



# T U P D P

## Tulsa University Paraffin Deposition Projects

August 2005

Volume 1, Issue 2

### Executive Summary

Construction of the facility to directly observe the wax deposition process is nearing completion. Bench top studies were conducted using mineral oil and candle wax and a Lubsnap Oil with 2.2% wax content was selected as the test fluid. Test matrices were developed and testing is scheduled to begin in August. Preliminary results should be available for the upcoming Advisory Board Meeting that will be held in Tulsa, Oklahoma on October 5, 2005.

Shake down studies continued with the small scale test facility. The reason for pressure fluctuations with temperature was identified and the problem fixed. Oil-water tests are now underway with S. Pelto crude oil. After the S. Pelto tests are complete, tests will begin with model oils for flow pattern determination.

A simple pigging facility is under construction. Tests will begin shortly to determine breaking forces of wax deposits, transport forces of wax plugs, and the effects of by pass and non-by pass pigs on each force.

Several bugs were identified and fixed in the MSI-TUWAX software. For the water-oil wax deposition simulator a user friendly GUI was developed. Work continued on the new Excel based software that will replace the MSI version. A beta version of this software should be available before the October ABM.

### TUPDP Membership

Phase 3 of the Tulsa University Paraffin Deposition Projects (TUPDP) began on April 1, 2004. We currently have 15 members with the recent addition of JOGMEC. There are continuing discussions with DOE, Pemex and Sintef regarding membership in TUPDP.

Invoices for the 2005 membership fees were sent in February 2005. If your company has not yet paid their 2005 membership fee, payment as soon as possible would be greatly appreciated.

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### TUPDP Members

Baker Petrolite	BG Group
BHP Billiton	BP
ChevronTexaco	ConocoPhillips
ExxonMobil	JOGMEC
Marathon Oil Company	Nalco
Petrobras	Shell
Statoil	TOTAL
Unocal	

## New MS Student

Mr. Francis Anosike is being admitted for the Fall Term 2005 and will begin his M.S. degree in Petroleum Engineering with the Paraffin Deposition Projects. Francis has received both a B.S. and M.Sc. Degrees in Chemical Engineering from Moscow State Academy of Fine Chemical Technology. He will be studying multiphase paraffin deposition.

## Meetings/Conferences

### Fall 2005 Advisory Board Meetings

Plans have now been finalized for the Fall 2005 Advisory Board meetings. The Advisory Board Meetings for TUHFP, TUPDP and TUFFP along with the TUFFP/TUPDP reception will be held on campus in the Allen Chapman Activity Center. The TU Hydrate JIP (TUHFP) Advisory Board meeting will be held on Tuesday, October 4th in the President's Lounge. A tour of the test facilities on the North Campus will immediately follow the TUHFP Advisory Board meeting, the tour will begin at approximately 3:00 p.m. Following the tour, there will be a joint TUHFP/TUPDP/TUFFP BBQ between 5:00 - 7:00 p.m. The TUPDP Advisory Board meeting will begin at 8:30 a.m. on Wednesday, October 5th in the Gallery and will adjourn at 5:00 p.m. Following the TUPDP meeting, there will be a joint TUFFP/TUPDP reception from 6:00 - 9:00 p.m. in the President's Formal Lounge. The TUFFP Advisory Board meeting will be held on Thursday, October 6th in the Gallery. The meeting will begin at 8:00 a.m. and will adjourn at 5:00 p.m. The Request for Information form and suggested hotel information will be email soon and placed on the web page. All persons from your company that plan to attend the Advisory Board meetings, should complete and return this form as soon as possible to help us plan the meetings. Information on the Advisory Board meetings can also be found on our web site at [www.tupdp.utulsa.edu/abminfo.htm](http://www.tupdp.utulsa.edu/abminfo.htm). You can then follow the links for the Request for Information form. TUPDP Advisory Board meeting brochures will be available for members at the meeting and a concerted effort will again be made to have the combined brochure and slide copy available for downloading from the web site at <http://www.tupdp.utulsa.edu/abmbrochures.htm> shortly before the meeting. The brochure will contain sufficient information to help each attendee actively participate in discussions on current and future research projects, financial matters, and operating procedures.

### Upcoming ABM's

#### October 4, 2005

Hydrate JIP (TUHFP) Advisory Board Meeting  
The University of Tulsa  
Allen Chapman Activity Center  
President's Lounge  
Tulsa, Oklahoma  
8:00 a.m. - 2:30 p.m.

TUHFP/TUPDP/TUFFP Facilities Tour  
The University of Tulsa North Campus  
2450 East Marshall  
Tulsa, Oklahoma  
3:00 - 5:00 p.m.

TUHFP/TUPDP/TUFFP Barbeque  
The University of Tulsa North Campus  
2450 East Marshall  
Tulsa, Oklahoma  
5:00 - 7:00 p.m.

#### October 5, 2005

TUPDP Advisory Board Meeting  
The University of Tulsa  
Allen Chapman Activity Center  
Gallery  
Tulsa, Oklahoma  
8:30 a.m. - 5:00 p.m.

TUFFP/TUPDP Reception  
The University of Tulsa  
Allen Chapman Activity Center  
Presidents Formal Lounge  
Tulsa, Oklahoma  
6:00 - 9:00 p.m.

#### October 6, 2005

TUFFP Advisory Board Meeting  
The University of Tulsa  
Allen Chapman Activity Center  
Gallery  
Tulsa, Oklahoma  
8:00 a.m. - 5:00 p.m.  
Tulsa, Oklahoma

# Progress Updates

## Project 1 - Single Phase Studies



### Task 3 - Single Phase Model Enhancements Objectives

**Gladys Sucre** The main objective of this work is to study the shear prevention/removal effect during the wax deposition process under turbulent flow conditions.

### Facility Construction

A direct observation of the wax deposition process in a laboratory controlled environment is expected to provide better insight into paraffin deposition; therefore, a new laboratory device was designed and is being constructed.

A schematic of the device is given in Fig. 1. The device consists of two rectangular ducts. The test fluid (waxy model oil) will circulate in the top transparent duct and a coolant mixture of glycol will flow in the bottom duct. These two ducts are separated by an aluminum plate. Various components of the device are briefly described below:

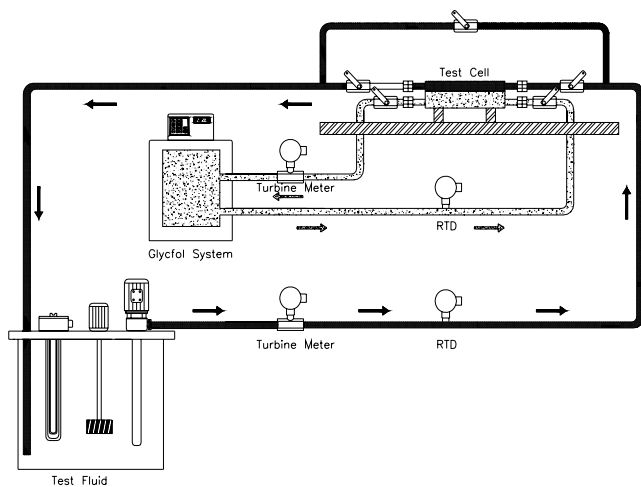


Figure 1: Schematic of Laboratory Facility

### Oil System

The major components for the oil system are: a 17 gallon oil tank, an electrical heater, a mixer, a pump with a capacity of 20 gpm, a variable speed drive to control the flow rate, and a mass flow meter. The oil pump is fed by

the oil tank equipped with a mixer and an electrical heater sending the fluid through the test section.

### Test Section

The test section is 2.8 ft long with the two side and upper walls made of half inch thick acrylic. The rectangular cross section is 1.5 inches wide and 0.5 inches high.

### Glycol Circulating System

The glycol system provides cooling for the bottom plate to induce paraffin deposition. A chiller is used to circulate the glycol through the cold plate and keep it at a desired temperature.

### Data Acquisition System

The data acquisition system is LabView™ based and the parameters recorded are: temperature of oil tank; temperature of cold plate at four different locations; heat flux through the cold plate; temperature of oil and glycol, and flow rates of oil and glycol before entering the test section.

The device can be operated almost entirely from a DAQ computer interface. Control logics are placed for flow rates of oil and glycol and inlet temperatures of oil and glycol for safety concerns.

All major equipment components were identified and ordered. The construction of the device is ongoing and will be completed in August.

### Model Wax - Model Oil System

A commercially available candle wax and two mineral oils were identified as possible materials to be used in the study. The DSC, pour point, viscosity and cold finger analysis has been performed to determine the combinations and proportions between candle wax and mineral oils. The results are shown on Table 1.

Table 1 - Results of Comparative Analysis of Various Oils

Oil	Kerosene	Pour Point (F)	DSC		Cold Finger		$\mu$ (cp)
			WAT (F)	%Wax	Weight	%Wax	
Lubsnap 40	0	50	70	2.2	3.2	6.45	4.7
Lubsnap 40	0	70	92	4.9	42	6	4.7
AFM Crystex	0	50	79	1.9	3.4	7	19.5
AFM Crystex	0	75	91	4.5	37.5	6.5	19.5
AFM Crystex	25% vol	50	79	1.84	4	6.89	8.1
AFM Crystex	50% vol	70	95	5.1	Deposit Fell	6.8	3.2

The kerosene lowers the viscosity of the oil and was found to have no effect on the wax appearance temperature or the pour point of the mixture. It was decided to work with the low viscosity mineral oil and thereby avoiding the problems associated with a more volatile fluid.

The narrow carbon distribution of the mineral oil and wax causes an increase in pour point with an increase of wax content. The wax tends to precipitate out of solution very fast once the temperature goes below WAT. A very large deposit was obtained in the cold finger analysis for 5% wax content. Figures 2 and 3 show the deposit obtained from the cold finger analysis for 2.2% and 5% wax content, respectively. Lubsnap Oil with 2.2% wax content is selected as the test fluid.



Figure 2: Cold Finger Deposit - Lubsnap 40 – 2.2% Wax



Figure 3: Cold Finger Deposit - Lubsnap 40 – 5% Wax

## Proposed Tests

The proposed test matrix should be based on the facility operating limits at the temperatures both above and

below wax appearance temperature. Table 2 shows the proposed test matrix.

Table 2 - Proposed Test Matrix

Test	Oil Temperature (K)	Oil Flow Rate (gpm)	RE	$\Delta T$ (K)	Cold Plate Temperature (K)
2005-01	298	20	6400	15	281
2005-02	298	12	3840	15	281
2005-03	298	20	6400	8	288
2005-04	298	12	3840	8	288
2005-05	294	20	6400	8	286
2005-06	294	12	3840	8	286

The models were modified to adapt to the rectangular geometry and an excel-visual basic program was written that can calculate thickness and wax content together with model uncertainty.

An example of the results obtained using the equilibrium model above and below WAT is shown in Figures 4 to 6.

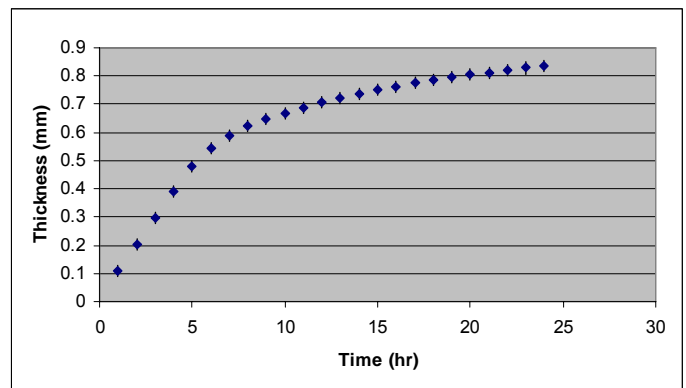


Figure 4: Average Thickness vs. Time – Test 2005-03

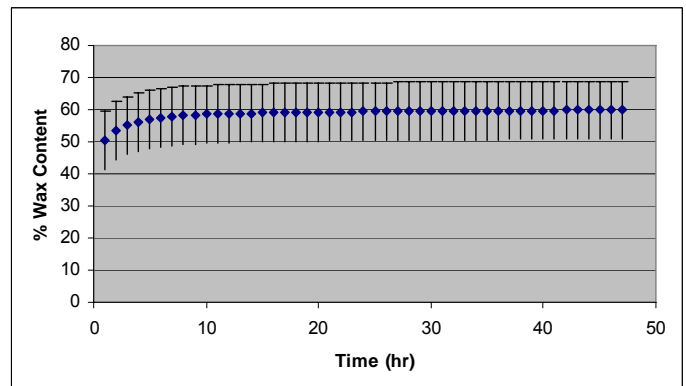
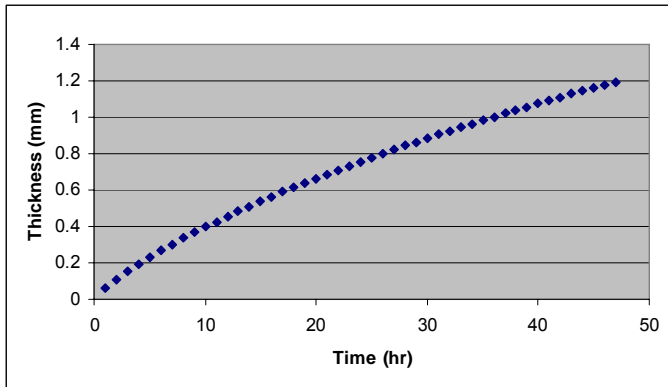


Figure 5: Wax Content vs. Time – Test 2005-03





**Figure 6: Average Thickness vs. Time – Test 2005-05**

Figure 4 shows the thickness vs. time. The results were obtained using equilibrium model with the conditions of Test 2005-03, we can see a rapid growth of the thickness and an eventual stabilization when the deposit surface reaches WAT, contrary to Figure 6 which was model with the conditions of Test 2005-05 where the wax keeps growing since the oil temperature is below WAT.

The predicted changes of wax content vs. time are shown in Figure 5 for Test 2005-03. The model shows a really fast rate of aging at the beginning of the test and a stabilization of the fraction of oil in deposit with time.

The models results showed that for the entire test matrix the thickness will be reasonable and easy to measure.

## Summary, Conclusions and Future Work

A rectangular duct test section is being constructed to study shear removal/prevention and aging effects in paraffin deposition.

Lubsnap 40 mineral oil with a wax content of 2.2% is selected as the working fluid.

The tests will be performed and the model results will be compared with the experimental data before the Fall 2005 Advisory Board meeting.

## Introduction

In the past, MSI was responsible for developing and maintaining the GUI (graphic user interface) for the TUWAX software. Since MSI is no longer a member of TUPDP project, it is necessary for TUPDP to develop a new TUWAX software package. This new software is proposed to have a new designed GUI running on the Microsoft Excel platform. The new designed GUI will be easily maintained and updated.

The first version of the new Excel based software will be available in September 2005. For the time being, members should use MSI-TUWAX for the wax deposition simulation.

## Model/Software

### Improvements

Recently, several bugs were identified and fixed in the MSI-TUWAX software. These bugs were:

- 1) A unit conversion error in the default viscosity calculation in the multiphase wax deposition routine,
- 2) a bug in the calculation of the total wax deposit volume in the multiphase wax deposition routine, and
- 3) a bug in the calculation of the effective pipe diameter in the single phase wax deposition routine.

For the water-oil wax deposition simulation, a new software with a user friendly Excel GUI for generating look-up table for the simulation of water-oil wax deposition using MSI-TUWAX single phase routine is now available at TUPDP web site. Members can download all recent updated software from TUPDP's website at [www.tupdp.utulsa.edu/software.htm](http://www.tupdp.utulsa.edu/software.htm).

## New Software Development

The new Excel based software is currently under development. The previous single phase wax deposition and multiphase wax deposition routines will be incorporated into one single routine as well as pipe configuration file. The first version of the new software will be available before the fall ABM meeting.

## Future Work

The development of the new software package will be continued and the first beta version of the software will be available before October 2005 (next ABM).



**Hong Chen**

## Task 4 - Software Development Objectives

The objective of this project is to develop an up-to-date theoretical/numerical model for the prediction of wax deposition and to code this model in user-friendly software.

# Project 2 - Multiphase Flow Studies



Antonio Bruno

## Task 2—Two-Phase Oil-Water Deposition Model Enhancements and Developments

### Objective

The main objective of this study is to develop an oil-water paraffin deposition model.

In order to achieve the objective, the following tasks were identified and are being performed:

- Develop a preliminary oil-water deposition model based on the TU Single-Phase model.
- Validate this preliminary model by conducting a series of experiments using model oils with different characteristics emulating those of commercial crude oils.
- Establish the limitations and applications of the preliminary model under different flow patterns.
- Propose improvements to this preliminary model and establish a new enhanced model.

### Introduction

At the 10<sup>th</sup> Semi-Annual Advisory Board Meeting<sup>1</sup>, a discussion about previous oil-water test results obtained in the small scale loop with South Pelto Crude Oil showed the need for further verification of these experimental data. Several fluctuations in the differential pressure measurements were observed, these fluctuations made the thickness calculations using the pressure loss ( $\Delta p$ ) method highly unreliable. Using the boroscope measurements, these tests showed an increasing trend in deposit thickness with increasing water cuts. Therefore, to verify these experiments, and to conduct a systematic study with model oils & waxes, the small scale facility was re-commissioned.

### Facility Modification

#### Online Viscometer

One of the improvements recently made to the small scale facility was the installation of a new Micromotion Mass Flow Meter capable of measuring fluid viscosity<sup>2</sup>. The primary system components are the mass flow meter and a differential pressure measuring device. Viscosity

measurement is performed by determining the pressure drop through the mass flowmeter under flowing conditions. The calculation of viscosity is based on the Hagen-Poiseuille equation,

$$\mu = \frac{K\Delta P\rho}{\dot{m}}$$

The viscosity of a flowing medium is directly proportional to the ratio of pressure drop (as measured through a length of piping or tubing) to volumetric flow rate. The coefficient, **K**, introduces the required scaling multiplier to obtain viscosity in any absolute viscosity units.

**K** factor is obtained by making several viscosity measurements in the lab using a Cannon-Fenske viscometer (ASTM Method). These data points were then used to adjust the original South Pelto viscosity correlation. The South Pelto Crude Oil available to us for research has been in storage for many years at ambient temperature and pressure. Under these conditions, some of the lighter ends of the oil might evaporate; therefore it was important to verify the actual viscosity of the oil. Figure 1 shows the original and adjusted viscosity correlations.

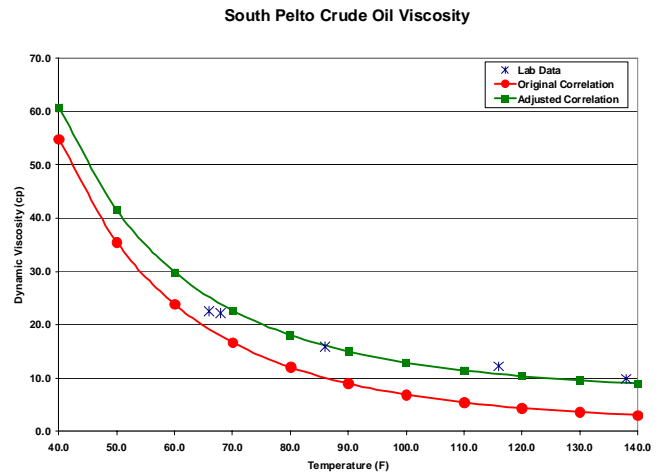


Figure 1: Original and Adjusted Viscosity Correlations

### Canopy Installation

A canopy has been designed to reduce the effects of sunlight to the facility (Fig. 2). This design has already been submitted to TU's Physical Plant for final approval.

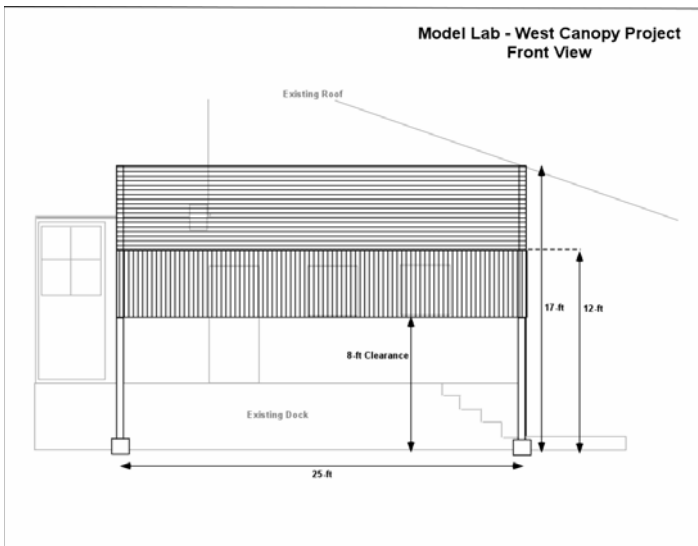


Figure 2: Canopy Design. Front View

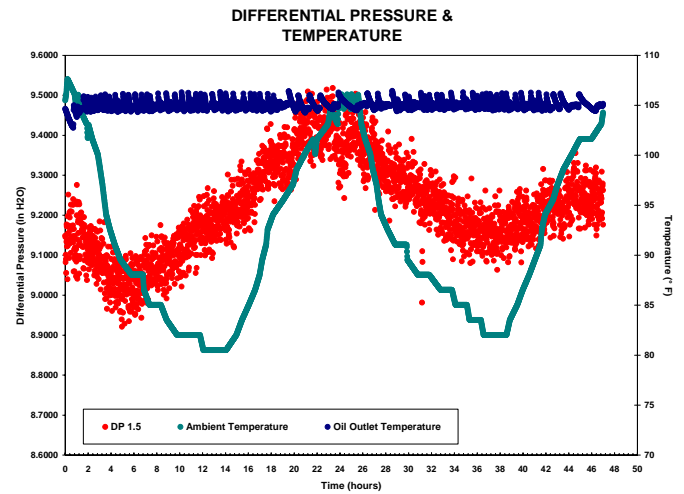


Figure 3: Test WAX-2005-001. Single-Phase South Pelto Crude Oil. 1.5" Test Section

## South Pelto Crude Oil Experiments

In order to maintain the same operating conditions of Gao<sup>3</sup>, the same test matrix has been used (Table 1). A fresh 30 gallons charge of South Pelto Crude Oil was pumped into the facility. This volume was selected in order to keep a constant oil volume throughout the complete test schedule, up to 75% water cut. The storage capacity of the facility is 2.9 barrels. The 1.5" test section will be used in all four tests.

Table1: South Pelto Crude Oil Test Matrix

Parameter	Test 1	Test 2	Test 3	Test 4
Water Cut	Single Phase	25%	40%	75%
Mixture Temperature	105 °F	105 °F	105 °F	105 °F
Mixture Flow Rate	850 BPD	850 BPD	850 BPD	850 BPD
Glycol Temperature	75 °F	75 °F	75 °F	75 °F
Glycol Flow Rate	1600 BPD	1600 BPD	1600 BPD	1600 BPD
Glycol Flow Direction	Co-Current	Co-Current	Co-Current	Co-Current
Duration	48 Hours	48 Hours	48 Hours	48 Hours

### Test WAX-2005-001

Results from this single-phase test are shown in Figure 3. It is apparent from the graph that differential pressure readings have a strong dependence on ambient temperature. The fluctuations observed in previous tests performed by Gao<sup>3</sup> could now be attributed to changes in ambient temperature. From boroscope measurements, a wax thickness of 1.0 mm was established; nevertheless, the differential pressure calculations could not be used to verify this thickness due to the severe fluctuations in the data.

Four fluid samples were taken during the 48 hour test, at 12 hour intervals. DSC analysis on the first fluid sample shows a WAT of 54 °C, the same test performed on the last fluid sample shows a WAT of 52 °C. Analysis on the deposit shows a 30% wax content.

### Ambient Temperature Dependence

To solve the ambient temperature dependence problem, a series of tests was designed to determine the root cause. First, a 24 hour test with no flow was performed; Figure 4 shows the results from this test. A typical 48-hour single-phase test shows a differential pressure difference between start and finish of approximately 1.5 in H<sub>2</sub>O. The error range is in the order of 0.37 in H<sub>2</sub>O representing 25% error. This error percentage is completely out of specifications of the differential pressure (dp) transducer.

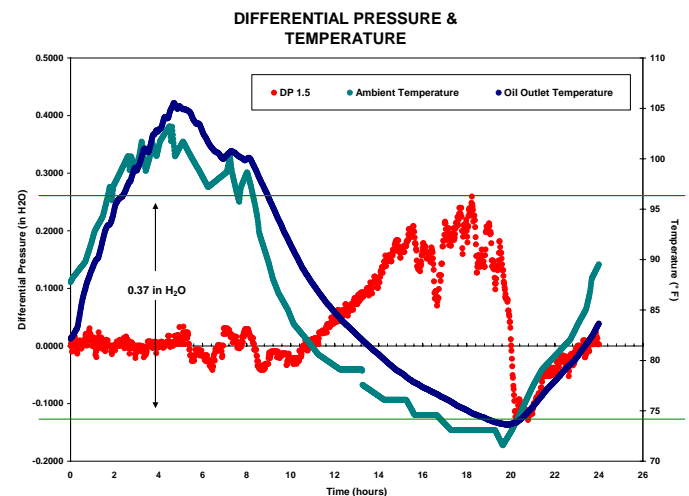


Figure 4: No Flow Conditions. Impulse Lines Connected

The impulse lines were then flushed and disconnected

from the dp transducer to observe the behavior of the device itself. Figure 5 shows a 0.44 in H<sub>2</sub>O error range, no improvements were observed by isolating the dp meter from the impulse lines, which indicates that the problem is within the device itself. The manufacturer (Rosemount) was contacted and all three dp transducers in the facility were replaced.

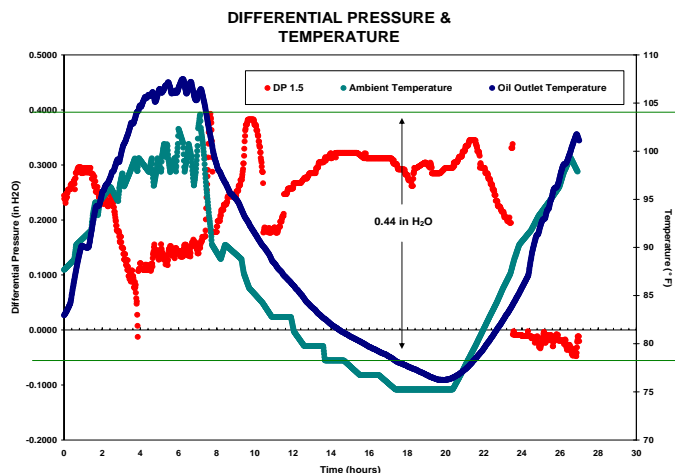


Figure 5: No Flow Conditions. Impulse Lines Disconnected

Figure 6 shows the behavior of the new transducer using the same conditions present in Figure 5. A 0.05 in H<sub>2</sub>O error range is observed, representing a considerable improvement from the original readings. The error range decreased from 25% to approximately 1%. Single-phase test WAX-2005-001 will be repeated using the new instruments to perform wax deposition calculations with time using the pressure drop method.

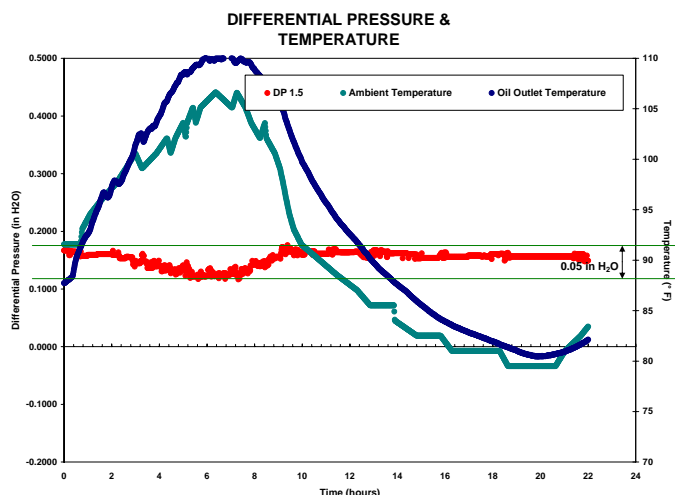


Figure 6: No Flow Conditions. Impulse Lines Disconnected. New dp Transducer

## Oil-Water Preliminary Model

The preliminary oil-water software module was presented during the 10<sup>th</sup> Semiannual Advisory Board Meeting<sup>1</sup>. A

new GUI has been developed for this module that makes the application more user-friendly. Figure 7 shows the main screen of the GUI. This Visual Basic module can be used to select input and output files, and specify water cuts. The GUI then calls the FORTRAN application that generates the new look-up tables. After the new look-up tables are generated, TUWAX can be run from within the GUI. The software is available on TUPDP's web site.

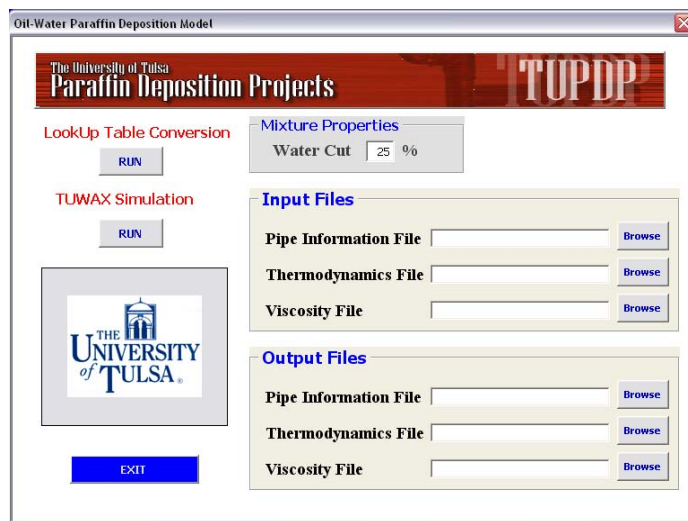


Figure 7: Preliminary Oil-Water Model GUI

## Conclusions and Future Work

After the debugging process of the facility is completed, test WAX-2005-001 will be repeated in order to obtain reliable pressure drop data that enables the calculation of wax buildup with time.

The next three experiments will complete the South Pelto test matrix. These results will then be compared with previous available data (Gao<sup>3</sup> 2003) and correlated with the preliminary oil-water model.

After the South Pelto test matrix is completed, the next phase will focus on model oils and flow pattern determination.

## References

1. TUPDP 10<sup>th</sup> Semi-Annual Advisory Board Report. October 2004-March 2005. The University of Tulsa, Tulsa, Oklahoma.
2. Fisher-Rosemount: "Viscosity Measurement with Micro Motion Mass Flowmeters", 1994, North Andover, Massachusetts.
3. Gao, C.: "Investigation of Long Term Paraffin Deposition Behavior for South Pelto Oil", MS Thesis, The University of Tulsa, Tulsa, Oklahoma (2003).



## Nomenclature

$\mu$ : absolute viscosity

$\rho$ : fluid density

$m$ : mass flow rate

$K$ : proportionality constant

$\Delta P$ : pressure drop

WAT: Wax Appearance Temperature

GUI: Graphics User Interface

## Project 3 Pigging Studies



**Qian Wang**

### Task 4 - Continuation Scope of Work Development Objectives

It is desired to determine the pigging frequency accurately so that pigs will not be stuck in the

line or to prevent unnecessary pig runs. The available tools in the literature or commercial models have been found inadequate.

Pigging frequency is primarily controlled by the wax deposition rate, pigging efficiency and the required force to run a pig in the line. The wax deposition rate or thickness can be predicted by the wax deposition models. Therefore, the primary objective of the pigging studies is to develop a predictive model to determine the required force to keep the pig mobile.

## Background

This project had four tasks, which are outlined in the proposal. Two of the tasks, literature review and feasibility study have been conducted.

The initial findings presented at the Fall 2004 Advisory Board meeting<sup>1</sup> indicated that wax transportation force rather than wax breaking force was the dominant factor in determining the requirements of a pigging operation.

Based on the feed back from TUPDP members, a further detailed feasibility study was conducted before starting any experimental or modeling study. The results of the feasibility study were presented at the Spring 2005

Advisory Board meeting<sup>2</sup>. These results indicated that the only available model for the transportation of the cut-waxes, Pedersen & Rønningsen<sup>3</sup> did not perform well when compared with available flow loop and laboratory data. Moreover, a simplified pigging transport model was proposed based on the available data.

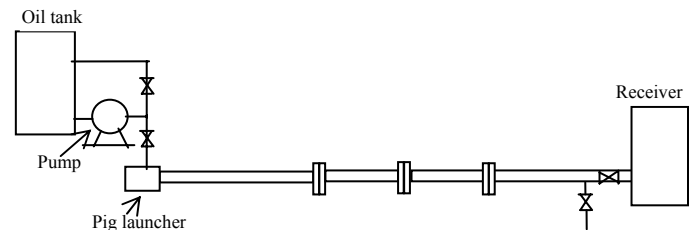
At the Spring 2005 Advisory Board meeting discussions, and the following communications with member companies, it was apparent that an investigation of by-pass pigs was of interest as well as the regular disc or cup pigs. Therefore a pigging studies experimental study has recently been started.

The specific objectives of the experimental studies are to determine the relative contributions of each of the following forces during a pigging run.

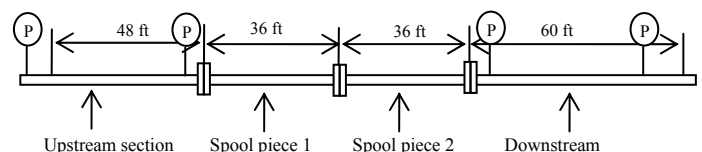
- Breaking force of wax deposits
- Transport force of wax plugs in front of pigs
- The effect of pig type (by-pass vs. non by-pass) on the relative importance of each force (pushing vs. cutting)

## Facility Design and Construction

A simple facility consisting of 3-ft sections of carbon steel pipe, a mineral oil tank, a pump to push the pig with liquid as in real pigging operations and a receiving tank to observe the structure of the pigged materials is designed. The wax will be cast into the 3-ft section before the experiments. A flow meter and a pressure transducer will record the pigging data. The schematic of the facility is shown in Fig. 1. The test section consists of an upstream section, two spool pieces and a down stream section, as shown in Fig. 2.



**Figure 1: Schematic of Pigging Facility**



**Figure 2: Test Section**

The construction of the facility is underway and will be completed by August 2005. The facility will be located in the lower section of the Model Laboratory building.

Disc pigs with and without bypass will be used in this project. The pig designs were discussed with TD Williamson Pig Company, and the order is placed. TD Williamson indicated their interest in the pigging data. In-kind involvement of TD Williamson in pigging studies is currently being negotiated.

Wax casting molds (wood cores) for different wax thickness are designed and will be manufactured. Candle wax was purchased and analyzed. Other necessary materials and tools for the casting were acquired.

## Test Procedure

Candle wax with different oil contents will be cast as a film and a plug for measuring wax breaking and plug transportation forces.

Once the spool pieces cast with wax are mounted on the test section, the oil from the pump will push the pig through the pipe. The pressure drop in the test section will be monitored during the testing.

## Preliminary Test Matrix

Breaking force are proposed to be measured at three different wax thicknesses and three different oil contents. A preliminary test matrix is given in Table-1 for the breaking force tests.

**Table 1: Preliminary Test Matrix for Breaking Force**

	Thickness (mm)	Oil content (%)
BF-1	2	70
BF-2	2	50
BF-3	2	40
BF-4	4	70
BF-5	4	50
BF-6	4	40
BF-7	6	70
BF-8	6	50
BF-9	6	40

To measure the transport force of wax plugs, wax will be cast as plug with three different plug lengths and three different oil contents. Table-2 shows the preliminary test matrix for the plug transportation force experiments.

**Table 2: Preliminary Test Matrix for Transportation Force**

	Plug Length (in)	Oil content (%)
TF-1	2	70
TF -2	2	50
TF -3	2	40
TF -4	4	70
TF -5	4	50
TF -6	4	40
TF -7	6	70
TF -8	6	50
TF -9	6	40

Two different kinds of bypass pig designs are considered. The first design has many small holes distributed across the cross section of the disc. The second design has a large opening at the center of the pig. A preliminary test matrix is given in Table-3 for the by-pass pig tests.

**Table 3: Preliminary Test Matrix for By-Pass Pig**

	Thickness (in)	Oil content (%)
BP1 - 1	2	50
BP1 - 2	4	50
BP1 - 3	6	50
BP2 - 1	2	50
BP2 - 2	4	50
BP2 - 3	6	50

## References

1. TUPDP 9<sup>th</sup> Semi-Annual Advisory Board Report. March 2004 - October 2005. The University of Tulsa, Tulsa, Oklahoma.
2. TUPDP 10<sup>th</sup> Semi-Annual Advisory Board Report. October 2004 - March 2005. The University of Tulsa, Tulsa, Oklahoma.
3. Pedersen, K.S. and Ronningsen, H. P., "Effect of precipitated wax on viscosity", presentation at AIChE Spring National Meeting, Houston, TX, March 14-18, 1999.

# Calendar of Events

## 2005

- September 6 - 9 Offshore Europe 2005-Aberdeen Exhibition and Conference Centre-Aberdeen, United Kingdom
- October 4 Hydrate JIP (TUHFP) Advisory Board Meeting, The University of Tulsa, Allen Chapman Activity Center, President's Lounge, Tulsa, Oklahoma
- TUHFP/TUPDP/TUFFP Facilities Tour, The University of Tulsa North Campus, Tulsa, Oklahoma
- TUHFP/TUPDP/TUFFP Barbeque, The University of Tulsa North Campus, Tulsa, Oklahoma
- October 5 TUPDP Advisory Board Meeting, The University of Tulsa, Allen Chapman Activity Center, Gallery, Tulsa, Oklahoma
- TUFFP/TUPDP Reception, The University of Tulsa, Allen Chapman Activity Center, President's Formal Lounge, Tulsa, Oklahoma
- October 6 TUFFP Advisory Board Meeting, The University of Tulsa, Allen Chapman Activity Center, Gallery, Tulsa, Oklahoma
- October 9 - 12 SPE Annual Technical Conference and Exhibition (ATCE)-Dallas Convention Center-Dallas, Texas
- November 21 - 23 International Petroleum Technology Conference (IPTC)-Qatar International Exhibition Centre-Doha, Qatar

## 2006

- March 12 - 16 NACEpo 2006, 61st Annual Conference and Exhibition, San Diego, California
- April 23 - 27 AIChE 2006 Spring National Meeting, Orlando, Florida
- May 1 - 4 Offshore Technology Conference, Reliant Center at Reliant Park, Houston, Texas
- May Fluid Flow Projects Two-Phase Flow in Pipes Short Course, Tulsa, Oklahoma (date to be determined)
- June 1 - 2 5th North American Conference on Multiphase Technology, Banff, Canada