

A New Apparatus for Simultaneous Measurements of Viscosity and Density over Wide Temperature and Pressure Ranges

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A newly designed apparatus intended for accurate simultaneous viscosity and density measurements on gases is presented. The reason for a need for a combined precise determination of the density is that accurate viscosity measuring techniques require reliable density values. The working range of the instrument covers temperatures from 240 to 473 K at pressures up to 30 MPa. A vibrating-wire viscometer and a single-sinker densimeter based on Archimedes' buoyancy principle are used to determine the viscosity and the density. Their values together with the measured temperatures and pressures enable us to improve the viscosity surface correlation and the equation of state of the fluids under investigation. An extension to fluid mixtures is planned with regard to the further development of the calculation procedures for industrially important mixtures such as air, humid air, or natural gas. Such procedures are needed for a more accurate basic design of compressors, gas turbines, and gas pipelines.

Several isothermal series of measurements on nitrogen and helium up to pressures of 30 MPa were carried out in order to verify the performance of the new apparatus. In general, the viscosity measurements are characterized by an uncertainty of $\pm 0.25\%$ to $\pm 0.4\%$, whereas the uncertainty in the density is estimated to be less than $\pm 0.1\%$, except for within the low-density range. The measurements made with the new apparatus may appropriately test the viscosity surface correlations and equations of state available in the literature. Furthermore, the new values are compared with direct experimental data. In the near future, measurements will be extended to alkanes, for which only a limited number of reliable viscosity data is available.