THE UNIVERSITY of TULSA

TUFFP

TULSA UNIVERSITY FLUID FLOW PROJECTS NEWSLETTER

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New Project Assistant Hired

Mrs. Suzette Blankenship has recently been hired as Pam Clark's replacement. She has a Bachelor's Degree in Finance and broad experience in office management. She will handle all budget implementations, coordination of meetings, and supervision of clerical and part-time office help for TUFFP and related projects. She will introduce herself. I am turning the pen to her.

I would like to take this time and introduce myself as the new Project Assistant for Fluid Flow Projects. I have been working at The University of Tulsa since April 8, 2002 on the North Campus with the Department of Petroleum Engineering. (What a wonderful group of people to work with!) My background includes many years of experience in management in the medical field, both hospital setting and physician practices.

I have my Bachelor's Degree in Business Administration from Northeastern State University. It would be nice to pursue my Master's Degree in the near future. I have lived in the Tulsa area all my life, currently north of Skiatook. I have two healthy, beautiful children who are such a blessing to me. We have a wide range of interests including sports which my children are very active in.

It is a blessing to be here at The University of Tulsa. I would like to thank everyone for the warm welcome and also for all the help during my orientation period. A big "Thank You" to Linda Jones for her patience and skill while training me for the position of Project Assistant.

Fax Numbers

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Linda's Fax: (918) 631-5130
Emmanuel's Fax: (918) 631-5140

Web Sites

www.tuffp.utulsa.edu
www.tupdp.utulsa.edu
www.tuhfp.utulsa.edu

Mrs. Pam Clark and Mr. Charles Ingle Leaves

Pam Clark, Project Assistant in TUFFP and related projects has resigned effective March 20, 2002 to assume a position with Duke Energy Services. She later accepted a position with the Muscular Dystrophy Association (MDA). Pam served The University of Tulsa with dedication and her service is greatly acknowledged and appreciated. We wish her well in her future endeavors.

Mr. Charles (Skip) Ingle has retired after over 23 years of service to The University of Tulsa in different capacities. He will be remembered by all of us for his dedicated service to TUFFP and TUPDP. Howard Rettig and Craig Waldron have collectively assumed his job responsibilities.

Congratulations to Our New Graduates

We are happy to inform you that two of our excellent students have recently completed their graduate studies. Jarl Tengesdal, the Tulsa University Severe Slugging Projects (TUSSP) research assistant, successfully defended his Ph.D. Dissertation. He will receive his Ph.D. degree from Penn State University (PSU) where he completed his course requirements and comprehensive PhD exams. Jarl has already accepted a position with Statoil in Norway. Oris Hernandez, a Tulsa University Paraffin Deposition Projects (TUPDP) Research Assistant successfully defended her MS Thesis. Oris accepted a position with Technip Co-Flexip in Houston, TX. We wish both Jarl and Oris well in their future endeavors.

Words from Our Computer Manager

Jose Aramburu

We have recently purchased MathCAD - an easy to use and friendly mathematical software tool that is very useful for modeling studies - and also the new version of LabView™, which will improve the data acquisition capability of our projects.

A comprehensive hardware and software database is being developed that contains lists of software programs used by each computer and the necessary drivers for all peripherals. This information will help us identify and promptly fix any hardware or software problems. We are currently working on a better backup system to ensure quick and full recovery in case of hardware failures.

A video library of TUFFP projects is being developed. This library would be used as an educational tool, allowing our students and members to visualize the different aspects of multiphase flow. Moreover, an attempt will be made to create a comprehensive TUFFP Data library consisting of all TUFFP experimental data.

TUFFP Graduate Seminars

The TUFFP Fall 2002 graduate seminar program will soon be prepared and uploaded to our web page.

TUFFP Membership

TUFFP 2002 membership stands at 12 companies. Efforts are underway to increase the number of members. We expect to lose one member for 2003 due to the Conoco Phillips merger. Advantica has informed us that they will terminate their memberships in TUFFP (effective 2003) and TUPDP (after completion of the current project cycle) as part of their restructuring. We are pleased to announce that Schlumberger has informed us about their intention to join TUFFP this year. We expect them to join before the next Advisory Board meeting.

We have initiated communications with both past and possible new members in an effort to expand our membership. TotalFinaElf has recently indicated their intention to rejoin for 2003. We have recently had positive meetings with Simulation Sciences (Invensys), Petrobras and Saudi Aramco about rejoining TUFFP for 2003.

We recently submitted a proposal in response to DOE's PRIME Solicitation to significantly leverage TUFFP industry funding. DOE is expected to announce their decision on PRIME Solicitation funding in late Fall 2002.

Cem Sarica to Serve on New SPE Committee for Facilities and Construction

In March 2001, the SPE governance structure was modified to provide representation of the Society's specialty (technical/functional) interests on the SPE Board of Directors. This enhanced governance model will serve to build technical excellence in all areas of the upstream oil and gas business and further the mission of the Society to facilitate the worldwide collection and dissemination of technology.

Ken Arnold of Paragon Engineering serves as the Specialty Director for Facilities and Construction. The main responsibilities of the Specialty Director for Facilities and Construction are to ensure coverage of facilities and construction across all areas of SPE's programs and services. This includes the SPE Technical Interest Groups (TIGs), publications, and SPE (corporate) meeting programs including the Annual Technical Conference and Exhibition, topical meetings, Applied Technology Workshops, Forum Series, Distinguished Lecturer Program, and technical awards. A new SPE Committee for Facilities and Construction is being formed to fulfill the objectives of the new governance model. Cem Sarica has accepted an invitation to serve as a member of the committee. The committee will hold its first meeting at the 2002 SPE ATCE.

TUFFP Financial Status

TUFFP's financial status remains stable for 2002. We entered 2002 with $304,260 in our reserve fund. Our 2002 income will be $420,000 from 12 membership fees. Our total expenditures for 2002 are estimated to be $520,000. The imbalance between 2002 income and expenditures will be compensated from the reserve account lowering the balance to $200,000 at the end of 2002.

Multiphase Flow Knowledge Map

As part of the TAC's recommendations, we have started to develop on a knowledge map of multi-phase flows to identify existing technology gaps and direct TUFFP resources to fill those gaps. An initial meeting with Harvey Hensley of Phillips was held in Tulsa, OK. Harvey has been involved in a similar exercise within Deep Star.

Meetings and Conferences

Fall 2002 Advisory Board Meetings

Final plans have now been made for the Fall 2002 Advisory Board meetings. The severe slugging JIP Advisory Board meeting will begin at 9:00 a.m. on Monday October 7, 2002 at the Doubletree Hotel at Warren Place in Tulsa. A tour of test facilities will be held at 3:00 p.m. Following the tour, there will be a joint Severe Slugging, TUFFP, and TUPDP Barbeque dinner on the North Campus between 5:00 - 7:00 p.m. The TUFFP Advisory Board meeting will begin at 8:30 a.m. on Tuesday, October 8 and will adjourn at 5:00 p.m. Following the meeting, there will be a joint Severe Slugging, TUFFP, and TUPDP reception at the Doubletree Hotel at Warren Place from 6:00-9:00 p.m. On October 9, 2002, the TUPDP Advisory Board start at 8:00 a.m. and will adjourn at 5:00 p.m.

The Request for Information Form and the Double Tree Hotel at Warren Place Reservation Form will be placed on the TUFFP web page in early September. All persons from your company that plan to attend the Advisory Board meetings should complete and return these forms 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.tuffp.utulsa.edu/ABM/index.html. You can then follow the links for the Request for Information Form. The hotel reservation form is a word document for downloading and faxing to the hotel.

Tentative dates and locations for the Spring 2003 Advisory Board meeting are yet to be determined.

TUFFP 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 TUFFP web site at www.tuffp.utulsa.edu 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.

SPE Annual Technical Conference and Exhibition

Dr. Jarl Tengesdal will present a paper titled "Investigation of Self-Lifting Concept for Severe Slugging Elimination In Deep-Water Pipeline/Riser Systems" at the SPE ATCE.

TUFFP Short Course

The 28th annual TUFFP Short Course on Two-Phase Flow in Pipes was taught May 13-17, 2002 at the Tulsa Marriott Southern Hills Hotel by Drs. Sarica and Brill. Nine engineers and scientists, including 8 from TUFFP and TUPDP members and 1 from a non-member company attended the course. Although the income was not sufficient to pay all the expenses incurred, it was decided to proceed with the short course to accommodate the training needs of our member companies by reducing the instructor compensation significantly. A major change in the 2002 course was the replacement of the module on Inflow Performance Relationship with one on paraffin deposition. The 29th annual TUFFP short course will be held in Tulsa, OK in May 2003. A firm date and location will be announced early in Spring 2003.

Flow Assurance 2002

Flow Assurance 2002 is a forum managed by PennWell, organized by Offshore, and hosted by BP. The forum focuses on the several aspects of flow assurance. The forum will be held September 17-19, 2002 in Galveston, TX at the San Luis Hotel. Detailed information on the forum can be obtained at www.global-energy-events.com.

This open-forum will feature brief, up-to-the-minute presentations. Each presentation will be followed by an extended question and answer session. No proceedings will be published, and the press will not be invited to attend.

Cem Sarica will make a presentation on Severe Slugging Mitigation in the emerging technologies session.

Please complete and send in your Request for Information form and make hotel reservations for the upcoming Advisory Board meetings as soon as possible.

BHR Group Conferences on Multiphase Production

Since 1991, TUFFP has participated as a co-sponsor of BHR Group Conferences on Multiphase Production. TUFFP personnel participate in reviewing papers, serving as session chairs, and advertising the conference to our members.

The third North American BHR Group Multiphase Technology conference was held in Banff, Canada on June 6-7, 2002. Over 30 papers were presented, including one by Dr. Hong Quan (Holden) Zhang on the new TUFFP Unified Mechanistic Model. Four TUFFP personnel attended the meeting.

BHR Group's Multiphase '03 Conference is scheduled for June 11-13, 2003. The Conference is moving from its previous home in Cannes, France to the beautiful resort of San Remo, Italy. The opening address of the conference will be given by Dr. James P. Brill. The title of his address will be "Multiphase Technology - Past, Present and Future, the World According to Brill". It is expected that Multiphase '03 will benefit anyone engaged in the application, development and research of multiphase technology for the oil and gas industry. The deadlines for abstract and final manuscript submission are September 6, 2002 and December 16, 2002, respectively.

Future Advisory Board Meetings Schedule

October 7, 2002

Severe Slugging JIP
Advisory Board Meeting
Doubletree Hotel at Warren Place - Tulsa, OK
9:00 a.m. - 1:00 p.m.

Severe Slugging JIP/TUFFP/TUPDP/TUHFP JIP
Tour of Test Facilities
University of Tulsa North Campus - Tulsa, OK
3:00 - 5:00 p.m.

Severe Slugging JIP/TUFFP/TUPDP/TUHFP JIP
Barbeque
University of Tulsa North Campus - Tulsa, OK
5:00 - 7:00 p.m.

October 8, 2002

Tulsa University Fluid Flow Projects (TUFFP)
Advisory Board Meeting
Doubletree Hotel at Warren Place - Tulsa, OK
8:00 a.m. - 4:00 p.m.

Severe Slugging JIP/TUFFP/TUPDP/TUHFP
Reception
Doubletree Hotel at Warren Place - Tulsa, OK
5:30 - 9:00 p.m.

October 9, 2002

Tulsa University Paraffin Deposition Projects (TUPDP)
Advisory Board Meeting
Doubletree Hotel at Warren Place - Tulsa, OK
8:00 a.m. - 4:00 p.m.

Tulsa University Hydrate Flow Performance JIP
Dinner Social - Steak and Ale
4710 East 51st Street
6:30 - 8:00 p.m.

October 10, 2002

Tulsa University Hydrate Flow Performance JIP (TUHFP)
Advisory Board Meeting
Allen Chapman Activity Center - Tulsa University
President's Formal Lounge
8:00 a.m. - 2:45 p.m.

Calendar of Events

2002

September 17 - 19	Flow Assurance Forum 2002 - Galveston, Texas
September 29 - October 2	SPE Annual Technical Conference and Exhibition San Antonio, Texas
October 7	Severe Slugging JIP Advisory Board Meeting - Doubletree Hotel at Warren Place - Tulsa, Oklahoma
October 8	Fluid Flow Projects Advisory Board Meeting - Doubletree Hotel at Warren Place - Tulsa, Oklahoma
October 9	Paraffin Deposition Projects Advisory Board Meeting - Doubletree Hotel at Warren Place - Tulsa, Oklahoma
October 10	Hydrate Flow Performance JIP Advisory Board Meeting - University of Tulsa Allen Chapman Activity Center - President's Formal Lounge
November 17 - 22	ASME International Mechanical Engineering Congress and Exposition - New Orleans, Louisiana

2003

March 30 - April 3, 2003	AIChE Spring National Meeting and Petrochemical and Refining Exposition - New Orleans, Louisiana
May 5 - 8, 2003	Offshore Technology Conference - Houston, Texas
June 11 - 13, 2003	BHR Group 11th International Conference on Multiphase Technology - San Remo, Italy

Progress Reports

Two Phase Flow in Hilly Terrain Pipeline

A hilly-terrain pipeline consists of interconnected horizontal, uphill, and downhill sections. Both offshore and onshore pipelines exhibit such configurations. The prediction of slug characteristics in these pipelines is very crucial. Long slugs often cause operational problems, flooding of downstream facilities, severe pipe corrosion, and structural instability of the pipeline, as well as production loss and poor reservoir management.

The objectives of this project are four fold: 1) investigate, experimentally and theoretically, slug initiation at the bottom elbow 2) develop closure relationships for slug tracking models 3) generate data to evaluate the developed models and 4) develop sub-models to be integrated with TUFFP slug tracking model to simulate two-phase flow in hilly-terrain pipelines.

A 420-m (1378-ft) long, 50.8-mm (2-in.) diameter, horizontal, steel pipeline was used to conduct the experimental tests. The test section, made of 2-in. diameter transparent acrylic pipe was used to simulate a single hilly-terrain unit of 70-ft uphill (downhill) and 70-ft downhill (uphill) sections. The inclination angles were +1°, +2° from horizontal (valley configuration), horizontal configuration, and +1°, +2° from the horizontal (hill configuration). The test section included four measurement stations to monitor the change in slug flow characteristics along the test section. A total of 105 tests were conducted with hill and valley configurations. The superficial liquid and gas velocities ranged from 0.2 to 4 ft/s and from 2 to 15 ft/s, respectively.

Two types of initiation mechanisms, namely wave growth, and wave coalescence have been observed. The wave growth mechanism is characterized by flow reversal of the liquid downstream of the elbow (counter-current flow). As the liquid level increases, a new slug will be generated by Kelvin Helmholtz (K-H) instability. The generated slugs are characterized by high liquid holdup and frequency, and low velocity. The wave coalescence initiation mechanism is governed by different physical phenomenon where small amplitude waves are generated at the dip, move downstream, and eventually coalesce to form a large wave that becomes a slug under K-H instability.

Two-phase flow mechanistic-probabilistic-empirical models have been developed to predict initiated slug length distribution at the bottom elbow, and slug length distribution at the hilly terrain pipeline entrance have been developed. A Lognormal probability model was found to fit the experimental slug length distribution better than an Inverse Gaussian probability model. The Lognormal probability model was then correlated empirically with mechanistic, operational and geometrical parameters of slug flow. Validation studies were carried out that showed a satisfactory match between the model prediction and experimental data. These models will eventually be integrated into the TUFFP slug-tracking model to improve predictions of slug flow characteristics variation along a hilly-terrain pipeline. A detailed progress report will be presented at the next Advisory Board meeting in October 2002.

Mechanistic Modeling of Multiphase Heat Transfer in Wells and Pipelines

Estimating heat transfer for gas-liquid pipe flow is required to model the thermal behavior of petroleum multiphase systems. However, heat transfer in crude oil-natural gas pipe flow is not well understood. A robust prediction method for all possible operating conditions in these petroleum multiphase systems does not exist.

The objectives of this project are to: 1) acquire experimental data on average convective heat transfer coefficients for high-pressure, gas-liquid (natural gas-crude oil) flow in horizontal, inclined and vertical pipes; 2) develop a comprehensive mechanistic heat transfer model; and 3) validate the proposed model with experimental data.

As part of his PhD dissertation, Ryo Manabe developed a comprehensive mechanistic model for heat transfer in gas-liquid pipe flow. When compared with experimental results, the model overall performance is better than previous correlations. However, there is room for further improvements. Dr. Qian Wang is currently making modifications to the model and comparisons with experimental results. The model with computer programs will be available to TUFFP and TUPDP members following the 2002 Fall Advisory Board meeting.

Multiphase heat transfer and hydrodynamics are interrelated. A unified model for gas-liquid flow heat transfer in pipes at different inclination angles is being developed through careful analysis of the heat transfer in different flow patterns. The objective of TUFFP is to develop an integrated unified multiphase hydrodynamic and thermal model.

Gas-Oil-Water Pipe Flow

Three-phase gas-oil-water flow is a common occurrence in the petroleum industry. However, only a limited amount of experimental data and modeling results can be found in the literature. The ultimate objective of TUFFP for gas-oil-water studies is to develop a mechanistic model based on theoretical analysis and experimental results. Two initial studies of gas-oil-water flow are currently underway. The first study focuses on assessing current three-phase flow technology, identifying technology gaps and weaknesses, and developing a modeling framework. The goal of the second study is to investigate gas-oil-water flows in horizontal and slightly inclined pipes, starting with the investigation of flow patterns.

The objectives of the assessment study are to: 1) collect experimental data and review theoretical models for gas-oil-water pipe flow from the open literature, 2) evaluate existing models with experimental results, 3) identify limitations and shortcomings of the models, 4) suggest modifications and new developments for future studies, and 5) develop a preliminary three-phase flow model. Collection of experimental data from the open literature and a thorough the literature review are underway. They are expected to be completed by the end of 2002.

The experimental work will be conducted on the existing TUFFP facility for oil-water flow. The facility consists of a closed circuit loop with the following components: pumps, heat exchangers, metering sections, filters, test section, separator and storage tanks. The test section is attached to a boom whose angle can be changed with a cable system and a vertical tower. Since it is a facility designed for only oil-water flow, modifications are needed to both the flow loop and the test section to perform three-phase flow experiments. A gas-metering run was constructed, and new Micro-Motion mass flow meters were installed for the measurement of air flow rate. The existing test section was modified by building a new mixing tee. Wiring of the flow loop and test section was completed.

Currently, efforts are focused on checking the the existing equipment such as pumps, heat exchangers, flow meters, separator and storage tanks, and making them operational. For the measurement of phase fractions and flow characteristics, fiber optic conductance probes and a gamma densitometer are being evaluated. Several mineral oil samples will be tested for their suitability. Calibration of the instruments and updating the data acquisition program will be started soon. Preliminary testing is expected

Unified Model for Spatially Developing Gas-Liquid Pipe Flows (Including Slug Tracking)

Hilly-terrain pipelines and deviated wells consist of interconnected pipe sections of different inclination angles. Multiphase flow can experience transition from one state to another as pipe inclination angle changes. Normally, slugs dissipate if the upward inclination becomes smaller or the downward inclination becomes larger, and slug generation occurs vice versa. As a result, flow pattern transition may occur between stratified (annular) and slug flows. Appropriate prediction of multiphase flow behavior is crucial for the design of pipelines and downstream facilities. In this study, a unified model has been developed for spatially developing gas-liquid pipe flow. The model can be used to simulate the transitions in spatial development between different flow patterns, and to predict slug dissipation and generation in slug flows.

New closure relationships for slug length and distribution have been developed for both fully developed slug flow and slug initiation in the experimental study of "Two Phase Flow in Hilly-Terrain Pipelines." They can be incorporated into the unified model for spatially developing gas-liquid pipe flow. The new unified model can also be used for slug tracking in hilly-terrain pipelines. The model validation against experimental results is under way.

Unified Model for Gas-Liquid Flow in Wells and Pipelines

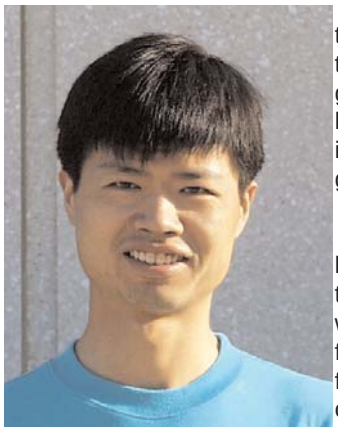
This project was initiated in July 2000. A unified hydrodynamic model has been developed for predictions of flow pattern transitions, pressure gradient, liquid holdup and slug characteristics in gas-liquid pipe flow at different inclination angles from -90° to 90°. The model is based on the dynamics of slug flow.

In a recent study presented at the BHRg 2002 meeting, it was shown that the flow pattern transitions from slug flow to the other flow patterns (dispersed bubble, stratified or annular) are related to the slug dynamics and can be predicted by solving the equations for slug flow at different inclination angles.

Through careful selection and generalization, significant effort has been expended to eliminate discontinuities among the closure relationships. The flow pattern classification is also simplified according to the hydrodynamic characteristics of two-phase flow. The new model has been validated with extensive experimental data acquired with different pipe diameters, inclination angles, fluid physical properties, gas-liquid flow rates and flow patterns. Good agreement is observed in every aspect of the two-phase pipe flow. The model predictions have also been compared with data in the TUFFP well and pipeline databanks.

The TUFFP unified model will be updated as additional data and better closure relationships become available. Currently, the TUFFP pipeline databank is being expanded for this purpose.

Low Liquid Loading Gas-Liquid Flow in Near-Horizontal Pipes



The objective of this study is to investigate, experimentally and theoretically, low liquid loading gas-liquid two-phase flow in near-horizontal pipes, and to develop improved design models for wet-gas pipelines.

A 50.8-mm diameter, 19-m long flow loop is being used for this study. Both air-oil and air-water low liquid loading two-phase flow experiments have been finished, with the inclination angle changing from -2° to 2°. The measured parameters include gas flow rate, liquid flow rate, pressure, differential pressure, temperature, liquid holdup, liquid film flow rate and liquid entrainment fraction. The results were reported at the 2002 Spring Advisory Board meeting.

In order to further investigate low liquid loading flow characteristics and collect more test data, the 6-in. (152.4 mm) diameter BP flow loop will be used. The gas superficial velocity will change from 5 to 30 m/s with the liquid loading varying between 50 and 1800 m3/MMm3. The measured parameters will be the same as above.

Simultaneously, efforts will be made to construct a mechanistic model for low liquid loading two-phase flow at different flow patterns. The collected data can be used to verify the model.

2002 Fluid Flow Projects Membership

Baker Atlas
BG International
BP Exploration
Chevron Petroleum Technology Company
Conoco, Inc.
Japan National Oil Corporation
Marathon Oil Company
Minerals Management Service
PDVSA - Intevep
Pemex
Petronas
Phillips Petroleum Company

Related Projects

Severe Slugging JIP

Severe slugging elimination or slug flow suppression has been one of the emerging flow assurance problems for deepwater developments. The Joint Industry Project titled "Severe Slugging Elimination in Ultra-Deep Water Tie-backs and Risers" has been successfully completed. The JIP was supported by Chevron, Marathon, MMS, and TotalFinaElf (Norway). The major deliverables of the project were a proven novel severe slugging elimination technique and a design model.

An existing TUFFP test facility has been modified and used for this project. It consists of a 65-ft long pipeline followed by a 40-ft high riser using 3-in. diameter Acrylic pipe. The pipeline can be expanded to simulate a 280 ft. length by using variable volume tanks.

There have been several ideas proposed by current and potential participants for a follow-up study beyond August 2002. Severe slugging and its elimination for gas-oil-water flows, and the testing of several elimination techniques emerged to be a common interest among the interested parties. A decision on future studies will be made at the Fall 2002 Advisory Board meeting.

A proposal for field-testing of the self-lifting concept has been submitted to ITF (Industry Technology Facilitator), a European entity, as a response to a Call For Proposals.

Paraffin Deposition Projects

Activities on single-phase and multiphase flow facilities

Two fluids with significantly different properties (fluid viscosity and wax content) were studied extensively in both flow loops. Of particular importance were several experiments where test conditions were changed to isolate diffusion mechanisms from other transport mechanisms, such as shear stripping.

The Garden Banks condensate was transferred from the single-phase flow loop into storage tanks. The Cote Blanche Island (CBI) fluid was then loaded into the flow loop (10 bbl). The CBI has been sampled and sent to some TUPDP members for HTGC, viscosity and WAT analyses. In addition to the fluid changes, the flow loop has been modified to allow sampling while testing based on a bypass system since the previous coupon design has proven unreliable.

Two-phase flow testing continues on the multiphase flow loop. Horizontal flow tests with Garden Banks have been completed. Vertical testing with Garden Banks will continue until the next Advisory Board meeting. The design of the water system for the multiphase flow loop is now completed. The water pump and instrumentation have been received. Oil/water separator will be received by September. Construction of the water system will begin early October. Commissioning is anticipated to start early 2003.

Small-scale flow facility

Construction of the small-scale flow loop has been completed. Commissioning is near completion. Initial shakedown tests with water will be conducted soon to verify the stability of the controls and the safety of the system. This facility is designed to operate with no attendance except for startup and shutdown procedures. The first oil to be tested in the small-scale loop will be South Pelto oil. South Pelto will be loaded after commissioning is complete. It is anticipated that preliminary deposition tests with South Pelto will be completed before the next Advisory Board meeting.

Pigging studies

A literature search revealed that only a few papers have been published on pigging or mechanical removal of wax deposits. Our pigging skid is being redesigned to allow pigging of spool pieces. A new design will be presented at the next Advisory Board meeting.

Laboratory experiments

The DSC procedure is being revised to permit use of different sample pans and reference materials. A method has been developed to compute the wax content a sample, without guessing the enthalpy of crystallization of the sample. This method will be evaluated with samples of known wax content (HTGC analyses performed by Chevron Texaco) and results will be presented at the next Advisory Board meeting.

Oil/water experiments are also being conducted with the South Pelto and Garden Banks fluids. The purpose of these tests is to evaluate the difficulty of water separation with the two fluids, as well as emulsifying tendencies. These tests will be useful in the test matrix design and operation of the three-phase flow loop.

Modeling

A previous single-phase paraffin deposition model was modified to account for changes in deposit wax content (aging), kinetic effects and shear stripping. The proposed model is based on physical phenomena, reducing the empiricism of previous models. Model predictions agree fairly well with experimental data acquired in this and previous studies. The model will be incorporated in the software, with an updated GUI.

Samples of Garden Banks and South Pelto have been sent to Conoco to develop a laboratory experiment that could determine the kinetic parameter. Determination of the aspect ratio of the paraffin crystals using a microscope donated by Phillips is being considered.

TUCoRE Activities

The University of Tulsa and ChevronTexaco have initiated a research and educational partnership with seed money of $500,000. The collaboration is known as the TU Center of Research Excellence, or TUCoRE.

CORE's objectives include research and educating students, particularly from countries where ChevronTexaco operates. The education objective will also involve training of company personnel, short courses, seminars led by visiting experts, and distance learning.

Initial research will focus on flow assurance, and several pilot projects are underway. Projects must be approved by a six-member board with equal representation from TU and ChevronTexaco. TUFFP researchers have already been involved in TUCoRE activities through conducting one of the pilot projects. Moreover, TUFFP personnel have attended the short courses sponsored by TUCoRE.

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