New International Formulations for the Viscosity and Thermal Conductivity of Heavy Water

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The International Association for the Properties of Water and Steam (IAPWS) adopted a new formulation for the thermodynamic properties of heavy water in 2017. This paper describes the development of new correlations for the viscosity and thermal conductivity of heavy water that are consistent with this new equation of state. The correlation for viscosity is valid for fluid states up to 775 K and 960 MPa with uncertainties ranging from 1 % to 5 % depending on the state point. The correlation for thermal conductivity is valid for fluid states up to 825 K and 250 MPa with uncertainties ranging from 1.5% to 6% depending on the state point. Comparisons with experimental data and with previous formulations for the viscosity and thermal conductivity of heavy water are presented. The new formulations account for the critical enhancement of the viscosity and thermal conductivity, which were not incorporated in the previous formulations. In the zero-density limit, the new formulation is consistent with predicted values of viscosity and thermal conductivity at temperatures from 250 to 2500 K obtained from the kinetic theory of polyatomic gases. In addition, the new formulation is applicable over larger ranges of temperature and pressure.