A Cubic Statistical Mechanical Based Equation of State for Metals

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Liquid metals exhibit various invaluable characteristics in industrial applications. High boiling temperatures, extended liquid ranges, high thermal conductivities, law vapor pressures and high heats of vaporization have made them very useful in machine design and processing operations. Therefore a precise knowledge of their thermodynamic properties seems to be extremely helpful. In the case of metals, difficult experimental conditions such as high temperatures and low vapor pressures limit the experimental measurements. This has led many investigators to apply various accurate predictive methods. In this work, an analytical equation of state is proposed for different molten metals in the periodic table. This statistical mechanical based 5th order equation of state is that of Song and Mason in conjunction with the corresponding states correlations of Boushehri and Mason. The purpose of this paper is to present a method for predicting the equation of state of liquid metals from properties that are readily available at ordinary pressures and temperatures. In particular, the latent heat of vaporization and the liquid density at melting point are used as two numbers that can correlate and predict the behavior of liquid metals. These two numbers, if not directly available, can be obtained with sufficient accuracy from two measured vapor pressures and liquid densities. The virial coefficients of metals cannot be expected to obey a law of corresponding states for normal fluids. The unique adjustable parameter of the equation of state, γ, is used for compensation of any discrepancies in potential function with respect to the Lennard-Jones potential which is used by Boushehri and Mason. The equation of state includes a great range of (main group and transition) metals in a vast range of temperatures from bellow melting point up to near the critical point and pressures up to 200 MPa with very good accuracies.