Determination of Dew Points, Gas Phase Densities and Liquid Volume Fractions of Gas Condensates

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The optimal recovery of natural gas requires knowledge of the dew point and liquid volume fraction (quality) as a function of pressure under reservoir conditions. Present methods of determining these properties require removal of a sample from the reservoir and transportation to a laboratory for the measurements, which usually involve the visual observation of the first onset of liquid, a method that is known to suffer systematic errors. A microwave reentrant cavity has been developed for these measurements that are capable of operating at reservoir conditions. The performance of the apparatus has been tested on a mixture of methane-propane. From the measured frequency in the vicinity of the inductive-capacitive resonance frequency of the cavity the relative permittivity of the fluid can be determined. Gas densities were obtained from the relative permittivity and the results lie within <0.6 % of the values estimated from the Soave-Redlich-Kwong cubic equation of state. Liquid volume fractions, in the 2-phase region, were obtained from the resonance frequency over the volume range (0.5 to 7) ml when the cavity volume (of about 50 ml) had been determined by calibration with octane, for which the permittivity is known. These liquid volume fractions differ from values obtained with the Soave-Redlich-Kwong cubic equation of state by between 0 and to 3 % at T < 326 K and about 8 % in the critical region. The dew pressures for {0.4026 CH_4 0.5974 C_3H_8} agree with literature values and EoS calculations. Details of the construction of the microwave apparatus will be described and the theory underlying the calculation of density and liquid volume for the relative permittivity will be outlined.