

Microwave Kick Detector Using Dielectric-Filled Waveguides

Jose Alvarez

Aramco Americas: Aramco Research Center -- Houston

Abstract

The objective of this work is to show the feasibility of a high frequency electromagnetic inline tool to enable real-time detection of kicks or Oil-Brine-Ratio (OBR), the Microwave Drilling Mud Analyzer. This tool could give drillers an early warning that will allow them to react and start safety procedures in advance. The tool test is based on a 3D numerical model of a surface prototype. The tools consist of two dielectrically filled waveguides on opposite sides of a drill mud pipe. They are facing each other and their ends contour to the pipe walls, thus providing no obstruction to the flow. The dielectric constant of the filling material was that of Noryl. Tapered ridges are used to make a smooth coaxial to waveguide transition. The model uses previously published results that showed a direct correlation between the density and the dielectric constant. Thus, the effect of a kick is modelled using a sensitivity analysis of different values of the dielectric constant. The magnitude and phase of the transmission and reflection coefficients were measured for different oil, gas, and water volume fractions. The results demonstrate there is a strong sensitivity on the losses, which allows for detection of brine kicks in oil-based mud or gas kicks in water-based muds. Also, the contrast of water-based mud with average conductive losses and gas, and oil based muds and brine content is significant. Thus, detection of kicks is possible with the current system. The current system can provide real-time information on the OBR and detect any departure from a baseline signal that indicate a type of kick. The fillings of the waveguides are pressure and chemical resistant and can give an early gas kick warning that could give the rig crew enough time to turn emergency procedures, control the kick, and regain well control.