A New Fundamental Equation of State for Heavy Water

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Many engineering applications such as simulation, control, and evaluation of processes in energy technologies demand extensive knowledge about the thermodynamic properties of the involved fluids. Nowadays, the most accurate way to determine these properties is by means of empirical multiparameter equations of state. In this work, a new fundamental equation of state for the thermodynamic properties of heavy water was developed. Since its discovery in the early 1930's, heavy water has been of significant industrial interest, especially in nuclear power cycles. Aside from this application, it is scientifically important as a source of information about the isotopic impacts on thermophysical properties. The current reference equation of state for heavy water was published by *Hill et al. (1982)*. In comparison to modern formulations for other fluids, this equation has an unnecessarily complex functional form with a total of 50 terms. Due to advances in the development of equations of state and modern computer technology, it is now possible to develop an equation with fewer parameters without loss of accuracy. The new equation is explicit in the reduced Helmholtz energy with density and temperature as independent variables. Compared to the formulation by *Hill et al.*(1982), the new equation of state contains less than half the number of terms. It describes the whole fluid region for temperatures and pressures up to T = 825 K and p = 1200 MPa. The accuracy of the equation was validated by comparisons to the available experimental data. Based on an evaluation of properties at extreme conditions of temperature and pressure, the extrapolation behavior of the equation was found to be reasonable. The new formulation will be proposed as a standard for adoption by the International Association for the Properties of Water and Steam (IAPWS).