

## Design of a Novel Microwave Cylindrical Resonant Cavity for Phase Equilibria Measurements

Rodrigo Susial, Angel Gómez-Hernández, Jorge Rubio, M. Carmen Martín<sup>C, S</sup> and José J. Segovia  
*TERMOCAL (Thermodynamics and Calibration) Research Group, University of Valladolid, Valladolid, Spain*  
*mcarmen.martin@eii.uva.es*

Processing industries require extensive measurements to determine the onset of phase separation in mixtures, often at high pressures and high temperatures. This has led to continuing refinement of techniques for automated determination of phase boundaries and of phase volumes. An additional motivation for the present research originated in our own laboratory from the need to map the phase boundaries of mixtures of environmentally acceptable working fluids for heat engines and mixtures of such fluids with much less volatile lubricants. Here, we describe a novel, rugged, automated apparatus for determining phase boundaries as a function of temperature and pressure. The apparatus is suitable for operation at high temperatures and pressures and with corrosive materials.

The heart of the present apparatus is a novel reentrant microwave cavity resonator. The fluid mixture under study is introduced by a sapphire tube along the cavity. Then the temperature is changed while the pressure and the resonance frequency are monitored. When a new phase appears at either the top or the bottom of the cavity, there is a change in the resonance frequency. This change is easily measured and mostly determined by the change in the dielectric constant of the portion of the mixture contained within the annular gap labeled “capacitor”. The reentrant resonator was very well suited for accurately measuring the dielectric polarizability of fluid samples. This additional capability can be exploited in two ways: the validation of the technique and studying the phase equilibria of a mixture.

Acknowledgements: Support for this work came from the projects: VA035U16 (UIC-114) from the Junta de Castilla y León and ENE2013-47812-R from the Spanish Government.