

Design of a Small-Volume, Quad-Cell, Dual-Method, Dew/Bubble Point Apparatus

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Our apparatus combines both isochoric (constant volume) and isothermal (constant temperature dew- and bubble- point measurements). It consists of four measurement cells: one small isochoric cell for bubble- point measurements, one large isochoric cell for dew-point measurements, one small bellows cell for bubble-point measurements, and one large bellows cell for dew-point measurements. The apparatus operates over a temperature range from 273 to 423 K at pressures to 20 MPa. The isochoric cell volumes have been calibrated for PVT measurements. The apparatus was tested with R134a and used to measure hydrocarbon mixtures. The experimental uncertainties are ± 0.01 K for the temperature measurement, ± 0.0023 MPa for the pressure measurements, ± 0.0002 g/cm³ for the vapor density measurement, and ± 0.001 g/cm³ for the liquid density measurements.

Both methods were incorporated into one apparatus because each method has its own advantages and disadvantages. The isochoric measurement is a simpler design and the volume can be calibrated for density measurements. The advantage of isothermal systems is that they produce dew- and bubble- point pressure data that are more convenient for equation of state development and thermodynamic consistency tests. We can use both methods to check the internal consistency of the measurements or choose the method that is the most appropriate for the system being studied.