
Project 1- Mechanistic Study of Turbulent Flow Wax Deposition

Objective

The main objective of this project is to elucidate the turbulent flow wax deposition mechanism. The mechanistic study of deposition mechanism will be conducted to complement the understanding obtained from flow loop studies.

Project Description

A new laboratory-scale deposition flow loop will be built. It will be equipped with a microscope to allow microscopic visualization of wax deposition. The turbulent flow wax deposition mechanism will be investigated using the mini flow loop of TUPDP. The precipitation of wax near the deposit interface will be determined. The experiments are expected to shed light on the mechanisms of wax deposition under flowing conditions.

Scope

This project will study the wax deposition microscopically at the deposit interface to investigate the flow effects. It will serve as a theoretical basis for the TUPDP closure relationship development. The project will be pursued in two parallel tracks: visualization study and conventional deposition study as outlined below.

Visualization Study: Microscopic Visualization is relatively new to wax deposition research. The visualization technique has to be developed before implementing the technique to a flow loop. This will be performed in the first and the second stages of this project. The first and second stages of this project are titled *Static deposition visualization* and *Laminar flow deposition visualization*, respectively. The visualization technique development will ensure that wax deposition visualization can be achieved in a smaller scale experiment before up-scaling the study to TUPDP's mini flow loop for turbulent flow. Moreover, the studies from Stages 1 and 2 will serve as base cases for the turbulent deposition study. At Stage 3, the turbulent flow deposition will be studied microscopically.

Stage 1: Static deposition visualization: This stage serves as an initial development of the visualization technique. The deposition mechanism of no shear case will be investigated visually and used as a base case for a comparison with the laminar and turbulent flow cases.

Stage 2: Laminar flow deposition visualization: This stage serves as the development of the visualization technique under a laminar flow condition. With laminar flow, the experimental procedure is expected to be more complex. This development will reveal any unforeseen visualization and flow related problems that might occur during the actual experimental program. The laminar flow deposition visualization results will serve as the base case for the turbulent deposition microscopic study.

Stage 3: Turbulent flow deposition visualization: The turbulent deposition visualization experiments will be conducted at this stage of the project. The turbulent flow deposition mechanism and the precipitation near the deposit interface information will be obtained. The deposition mechanism will be incorporated into the model. A new test section to replace the rectangular test section of TUPDP's mini flow will be designed and constructed. The new test section will be able to accommodate the microscope to be used.

Conventional Deposition Study for Turbulent Flow: The mini-pilot scale flow loop designed and used by Panacharoensawad (2012) will be utilized for a detailed study of single-phase wax deposition. The local deposit thickness, composition, and roughness information will be obtained

by using this facility. The Garden Banks condensate and new oil will be used for wax deposition experiments. Both laminar and turbulent flow tests will be conducted. The laminar flow test results will be used as a base case for the turbulent flow tests. The results will include the impact of shear stress on wax deposition characteristics, additional experimental data for the development of the deposition model closure relationship and effect of heat transfer on wax deposition.