Chapter 9

SURFACE TENSION

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ABSTRACT

Results for surface tension are presented for major organic and inorganic chemicals. For many of the chemicals, the complete temperature range for the liquid is covered from freezing point to the critical point. The results are displayed in easy-to-use tabulations that are especially applicable for rapid engineering usage with the personal computer or hand calculator.

INTRODUCTION

Physical and thermodynamic property data such as surface tension are of special value to engineers in the chemical processing and petroleum refining industries. As an example, surface tension data are important in many chemical-process engineering applications, such as heat, mass and momentum transfer operations that involve process equipment such as heat exchangers, distillation columns, absorption and fluid-flow piping. In this article, results for surface tension as a function of temperature are presented for a wide variety of compounds.

SURFACE TENSION CORRELATION

A modified Othmer relation was selected for correlation of surface tension as a function of temperature:

$$\text{sigma} = A\,(1 - T/T_C)^n \qquad (9\text{-}1)$$

where sigma = surface tension, dynes/cm
A, T_C and n = regression coefficients for chemical compound
T = temperature, K

The results for surface tension are given in Tables 9-1 and 9-2. The tabulations are arranged by chemical formula to provides ease of use in quickly locating data. A wide variety of substances are covered. The range for application is denoted by the respective minimum and maximum temperatures (TMIN and TMAX).

In preparing the compilation, a literature search was conducted to identify data source publications for organics (1-40) and inorganics (1-112). 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, estimates were primarily based on Sugden method (group contribution, 29) and Brock and Bird correlation (corresponding states, 29). Experimental data and estimates were then regressed to provide the same equation for all compounds.

A comparison of calculations and data for surface tension is shown in Figure 9-1 for a representative chemical. The graph indicates good agreement of calculations and data.

EXAMPLES

The correlation results maybe used for prediction and calculation of surface tension. Examples are given below.

Example 1 Estimate the surface tension of carbon tetrachloride (CCl4) at 378.15 K.

Substitution of the regression coefficients from the table and temperature into the equation for surface tension yields:

$$\text{sigma} = 66.750*(1 - 378.15/556.35)^{1.2140}$$

sigma = 16.76 dyne/cm

The calculated and data values compare favorably (16.76 vs 16.64, deviation = 0.7%).

Example 2 Estimate the surface tension of ethane (C2H6) at 133.15 K.

Substitution of the regression coefficients from the table and temperature into the equation for surface tension yields: $\text{sigma} = 48.984*(1 - 133.15/305.42)^{1.2065}$

sigma = 24.55 dyne/cm

The calculated and data values compare favorably (24.55 Vs 24.48, deviation = 0.3%).

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