

## **An Equation of State for the Calculation of the Thermodynamic Properties of Helium-4**

Eric W. Lemmon<sup>C,S</sup> and Vince Arp

*Thermophysical Properties Division, National Institute of Standards and Technology, Boulder, CO, U.S.A.*

A new formulation is presented for the thermodynamic properties of helium-4 based upon available experimental data. The formulation can be used for the calculation of density, heat capacity, speed of sound, energy, saturation properties, etc., using an equation of state explicit in Helmholtz energy. The equation was made using the latest fitting techniques arrived at during the development of the R-125, propane, and propylene equations of state. These include the behavior of the ideal curves and extrapolation to temperatures far below the triple point temperature and to extremely high temperatures, pressures, and densities. The magnitude of the loops in the two phase were kept to minimum and reasonable values. The equation is valid over all valid liquid, vapor, and supercritical states, except in the superfluid region. The lower temperature limit of the liquid is that of the lambda line. Comparisons to available experimental data are given that establish the accuracy of calculated properties using this equation of state.