Chapter 23

THERMAL CONDUCTIVITY OF GAS

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ABSTRACT

Results for gas thermal conductivity as function of temperature are presented for a wide range of organic and inorganic chemicals. The major chemicals include many compound types. The results are provided in easy-to-use tables 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

Gas thermal conductivity data are 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 temperatures of interest.

THERMAL CONDUCTIVITY CORRELATION

The correlation for thermal conductivity of gas as a function of temperature is given by the equation shown below:

$$k_{gas} = A + B\,T + C\,T^2 \qquad (23\text{-}1)$$

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

The results for gas thermal conductivity at low pressure are given in Tables 23-1 and 23-2. The tabulation is arranged by chemical formula to provides ease of use in quickly locating data.

In preparing the compilation, a literature search was conducted to identify data source publications for organics (1-38) 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 were primarily based on correlations (29) of Roy and Thodos; Misic and Thodos; Stiel and Thodos and modified Eucken models. For inorganic compounds, estimates were primarily based on modified Eucken models. Experimental data and estimates were then regressed to provide the same equation for all compounds.

Very limited experimental data are available for highly polar and high molecular weight compounds. Also, very few experimental data are available at high temperatures above 600 K. Thus, the values for these compounds and high temperatures should be considered rough approximations.

A comparison of correlation and experimental data is shown in Figure 23-1 for a representative chemical. The graph discloses good agreement of correlation and data.

EXAMPLES

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

Example 1 Calculate the gas thermal conductivity of n-hexane (C6H14) at a temperature of 300 K.

Substitution of the coefficients from the table and temperature into the correlation equation yields:

$k_{gas} = - 0.00200 + 7.7788E\text{-}06*300 + 1.3824E\text{-}07*300^2$

$k_{gas} = 0.01278$ W/(m K)

The calculated and data values compare favorably (0.01278 vs 0.00128, deviation = 0.2%).

Example 2 Calculate the gas thermal conductivity of carbon dioxide (CO2) at a temperature of 550 K.

Substitution of the coefficients from the table and temperature into the correlation equation yields:

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

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

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

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