Viscosity Measurements of Next-Generation Refrigerants in a Sealed Gravitational Capillary Viscometer

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Viscosity measurements of saturated liquid 2,3,3,3-tetrafluoropropene (R1234yf, $C_3H_2F_4$), 1,3,3,3-tetrafluoropropene (R1234ze, $C_3H_2F_4$), and dimethyl ether (DME, C_2H_6O) were conducted in a combined temperature range from 242 K to 350 K. The instrument used for the measurements was a sealed gravitational capillary viscometer developed at NIST for volatile liquids. It had been used extensively from 1996 until 2001 and the quality of the measurement results obtained during this period was confirmed by later measurements at other laboratories with different viscometer techniques. Calibration and adjustment of the instrument constant was conducted with n-pentane as a volatile compound of accurately known viscosity. The repeatability of the present measurements was found to be approximately 1.5 % leading to an estimated overall combined uncertainty of the experimental data of 3.1 % (k = 2). The measurement results were compared with viscosities predicted with an extended corresponding states model developed at NIST Boulder. Deviations from the model of up to 4 % were observed for the fluorinated olefin isomers. While the measured viscosities of R1234ze match those of R134a, those of R1234yf are up to 25 % lower. Literature data for the viscosity of DME exceed the present results systematically up to 12 %. This work provides accurate data to the automotive industry for the design of efficient refrigeration and air conditioning systems with low environmental impact.