Surface Tension and Density of Water + Ethylene Glycol Mixtures at Low Temperatures Including Metastable Supercooled State

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We introduce new data for the surface tension and density of water + ethylene glycol mixtures obtained with various measuring techniques. An in-house developed apparatus based on a modified capillary rise method [Vinš et al. J. Phys. Chem. B 119 (2015) and Vinš et al. Marine Chem. 213 (2019)] was employed for the measurement of surface tension of low-concentration mixtures at temperatures from +30 down to -27 °C. The presented data contain unique measurements under the supercooled metastable state, i.e. under the equilibrium freezing point temperature. Verification measurements under stable conditions from 10 to 60 °C were carried out with the Wilhelmy plate method for samples with 2, 5, 30, 50, and 75 % wt ethylene glycol. The new data for surface tension show remarkably good agreement with the correlation by Wang et al. [Ind. Eng. Chem. Res. 50 (2011)] including its extrapolation into the supercooled region. The density at 0.1 MPa was measured over the full composition range with the vibrating tube densimeter in the temperature range from 0 to 90 °C. A series of verification measurements with a buoyancy method using a single-crystal silicon was performed in a temperature range from -10 to 30 °C for selected mass fractions of ethylene glycol. The new measurements were compared to the literature data. Empirical correlations for the density of pure ethylene glycol and the excess molar volume of water + ethylene glycol mixture were developed based on own measurements and the literature data. The correlations show physically reasonable behavior in the supercooled region and could therefore be employed in the evaluation of the surface tension data obtained with the capillary rise apparatus.