ABSTRACT

A microwave technique for measuring small water holdup in oil production pipelines is investigated. The proposed technique utilizes the pipelines as circular waveguides. The cutoff frequency, corresponding to propagating electromagnetic waves in the waveguide is monitored. The cutoff frequency depends on the dielectric constant of the fluids filling the pipeline. Accordingly, the change of the oil to water ratio inside the pipeline results in a change in the dielectric constant. In our study, the fluids are considered static and the water conductivity is considered $(\sigma = 4\ S/m)$.

An aluminum pipe of diameter 43.78 mm is used where the probes are separated by 75.84 or 303.36 mm. The water height inside the pipe changes in steps of around 1 mm to a maximum height of 10 mm. The S-parameters are used to determine the cutoff frequency corresponding to every step of the water height. The oil and water have relative permittivities of 2.15 and 81, respectively. Numerical calculations and experimental measurements are achieved which show a very good agreement. It is found that the cutoff frequency decreases as water height increases.