

Clathrate Hydrate Measurements and Thermodynamic Modelling for Refrigerants with Electrolytes Solution in the Presence of Cyclopentane

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Abstract : Phase equilibrium data (dissociation data) for clathrate hydrate (gas hydrate) were undertaken for systems involving fluorinated refrigerants with a single and mixed electrolytes (NaCl, CaCl₂, MgCl₂, and Na₂SO₄) aqueous solution at various salt concentrations in the absence and presence of cyclopentane (CP). The ternary systems for (R410a or R507) with the water system in the presence of CP were performed in the temperature and pressures ranges of (279.8 to 294.4) K and (0.158 to 1.385) MPa, respectively. Measurements for R410a with single electrolyte {NaCl or CaCl₂} solution in the presence of CP were undertaken at salt concentrations of (0.10, 0.15 and 0.20) mass fractions in the temperature and pressure ranges of (278.4 to 293.7) K and (0.214 to 1.179) MPa, respectively. The temperature and pressure conditions for R410a with Na₂SO₄ aqueous solution system were investigated at a salt concentration of 0.10 mass fraction in the range of (283.3 to 291.6) K and (0.483 to 1.373) MPa respectively. Measurements for {R410a or R507} with mixed electrolytes {NaCl, CaCl₂, MgCl₂} aqueous solution was undertaken at various salt concentrations of (0.002 to 0.15) mass fractions in the temperature and pressure ranges of (274.5 to 292.9) K and (0.149 to 1.119) MPa in the absence and presence of CP, in which there is no published data related to mixed salt and a promoter. The phase equilibrium measurements were performed using a non-visual isochoric equilibrium cell that co-operates the pressure-search technique. This study is focused on obtaining equilibrium data that can be utilized to design and optimize industrial wastewater, desalination process and the development of Hydrate Electrolyte-Cubic Plus Association (HE-CPA) Equation of State. The results show an impressive improvement in the presence of promoter (CP) on hydrate formation because it increases the dissociation temperatures near ambient conditions. The results obtained were modeled using a developed HE-CPA equation of state. The model results strongly agree with the measured hydrate dissociation data.

Keywords : association, desalination, electrolytes, promoter

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