

Determination of Equilibrium Fluid Properties from Kinetic Measurements

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The measurement of water properties below its triple point is impeded because of the propensity of water to freeze in this temperature range. A method was recently introduced by which the equilibrium saturation-vapor pressure could be determined from steady-state phase-change experiments and the quantum-mechanically-based statistical rate theory (SRT) [1, 2]. From the measurement of the temperature gradients in the liquid and vapor phases, the evaporation or condensation flux can be determined. The value of this flux and the measured values of the interfacial temperatures and pressures can be used with SRT to predict the value of the saturation vapor pressure, $P_s(T)$, at the interfacial temperature of the liquid phase. The validity of the predictions can be examined by forming a fitting relation for $P_s(T)$ that is valid over a range of temperatures. From this expression, the latent heat, h_{fg} and the constant-pressure specific heat of the liquid, c_{Lp} , can be predicted and compared with independently measured values of these properties. For water, provided that the molecular phonons of the water molecule are included [3], it is found that the predicted values of h_{fg} and c_{Lp} down to $-20\text{ }^\circ\text{C}$ agree well with the independent measurements of these properties. This program is now being carried out using ethanol as the test liquid.

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