

Precise Measurement of the Dielectric Constant of Seawater at 1.413 GHz: The Capillary Exit Hole Correction

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The effect of the capillary-tube exit holes in the microwave resonant cavity used to measure the dielectric constant of seawater at L-band, is investigated. The cavity technique is a perturbation method that uses the change in the resonant frequency and Q of the cavity when seawater is added to determine the complex dielectric constant of seawater. The tube, through which the seawater is introduced into the cavity, enters through two small center holes in the cavity's endplates. It has been suggested in the literature that these small exit holes could affect the change in the resonant frequency measurement, thus introducing a frequency pulling error into the measurements.

Numerical modeling of similar cavities indicates that a frequency pulling effect can occur due to the center holes in the endplates. These simulations indicate that a coaxial TEM-like mode is created in the connector that holds the capillary tube to the endplates. This TEM-like mode reflects from the end of the connector and acts as a resonant circuit. Since the seawater is acting as the center conductor of the TEM guide, the effect should be more noticeable as the conductivity of the seawater increases. The conductivity increases with increasing salinity and temperature. To see whether the frequency-pulling effect is important, a lossy graphite cylinder with a hole in the center has been inserted into the connector, to attenuate the TEM wave. Measurements for high salinity and high temperatures have been made with and without the graphite cylinder. The results of the measurements will be discussed in this study.