

Viscosities and Densities of Binary Mixtures of Water with NaCl between 293.15 and 353.15 K

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The thermophysical properties of binary mixtures containing water solutions have been extensively studied with the aim of a better understanding of the intermolecular interactions. A detailed understanding of the excess thermodynamic properties and the behavior of water solutions is important from both practical and fundamental viewpoints. On the other hand, knowledge of the thermophysical properties of electrolyte solutions such as viscosity and density will be helpful for the chemical industry for the design of mass transfer, heat transfer, and fluid flow.

In this work, the viscosity and density of the water solutions were measured at temperatures from 293.15 K to 353.15 K. The excess molar volume of these solutions was found in the literature at 298.15 K. Our literature survey does not include experimental data on the viscosities of the mixture chosen for this study. Densities were measured with an Ostwald- Sprengel type pycnometer, with a capacity of approximately 50 cm³. The uncertainty of the density measurements was estimated to be $3 \cdot 10^{-5}$ g/cm³. The cinematic viscosities of the pure liquids and liquid mixture were measured between 293.15 and 353.15 K with a step of 10 K, and atmospheric pressure was determined with a calibrated Ubbelohde suspended level viscometer of 0.32 mm diameter. The accuracy of the flow time measurement was ± 0.01 s. Flow time was taken as an average of 15 measurements. The viscometer was always kept in a vertical position in a water thermostat controlled to ± 0.01 K. The viscometers were calibrated by using high-purity toluene, heptane, hexane and nonane at the working temperatures. The estimated error of the viscosity measurements was ± 0.5 %. Experimental values of densities and viscosities for the pure liquids at different temperatures were compared with those found in the literature and were in fairly good agreement. The measured values of density (ρ) and viscosity (η) along with the values of deviations in viscosity ($\Delta\eta$) calculated as described below for binary mixtures water(1) + NaCl (2) as a function of mole fraction x_2 . The density values were regressed using the polynomial of the second power; because of the value 2 is the minimal degree of the polynomial capable within the limits of error of the measurements of correlating the character of the temperature-density dependence in the researched interval of temperature.