Reference Values of the Viscosity of Hydrogen, Methane, Argon, and Xenon Determined with Capillary Viscometers

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Using coiled capillaries, we measured the low-density viscosity of H_2, CH_4, Ar, and Xe with uncertainties of approximately 0.04 %; these uncertainties are an order of magnitude smaller than the uncertainties of previous viscosity measurements. At 298.15 K, we measured the flow rate of these gases through a coiled quartz capillary calibrated using helium and simultaneously measured the pressures at the ends of the capillary. To efficiently extend the temperature range of the data without introducing additional uncertainties, we developed an automated viscometer that features: (1) two nickel capillaries in series, one maintained at 298.15 K, and the second in a variable-temperature bath, (2) voltage controlled piezoelectric leak valves, (3) quartz crystal pressure transducers maintained in thermostatted enclosures, (4) in situ calibration at each temperature and time of use, and (5) analysis using the model for gas flow in coiled capillaries developed by Berg. [Metrologia **42** 11-23 (2005), and erratum (2006)] To calibrate the impedance ratio of the two-capillary viscometer at each temperature, we flowed helium through it and used the viscosity values calculated from an *ab initio* helium-helium potential developed by Hurly et al. [this meeting]. We compare our results with literature data for helium, methane, and hydrogen in the temperature range 200 K to 400 K and with literature results for xenon spanning the range 200 K to 300 K.