Viscosity Measurements of Potential ORC Working Fluids in a Sealed Gravitational Capillary Viscometer

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Viscosity measurements of two binary mixtures of 1,1,1,3,3-pentafluoropropane (R245fa, C3H3F5) with n-pentane (C5H12) and of the perfluorinated ether dodecafluoro-2-methylpentan-3-one (C6F12O) were conducted at temperatures from 245 K to 340 K. The mixtures contained R245fa at mole fractions of 0.342 and 0.776, respectively. In sealed gravitational capillary viscometers, the vapor exerts a non-negligible bouyancy on the capillary flow of the liquid. Correcting the efflux measurements for this vapor bouyancy is key to obtain accurate results from such viscometers. Viscosity measurements of R245fa with the present instrument were published in 1998. Their quality was confirmed in 2011 by measurements with a vibrating wire viscometer at Xi'an Jiaotong University. The instrument was calibrated with n-pentane as a volatile compound of accurately known viscosity. The repeatability of the present measurements was found to be approximately 1.4 % leading to an estimated overall combined uncertainty of 2.8 % (k = 2). The measurement results were compared with viscosities predicted with an extended corresponding states model developed at NIST Boulder. Deviations from the model between 15 % at 245 K and -9 % at 340 K were observed for the binary mixtures. They reflect the difficulty to predict the properties of mixtures consisting of a nonpolar and a polar compound. The experimental data provide a basis to improve the predictive capability of the NIST viscosity model for nonideal mixtures. They also contribute to the sound design of efficient power cycles for low-temperature heat utilization.