Measurements of the Surface Tensions of Some Alcohols

K. Tanaka[C,S] and Y. Higashi
Department of Mechanical Systems and Design Engineering, Iwaki Meisei University, Fukushima, Japan
ktanaka@iwakimu.ac.jp

The surface tensions of seven alcohols were measured by the differential capillary-rise method. The alcohols measured in this work were 99.8 % methanol (CH_3OH), 99.5 % ethanol (C_2H_5OH), 99.5 % 1-propanol (C_3H_7OH), 99.0 % 1-butanol (C_4H_9OH), 98.5 % 1-pentanol ($C_5H_{11}OH$), 98.0 % 1-hexanol ($C_6H_{13}OH$), and 98.0 % 1-heptanol ($C_7H_{15}OH$). Measurements of the surface tensions were made in the temperature range between 273 and 360 K, because the surface tension of pure alcohol has a temperature dependence that decreases with increasing temperature. The experimental uncertainties in temperature are estimated to be within 0.02 K.

In order to measure the surface tension by the differential capillary-rise method, the difference between the saturated liquid density value and saturated vapor density value are needed. For the saturated liquid density, the actual measurements were carried out with a vibrating-tube densimeter over the temperature range between 273 and 363 K or boiling point. The correlation of saturated liquid densities for each alcohol was formulated. The experimental uncertainty of the saturated liquid density is estimated to be within 0.044 kg/m^3. The saturated vapor density was calculated by using the equation of state of an ideal gas. The estimated uncertainties with respect to the inner radii of the capillaries were 0.0003 mm for the 0.2754 mm i.d. and 0.0003 mm for the 0.8541 mm i.d. That of the difference of the capillary-rise height value was considered to be less than 0.02 mm. Therefore the uncertainties in the experimental surface tension values were estimated to be within 0.1 mN/m with a coverage factor k = 2.

Based on the experimental data, the correlation of surface tension for each alcohol was formulated. Not only the temperature dependence but also relationships in the number of carbon atoms of alcohols against the surface tension and the saturated liquid density are discussed.