

Paraffin Deposition Progress Report October through December 2002

Facilities

Flow Assurance Laboratory



A dedicated flow assurance laboratory is currently being set-up to house all of the flow assurance related laboratory devices such as a DSC, viscometers, oil-water separation, a hydrate cell, a cold-finger apparatus, etc. The laboratory is located in the upper floor of The University of Tulsa Model Lab building. The TUFFP horizontal well facility, which was idle for four years, has been dismantled to make space for the Flow Assurance Lab.

Wax Deposition Tests

Single-Phase Paraffin Deposition Studies

A new thickness estimation technique using a boroscope has been successfully tested. The boroscope can capture the images of the reference marks on the submerged tip and the interface of the deposit. The distance between the reference mark and the deposit surface and consequently the deposit thickness are calculated using appropriate software. The thickness results agree with those obtained from Ld-Ld device within $\pm 20\%$.

Fluid and flow characterization studies for the CBI oil have been conducted in the transition zone between laminar and turbulent flow to improve the data processing. The studies included a series of short tests for friction factor and overall heat transfer coefficient. HTGC, DSC and shear stress analyses are expected to give a better understanding of the rheology and fluid characteristics. Moreover, the existing Fortran Code for data processing has been reviewed and modified for the current and next fluids.

A second static mixer was installed at the end of the test section. Together with the one at the inlet, this mixer will improve the average oil temperature measurements, especially for laminar flow tests.

Two-Phase Paraffin Deposition Studies

New pressure transducers were installed to capture small and large pressure readings more accurately, thereby improving the pressure drop readings over the test section. Differential pressure lines were filled with a heavy mineral oil to eliminate the inaccuracies due to possible gas entrapment.

One vertical intermittent flow multiphase test (WAX2002-014) was run in the modified multiphase flow loop. The test conditions were: $T_{\text{oil}}=85$ °F; temperature difference between oil and glycol, $\Delta T=45$ °F; and superficial liquid and gas velocities of 2 ft/s and 3 ft/s, respectively. The duration of the test was 24 hours. The offline Ld-Ld measurement indicated a 0.8 mm thick wax deposit.

Three-Phase Paraffin Deposition Studies

On the multiphase loop, all the main equipment necessary for the installation of the water phase system have been received, including the oil-water separator. Installation of this equipment on site will take place in January. Piping and instrumentation installation will begin shortly after the main equipment is positioned.

Additional oil-water separation tests are being conducted to assess the separation difficulties.



Deposition Physics Studies Using Small Scale Facility

The oil pump was overhauled and a series of tests with water were conducted on the small-scale loop. The objectives of these tests were to test the oil pump and its control system and to obtain friction factor data. The tests lasted 24 hours. Data obtained confirm that all of the equipment items are working fine. Careful analysis of the water data continues.

Two barrels of South Pelto oil were transferred to the oil tank. A preliminary test was conducted using the 1.5 in. test section with an oil temperature of 105 °F, a glycol temperature 75 °F and with oil and glycol flow rates of 850 BPD and 1700 BPD, respectively. The test produced a wax deposit that had an average wax thickness of 1 mm. This deposit thickness is comparable to the test results obtained from the single-phase flow loop using the same test conditions. However, these test results have indicated a need for re-tuning of the controllers, which is currently underway.

Discussions were held with Inline Corp. regarding pigs for the facility. They manufactured two different types of pigs; one is a foam disc pig made from 8 pound foam, and the other is a one-piece urethane pig with sealing and scraping discs. These pigs will be evaluated during the next quarter.

Oil-Water Experiments

Since the last ABM two additional separation tests were run using the South Pelto crude oil and salt water. After the separation, the oil was collected and used again to run tests with salt water to compare how it would behave after being in contact with water (washed oil). The separation was similar to the previous case, indicating that the emulsification was not worse.

The DSC was calibrated using the new sample pans. DSC analyses of the SouthPelto, Garden Banks and CBI samples are underway.

Ondeo-Nalco has volunteered to build and donate a new cold-finger device to be used in oil-water deposition studies. This device is expected to be operational by early February 2003. Tests with the cold-finger device will be performed before any flow loop tests are begun.

Software Development

During the last quarter, several bugs were reported by the members, including:

1. Erroneous fluid temperature along the pipeline when the outlet temperature is given for the single-phase wax deposition.
2. Unit conversion problems.
3. A problem with the gas viscosity in heat transfer subroutines of the multiphase wax deposition calculation.

All of the above bugs have been fixed. The limitations of pipe segment number, pipe section number and time step number were also removed from the software by means of dynamical allocation of the arrays. The new version will be available at www.tupdp.utulsa.edu after necessary GUI changes are made by MSI.

To further improve the performance of the software, the following changes will be made in the near future:

1. Unify pipeline input files for single-phase and multiphase calculations.
2. Obtain fluid thermal conductivity and heat capacity from lookup tables instead of inputting values separately for single-phase calculations.
3. Impose a time step limitation for high wax deposition rate conditions.
4. Output more variables.

Future Meetings

The next Tulsa University Paraffin Deposition Projects (TUPDP) Advisory Board meeting has been tentatively scheduled to be held on April 16, 2003 in Tulsa, Oklahoma at the Doubletree Hotel at Warren Place. A continental breakfast will be served starting at 8:00 a.m. with the Advisory Board meeting commencing at 8:30 a.m. A joint reception with TUFFP will be held on Tuesday, April 15th at 6:00 p.m. Below is a schedule for April 2003 Advisory Board activities.

Day	Date	Event	Time	Location
Monday	April 14	Tour of Facilities	3:00 – 5:00 p.m.	University of Tulsa North Campus
Tuesday	April 15	Tulsa University Fluid Flow Projects Advisory Board Meeting	8:00 a.m. - 5:00 p.m.	Doubletree Hotel at Warren Place
		Joint Reception	6:00 - 9:00	Doubletree Hotel at Warren Place
Wednesday	April 16	Tulsa University Paraffin Deposition Projects Advisory Board Meeting	8:00 a.m. - 5:00 p.m.	Doubletree Hotel at Warren Place
Thursday	April 17	Tulsa University Hydrate Flow Performance JIP Advisory Board Meeting	8:00 a.m. – 5:00	Doubletree Hotel at Warren Place

Modeling Workshop

We will soon be in contact with members regarding the modeling workshop. We are currently working on the specifics and will be sending out a questionnaire.