Design, Calibration, and Performance of a Vapor-Liquid Equilibria, Coexisting Density, and Surface Tension Apparatus

C.D. Holcomb and S.L. Outcalt
National Institute of Standards and Technology
Physical and Chemical Properties Division
Boulder, CO 80303 USA

A new apparatus capable of measuring vapor-liquid equilibria, densities of coexisting phases, and surface tensions has been designed and constructed. The apparatus is designed to operate over a temperature range from 223 to 423 K and pressures to 17 MPa. It consists of an equilibrium cell, two vibrating tube densimeters, and two recirculating pumps submerged in a well-stirred oil bath to minimize the temperature gradients throughout the system. Surface tension measurements are based on the differential bubble pressure method utilizing two dip tubes located in the main cell. The external piping, valves, pressure measurement system, and the surface tension measurement system are contained in an insulated box controlled at a temperature above the temperature of the equilibrium cell. This is done to prevent condensation in the external lines which may adversely affect the pressure or surface tension measurements. An automated data acquisition system is used to measure temperature, pressure, and liquid and vapor densities at equilibrium. For multi-component systems, a capillary sampling method is used to obtain samples of the liquid and vapor. These samples are analyzed by a gas chromatograph. The pressure transducers, differential pressure transducers, platinum resistance thermometer, and densimeters have been calibrated.

The vapor-liquid equilibrium capabilities of the apparatus are tested. Data for binary refrigerant systems R32/134a and R32/125 are presented. The surface tension and density measurement capabilities of the apparatus are tested with propane. The data are in good agreement with the data from the literature