Density Measurements of Deuterium Oxide at Pressure up to 160 MPa

Raffaella Romeo [C, S], P. Alberto Giuliano Albo and Simona Lago
INRIM, Turin, Italy
r.romeo@inrim.it

Giuseppe Cavuoto
Politecnico di Torino, Turin, Italy

Heavy water (D_2O - deuterium oxide) is of interest in different fields for its applications, e.g. as a moderator in nuclear reactors, for diagnostics in nuclear magnetic resonance or for the biological effects on organisms. Currently, there are only a very few experimental measurements of heavy water thermodynamic properties. In this work, an experimental apparatus for measuring heavy water density at high pressure and in a wide range of temperature, by means of a pseudo-isochoric method, and the experimental results are presented. A dedicated stainless steel cell has been devised and built to be used as a pycnometer and filled with a variable mass of heavy water. The latter has been measured by weighing the cell through an analytical balance and by using the substitution method. The reference volume of the cell has been measured by the gravimetric method. In order to correct the reference volume for the effects of temperature and pressure, an accurate calibration has been carried out to experimentally determine its thermal expansion and compressibility coefficients. Each measurement cycle has been performed at constant mass. The cell has been loaded with a sample of heavy water at a certain pressure and then, by changing the temperature value, the pressure has been measured at the equilibrium. Finally, density has been calculated according to its definition, from the mass and volume values. Heavy water density has been measured for temperature down to 253 K and for pressure up to 160 MPa, both in stable and supercooled metastable states. All terms contributing to the uncertainty in determining the volume and the mass have been considered, obtaining an expanded relative uncertainty of D_2O density of 0.05%.