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Thermal Conductivity of Liquid Dimethoxymethane and Dimethoxymethane + Diesel Fuel at Pressures to 30 MPa

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The measurement of thermal conductivity of liquid dimethoxymethane had been performed at temperatures from (245 to 385) K and pressures from saturation pressure to 30 MPa. The thermal conductivity of the mixtures of dimethoxymethane + diesel fuel had been measured in the temperature range from (275 to 375) K and in the pressure range from (5 to 30) MPa with dimethoxymethane mass fractions of 0.05, 0.10, and 0.15. The transient hot-wire method with a single bare platinum hot wire was used. The experimental data of pure dimethoxymethane and the mixtures with diesel fuel, which had an estimated expanded uncertainty of ± 2.0 % with the coverage factor $k = 2$, had been correlated as functions of temperature, pressure, and mass fraction, respectively.

Introduction

Dimethoxymethane, a solvent and analytical reagent, is of great importance in pharmaceuticals, aerosols, paints, varnishes, paint strippers, and cleaning, resin manufacture, ion exchange resins, fragrances, and pesticides. It has been recognized as an excellent fuel additive because it can improve fuel efficiency and optimize emissions of diesel engine.[1] Recently, the measurement of the thermal conductivity of saturated liquid dimethoxymethane had been reported in the previous literature of our group.[2] As an ideal fuel additive, there is an urgent need for the experimental value at high pressures and that of the data of its mixtures with diesel fuel. In this paper, the thermal conductivity of liquid dimethoxymethane was measured at temperatures from (245 to 385) K and pressures from saturation pressure to 30 MPa. The measurements of the mixtures of dimethoxymethane + diesel fuel were performed in the temperature range from (275 to 375) K and in the pressure range from (5 to 30) MPa with dimethoxymethane mass fractions of 0.05, 0.10, and 0.15, respectively.

Experimental Section

The transient hot-wire technique is widely recognized as the most accurate method to measure the thermal conductivity of fluids. In this work, an improved transient hot-wire method apparatus with a single bare platinum wire was used. The fundamental working equation takes the form:

$$\lambda(T_r, P) = \frac{\dfrac{q}{4\pi}}{\dfrac{d\Delta T}{d\ln t}} \tag{1}$$

where q is the power input per unit length of wire, $\lambda(T_r, P)$ represents the thermal conductivity of the fluid at a reference temperature (T_r) and the working pressure (P), $d\Delta T/d\ln t$ is the slope of a linear fit to the ideal temperature rise and the natural logarithm of elapsed time. Detailed descriptions of the transient hot-wire method have been presented elsewhere.[2−6]

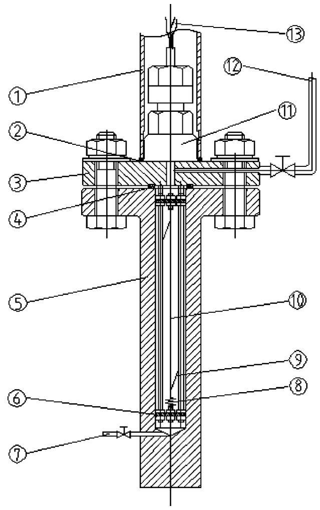

Figure 1. Hot-wire assembly: 1, steel cover; 2, Teflon O-ring; 3, flange; 4, Cu O-ring; 5, pressure vessel; 6, Teflon disk; 7, injecting pipeline; 8, spring; 9, leader; 10, platinum wire; 11, seal; 12, effusing pipeline; 13, leads.

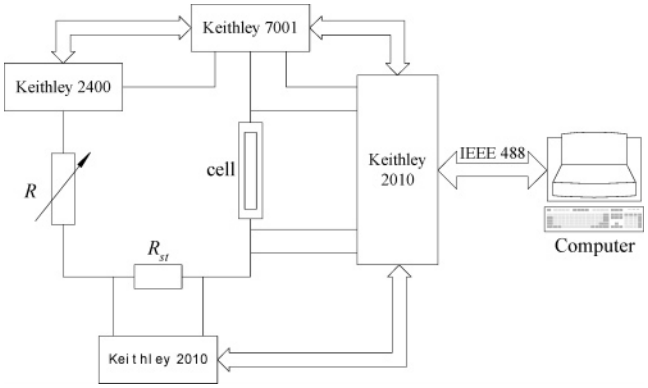

Figure 2. Block diagram of electrical system.

A schematic diagram describing the transient hot-wire assembly is shown in Figure 1. The bare platinum wire (10) was 20 μm in diameter and about 90 mm in length, and a spring (8) was used to ensure a constant tension on the wire. The

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Table 1. Thermal Conductivity of Liquid Dimethoxymethane

T_r/K	P/MPa	q/mW·m^{-1}	λ/W·m^{-1}·K^{-1}	T_r/K	P/MPa	q/mW·m^{-1}	λ/W·m^{-1}·K^{-1}	T_r/K	P/MPa	q/mW·m^{-1}	λ/W·m^{-1}·K^{-1}
244.53	0.10	335.3	0.161	285.05	20.2	529.2	0.154	344.37	5.01	242.7	0.124
244.93	0.10	443.3	0.161	285.36	20.2	610.5	0.154	345.38	10.0	475.7	0.126
245.11	0.10	482.7	0.160	284.56	29.9	418.2	0.157	344.57	10.0	293.7	0.127
245.41	0.10	566.4	0.160	284.78	29.9	490.7	0.157	344.45	10.1	267.6	0.126
245.03	4.97	482.8	0.162	285.35	30.0	610.6	0.157	344.91	10.1	379.1	0.126
245.05	5.05	482.8	0.163	284.81	30.0	453.7	0.158	344.45	20.0	293.7	0.132
245.37	5.08	566.5	0.163	304.55	0.17	300.5	0.138	344.58	20.0	321.0	0.132
244.87	5.09	443.4	0.164	304.77	0.17	360.4	0.137	344.75	20.0	349.5	0.131
244.61	10.0	401.2	0.165	305.05	0.17	425.6	0.138	344.92	20.0	410.1	0.131
245.07	10.0	524.0	0.165	305.56	0.17	534.2	0.136	344.49	30.0	321.0	0.134
244.86	10.1	481.3	0.166	305.35	5.09	496.9	0.139	344.14	30.1	242.8	0.136
245.18	10.1	568.5	0.167	305.49	5.09	534.4	0.139	344.45	30.1	321.0	0.135
244.98	19.9	482.9	0.169	305.80	5.05	613.3	0.139	344.71	30.1	379.2	0.135
244.68	20.0	405.8	0.170	305.03	5.09	425.9	0.139	365.12	0.79	450.2	0.114
244.43	20.0	335.4	0.169	304.45	10.0	300.5	0.143	365.39	0.79	516.8	0.114
245.49	20.0	611.1	0.169	305.01	10.0	425.9	0.143	364.94	0.79	418.6	0.113
244.95	30.0	482.9	0.171	305.17	10.2	460.5	0.142	364.81	0.79	388.1	0.114
245.05	30.0	523.9	0.171	304.76	10.2	360.4	0.142	364.51	4.96	330.7	0.116
244.86	29.9	482.9	0.171	305.82	20.0	654.9	0.146	364.92	4.97	418.6	0.115
244.73	29.9	443.6	0.172	304.31	20.1	272.7	0.146	364.80	5.09	388.1	0.114
264.64	0.10	377.0	0.154	304.54	20.1	329.9	0.146	365.28	5.09	482.9	0.116
264.82	0.10	412.1	0.153	304.93	20.0	425.9	0.146	364.66	10.0	388.1	0.118
264.93	0.10	448.6	0.153	304.38	30.0	300.6	0.150	364.80	10.0	418.6	0.119
265.51	0.10	610.6	0.153	304.22	30.0	272.6	0.150	364.10	10.1	253.2	0.118
265.50	5.13	610.6	0.155	304.94	30.0	460.6	0.149	364.18	10.1	278.0	0.119
264.79	5.09	412.0	0.155	305.12	30.0	496.8	0.150	364.41	20.1	358.9	0.124
265.18	5.05	526.4	0.155	324.26	0.25	231.6	0.129	363.90	20.1	229.7	0.123
264.41	5.17	311.6	0.156	324.49	0.25	282.8	0.130	364.87	20.1	450.2	0.123
264.91	10.1	486.8	0.157	324.60	0.25	310.5	0.130	365.04	20.1	483.0	0.124
264.33	10.1	338.1	0.159	324.89	0.25	369.4	0.129	365.07	29.8	516.8	0.127
265.81	10.1	760.6	0.158	324.71	4.92	339.3	0.132	363.93	29.9	253.2	0.129
264.46	10.1	372.7	0.158	324.82	4.92	369.4	0.131	364.92	29.9	483.0	0.127
264.55	20.0	377.0	0.162	325.57	4.92	539.4	0.130	364.41	29.9	358.9	0.127
264.63	20.0	412.0	0.162	324.95	4.97	400.8	0.131	384.44	0.95	288.5	0.106
265.27	20.0	567.7	0.161	324.44	10.0	282.8	0.135	384.83	0.95	368.6	0.105
264.34	20.1	311.5	0.162	324.79	10.0	369.4	0.135	384.96	0.95	397.6	0.105
264.82	30.0	486.6	0.165	325.11	10.0	433.5	0.133	385.26	0.95	458.7	0.106
265.30	30.0	610.5	0.165	324.93	10.1	400.8	0.134	384.11	4.88	240.5	0.108
265.60	30.0	700.8	0.165	324.57	20.0	339.3	0.138	384.19	4.92	264.0	0.107
264.25	30.0	311.5	0.165	325.26	20.0	502.8	0.138	385.22	4.92	458.6	0.108
284.27	0.10	290.4	0.145	324.81	20.0	400.8	0.139	384.80	5.01	368.6	0.107
284.56	0.10	351.4	0.145	325.48	20.1	577.2	0.139	384.16	9.92	288.5	0.111
284.64	0.10	384.1	0.146	324.48	30.0	339.3	0.143	384.26	9.94	458.7	0.111
284.90	0.10	453.7	0.145	325.25	30.0	539.4	0.141	385.14	9.96	368.6	0.111
284.62	5.14	384.0	0.148	324.24	30.1	282.8	0.144	384.16	9.93	264.0	0.111
285.18	5.10	529.2	0.148	324.65	30.1	369.5	0.142	384.69	20.1	347.9	0.116
285.35	5.09	569.0	0.147	345.32	0.12	442.1	0.122	384.75	20.1	307.7	0.115
285.03	5.01	490.6	0.148	345.04	0.12	378.8	0.121	384.42	20.1	422.9	0.115
284.94	10.0	492.3	0.150	344.39	0.29	242.7	0.121	385.23	20.1	269.5	0.116
284.78	10.1	453.8	0.150	345.06	0.29	379.1	0.120	384.61	30.0	408.7	0.121
285.03	10.1	532.4	0.150	344.85	5.05	349.5	0.123	384.87	30.0	470.1	0.121
284.35	10.1	347.4	0.149	345.00	5.01	379.1	0.122	384.45	30.1	374.4	0.120
284.52	20.1	384.1	0.154	344.67	5.01	293.7	0.123	384.17	30.1	305.7	0.121
284.18	20.2	290.4	0.155								

calibration of the resistance-temperature relation of the platinum wire was carried out in the temperature range from (245 to 385) K by the F18 precision thermometry bridge. To compensate for the end effect, two potential leads (9) of the same platinum wire were welded at the positions about 10 mm to each end of the wire. The pressures of liquids in the cell were achieved by a HPLC pump with the pressure readings acquired. The measuring liquids injected from pipeline (7) and effused from pipeline (12). The liquids pressure changed not exceeding 138 Pa•s^{-1} and was accurate within ± 1.0 %. The volume of sample employed in one measurement was about 60 mL including that in the pipelines.

The block diagram in Figure 2 shows the data acquisition system used in the present work. It contains some improvements in comparison with refs 2 and 3. (i) The conventional power supply was replaced by a Keithley 2400 sourcemeter, which can be well-controlled by a computer as a constant voltage source. (ii) The Keithley 7001 switch systems were introduced to the circuit as the switches with a low noise and controlled easily by the computer. All the data acquisition and instrument control were performed by a computer via the IEEE-488 interfaces.

The transient hot-wire apparatus was immersed completely in a thermostatic bath. The methyl silicone oil was selected as the bath fluid for the temperature range from (243 to 403) K. The total uncertainty of temperature for thermal conductivity was less than ± 10 mK•h^{-1} (ITS90) with a coverage factor of $k = 2$. More details about the thermostatic bath and temperature measurement system have been described in previous works.[7,8] The performance of the apparatus was tested by measuring the thermal conductivity of saturated liquid toluene from (245 to 385) K, which agreed with recommended values[9] within a maximum deviation of 0.78 % and a standard deviation of 0.37 %.

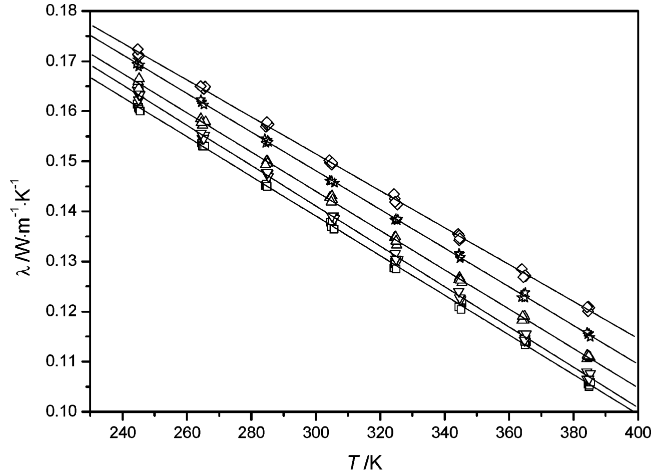

Figure 3. Temperature dependence of the thermal conductivity of dimethoxymethane at different pressure: ◇, saturation pressure; ☆, 5 MPa; △, 10 MPa; ▽, 20 MPa; □, 30 MPa.

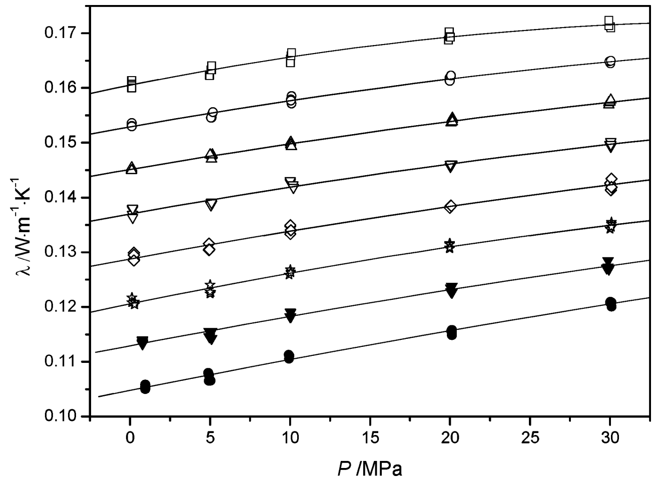

Figure 4. Pressure dependence of the thermal conductivity of dimethoxymethane at different temperature: □, 385 K; ○, 365 K; △, 345 K; ▽, 325 K; ◇305 K; ☆, 285 K; ▼, 265 K; ●, 245 K.

Table 2. Coefficients a_{ij}/W·m^{-1}·K$^{-(i+1)}$·MPa^{-j} Used in Equation 2

	$j = 0$	$j = 1$	$j = 2$
$i = 0$	2.589×10^{-1}	4.787×10^{-4}	-1.224×10^{-5}
$i = 1$	-4.002×10^{-4}	2.178×10^{-7}	2.753×10^{-8}

Results and Discussion

The sample of dimethoxymethane was provided by Shanghai Yongfu Aerosol Manufacturing Co. Ltd. The sample was further purified with sodium wire, followed by fractional distillation from sodium. Finally, the mass fraction purity of dimethoxymethane was better than 99.6 %, as indicated by analysis with the Agilent 6890N gas chromatograph. The sample of diesel fuel was the 0# commercial diesel fuel provided by China Petroleum & Chemical Corporation. Its mass compositions were 72.86 % alkane + alkene and 27.14 % aromatic hydrocarbon. The cetane number and its freezing point were 48 and 273.15 K, respectively. The details can be referred from China Standard of GB 252-2000.

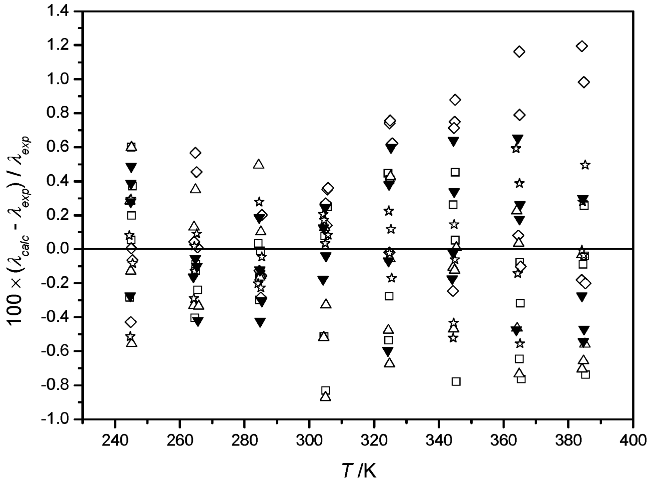

Figure 5. Relative deviations of calculated values by eq 2 from experimental data for pure dimethoxymethane: □, saturation pressure; ◇, 5 MPa; △, 10 MPa; ☆, 20 MPa; ▼, 30 MPa.

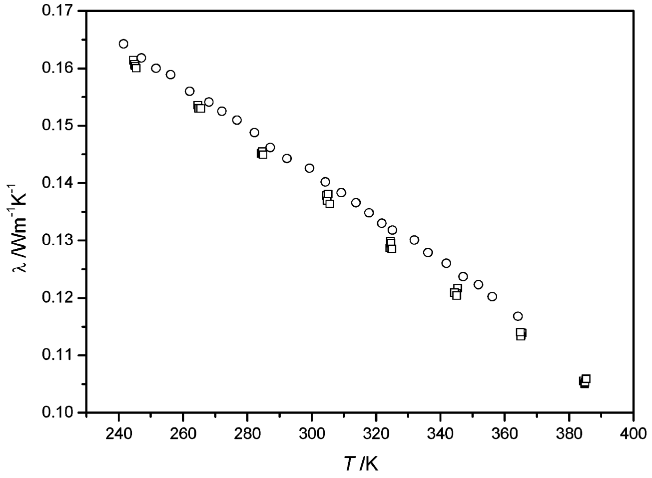

Figure 6. Comparison of the present data with the previous work:[2] □, this work; ○, previous work.

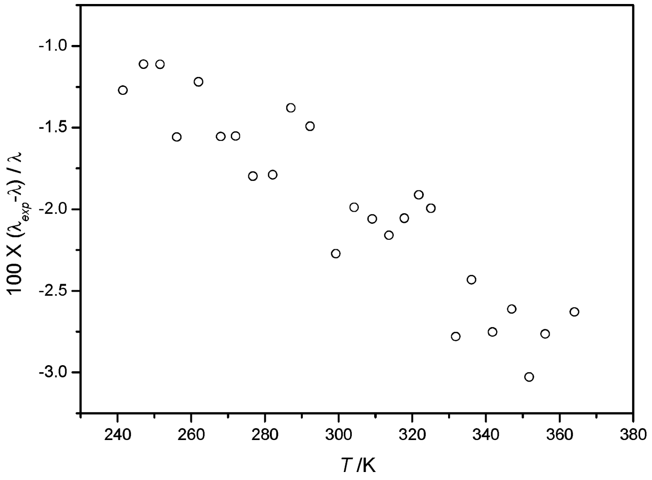

Figure 7. Relative deviations of the experimental results from the previous work.[2]

Dimethoxymethane. Table 1 lists the thermal conductivity of dimethoxymethane in the temperature range from (245 to 385) K and pressure range from saturation pressure to 30 MPa. The temperature rise of the wire in each measurement was about (1 to 3) K. The temperature dependence of the thermal conductivity of dimethoxymethane at different pressures is plotted in Figure 3. Figure 4 illustrates the pressure dependence of the experimental results of dimethoxymethane at different temperatures. The approximating lines in Figure 3 and Figure

Table 3. Thermal Conductivity of Dimethoxymethane + Diesel Fuel; $w = 0.05$

T_r/K	P/MPa	q/mW·m^{-1}	λ/W·m^{-1}·K^{-1}	T_r/K	P/MPa	q/mW·m^{-1}	λ/W·m^{-1}·K^{-1}	T_r/K	P/MPa	q/mW·m^{-1}	λ/W·m^{-1}·K^{-1}
275.13	4.92	370.6	0.134	314.49	10.0	265.3	0.128	354.92	19.9	344.1	0.123
275.32	4.97	406.8	0.133	315.11	10.1	388.6	0.128	355.24	20.0	406.5	0.124
275.32	5.05	406.8	0.133	315.49	10.1	459.1	0.128	355.55	20.0	439.6	0.124
276.06	5.05	525.2	0.134	315.62	10.1	496.5	0.127	354.60	20.1	260.2	0.124
294.90	4.92	345.3	0.129	334.68	9.93	303.8	0.127	375.47	19.9	450.7	0.120
296.32	4.97	613.8	0.129	335.68	9.93	502.1	0.127	374.50	19.9	247.3	0.120
295.66	5.01	489.3	0.130	334.55	10.0	275.5	0.127	374.56	19.9	272.7	0.120
294.64	5.05	282.7	0.129	335.33	10.0	430.4	0.127	374.85	20.0	327.1	0.121
316.13	5.09	575.9	0.125	355.56	9.99	439.6	0.120	275.50	29.9	483.9	0.141
314.80	5.09	324.0	0.126	355.40	10.0	406.5	0.121	274.98	29.7	370.5	0.140
315.94	5.09	535.6	0.125	355.91	10.0	509.9	0.121	274.78	29.9	336.1	0.141
314.67	5.09	293.9	0.126	354.78	10.1	286.8	0.121	275.15	30.0	406.7	0.141
334.71	4.97	303.8	0.124	375.64	9.93	450.7	0.117	295.07	30.0	414.0	0.137
335.52	4.97	465.5	0.124	375.33	10.0	386.4	0.116	295.17	30.0	450.7	0.137
336.14	4.97	579.2	0.125	374.54	10.1	247.3	0.117	295.71	30.0	528.9	0.137
335.70	5.05	502.1	0.124	375.07	10.1	356.1	0.117	294.74	29.9	345.1	0.137
355.97	4.97	509.9	0.122	274.71	19.9	303.4	0.138	314.34	30.0	265.2	0.133
354.77	4.94	286.8	0.123	275.02	19.9	370.5	0.138	315.14	30.0	423.1	0.133
356.22	4.97	546.9	0.123	274.86	20.0	336.1	0.138	314.46	30.0	293.8	0.133
354.67	5.05	260.2	0.123	275.87	20.0	525.0	0.138	315.53	30.0	496.4	0.133
375.86	4.97	484.7	0.115	294.85	19.9	345.2	0.134	334.45	29.9	275.5	0.119
375.88	4.97	484.7	0.115	295.36	20.0	450.8	0.135	334.52	29.9	303.7	0.119
375.14	5.05	356.1	0.114	295.25	20.0	414.1	0.134	335.06	30.0	396.7	0.118
375.18	5.05	356.1	0.115	295.04	20.1	378.9	0.135	335.57	30.1	502.1	0.118
275.12	9.93	370.6	0.135	315.19	19.9	423.1	0.130	355.32	29.8	406.5	0.126
275.72	9.97	484.0	0.135	314.28	20.0	238.1	0.131	354.84	30.0	314.9	0.127
275.87	10.0	525.1	0.135	314.59	20.0	293.8	0.131	354.96	30.1	344.1	0.126
275.28	10.1	406.8	0.135	315.63	20.1	496.4	0.131	355.13	30.2	374.7	0.126
295.61	9.93	489.2	0.132	335.62	19.9	502.2	0.129	374.68	29.8	299.3	0.123
295.06	10.1	379.0	0.131	334.87	20.0	364.4	0.129	375.62	29.9	484.8	0.123
295.42	10.1	450.9	0.132	335.50	20.0	465.6	0.130	375.18	30.0	417.9	0.123
295.22	10.1	414.2	0.131	334.48	20.1	275.6	0.130	375.49	30.1	450.8	0.123

Table 4. Thermal Conductivity of Dimethoxymethane + Diesel Fuel; $w = 0.10$

T_r/K	P/MPa	q/mW·m^{-1}	λ/W·m^{-1}·K^{-1}	T_r/K	P/MPa	q/mW·m^{-1}	λ/W·m^{-1}·K^{-1}	T_r/K	P/MPa	q/mW·m^{-1}	λ/W·m^{-1}·K^{-1}
276.09	5.01	567.3	0.136	316.25	10.0	640.2	0.128	355.20	20.0	422.2	0.125
274.97	5.05	335.8	0.135	315.87	10.0	566.4	0.128	355.62	20.0	508.9	0.125
275.93	5.05	524.5	0.135	314.79	10.0	339.6	0.128	354.52	20.0	295.2	0.124
275.00	4.97	335.8	0.135	315.35	10.1	464.0	0.128	356.04	20.1	610.3	0.125
295.30	4.97	414.4	0.131	334.68	9.93	352.2	0.125	376.21	20.0	623.2	0.121
294.70	5.03	282.9	0.131	335.27	9.93	473.6	0.125	375.77	20.0	529.6	0.121
295.66	5.05	451.1	0.130	336.13	9.93	621.4	0.125	375.46	20.0	462.0	0.121
294.91	5.09	313.3	0.131	335.85	10.0	567.9	0.125	374.54	20.0	292.4	0.121
315.25	5.05	479.8	0.127	356.02	9.97	618.3	0.121	274.91	30.0	382.2	0.142
316.02	5.05	598.9	0.127	355.86	10.0	588.3	0.121	275.16	30.0	452.3	0.142
315.66	5.05	543.5	0.126	355.37	10.0	483.0	0.122	275.83	29.9	591.2	0.142
314.87	5.09	394.2	0.127	354.76	10.1	340.4	0.121	276.01	29.9	645.9	0.142
334.98	4.97	385.9	0.123	375.26	10.0	413.2	0.117	295.14	30.0	414.4	0.138
335.48	4.97	456.0	0.123	374.90	10.0	338.4	0.118	294.70	30.0	313.4	0.138
336.05	5.01	542.4	0.123	375.86	10.0	528.6	0.118	295.00	30.0	379.2	0.138
335.20	5.01	492.1	0.123	376.23	10.1	612.1	0.118	295.75	30.0	529.5	0.137
355.86	5.05	556.3	0.119	275.07	20.1	370.2	0.139	314.82	30.0	393.0	0.135
354.66	5.05	386.0	0.119	275.06	20.1	370.2	0.139	315.28	30.0	471.5	0.134
355.18	4.97	484.7	0.119	275.03	20.1	370.2	0.140	315.88	30.1	582.9	0.135
354.32	4.97	310.4	0.119	274.97	20.1	370.2	0.139	315.53	30.1	523.9	0.134
374.82	4.88	299.6	0.116	294.60	20.0	282.9	0.135	335.29	30.0	476.2	0.131
374.82	4.92	299.6	0.115	295.20	20.0	414.5	0.135	336.15	30.0	685.6	0.130
375.30	4.92	386.8	0.115	295.83	20.0	529.5	0.135	335.93	30.0	621.1	0.131
375.69	4.97	451.2	0.115	295.62	20.2	489.6	0.135	335.57	30.0	539.5	0.131
275.86	10.0	542.7	0.136	315.27	20.0	465.4	0.131	355.65	30.0	495.8	0.127
276.10	10.0	601.3	0.136	316.01	20.0	609.4	0.131	356.04	30.0	572.8	0.127
274.98	10.0	350.2	0.135	314.54	20.0	312.5	0.132	354.91	30.0	355.7	0.127
275.35	10.0	445.4	0.136	315.85	20.0	566.4	0.131	355.12	30.0	400.6	0.127
295.31	10.0	414.5	0.132	336.01	20.0	615.3	0.128	375.93	30.0	581.6	0.123
295.14	10.0	379.3	0.132	335.87	20.0	576.4	0.128	375.58	30.0	498.2	0.123
295.10	10.0	379.3	0.132	335.22	20.0	445.7	0.128	375.30	30.0	468.4	0.123
294.83	9.93	313.4	0.132	334.48	20.1	305.7	0.128	374.79	30.0	353.1	0.124

4 were fitted from the experimental data at different pressures and temperatures, respectively.

Usually the thermal conductivity of fluids is correlated as the function of density and temperature. But the *PVT* data of dimethoxymethane have not been reported at present. In this paper, therefore, the experimental results of liquid dimethoxymethane were correlated by a polynomial of temperature and pressure:

$$\lambda/\mathrm{W{\cdot}m^{-1}{\cdot}K^{-1}} = \sum_{i=0}^{1}\sum_{j=0}^{2} a_{ij}(T/\mathrm{K})^{i}(P/\mathrm{MPa})^{j} \qquad (2)$$

Table 5. Thermal Conductivity of Dimethoxymethane + Diesel Fuel; $w = 0.15$'

T_r/K	P/MPa	q/mW·m^{-1}	λ/W·m^{-1}·K^{-1}	T_r/K	P/MPa	q/mW·m^{-1}	λ/W·m^{-1}·K^{-1}	T_r/K	P/MPa	q/mW·m^{-1}	λ/W·m^{-1}·K^{-1}
275.39	4.97	439.9	0.136	314.67	10.1	322.6	0.127	354.88	20.0	381.4	0.125
275.49	4.97	478.9	0.136	314.75	10.1	354.1	0.129	355.34	20.1	466.9	0.125
274.65	5.05	300.2	0.136	315.15	10.1	421.3	0.128	355.85	20.1	590.0	0.126
276.05	5.05	562.3	0.136	315.44	10.1	457.1	0.128	356.24	20.1	692.7	0.125
294.44	5.05	279.7	0.132	335.97	10.1	565.3	0.125	376.03	19.9	633.2	0.121
294.66	5.05	309.9	0.132	336.35	10.1	631.2	0.125	375.76	19.9	567.5	0.122
295.52	5.05	484.1	0.131	335.20	10.0	435.7	0.126	375.37	20.0	456.4	0.121
295.77	5.05	523.5	0.132	334.52	10.0	299.8	0.126	374.67	20.0	319.8	0.121
314.89	5.01	354.0	0.127	354.50	10.1	325.3	0.122	275.87	29.9	561.0	0.143
315.45	5.01	457.0	0.128	356.01	10.1	635.1	0.122	275.16	30.1	439.1	0.143
314.42	5.05	264.1	0.127	355.35	10.0	502.4	0.122	275.33	30.1	478.1	0.144
315.08	5.05	386.9	0.128	355.85	10.0	599.2	0.122	274.45	30.1	299.7	0.143
335.13	5.05	425.7	0.124	375.29	10.1	423.1	0.118	295.58	30.0	523.3	0.139
335.30	5.05	485.0	0.124	376.14	10.0	631.6	0.119	294.49	30.0	309.8	0.140
336.37	5.05	622.6	0.124	374.76	10.0	321.3	0.118	294.80	30.0	374.9	0.139
335.98	4.97	582.1	0.124	375.56	10.1	496.3	0.118	294.69	30.0	358.0	0.139
356.03	5.01	585.3	0.120	274.53	19.9	299.8	0.140	314.22	30.0	264.1	0.135
354.14	5.01	303.9	0.120	274.84	20.0	366.2	0.141	314.36	30.0	292.6	0.135
356.63	5.05	666.3	0.120	275.48	20.1	478.2	0.140	315.22	30.0	457.0	0.135
354.79	5.05	462.7	0.120	274.40	20.1	269.1	0.141	315.32	30.0	494.2	0.136
375.26	5.01	419.6	0.116	294.38	20.0	279.6	0.136	336.02	30.0	678.2	0.132
374.86	5.01	325.7	0.116	295.06	20.0	409.6	0.136	335.80	30.0	618.3	0.131
376.12	5.05	629.3	0.117	294.57	20.1	309.7	0.136	334.56	30.0	341.4	0.132
375.57	5.05	472.1	0.116	295.48	20.1	483.8	0.136	335.57	30.0	552.8	0.131
274.98	9.97	366.5	0.137	314.61	20.0	322.5	0.132	355.28	30.0	450.3	0.128
275.56	9.97	478.7	0.137	315.08	20.0	421.3	0.132	355.95	30.0	582.8	0.127
274.50	9.97	269.4	0.136	315.30	20.0	457.1	0.133	354.74	30.0	337.1	0.128
275.36	10.0	439.7	0.137	314.45	20.1	292.6	0.132	355.58	30.0	518.6	0.127
294.62	10.1	309.8	0.133	335.98	20.1	630.1	0.129	375.24	30.0	467.9	0.124
294.80	10.1	341.6	0.133	335.65	20.1	568.2	0.129	375.64	30.0	556.9	0.124
295.13	10.1	409.8	0.132	335.21	20.1	470.6	0.129	375.90	30.0	612.1	0.124
295.60	10.1	484.0	0.132	334.48	20.1	324.1	0.129	374.76	30.1	355.7	0.124

Table 6. Coefficients a_{ijk}/W·m^{-1}·K$^{-(j+1)}$·MPa^{-k} Used in Equation 3

		$k = 0$	$k = 1$	$k = 2$
$i = 0$	$j = 0$	1.825×10^{-1}	7.775×10^{-5}	5.880×10^{-8}
	$j = 1$	-1.888×10^{-4}	1.107×10^{-6}	-1.315×10^{-8}
$i = 1$	$j = 0$	6.372×10^{-2}	-5.247×10^{-3}	1.977×10^{-4}
	$j = 1$	-1.336×10^{-4}	1.412×10^{-5}	-5.407×10^{-7}

The coefficients in eq 2 for dimethoxymethane are listed in Table 2. The correlation can represent the experimental data for liquid dimethoxymethane with the standard deviation of 0.41 % and the maximum deviation of 1.2 % as shown in Figure 5.

To our knowledge, only our group has reported the thermal conductivity of dimethoxymethane at the saturation pressure with an uncertainty less than ± 2 %. Figure 6 illustrates our previous work and the present experimental data at the saturation pressure. Figure 7 shows the relative deviations between them. It can be learned that the deviations are in the declared uncertainty. Compared to our previous work, the measurement system was improved including more advance instruments and new data acquired rate speeded up from 17 readings to 50 readings per second. It can be concluded that the measured data in this paper are more convincing.

Dimethoxymethane* + *Diesel Fuel. The measurements of the thermal conductivity of three mixtures of dimethoxymethane + diesel fuel were carried out in the temperature range from (275 to 375) K and in the pressure range from (5 to 30) MPa with dimethoxymethane mass fractions of 0.05, 0.10, and 0.15. The experimental results of the three mixtures are listed in Tables 3 to 5, respectively.

For engineering applications, the experimental data were correlated by the following correlation:

$$\lambda/\mathrm{W{\cdot}m^{-1}{\cdot}K^{-1}} = \sum_{i=0}^{1}\sum_{j=0}^{1}\sum_{k=0}^{2} a_{ijk} w^i (T/\mathrm{K})^j (P/\mathrm{MPa})^k \qquad (3)$$

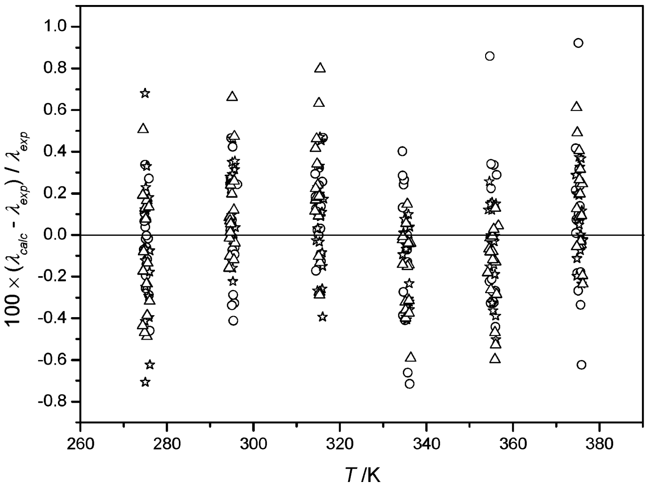

Figure 8. Relative deviations of calculated values by eq 3 from experimental data for dimethoxymethane + diesel fuel: ○, 0.05; ☆, 0.10; △, 0.15.

where w is the mass fraction of dimethoxymethane, $0.05 \le w \le 0.15$. The coefficients in eq 3 for dimethoxymethane are listed in Table 6. Figure 8 illustrates the deviations of the experimental values from eq 3. The maximum deviation is 0.92 %, and the standard deviation is 0.28 %.

Conclusion

The thermal conductivity of liquid dimethoxymethane was measured in the temperature range form (245 to 385) K and pressure range from saturation pressure to 30 MPa. The correlation of the experimental data was provided with the maximum deviation of 1.2 % and the standard deviation of 0.41 %. The thermal conductivity of mixtures of dimethoxymethane + diesel fuel had been measured in the temperature range from (275 to 375) K and in the pressure range from (5 to 30) MPa.

The experimental data were correlated as a function of temperature, pressure, and mass fraction with the maximum deviation of 0.92 % and the standard deviation of 0.28 %. The expanded uncertainty of the experimental data was estimated within ± 2.0 % with the coverage factor $k = 2$.

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