A Viscometer for Ammonia-Water Mixtures

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A viscometer is presented that was designed especially for ammonia-water mixtures. Viscosities are measured by applying the transient vibrating-wire technique. The instrument is designed to operate for extended periods at temperatures from 300 to 700 K at pressures to 70 MPa. For limited experimental times, the temperature may be raised to 850 K at pressures no higher than 50 MPa. Measurements may be conducted in single- and two-phase states along isochores. The internal volume of the apparatus is approximately 5.5 cm^3.

Due to the extreme corrosivity of ammonia-water mixtures, the selection of materials is very critical for the instrument. All parts, including the pressure cell, the vibrating wire and its suspension, are built from 316 SS. .For the electrical insulation, high purity alumina ceramic is used. At low temperatures, permanent magnets made from samarium-cobalt alloy provide a high strength magnetic field. These are replaced by aluminum-nickel-cobalt magnets at temperatures above 620 K. Magnets are mounted outside the cell so they can be rotated around it. The wire is tensioned with both ends fixed. The distance between suspension points is 50 mm. Various wire diameters, less than 75 μm, are used depending on the viscosity range investigated. For safety reasons, the volume was designed to be as small as possible and measurements are performed on a closed system along isochores. Viscosity data are reported as function of measured temperature and pressure with the density obtained from an equation of state.

Results of calibration and test measurements on water and toluene are presented and compared to literature values. Principal sources of uncertainty for the viscometer are the evaluation of the wire oscillation and the determination of the sample density. The expanded uncertainty, at the 95% confidence level, for viscosity measurements on ammonia-water mixtures is estimated to be 2.5%.

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