Density and Dynamic Viscosity of Carbon Dioxide + Polyolester Mixtures up to 353.15 K and 60 MPa at Low Lubricant Concentrations

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Following the Kyoto conference on climate change, carbon dioxide has been proposed as a substitute for CFCs and HFCs for refrigeration systems. Pentaerythritol esters, PE, have been suggested as important components of lubricants for refrigeration with carbon dioxide due to their good biodegradability when compared with mineral oils, to their excellent lubricant properties, good thermal stability, and better miscibility with carbon dioxide than other oils. In refrigeration systems, a mixture of the lubrication oil with the refrigerant circulates, so thermophysical properties of mixtures CO_2 + PE over wide ranges of temperature and pressure are needed to optimize the design of refrigeration systems. In the present work, experimental density and dynamic viscosity values at temperatures ranging from (303.15 to 353.15) K and pressures up to 60 MPa are reported, for mixtures of carbon dioxide with four pentaerythritol esters (pentaerythritol tetrapentanoate, VG15, pentaerythritol tetraheptanoate, VG22, pentaerythritol tetranonanoate, VG32, and pentaerythritol tetra-2-ethylhexanoate, VG46) at low lubricant concentrations. Viscosity and density were measured simultaneously using a vibrating-wire sensor, in an apparatus specifically built to study gas–liquid mixtures. The behavior of density and viscosity, and their derived properties (isothermal compressibility, isobaric thermal expansivity, pressure viscosity coefficient and temperature viscosity coefficient) for the different mixtures were analyzed. The viscosity increases significantly with the addition of a slight amount of lubricant to the refrigerant.

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