators from amorphous carbon black by the addition of a binder solution of molasses in water using 3% molasses by weight. The granules are then dried at temperatures on the order of 350-500°K. In this and certain other processes, in calculating heat-transfer processes it is necessary to know the effective thermal conductivity coefficient of such carbon black particles. In [1-3] some information is provided on the thermal conductivity of lamp black, but these data refer to other brands of carbon black and were obtained in different gaseous media.

The present study made use of the stationary comparative method of determining thermal properties of materials in an inorganic plane layer, described in [4, 5], for determination of the thermal conductivity of type PM-15 carbon black.

Using this method, the carbon black to be studied was first milled into a powderlike state and pressed into the form of a relatively thin circular plate, with thickness less than 0.1 mm diameter. The plates were produced between two reference specimens by pouring carbon black on the top of the lower specimen, which was bounded by a cork ring slipped over its upper part. The poured powder was leveled by light taps on the reference specimen and a second reference specimen placed on top of it within the cork ring. Slight pressure with simultaneous twisting of the reference specimens together provided a final equalization of the carbon black layer height. The transfer parameters of the cork ring are approximately the same as those of the carbon black studied, so that the ring was maintained in place for all experiments as mechanical protection and an aid in eliminating thermal flux loss through the lateral surface into the surrounding medium. The height of the reference specimens together with the carbon black layer was measured by a micrometer to an accuracy of ±0.01 mm. The bar-type experimental apparatus with beam landing system used in the present studies was described in detail in [6].

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