The Thermophysical Properties of 304L and 16MND5 (A508) Steel Using the Sessile Drop Technique and the Maximum Bubble Pressure Method

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During a severe accident in a nuclear reactor, the core heat up may lead to the formation of a molten pool maintained in the lower plenum of the reactor vessel. The thermalhydraulics of the molten pool is mainly driven by Rayleigh-Bénard convection and Marangoni flow at the upper surface. To compute these flows, the liquid metal physical properties such as density, surface tension, and viscosity, are required. In French reactors, the core component and the vessel are respectively made of 304L steel and 16MND5 (A508) steel. In the present paper, original data of their physical properties are proposed at the melting point and up to 200 °C above the melting point. Density and surface tension measurements have been performed using various techniques at CEA Cadarache and at TU Freiberg: the classical sessile drop technique (CEA), the constrained sessile drop technique (TU Freiberg), and the maximum bubble pressure technique (CEA and TU Freiberg). The measurements have been performed on the same materials at CEA and TU Freiberg allowing benchmark studies. Correlations have been established to define the density and surface tension as a function of the temperature. For the 304L steel, the surface tension temperature coefficient is negative which is explained by the sulfur content (280 ppm) larger than 50 ppm. The measurement uncertainties are presented together with post-test chemical analyses which aim to check the composition evolution after the tests.