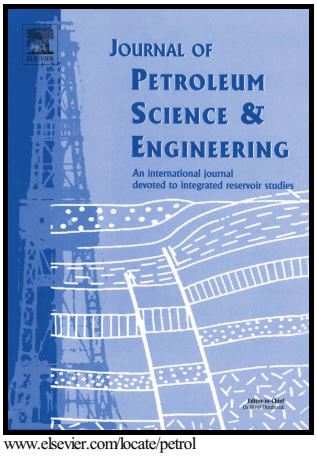

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Experiments and Simulation of Water Displacement from Lower Sections of Oil Pipelines

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Abstract

Lab-scale experiments were conducted to identify the flow phenomena of water flushed from a low horizontal section into an upward inclined section of a 50mm tube by oil flow. The process of water displacement by the oil was also simulated by using the volume of fluid (VOF) model implemented in FLUENT. The simulations were found to be in good agreement with the experimental results. The simulation results substantiate the applicability of a simple mechanistic model, which is based on water 'plug formation' for predicting the critical conditions for the onset of water displacement. A parametric study on the effects of the water volume, oil velocity, pipe diameter, inclination angle, physical properties on the simulation results was also carried out.

Keywords: Product oil pipelines, Water displacement, Corrosion, Oil-water flow, hilly pipelines

1 Introduction

A great concern for oil companies is to avoid blockage or leakage of oil during the pipeline operation which may result from internal corrosion. The resulting corrosion products tend to deposit on the bottom of the pipeline and plug the equipment such as filters, valves and pumps. The resulting unplanned shutdowns have an adverse impact on the regular transportation plan and maintenance of oil pipelines.

Song et al. (2010) reported the internal corrosion rate of steel tube under two different conditions, one was exposed to air saturated with water and the other was filled with oil products of an oil field. They concluded that the iron rust was caused by corrosion when the pipeline was exposed to air during its construction. A similar conclusion was proposed by a few other scholars (Yang, 2009; Gao and Zhang, 2006). However, this conclusion appears to be in contradiction with practice, where tons of iron rust were found in sediments removed via pipeline pigging (Xu, 2011). As the amount of rust produced during pipeline construction is fixed, these large amounts of rust imply that the rust is mainly a result of the pipeline internal corrosion during its operation, which increases perpetually if water presents in the pipeline. In order to reduce the corrosion rates, the contact of the water with the pipe surface should be minimized (Li, et al., 2014; Cai, et al., 2012).