Digital Twin Of Multiphase Flow Loop Test To Develop New Generation Of Production Technologies

M. Arsalan, Saudi Aramco

Abstract
Objectives/Scope: Multiphase flow is frequently encountered in upstream O&G industry which has significant impact on the development of numerous production technologies such as multiphase flow meter. Before the deployment of these technologies in an oil/gas field, the technologies are tested in a multiphase industrial flow loop which emulates multiphase test conditions. This paper presents a digital twin of multiphase flow as a low cost alternative to expensive multiphase flow test.

Methods, Procedures, Process: We have adopted backward strategy to design the digital twin of industrial flow loop. At first, we characterized our proprietary microwave water-cut (WC) meter in an actual flow loop at variable test conditions. Then, multiple digital models of the flow regimes were built and tested on our microwave WC meter. One of those models (namely rotated zigzag) was able to accurately predict WC sensor response over full Water Cut range (0-100%) in oil continuous as well as water continuous flow conditions and under varying salinity levels.

Results, Observations, Conclusions: Two sets of responses have been recorded and compared - first obtained from the industrial flow loop trials and second from our EM simulation model. Key microwave resonator parameters such as resonant frequency (f0) and quality (Q) factor have been compared under varying conditions. The comparison suggests that f0 & Q-factor give higher sensitivity against WC in oil continuous and water continuous flow conditions respectively. Moreover, WC sensor performance was also compared under varying salinity conditions in the range of 20,000 ppm to 80,000 ppm and digital twin is able to successfully predict the sensor response in these conditions as well.

Novel/Additive Information: Significant amount of resources are spent on setting desired flow condition such as flow regime, WC and required salinity level. Our proposed digital twin model is able to emulate all of these multiphase flow conditions at negligible cost. It can help develop & test new production technologies without requiring to spend huge amount of money on lengthy, complex and expensive multiphase flow loop tests.