
Project 4 – Experimental Investigation into the Role of Gelation on Wax Deposition to Guide Scale-up and the Design of Wax Inhibitor Treatment Programs

Objectives

The general objectives of this study are:

- To develop a reliable wax deposition modeling workflow, involving experimental characterizations at lab-scale and modeling approaches, to predict wax deposition at field scale.
- To improve the current practice for wax inhibitor treatment design using the workflow as mentioned above and to achieve reliable quantitative recommendations with the improved testing and/or scale-up methods

Project Description

It has been well understood that wax deposition on the inner wall of oil transportation pipelines is driven by radial molecular diffusion of dissolved wax molecules. As a result, contemporary wax deposition models are largely developed based on mathematical descriptions of molecular diffusion. However, it should be noted that diffusion-based wax deposition models present significant limitations when applied to study the effect of wax inhibitors on wax deposition as the altered rheology of the oil and deposit due to additives is not captured. Because of the same limitation, existing wax deposition models, in general, cannot predict the reduction of wax deposits with increasing shear. To model the effect of shear and wax inhibitors on the wax deposition, the wax deposition model needs to link the shear imposed by the fluid with the rheology and the gelation process in the vicinity of the pipe wall. Preliminary investigations jointly conducted by SWTS and Chevron have shown that combining rheological characterization with wax deposition modeling is promising to enhance wax deposition models for the application of wax inhibitor treatment design. To advance the understanding of the role of gelation on wax deposition and develop more reliable methodologies to predict wax deposition rates under various conditions and with chemical treatments, an experimental investigation into the role of gelation on wax deposition is proposed.

Proposed Program

Experimental:

Step 1: Wax deposition experiments under controlled temperature driving force and wall shear stress (rate) to form the incipient deposit layers for rheological characterizations

- With and without wax inhibitor
- Different geometry
 - Microscopic flow cell – the goal is not to quantify deposit mass but use this technique as a visual aid to observe morphological change induced by chemicals.
 - Flow loop (with different pipe diameter, start with the 1-in loop)

Step 2: Characterization of the incipient deposit gelation solid fraction under the same controlled shear stress using a rheometer

Simulation:

Explore tweaks in TUWAX to incorporate the effect of the solid fraction of the incipient deposit and predict the change in the wax deposition rate due to the addition of chemicals or varying shear conditions in the experimental programs.