THE (p, ρ, T) and (p_s, ρ_s, T_s) PROPERTIES OF AQUEOUS METHANOL SOLUTIONS

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The (p, ρ, T) and (p_s, ρ_s, T_s) properties of aqueous methanol solutions at temperatures T=(298.15 to 473.15) K and mole fractions of methanol x=(0.12324, 0.27263, 0.35989, 0.45751, and 0.69221) and from the bubble point pressure up to 60 MPa are reported.
The measurements were carried out by using an apparatus, which used a constant volume piezometer. The apparatus enables one to measure the (p, ρ, T) and (p_s, ρ_s, T_s) properties with high accuracy, as well as to perform experimental isotherms, isochores, and isobars. The volume of the piezometer was 350.13 x 10^{-6} m^3 at room temperature. At these conditions the density of ordinary water is known with high accuracy (0.001-0.003%) from the IAPWS formulation values for ordinary water.
The methanol from "Merck" company (Germany) was used in the experiments. The mass fraction of the methanol was $w\geq 0.998$. Double distilled water was used for the preparation of the solutions. The reliability of the obtained data was verified after each run by a control measurement of volumetric properties of water.
Calculation of deviations for experimental quantities was carried out according to the recommendations of meteorologic services: $\Delta T= \pm 3$ mK for temperature, $\Delta p=\pm 5\cdot 10^{-2}$ MPa for high pressure, $\Delta p=\pm 5\cdot 10^{-4}$ MPa for ambient pressure and $\Delta\rho=\pm 3\cdot 10^{-2}$ $kg\cdot m^{-3}$ for density.
Using standard data fitting programs an equation of state for aqueous methanol solutions was constructed and described below:

$$p = A\rho^2 + B\rho^8 + C\rho^{12}, \qquad (1)$$

where: A, B and C are coefficients of Eq. (1) and all functions of temperature and mole fraction in the following form:

$$A = \sum_{i=1}^{3} T^i \sum_{j=0}^{8} a_{ij} x^j;\ B = \sum_{i=0}^{2} T^i \sum_{j=0}^{8} b_{ij} x^j;\ C = \sum_{i=0}^{2} T^i \sum_{j=0}^{8} c_{ij} x^j. \qquad (2)$$

The a_{ij}, b_{ij} and c_{ij} are the coefficients of the polynomials. The Eq. (1) with Eq. (2) reproduces our experimental values with a ±0.05 % average deviation.

The excess molar volumes V_m^E of {(1-x)H_2O+$x$$CH_3OH$} were calculated from experimental (p, ρ, T) values of solutions using equation (1-2):

$$V_\mathrm{m}^\mathrm{E} = \{xM_\mathrm{a} + (1-x)M_\mathrm{w}\}/\rho - xM_\mathrm{a}/\rho_\mathrm{a} - (1-x)M_\mathrm{w}/\rho_\mathrm{w}, \qquad (1)$$

where: V_m^E is the excess molar volume of solution, M_a and M_w are the molar masses of methanol and water, respectively; and ρ_a and ρ_w are the densities of methanol and water, respectively.