

Thermal conductivity of liquids: Branched chain aliphatic esters

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THERMAL CONDUCTIVITY OF LIQUIDS: BRANCHED CHAIN ALIPHATIC ESTERS

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Data sheets for each of the liquids are given in the following order:

Formula	Name	Alternative Name(s)	
METHANOATES (FORMATES)			
1. $\text{HCOOCH}(\text{CH}_3)_2$	Isopropyl methanoate	Isopropyl formate 1-Methylethyl methanoate 1-Methylethyl formate Propan-2-yl methanoate	7
2. $\text{HCOOCH}_2\text{CH}(\text{CH}_3)_2$	Isobutyl methanoate	Isobutyl formate 2-Methylpropyl methanoate 2-Methylpropyl formate	8
3. $\text{HCOO}[\text{CH}_2]_2\text{CH}(\text{CH}_3)_2$	Isopentyl methanoate	Isoamyl formate 3-Methylbutyl methanoate Isopentyl formate 3-Methylbutyl formate	9
4. $\text{HCOOCH}_2\text{CH}(\text{CH}_2\text{CH}_3)[\text{CH}_2]_3\text{CH}_3$	2-Ethylhexyl methanoate	2-Ethylhexyl formate Isooctyl formate	10

Formula

Name

Alternative Name(s)

ETHANOATES (ACETATES)

5. $\text{CH}_3\text{COOCH}(\text{CH}_3)_2$	Isopropyl ethanoate	Isopropyl acetate 1-Methylethyl ethanoate 1-Methylethyl acetate Propan-2-yl ethanoate	11
6. $\text{CH}_3\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	Isobutyl ethanoate	Isobutyl acetate 2-Methylpropyl ethanoate 2-Methylpropyl acetate	12
7. $\text{CH}_3\text{COO}[\text{CH}_2]_2\text{CH}(\text{CH}_3)_2$	Isopentyl ethanoate	Isoamyl acetate 3-Methylbutyl ethanoate Isopentyl acetate 3-Methylbutyl acetate	14
8. $\text{CH}_3\text{COOCH}_2\text{CH}(\text{CH}_2\text{CH}_3)[\text{CH}_2]_3\text{CH}_3$	2-Ethylhexyl ethanoate	2-Ethylhexyl acetate Isooctyl acetate	16

PROPANOATES (PROPIONATES)

9. $\text{CH}_3\text{CH}_2\text{COOCH}(\text{CH}_3)_2$	Isopropyl propanoate	Isopropyl propionate 1-Methylethyl propanoate 1-Methylethyl propionate Propan-2-yl propanoate	17
10. $\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	Isobutyl propanoate	Isobutyl propionate 2-Methylpropyl propanoate 2-Methylpropyl propionate	18
11. $\text{CH}_3\text{CH}_2\text{COO}[\text{CH}_2]_2\text{CH}(\text{CH}_3)_2$	Isopentyl propanoate	Isoamyl propionate 3-Methylbutyl propanoate Isopentyl propionate 3-Methylbutyl propionate	19
12. $\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}(\text{CH}_2\text{CH}_3)[\text{CH}_2]_3\text{CH}_3$	2-Ethylhexyl propanoate	2-Ethylhexyl propionate Isooctyl propionate	20

BUTANOATES (BUTYRATES)

13. $\text{CH}_3[\text{CH}_2]_2\text{COOCH}(\text{CH}_3)_2$	Isopropyl butanoate	Isopropyl butyrate 1-Methylethyl butanoate 1-Methylethyl butyrate Propan-2-yl butanoate	21
14. $\text{CH}_3[\text{CH}_2]_2\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	Isobutyl butanoate	Isobutyl butyrate 2-Methylpropyl butanoate 2-Methylpropyl butyrate	22
15. $\text{CH}_3[\text{CH}_2]_2\text{COO}[\text{CH}_2]_2\text{CH}(\text{CH}_3)_2$	Isopentyl butanoate	Isoamyl butyrate 3-Methylbutyl butanoate Isopentyl butyrate 3-Methylbutyl butyrate	23
16. $\text{CH}_3[\text{CH}_2]_2\text{COOCH}_2\text{CH}(\text{CH}_2\text{CH}_3)[\text{CH}_2]_3\text{CH}_3$	2-Ethylhexyl butanoate	2-Ethylhexyl butyrate Isooctyl butyrate	24

Formula

Name

Alternative Name(s)

2-METHYLPROPANOATES (ISOBUTYRATES)

17. $(\text{CH}_3)_2\text{CHCOOCH}_3$	Methyl 2-methylpropanoate	Methyl isobutyrate Methyl isobutanoate	25
18. $(\text{CH}_3)_2\text{CHCOOCH}_2\text{CH}_3$	Ethyl 2-methylpropanoate	Ethyl isobutyrate Ethyl isobutanoate	26
19. $(\text{CH}_3)_2\text{CHCOO}[\text{CH}_2]_2\text{CH}_3$	Propyl 2-methylpropanoate	Propyl isobutyrate Propyl isobutanoate	27
20. $(\text{CH}_3)_2\text{CHCOO}[\text{CH}_2]_3\text{CH}_3$	Butyl 2-methylpropanoate	Butyl isobutyrate Butyl isobutanoate	28
21. $(\text{CH}_3)_2\text{CHCOO}[\text{CH}_2]_4\text{CH}_3$	Pentyl 2-methylpropanoate	Amyl isobutyrate Pentyl isobutyrate Pentyl isobutanoate	29
22. $(\text{CH}_3)_2\text{CHCOOCH}(\text{CH}_3)_2$	Isopropyl 2-methylpropanoate	Isopropyl isobutyrate 1-Methylethyl 2-methylpropanoate Isopropyl isobutanoate 1-Methylethyl isobutyrate Propan-2-yl 2-methylpropanoate	30
23. $(\text{CH}_3)_2\text{CHCOOCH}_2\text{CH}(\text{CH}_3)_2$	Isobutyl 2-methylpropanoate	Isobutyl isobutyrate 2-Methylpropyl 2-methylpropanoate Isobutyl isobutanoate 2-Methylpropyl isobutyrate	31
24. $(\text{CH}_3)_2\text{CHCOO}[\text{CH}_2]_2\text{CH}(\text{CH}_3)_2$	Isopentyl 2-methylpropanoate	Isoamyl isobutyrate 3-Methylbutyl 2-methylpropanoate Isopentyl isobutyrate Isopentyl isobutanoate 3-Methylbutyl isobutyrate	32

PENTANOATES (VALERATES)

25. $\text{CH}_3[\text{CH}_2]_3\text{COOCH}(\text{CH}_3)_2$	Isopropyl pentanoate	Isopropyl valerate 1-Methylethyl pentanoate 1-Methylethyl valerate Propan-2-yl pentanoate	33
26. $\text{CH}_3[\text{CH}_2]_3\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	Isobutyl pentanoate	Isobutyl valerate 2-Methylpropyl pentanoate 2-Methylpropyl valerate	34
27. $\text{CH}_3[\text{CH}_2]_3\text{COO}[\text{CH}_2]_2\text{CH}(\text{CH}_3)_2$	Isopentyl pentanoate	Isoamyl valerate 3-Methylbutyl pentanoate Isopentyl valerate 3-Methylbutyl valerate	35
28. $\text{CH}_3[\text{CH}_2]_3\text{COOCH}_2\text{CH}(\text{CH}_2\text{CH}_3)[\text{CH}_2]_3\text{CH}_3$	2-Ethylhexyl pentanoate	2-Ethylhexyl valerate Isooctyl valerate	37

Formula

Name

Alternative Name(s)

3-METHYLBUTANOATES (ISOVALERATES)

29. $(\text{CH}_3)_2\text{CHCH}_2\text{COOCH}_3$	Methyl 3-methylbutanoate	Methyl isovalerate Methyl isopentanoate	38
30. $(\text{CH}_3)_2\text{CHCH}_2\text{COOCH}_2\text{CH}_3$	Ethyl 3-methylbutanoate	Ethyl isovalerate Ethyl isopentanoate	39
31. $(\text{CH}_3)_2\text{CHCH}_2\text{COO}[\text{CH}_2]_2\text{CH}_3$	Propyl 3-methylbutanoate	Propyl isovalerate Propyl isopentanoate	40
32. $(\text{CH}_3)_2\text{CHCH}_2\text{COO}[\text{CH}_2]_3\text{CH}_3$	Butyl 3-methylbutanoate	Butyl isovalerate Butyl isopentanoate	41
33. $(\text{CH}_3)_2\text{CHCH}_2\text{COO}[\text{CH}_2]_4\text{CH}_3$	Pentyl 3-methylbutanoate	Amyl isovalerate Pentyl isovalerate Pentyl isopentanoate	42
34. $(\text{CH}_3)_2\text{CHCH}_2\text{COOCH}(\text{CH}_3)_2$	Isopropyl 3-methylbutanoate	Isopropyl isovalerate 1-Methylethyl 3-methylbutanoate Isopropyl isopentanoate 1-Methylethyl isovalerate Propan-2-yl 3-methylbutanoate	43
35. $(\text{CH}_3)_2\text{CHCH}_2\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	Isobutyl 3-methylbutanoate	Isobutyl isovalerate 2-Methylpropyl 3-methylbutanoate Isobutyl isopentanoate 2-Methylpropyl isovalerate	44
36. $(\text{CH}_3)_2\text{CHCH}_2\text{COO}[\text{CH}_2]_2\text{CH}(\text{CH}_3)_2$	Isopentyl 3-methylbutanoate	Isoamyl isovalerate 3-Methylbutyl 3-methylbutanoate Isopentyl isovalerate Isopentyl isopentanoate 3-Methylbutyl isovalerate	45

HEXANOATES (CAPROATES)

37. $\text{CH}_3[\text{CH}_2]_4\text{COOCH}(\text{CH}_3)_2$	Isopropyl hexanoate	Isopropyl caproate 1-Methylethyl hexanoate 1-Methylethyl caproate Propan-2-yl hexanoate	46
38. $\text{CH}_3[\text{CH}_2]_4\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	Isobutyl hexanoate	Isobutyl caproate 2-Methylpropyl hexanoate 2-Methylpropyl caproate	47
39. $\text{CH}_3[\text{CH}_2]_4\text{COO}[\text{CH}_2]_2\text{CH}(\text{CH}_3)_2$	Isopentyl hexanoate	Isoamyl caproate 3-Methylbutyl hexanoate Isopentyl caproate 3-Methylbutyl caproate	48
40. $\text{CH}_3[\text{CH}_2]_4\text{COOCH}_2\text{CH}(\text{CH}_2\text{CH}_3)[\text{CH}_2]_3\text{CH}_3$	2-Ethylhexyl hexanoate	2-Ethylhexyl caproate Isooctyl caproate	49

Formula

Name

Alternative Name(s)

OCTANOATES (CAPRYLATES)

41. $\text{CH}_3[\text{CH}_2]_6\text{COOCH}(\text{CH}_3)_2$	Isopropyl octanoate	Isopropyl caprylate 1-Methylethyl octanoate 1-Methylethyl caprylate Propan-2-yl octanoate	50
42. $\text{CH}_3[\text{CH}_2]_6\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	Isobutyl octanoate	Isobutyl caprylate 2-Methylpropyl octanoate 2-Methylpropyl caprylate	51
43. $\text{CH}_3[\text{CH}_2]_6\text{COO}[\text{CH}_2]_2\text{CH}(\text{CH}_3)_2$	Isopentyl octanoate	Isoamyl caprylate 3-Methylbutyl octanoate Isopentyl caprylate 3-Methylbutyl caprylate	52
44. $\text{CH}_3[\text{CH}_2]_6\text{COOCH}_2\text{CH}(\text{CH}_2\text{CH}_3)[\text{CH}_2]_3\text{CH}_3$	2-Ethylhexyl octanoate	2-Ethylhexyl caprylate Isooctyl caprylate	53

DECANOATES (CAPRATES)

45. $\text{CH}_3[\text{CH}_2]_8\text{COOCH}(\text{CH}_3)_2$	Isopropyl decanoate	Isopropyl caprate 1-Methylethyl decanoate 1-Methylethyl caprate Propan-2-yl decanoate	54
46. $\text{CH}_3[\text{CH}_2]_8\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	Isobutyl decanoate	Isobutyl caprate 2-Methylpropyl decanoate 2-Methylpropyl caprate	55
47. $\text{CH}_3[\text{CH}_2]_8\text{COO}[\text{CH}_2]_2\text{CH}(\text{CH}_3)_2$	Isopentyl decanoate	Isoamyl caprate 3-Methylbutyl decanoate Isopentyl caprate 3-Methylbutyl caprate	56
48. $\text{CH}_3[\text{CH}_2]_8\text{COOCH}_2\text{CH}(\text{CH}_2\text{CH}_3)[\text{CH}_2]_3\text{CH}_3$	2-Ethylhexyl decanoate	2-Ethylhexyl caprate Isooctyl caprate	57

DODECANOATES (LAURATES)

49. $\text{CH}_3[\text{CH}_2]_{10}\text{COOCH}(\text{CH}_3)_2$	Isopropyl dodecanoate	Isopropyl laurate 1-Methylethyl dodecanoate 1-Methylethyl laurate Propan-2-yl dodecanoate	58
50. $\text{CH}_3[\text{CH}_2]_{10}\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	Isobutyl dodecanoate	Isobutyl laurate 2-Methylpropyl dodecanoate 2-Methylpropyl laurate	59
51. $\text{CH}_3[\text{CH}_2]_{10}\text{COO}[\text{CH}_2]_2\text{CH}(\text{CH}_3)_2$	Isopentyl dodecanoate	Isoamyl laurate 3-Methylbutyl dodecanoate Isopentyl laurate 3-Methylbutyl laurate	60
52. $\text{CH}_3[\text{CH}_2]_{10}\text{COOCH}_2\text{CH}(\text{CH}_2\text{CH}_3)[\text{CH}_2]_3\text{CH}_3$	2-Ethylhexyl dodecanoate	2-Ethylhexyl laurate Isooctyl laurate	61

Formula

Name

Alternative Name(s)

TETRADECANOATES (MYRISTATES)

53. $\text{CH}_3[\text{CH}_2]_{12}\text{COOCH}(\text{CH}_3)_2$	Isopropyl tetradecanoate	Isopropyl myristate 1-Methylethyl tetradecanoate 1-Methylethyl myristate Propan-2-yl tetradecanoate	62
54. $\text{CH}_3[\text{CH}_2]_{12}\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	Isobutyl tetradecanoate	Isobutyl myristate 2-Methylpropyl tetradecanoate 2-Methylpropyl myristate	63
55. $\text{CH}_3[\text{CH}_2]_{12}\text{COO}[\text{CH}_2]_2\text{CH}(\text{CH}_3)_2$	Isopentyl tetradecanoate	Isoamyl myristate 3-Methylbutyl tetradecanoate Isopentyl myristate 3-Methylbutyl myristate	64
56. $\text{CH}_3[\text{CH}_2]_{12}\text{COOCH}_2\text{CH}(\text{CH}_2\text{CH}_3)[\text{CH}_2]_3\text{CH}_3$	2-Ethylhexyl tetradecanoate	2-Ethylhexyl myristate Isooctyl myristate	65

HEXADECANOATES (PALMITATES)

57. $\text{CH}_3[\text{CH}_2]_{14}\text{COOCH}(\text{CH}_3)_2$	Isopropyl hexadecanoate	Isopropyl palmitate 1-Methylethyl hexadecanoate 1-Methylethyl palmitate Propan-2-yl hexadecanoate	66
58. $\text{CH}_3[\text{CH}_2]_{14}\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	Isobutyl hexadecanoate	Isobutyl palmitate 2-Methylpropyl hexadecanoate 2-Methylpropyl palmitate	67
59. $\text{CH}_3[\text{CH}_2]_{14}\text{COO}[\text{CH}_2]_2\text{CH}(\text{CH}_3)_2$	Isopentyl hexadecanoate	Isoamyl palmitate 3-Methylbutyl hexadecanoate Isopentyl palmitate 3-Methylbutyl palmitate	68

OCTADECANOATES (STEARATES)

60. $\text{CH}_3[\text{CH}_2]_{16}\text{COOCH}(\text{CH}_3)_2$	Isopropyl octadecanoate	Isopropyl stearate 1-Methylethyl octadecanoate 1-Methylethyl stearate Propan-2-yl octadecanoate	69
61. $\text{CH}_3[\text{CH}_2]_{16}\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	Isobutyl octadecanoate	Isobutyl stearate 2-Methylpropyl octadecanoate 2-Methylpropyl stearate	70

THERMAL CONDUCTIVITY OF LIQUIDS: BRANCHED CHAIN ALIPHATIC ESTERS

1. INTRODUCTION

This Item presents values of thermal conductivity at saturation pressure, in tabular form, for liquid branched chain aliphatic esters.

The data on which these recommended values of thermal conductivity are based are the most reliable available and the temperature range covered is from the melting temperature to approximately 0.9 of the critical temperature. Quantities are expressed in SI units and conversion factors to other units are provided in Section 3.

Section 4 describes the procedure used to obtain the values of thermal conductivity presented and indicates the effect of pressure. Section 5 gives an explanation of the Tables and indicates the uncertainties in the values presented in them.

References to sources of supplementary information are given in Section 6. The data sources for each particular compound are listed on the appropriate data sheet.

2. NOTATION AND UNITS

The SI unit of thermal conductivity is the watt per metre kelvin (W/m K). A convenient submultiple SI unit for the range of thermal conductivity in this Item is the milliwatt per metre kelvin (mW/m K); hence that is the unit adopted here.

A	constant for each liquid in Equation (4.2)	mW/m K
A'	constant for each liquid in Equation (4.1)	mW/m K
B'	non-dimensional constant for each liquid in Equation (4.1)	–
B, C, D	non-dimensional constants for each liquid in Equation (4.2)	–
p	pressure	N/m ² (Pa)
T	kelvin temperature	K
t	Celsius temperature, $T - 273.15$	°C
λ	thermal conductivity	mW/m K

Subscripts

c	denotes value at the critical point
p	denotes value at pressure p
r	denotes reduced quantity, <i>e.g.</i> $T_r = T/T_c$.

3. CONVERSION FACTORS

$$\begin{aligned}
 1 \text{ mW/m K} &= 0.8598 \times 10^{-3} \text{ kcal/m h } ^\circ\text{C}^* \\
 &= 2.3885 \times 10^{-6} \text{ cal/cm s } ^\circ\text{C}^* \\
 &= 0.5778 \times 10^{-3} \text{ Chu/ft h } ^\circ\text{C}^* \\
 &= 0.5778 \times 10^{-3} \text{ Btu/ft h } ^\circ\text{F}^* \\
 &= 6.9335 \times 10^{-3} \text{ Btu in/ft}^2 \text{ h } ^\circ\text{F}^*
 \end{aligned}$$

$$\begin{aligned}
 10^5 \text{ N/m}^2 &= 1 \text{ bar} \\
 &= 14.5038 \text{ lbf/in}^2 \\
 &= 1.0197 \text{ kgf/cm}^2 \\
 &= 0.9869 \text{ atm} \\
 &= 750.062 \text{ mmHg.}
 \end{aligned}$$

* The values used for the calorie and British Thermal Unit are International Table values.

4. THERMAL CONDUCTIVITY

4.1 Thermal Conductivity at Saturation Pressure

In Reference 2 Riedel showed that the experimental data for the thermal conductivity of normal (that is unassociated) liquids along the saturation line could be represented by the equation:

$$\lambda = A'[1 + (20/3)(1 - T_r)^{2/3}].$$

For the liquids considered in this Item a better representation of the data is obtained, over a wide temperature range, from the modified equation which was used in some earlier ESDU Items:

$$\lambda = A'[1 + B'(1 - T_r)^{2/3}]. \quad (4.1)$$

The range of applicability of Equation (4.1) is limited for most compounds; recent data from several sources show that there may be marked deviations in the regions of the triple point and the critical point from extrapolations of Equation (4.1) fitted in the intermediate region.

For the liquids considered in this Item a good representation of the data* between the melting temperature and $T_r = 0.9$ is obtained from the equation:

$$\lambda = A[1 + B(1 - T_r)^{1/3} + C(1 - T_r)^{2/3} + D(1 - T_r)]. \quad (4.2)$$

Measurements of thermal conductivity have been made for relatively few liquids at $T_r > 0.9$ and so, because of the uncertain variation of thermal conductivity in the critical region, data are presented only for temperatures up to $T_r = 0.9$. The equation extrapolates in a physically realistic manner to within a few kelvin of the critical point.

The critical temperatures for these compounds have either been taken from ESDU 96021 (Reference 9) or estimated from correlations of ESDU values with chemical structure. In this Item, the critical temperatures

* Experimental data at temperatures below the normal boiling temperature, t_b are often at 1 atm pressure. As indicated in Section 4.2 the difference between values of λ at 1 atm pressure and at saturation pressure below t_b is not significant.

should be regarded as correlating parameters only and should not be taken as a source of accurate values.

The derived values of A , B , C and D given in Table 7.1 are a correlated set of values giving the best fit to the experimental data, not only as individual compounds but also as members of their chemical series. This method of correlating data for a series of compounds has been described in References 5 and 6. For the branched chain aliphatic esters in this Item, it was found that C and D are directly related to B^* , as was observed for other non-hydrogen-bonded compounds such as the alkanes. Correlated values of the constants A , B , C and D were used to estimate constants for the majority of the liquids, for which no experimental data exist. Using these values with the values of T_c given in Table 7.1, values of λ in mW/m K have been calculated for each compound from Equation (4.2) and are presented in the data sheets.

4.2 Effect of Pressure

At temperatures up to the normal boiling point, the effect of pressure from the saturation pressure to $50 \times 10^5 \text{ N/m}^2$ (up to 50 atm) is to increase the thermal conductivity by approximately 1 per cent and, for most practical purposes, values at saturation pressure may be taken as equal to those at atmospheric pressure.

Reference 1 gives measurements of thermal conductivity for a number of liquids up to $12\,000 \times 10^5 \text{ N/m}^2$ ($\approx 12\,000 \text{ atm}$) at 30°C and 75°C . A generalised correlation of these results is given in Reference 3, but a knowledge of the critical pressure of the substance is required for its use.

For pressures up to $500 \times 10^5 \text{ N/m}^2$ ($\approx 500 \text{ atm}$) between the melting temperature and the normal boiling point a very approximate relationship:

$$\lambda_p/\lambda \approx 1 + 0.2p \times 10^{-8}, \quad (4.3)$$

may be used where λ_p is the thermal conductivity at pressure p and λ is the thermal conductivity at a pressure of 10^5 N/m^2 ($\approx 1 \text{ atm}$), both at the same temperature.

5. EXPLANATION OF TABLES

The constants of Equation (4.2) are given in Table 7.1 and on the data sheets. Values of the thermal conductivity are given in the data sheets at 10 kelvin intervals in K and $^\circ\text{C}$ from within 10 kelvin of the melting temperature, or an appropriate starting temperature where the melting temperature is unknown, to a temperature corresponding with $T_r \approx 0.9$.

The sources are given in the data sheets and extrapolated values are indicated in parentheses.

For uniformity and ease of interpolation the data are presented and can be read to more significant digits than is warranted by their estimated accuracy.

The experimental data from the most reliable individual sources have a repeatability of about ± 1 per cent although differences in technique used by different workers (and possibly also in the purity of samples) can increase the uncertainty in the absolute values to about ± 2 per cent. However, such reliable data are not available for all the compounds considered, nor over the whole temperature range covered. Although it is considered that the correlation procedures adopted keep the errors in the values presented to a minimum, the user should in general allow for an uncertainty of ± 5 per cent unless the value in the data sheet is truncated to a whole number. Where whole numbers are given the uncertainty increases to ± 10 per cent.

* $C = 1 - 3B$ and $D = 3B$.

Some fluids have poor thermal stability coupled with a high critical temperature. Values have been tabulated for all fluids up to $T_r \approx 0.9$ but many of these fluids will decompose at elevated temperatures. As most compounds will decompose rapidly at temperatures above about 300 °C, uncertainties of greater than ± 10 per cent may occur for temperatures ≥ 573 K.

6. REFERENCES

The references given are recommended sources of information supplementary to that in this Item.

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7. TABLES

TABLE 7.1 Constants for Equation (4.2)

Compound	T_c K	A mW/m K	B	C	D	Range of Applicability °C	
1. Isopropyl methanoate	518.	65.9	1.30	-2.90	3.90	-110	to 200
2. Isobutyl methanoate	551.	64.3	1.20	-2.60	3.60	-90	to 230
3. Isopentyl methanoate	576.	63.0	1.10	-2.30	3.30	-90	to 250
4. 2-Ethylhexyl methanoate	635.	62.0	0.93	-1.79	2.79	-80	to 310
5. Isopropyl ethanoate	531.	64.3	1.20	-2.60	3.60	-70	to 210
6. Isobutyl ethanoate	565.	63.0	1.10	-2.30	3.30	-100	to 240
7. Isopentyl ethanoate	592.	62.4	1.03	-2.09	3.09	-80	to 270
8. 2-Ethylhexyl ethanoate	642.	62.1	0.90	-1.70	2.70	-80	to 310
9. Isopropyl propanoate	557.	63.0	1.10	-2.30	3.30	-100	to 240
10. Isobutyl propanoate	586.	62.4	1.03	-2.09	3.09	-70	to 260
11. Isopentyl propanoate	609.	62.2	0.97	-1.91	2.91	-90	to 280
12. 2-Ethylhexyl propanoate	660.	62.6	0.88	-1.64	2.64	-70	to 330
13. Isopropyl butanoate	577.	62.4	1.03	-2.09	3.09	-100	to 250
14. Isobutyl butanoate	606.	62.2	0.97	-1.91	2.91	-90	to 280
15. Isopentyl butanoate	627.	62.0	0.93	-1.79	2.79	-80	to 300
16. 2-Ethylhexyl butanoate	677.	63.5	0.87	-1.61	2.61	-70	to 340
17. Methyl 2-methylpropanoate	540.7	64.3	1.20	-2.60	3.60	-90	to 220
18. Ethyl 2-methylpropanoate	558.	63.0	1.10	-2.30	3.30	-90	to 240
19. Propyl 2-methylpropanoate	581.	62.4	1.03	-2.09	3.09	-90	to 260
20. Butyl 2-methylpropanoate	606.	62.2	0.97	-1.91	2.91	-90	to 280
21. Pentyl 2-methylpropanoate	627.	62.0	0.93	-1.79	2.79	-80	to 300
22. Isopropyl 2-methylpropanoate	567.	62.4	1.03	-2.09	3.09	-100	to 250
23. Isobutyl 2-methylpropanoate	597.	62.2	0.97	-1.91	2.91	-80	to 270
24. Isopentyl 2-methylpropanoate	617.	62.0	0.93	-1.79	2.79	-80	to 290
25. Isopropyl pentanoate	600.	62.2	0.97	-1.91	2.91	-80	to 270
26. Isobutyl pentanoate	628.	62.0	0.93	-1.79	2.79	-80	to 300
27. Isopentyl pentanoate	645.	62.1	0.90	-1.70	2.70	-80	to 320
28. 2-Ethylhexyl pentanoate	695.	63.1	0.86	-1.58	2.58	-60	to 360
29. Methyl 3-methylbutanoate	569.	63.0	1.10	-2.30	3.30	-50	to 250
30. Ethyl 3-methylbutanoate	584.	62.4	1.03	-2.09	3.09	-100	to 260
31. Propyl 3-methylbutanoate	604.	62.2	0.97	-1.91	2.91	-90	to 280
32. Butyl 3-methylbutanoate	623.	62.0	0.93	-1.79	2.79	-100	to 300

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TABLE 7.1 Constants for Equation (4.2) Continued

Compound	T_c	A	B	C	D	Range of Applicability °C	
	K	mW/m K					
33. Pentyl 3-methylbutanoate	642.	62.1	0.90	-1.70	2.70	-80	to 310
34. Isopropyl 3-methylbutanoate	588.	62.2	0.97	-1.91	2.91	-90	to 260
35. Isobutyl 3-methylbutanoate	620.	62.0	0.93	-1.79	2.79	-90	to 290
36. Isopentyl 3-methylbutanoate	640.	62.1	0.90	-1.70	2.70	-90	to 310
37. Isopropyl hexanoate	620.	62.0	0.93	-1.79	2.79	-70	to 290
38. Isobutyl hexanoate	643.	62.1	0.90	-1.70	2.70	-70	to 310
39. Isopentyl hexanoate	674.	62.6	0.88	-1.64	2.64	-70	to 340
40. 2-Ethylhexyl hexanoate	710.	63.1	0.86	-1.58	2.58	-60	to 370
41. Isopropyl octanoate	660.	62.6	0.88	-1.64	2.64	-70	to 330
42. Isobutyl octanoate	679.	63.5	0.87	-1.61	2.61	-50	to 350
43. Isopentyl octanoate	696.	63.1	0.86	-1.58	2.58	-50	to 360
44. 2-Ethylhexyl octanoate	738.	63.9	0.88	-1.64	2.64	-50	to 400
45. Isopropyl decanoate	695.	63.1	0.86	-1.58	2.58	-60	to 360
46. Isobutyl decanoate	710.	63.1	0.86	-1.58	2.58	-30	to 370
47. Isopentyl decanoate	726.	63.5	0.87	-1.61	2.61	-30	to 390
48. 2-Ethylhexyl decanoate	764.	64.2	0.91	-1.73	2.73	-40	to 420
49. Isopropyl dodecanoate	724.	63.5	0.87	-1.61	2.61	-10	to 390
50. Isobutyl dodecanoate	738.	62.6	0.88	-1.64	2.64	-10	to 400
51. Isopentyl dodecanoate	752.	64.1	0.89	-1.67	2.67	-10	to 410
52. 2-Ethylhexyl dodecanoate	787.	64.1	0.94	-1.82	2.82	0	to 440
53. Isopropyl tetradecanoate	751.	64.1	0.89	-1.67	2.67	0	to 410
54. Isobutyl tetradecanoate	764.	64.2	0.91	-1.73	2.73	0	to 420
55. Isopentyl tetradecanoate	776.	64.2	0.93	-1.79	2.79	0	to 430
56. 2-Ethylhexyl tetradecanoate	808.	64.1	0.99	-1.97	2.97	-30	to 460
57. Isopropyl hexadecanoate	775.	64.2	0.93	-1.79	2.79	20	to 430
58. Isobutyl hexadecanoate	786.	64.1	0.94	-1.82	2.82	10	to 440
59. Isopentyl hexadecanoate	797.	64.2	0.96	-1.88	2.88	10	to 450
60. Isopropyl octadecanoate	797.	64.2	0.96	-1.88	2.88	30	to 450
61. Isobutyl octadecanoate	807.	64.1	0.99	-1.97	2.97	20	to 460

HCOOCH(CH₃)₂ ISOPROPYL METHANOATE
(ISOPROPYL FORMATE, 1-METHYLETHYL METHANOATE,
1-METHYLETHYL FORMATE, PROPAN-2-YL METHANOATE)

$$\lambda = A[1 + B(1 - T_r)^{1/3} + C(1 - T_r)^{2/3} + D(1 - T_r)]$$

where

λ = thermal conductivity at saturation pressure (mW/m K)

$$T_r = T/T_c, \quad T = \text{temperature (K)}$$

$$T_c = 518. \text{ K}$$

$$A = 65.9, \quad B = 1.30, \quad C = -2.90, \quad D = 3.90$$

T K	λ mW/m K	T K	λ mW/m K	t °C	λ mW/m K	t °C	λ mW/m K
160	(169.9)	320	(126.)	-110	(169.0)	50	(125.)
170	(167.0)	330	(123.)	-100	(166.1)	60	(122.)
180	(164.1)	340	(120.)	-90	(163.2)	70	(120.)
190	(161.3)	350	(118.)	-80	(160.4)	80	(117.)
200	(158.4)	360	(115.)	-70	(157.6)	90	(115.)
210	(155.6)	370	(113.)	-60	(154.7)	100	(112.)
220	(152.8)	380	(110.)	-50	(151.9)	110	(110.)
230	(150.0)	390	(108.)	-40	(149.1)	120	(107.)
240	(147.2)	400	(105.)	-30	(146.4)	130	(105.)
250	(144.5)	410	(103.)	-20	(143.6)	140	(102.)
260	(141.7)	420	(101.)	-10	(140.9)	150	(100.)
270	(139.0)	430	(98.)	0	(138.2)	160	(98.)
280	(136.)	440	(96.)	10	(135.)	170	(95.)
290	(134.)	450	(94.)	20	(133.)	180	(93.)
300	(131.)	460	(92.)	30	(130.)	190	(91.)
310	(128.)	470	(89.)	40	(127.)	200	(89.)

HCOOCH₂CH(CH₃)₂ ISOBUTYL METHANOATE

(ISOBUTYL FORMATE, 2-METHYLPROPYL METHANOATE, 2-METHYLPROPYL FORMATE)

$$\lambda = A[1 + B(1 - T_r)^{1/3} + C(1 - T_r)^{2/3} + D(1 - T_r)]$$

where

λ = thermal conductivity at saturation pressure (mW/m K)

$T_r = T/T_c$, T = temperature (K)

$T_c = 551. \text{ K}$

$A = 64.3$, $B = 1.20$, $C = -2.60$, $D = 3.60$

T K	λ mW/m K	T K	λ mW/m K	t °C	λ mW/m K	t °C	λ mW/m K
180	(159.4)	350	(119.)	-90	(158.6)	80	(118.)
190	(156.9)	360	(116.)	-80	(156.1)	90	(116.)
200	(154.4)	370	(114.)	-70	(153.6)	100	(113.)
210	(151.9)	380	(112.)	-60	(151.1)	110	(111.)
220	(149.4)	390	(110.)	-50	(148.7)	120	(109.)
230	(147.0)	400	(107.)	-40	(146.2)	130	(107.)
240	(144.5)	410	(105.)	-30	(143.8)	140	(104.)
250	(142.1)	420	(103.)	-20	(141.3)	150	(102.)
260	(139.7)	430	(101.)	-10	(138.9)	160	(100.)
270	(137.3)	440	(99.)	0	(136.5)	170	(98.)
280	(135.)	450	(97.)	10	(134.)	180	(96.)
290	(133.)	460	(95.)	20	(132.)	190	(94.)
300	(130.)	470	(92.)	30	(129.)	200	(92.)
310	(128.)	480	(90.)	40	(127.)	210	(90.)
320	(125.)	490	(88.)	50	(125.)	220	(88.)
330	(123.)	500	(86.)	60	(122.)	230	(86.)
340	(121.)			70	(120.)		

HCOO[CH₂]₂CH(CH₃)₂ ISOPENTYL METHANOATE (ISOAMYL FORMATE, 3-METHYLBUTYL METHANOATE, ISOPENTYL FORMATE, 3-METHYLBUTYL FORMATE)

$$\lambda = A[1 + B(1 - T_r)^{1/3} + C(1 - T_r)^{2/3} + D(1 - T_r)]$$

where

λ = thermal conductivity at saturation pressure (mW/m K)

$T_r = T/T_c$, T = temperature (K)

$T_c = 576$. K

$A = 63.0$, $B = 1.10$, $C = -2.30$, $D = 3.30$

T K	λ mW/m K	T K	λ mW/m K	t °C	λ mW/m K	t °C	λ mW/m K
180	(154.)	360	115.6	-90	(154.)	90	114.9
190	(152.)	370	113.5	-80	(151.)	100	112.9
200	(150.)	380	111.5	-70	(149.)	110	110.9
210	(148.)	390	109.5	-60	(147.)	120	108.8
220	(145.)	400	107.5	-50	(144.7)	130	106.8
230	(143.2)	410	105.5	-40	(142.5)	140	104.8
240	(141.0)	420	103.5	-30	(140.3)	150	102.9
250	(138.8)	430	102.	-20	(138.2)	160	101.
260	(136.7)	440	100.	-10	(136.0)	170	99.
270	(134.5)	450	98.	0	(133.9)	180	97.
280	(132.4)	460	96.	10	(131.7)	190	95.
290	(130.2)	470	94.	20	(129.6)	200	93.
300	128.1	480	92.	30	127.5	210	91.
310	126.0	490	90.	40	125.3	220	89.
320	123.9	500	88.	50	123.2	230	88.
330	121.8	510	86.	60	121.1	240	86.
340	119.7	520	(84.)	70	119.1	250	(84.)
350	117.6			80	117.0		

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HCOOCH₂CH(CH₂CH₃)[CH₂]₃CH₃ 2-ETHYLHEXYL METHANOATE
(2-ETHYLHEXYL FORMATE, ISOOCTYL FORMATE)

$$\lambda = A[1 + B(1 - T_r)^{1/3} + C(1 - T_r)^{2/3} + D(1 - T_r)]$$

where

λ = thermal conductivity at saturation pressure (mW/m K)

$T_r = T/T_c$, T = temperature (K)

$T_c = 635$. K

$A = 62.0$, $B = 0.93$, $C = -1.79$, $D = 2.79$

T K	λ mW/m K	T K	λ mW/m K	t °C	λ mW/m K	t °C	λ mW/m K
190	(147.)	390	(111.9)	-80	(146.)	120	(111.4)
200	(145.)	400	(110.2)	-70	(145.)	130	(109.7)
210	(143.)	410	(108.5)	-60	(143.)	140	(108.0)
220	(142.)	420	(106.8)	-50	(141.)	150	(106.3)
230	(140.)	430	(105.)	-40	(139.)	160	(105.)
240	(138.)	440	(104.)	-30	(137.)	170	(103.)
250	(136.)	450	(102.)	-20	(136.)	180	(101.)
260	(134.)	460	(100.)	-10	(134.)	190	(100.)
270	(133.)	470	(99.)	0	(132.1)	200	(98.)
280	(130.9)	480	(97.)	10	(130.3)	210	(96.)
290	(129.1)	490	(95.)	20	(128.6)	220	(95.)
300	(127.4)	500	(94.)	30	(126.8)	230	(93.)
310	(125.6)	510	(92.)	40	(125.1)	240	(92.)
320	(123.9)	520	(90.)	50	(123.4)	250	(90.)
330	(122.2)	530	(89.)	60	(121.6)	260	(88.)
340	(120.4)	540	(87.)	70	(119.9)	270	(87.)
350	(118.7)	550	(86.)	80	(118.2)	280	(85.)
360	(117.0)	560	(84.)	90	(116.5)	290	(83.)
370	(115.3)	570	(82.)	100	(114.8)	300	(82.)
380	(113.6)	580	(81.)	110	(113.1)	310	(80.)

CH₃COOCH(CH₃)₂ ISOPROPYL ETHANOATE (ISOPROPYL ACETATE, 1-METHYLETHYL ETHANOATE, 1-METHYLETHYL ACETATE, PROPAN-2-YL ETHANOATE)

$$\lambda = A[1 + B(1 - T_r)^{1/3} + C(1 - T_r)^{2/3} + D(1 - T_r)]$$

where

λ = thermal conductivity at saturation pressure (mW/m K)

$T_r = T/T_c$, T = temperature (K)

$T_c = 531. \text{ K}$

$A = 64.3$, $B = 1.20$, $C = -2.60$, $D = 3.60$

T K	λ mW/m K	T K	λ mW/m K	t °C	λ mW/m K	t °C	λ mW/m K
200	(153.)	350	115.5	-70	(152.)	80	114.8
210	(150.)	360	(113.2)	-60	(149.)	90	(112.5)
220	(147.)	370	(110.9)	-50	(147.)	100	(110.1)
230	(145.)	380	(109.)	-40	(144.)	110	(108.)
240	(142.)	390	(106.)	-30	(142.)	120	(106.)
250	(140.)	400	(104.)	-20	(139.)	130	(103.)
260	(137.)	410	(102.)	-10	(137.)	140	(101.)
270	(135.)	420	(100.)	0	134.	150	(99.)
280	132.	430	(97.)	10	132.	160	(97.)
290	130.	440	(95.)	20	129.	170	(95.)
300	127.	450	(93.)	30	127.	180	(92.)
310	125.	460	(91.)	40	124.	190	(90.)
320	123.	470	(89.)	50	121.9	200	(88.)
330	120.3	480	(87.)	60	119.5	210	(86.)
340	117.9			70	117.1		

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CH₃COOCH₂CH(CH₃)₂ ISOBUTYL ETHANOATE
(ISOBUTYL ACETATE, 2-METHYLPROPYL ETHANOATE, 2-METHYLPROPYL ACETATE)

$$\lambda = A[1 + B(1 - T_r)^{1/3} + C(1 - T_r)^{2/3} + D(1 - T_r)]$$

where

λ = thermal conductivity at saturation pressure (mW/m K)

$T_r = T/T_c$, T = temperature (K)

$T_c = 565$. K

$A = 63.0$, $B = 1.10$, $C = -2.30$, $D = 3.30$

T K	λ mW/m K	T K	λ mW/m K	t °C	λ mW/m K	t °C	λ mW/m K
170	(156.)	350	116.	-100	(155.)	80	116.
180	(153.)	360	114.	-90	(153.)	90	113.
190	(151.)	370	112.	-80	(150.)	100	111.
200	(149.)	380	110.	-70	(148.)	110	109.
210	(147.)	390	108.	-60	(146.)	120	107.
220	(144.)	400	106.	-50	(144.)	130	105.
230	(142.)	410	104.	-40	(142.)	140	103.
240	(140.)	420	102.	-30	(139.)	150	101.
250	(138.)	430	100.	-20	(137.)	160	99.
260	(136.)	440	98.	-10	(135.)	170	97.
270	(133.)	450	96.	0	132.7	180	95.
280	131.2	460	94.	10	130.5	190	93.
290	129.0	470	92.	20	128.4	200	91.
300	126.9	480	90.	30	126.2	210	90.
310	124.7	490	88.	40	124.1	220	88.
320	122.6	500	86.	50	121.9	230	86.
330	120.	510	84.	60	120.	240	84.
340	118.			70	118.		

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**CH₃COO[CH₂]₂CH(CH₃)₂ ISOPENTYL ETHANOATE (ISOAMYL ACETATE,
3-METHYLBUTYL ETHANOATE, ISOPENTYL ACETATE, 3-METHYLBUTYL ACETATE)**

$$\lambda = A[1 + B(1 - T_r)^{1/3} + C(1 - T_r)^{2/3} + D(1 - T_r)]$$

where

λ = thermal conductivity at saturation pressure (mW/m K)

$T_r = T/T_c$, T = temperature (K)

$T_c = 592.$ K

$A = 62.4$, $B = 1.03$, $C = -2.09$, $D = 3.09$

T K	λ mW/m K	T K	λ mW/m K	t °C	λ mW/m K	t °C	λ mW/m K
190	(149.)	370	113.2	-80	(148.)	100	112.6
200	(147.)	380	111.3	-70	(146.)	110	110.7
210	(145.)	390	109.4	-60	(144.)	120	108.8
220	(143.)	400	107.5	-50	(142.3)	130	106.9
230	(140.9)	410	105.7	-40	(140.3)	140	105.1
240	(138.9)	420	103.8	-30	(138.2)	150	103.2
250	(136.9)	430	102.	-20	(136.2)	160	101.
260	(134.8)	440	100.	-10	(134.2)	170	99.
270	(132.8)	450	98.	0	132.2	180	98.
280	130.8	460	96.	10	130.2	190	96.
290	128.9	470	95.	20	128.2	200	94.
300	126.9	480	93.	30	126.2	210	92.
310	124.9	490	91.	40	124.3	220	90.
320	122.9	500	89.	50	122.3	230	89.
330	121.0	510	87.	60	120.4	240	87.
340	119.0	520	86.	70	118.4	250	85.
350	117.1	530	84.	80	116.5	260	83.
360	115.2	540	82.	90	114.6	270	82.

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CH₃COOCH₂CH(CH₂CH₃)[CH₂]₃CH₃ 2-ETHYLHEXYL ETHANOATE
(2-ETHYLHEXYL ACETATE, ISOOCYL ACETATE)

$$\lambda = A[1 + B(1 - T_r)^{1/3} + C(1 - T_r)^{2/3} + D(1 - T_r)]$$

where

λ = thermal conductivity at saturation pressure (mW/m K)

$T_r = T/T_c$, T = temperature (K)

$T_c = 642$. K

$A = 62.1$, $B = 0.90$, $C = -1.70$, $D = 2.70$

T K	λ mW/m K	T K	λ mW/m K	t °C	λ mW/m K	t °C	λ mW/m K
190	(146.)	390	112.2	-80	(146.)	120	111.7
200	(145.)	400	110.6	-70	(144.)	130	110.1
210	(143.)	410	108.9	-60	(142.)	140	108.4
220	(141.)	420	107.3	-50	(140.6)	150	106.8
230	(139.4)	430	(105.7)	-40	(138.8)	160	(105.1)
240	(137.6)	440	(104.0)	-30	(137.1)	170	(103.5)
250	(135.9)	450	(102.4)	-20	(135.4)	180	(101.9)
260	(134.2)	460	(100.8)	-10	(133.6)	190	(100.3)
270	(132.5)	470	(99.2)	0	(131.9)	200	(98.7)
280	(130.8)	480	(98.)	10	(130.2)	210	(97.)
290	(129.1)	490	(96.)	20	(128.5)	220	(95.)
300	127.4	500	(94.)	30	126.8	230	(94.)
310	125.7	510	(93.)	40	125.1	240	(92.)
320	124.0	520	(91.)	50	123.4	250	(91.)
330	122.3	530	(90.)	60	121.7	260	(89.)
340	120.6	540	(88.)	70	120.1	270	(88.)
350	118.9	550	(86.)	80	118.4	280	(86.)
360	117.2	560	(85.)	90	116.7	290	(84.)
370	115.6	570	(83.)	100	115.0	300	(83.)
380	113.9	580	(82.)	110	113.4	310	(81.)

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Unpublished data, Private communication to D.T. Jamieson.