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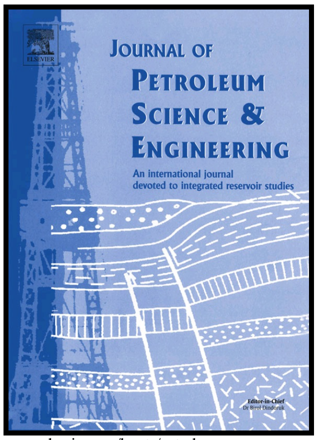

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Abstract

Experimental data at various conditions are important for improving wax deposition prediction and upscaling efforts. This study consolidates several single-phase wax deposition data acquired in recent years and validates available wax deposition models for a comprehensive range of experimental conditions. The film mass transfer (FMT), equilibrium (EM), Matzain (1999), and Venkatesan (2004) models were tested against 70 experimental data points (19 sets of initial operating conditions), obtained with four different oils and flow loop facilities. Uncertainty propagation analysis was performed to estimate reasonable ranges of error in the prediction that may be caused by fluid properties or standard correlations instead of the model formulation itself. The FMT model regularly over-predicts the deposition rate, which is consistent with previous theoretical, experimental, and visualization studies. It is observed that EM does not necessarily serves as the lower bound of deposition rate, suggesting that some form of flux reduction effects may exist. Sherwood number analysis was performed to validate conclusions from FMT and EM model assessment. A fix set of shear coefficient values in Venketasan's model is not sufficient to achieve acceptable accuracy in general, indicating that the shear coefficients are likely to be oil and flow conditions dependent. Matzain's model delivers relatively superior performance on deposit wax mass and flux predictions among the four models, although it is still unable to predict aging mechanistically and the deposition trends as a whole. In conclusion, more mechanistically rigorous wax deposition models and experimental data are still needed.

Keywords: wax deposition models, flow loop experiments, model verification

1. Introduction

Lack of mechanistic understanding has been highlighted as one of the primary shortcomings in available wax deposition models (Dwivedi et al., 2013; Sarica and Panacharoensawad, 2012; Venkatesan and Creek, 2007). Flow loop testing serves as the primary mean for model benchmarking prior to field application (Huang et al., 2015) and, to some extent, explain the deposition physics. It is important to organize available data and validate existing models with more comprehensive range of experimental conditions. Accurate prediction of single-phase wax deposition is the key enabler to develop predictive tools for more complex multiphase cases. Due to complex nature of wax deposition experiments, models are usually validated against limited data set. Recently, wax deposition flow loop data have been generated extensively, which involve different testing fluids, expanded experimental conditions range, and improved measurement techniques in general. Therefore, it is necessary to continue the models validation efforts with these newer sets of data. Moreover, with time constraints in collecting statistically meaningful data set, an effort is needed to consolidate available experimental data and enhance their