Chapter 24

THERMAL CONDUCTIVITY OF LIQUID AND SOLID

Carl L. Yaws, Xiaoyan Lin, Li Bu and Sachin Nijhawan
Lamar University, Beaumont, Texas

ABSTRACT

Results for thermal conductivity of liquid as function of temperature are presented for a wide range of organic chemicals. Results are also given for thermal conductivity of liquid and solid as function of temperature of inorganic chemicals. The chemicals include many compound types. The results are provided in easy-to-use tabulations that are especially applicable for rapid engineering usage with the personal computer or hand calculator. The agreement of correlation and data is quite good.

INTRODUCTION

Thermal conductivity of liquid and solid is important in many engineering applications in the chemical processing and petroleum refining industries. The objective of this article is to provide the engineer with such data. The compilation of data is presented for a wide temperature range to enable the engineer to determine values at the desired temperatures of interest.

THERMAL CONDUCTIVITY CORRELATION

For organic compounds, the correlation for thermal conductivity of liquid as a function of temperature is given by the equation shown below:

$$\log_{10} k_{liq} = A + B\,[1-T/C]^{2/7} \qquad (24\text{-}1)$$

where k_{liq} = thermal conductivity of liquid, W/(m K)
A, B and C = regression coefficients for chemical compound
T = temperature, K

For inorganic compounds, the correlation for thermal conductivity of liquid and solid as a function of temperature is given by the equation shown below:

$$k = A + B\,T + C\,T^2 \qquad (24\text{-}2)$$

where k = thermal conductivity of liquid or solid, W/(m K)
A, B and C = regression coefficients for chemical compound
T = temperature, K

The results for thermal conductivity of liquid and solid are given in Tables 24-1 and 24-2. The tabulation is arranged by chemical formula to provide ease of use in quickly locating data.

In preparing the compilation, a literature search was conducted to identify data source publications for organics (1-37) and inorganics (1-99). Both experimental values for the property under consideration and parameter values for estimation of the property are included in the source publications. The publications were screened for appropriate data. The compilation resulting from the screening is based on both experimental data and estimated values. In the absence of experimental data for organic compounds, estimates of liquids were primarily based on modified Missenard and Pachaiyappan methods (29) and the Sato equation (29). For inorganic compounds, estimates of liquids were primarily based on modified methods of Sato, Reidel and Pachaiyappan (29). For inorganic compounds, estimates of solids were primarily based on the work of Ho, Powell and Liley (23, 24 and 69). Experimental data and estimates were then regressed to provide the same equation for all compounds.

Very limited experimental data for liquid thermal conductivities are available at temperatures in the region of the melting point. Also, there are very few reliable data at temperatures above a reduced temperature of $T_r = 0.65$. Thus, the values in the regions of melting point and reduced temperatures above 0.65 should be considered rough approximations. The values in the intermediate region (above melting point and below reduced temperature of 0.65) are more accurate.

A comparison of correlation and experimental data is shown in Figure 24-1 for a representative chemical. The graph discloses good agreement of correlation and data.

EXAMPLES

The correlation results maybe used for prediction and calculation of thermal conductivity. Examples are given below.

k_{gas} = - 0.01200 + 1.0208E-04*550 - 2.2403E-08*550^2

k_{gas} = 0.03344 W/(m K)

The calculated and data values compare favorably (0.03344 Vs 0.03228, deviation = 3.59%).

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