Density and Viscosity of Supercritical CO_2-Ethanol Mixtures

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Thermophysical properties of binary mixtures at supercritical conditions, where one species is CO_2 and the other one an alcohol, are important in various supercritical fluid processes; e.g., extraction, chromatography, oil displacement and drying of alcogels to produce aerogels. An apparatus to measure mixture density as a function of temperature (up to 100°C) and pressure (up to 17.24 MPa, i.e., 2500 psia) over the full (0 to 1) range of CO_2 mass fractions was designed and commissioned. It advances the state-of-the-art by assuring a uniform binary mixture, by assuring accuracy by redundant measurements using a variable-volume method accurate to within 1% of reading and a Coriolis density meter accurate to within ±7 kg/m^3 and by increasing the speed at which measurements are obtained. Also measured are the viscosities of the mixtures using a viscometer accurate to 0.02 cP. The fluid delivery system has a syringe pump for each species to enable precise control and rapid variation of the CO_2 mass fraction to within 0.2% of the desired value. Results for the CO_2-ethanol (EtOH) system for 15 different CO_2 mass fractions, including 0 (pure EtOH) and 1 (pure CO_2), at a temperature of 50°C for pressures between 103.4 and 151.7 bar (1500 and 2200 psia) show that key data in the literature are erroneous due to insufficient mixing.