

Measurements of Solubility, Liquid Density, and Liquid Viscosity for CO₂-Lubricant Mixtures

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Experimental data on solubility, liquid density, liquid viscosity, and miscibility measured with carbon dioxide (CO₂) and three types of potential lubricants, a polyalkylene glycol (PAG), a polyolester (POE), and a polyvinyl ether (PVE) are presented. Measurements were also made and are presented with a baseline polyalkylene glycol (PAG) lubricant with 1,1,1,2-tetrafluoroethane (HFC-134a). An experimental facility for measuring the thermophysical properties of the refrigerant-lubricant mixtures has been developed to carry out experiments from -30 to 125°C with pressures from vacuum to 15.0 MPa. The apparatus operates on a recirculation method utilizing a vibrating tube densimeter for mixture density measurements, an oscillating piston viscometer for mixture viscosity measurements, platinum RTDs for temperature measurements and a precision strain gauge pressure transducer for solubility measurements. Measurements can currently be carried out with temperature uncertainty of ± 0.15 K, uncertainties of ± 20 kPa or ± 3.5 kPa in pressure, liquid density uncertainty of ± 0.002 g/cm³, liquid viscosity uncertainties down to ± 0.1 cP, and liquid refrigerant composition uncertainty below ± 0.002 g/g. The data is presented both in tabular formant and in the form of “Daniel Charts”, a viscosity-temperature chart that contains an overlay of the solubility of the refrigerant-lubricant mixture. Since CO₂ is only partially soluble in the chosen lubricants, the miscibility phase separation boundary (VLLE) was also measured.

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