Measurement and Correlation of Dielectric Permittivity for Difluoromethane (R32) with a Microwave Cavity Resonator

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Due to the increasing requirement for environmental protection, refrigerants with zero ozone depletion potential (ODP), high efficiency, inexpensive cost, low flammability, and low global warming potential (GWP) are required. Difluoromethane (R32) is one of the most widely-used third-generation refrigerants because of its zero ODP, relatively low GWP, and well-known thermodynamic properties. It is often considered for use in blends with fourth-generation refrigerants. Extensive characterization of the thermodynamic properties of refrigerants and their mixtures is essential for effectively implementing them into existing systems and optimizing new designs.

Methods of studying refrigerant mixtures using microwave cavity resonators are now under development. Studies of mixtures, however, first require the dielectric properties of the component pure fluids be sufficiently well characterized. The dielectric properties of refrigerants are also important for modelling the interaction of working fluids in direct contact with electrically-live parts. To our knowledge, however, only a few data are available for the temperature and pressure dependence of dielectric permittivity of R32.

In this study, dielectric permittivity has been measured using a microwave re-entrant resonator at temperatures from (283 to 343) K and pressures up to 7 MPa for difluoromethane (R32) in the liquid and vapor phase. The complex dielectric permittivity has been determined by measuring the cavity resonance frequency and the half-width of the resonance peak, first under vacuum, and then with the cavity's void filled with R32. Molecular polarizability, dipole moment, and the dielectric virial coefficients of R32 were determined by applying the dielectric virial expansion and Kirkwood equation to the measured permittivity data. In this analysis, the density data at the experimental temperature and pressure was calculated from the equation of state of R32. The resulting dielectric permittivity and polarizability data for R32 will be presented together with a new correlation and comparisons with the available literature data.