Fluid Flow Projects

The University of Tulsa

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Contents

News

Meetings

Progress Reports

Membership

Calendar

Directory

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Editorial - Clifford L. Redus

It is an exciting time to be in the oil and gas business! Technology is transforming the way we do business with advances in composite risers, multilateral horizontal completions, multiphase booster pumps and meters, subsea separation, compact cyclonic separators, advanced multiphase simulation tools and productions spars all enabling the industry to move into deeper water while clawing back capex and cycle time on new developments. Imbedded in almost every aspect of this new technology is multiphase flow. While operators continue to focus on their core business, which is the finding and developing oil and gas fields, they are relying more and more on leveraged research JIP's and consortia, like TUFFP, to develop new technology. Does this mean that universities, government laboratories and private research initiatives are automatically receiving a windfall in support of their technology development initiatives from the oil companies? Not necessarily. The industry is becoming more assertive in the distribution of R&D external funds by discriminating amongst potential funding opportunities based upon the establishment of a persuasive value proposition by research groups. Those research groups that are successful in articulating clear and persuasive value propositions will win a disproportionate percentage of available funding.

Technology advances changing the way we do business!

Industry being more assertive with R & D $$$$

What does this have to do with TUFFP? The answer is that we need your help through active participation in our advisory board process, the next of which is on May 24th in Tulsa. We can only be successful if together we can agree on the right projects to work on in the area of multiphase flow that add a real and demonstrable value to your bottom line. In other words, we need to have business pull as opposed to R&D push in establishment of our work scope. Please come and participate and help us build TUFFP into the kind of research program that you can continue to champion in your company.

Dr. Subash Jayawardena moves on to Shell

We are sad to announce that Dr. Subash Jayawardena has left TUFFP to join Shell E&P in Houston on a contract basis. Subash has done an outstanding job in working with our graduate students both in experimental design technique as well as modeling. Subash took a leading role in the coordination and execution of our advisory board meetings in addition to an active research effort in oil-water and gas-liquid multiphase flow. Even though we are sad at losing a valued colleague, by the nature of our work we know that we have access to our research associates and graduate students only for a short time until they relocated into the E&P business community or other educational institutions. We are actively looking for an experienced multiphase researcher to take Subash's research associate position.

Subash Jayawardena and Cliff Redus

Two Frenchmen Fulfilling French National Obligations at The University of Tulsa

Nicolas Olive joined TUFFP as a Visiting Scholar and is performing his French National Obligations (CSNS or Coopérant du Service National Scientifique) with the French Oil company Elf Exploration Production. He began working on his project in October 1999 and will continue until the end of this year.

Nicolas graduated from IFP School (or ENSPM) in Paris, where he specialized in the Oil and Gas industry. He followed the Refining, Engineering and Construction, Gas study program.

After a year of study, he obtained the IFP Engineer Diploma as well as a Master of Science in Applied Chemical Engineering degree, in July 1999.

Before attending the IFP School, Nicolas studied for 3 years at the French Engineer School, ENSEEG (École Nationale Supérieure d'Électrochimie et d'Électrométallurgie de Grenoble), which is a part of INPG (Institut National Polytechnique de Grenoble). He followed the Process Engineering option. He obtained the INPG Generalist Engineer diploma in 1998.

Nicolas Olive

During his studies, Nicolas did some industrial internships in the Oil and Gas industry. He did an internship in Scotland within Total Oil Marine, where he worked on the Frigg Transportation System. He worked for Framatome Equipements Industriels in Thermodyn (which designs and manufactures compressors and turbines) where he did a risk analysis on industrial compressors and turbines. He did a training period within SARA, the French West Indies Refinery in Martinique operated by Total Raffinage. His work was to improve the reliability of the SARA sour gas treatment plant, a SulFerox® unit. All these internships and his studies in IFP School enforced Nicolas' willingness to work in the Oil and Gas industry.

In TUFFP, Nicolas is involved in two different projects. The first is an experimental study on the low liquid loading gas-liquid two-phase flow in near-horizontal pipes. The other project involves the process design of a 6" diameter horizontal two-phase flow loop donated by BP-Amoco. He uses the ProII simulation software to do the necessary process calculations.

Nicolas Manjarres is fulfilling his French obligations (CSNS or "Coopérant du Service National Scientifique") at TUFFP for the French Oil Company Elf Exploration Production. He began working in the project in November 1999 and will continue until the beginning of 2001.

Nicolas Manjarres

Nicolas has completed 3-years of studies at the French Engineer School IUSTI (Institut Universitaire des Systemes Thermiques Industriels) and he majored in " Non conventional industrial compound materials". He obtained his degree in 1999.

Nicolas is working within TUFFP as a visiting scholar. His project deals with the Paraffin Deposition Prediction in Multiphase Flowlines and Wellbores and specifically, deposition physics.

During his studies, he performed some industrial internships in the Oil and Gas industry. He did an internship in Pau within Elf Exploration Production, where he studied the effects of shear stress, shear rate and temperature gradient on the paraffin deposition. He worked for Elf Antar France where he created a program that enabled the process department to have, in real time, a survey of different temperatures in each part of the pyrolisis oven.

Don't forget to send in your hotel and meeting reservations for the upcoming Advisory Board Meeting and related events!!!!

Brills Relax During Sabbatical

Jim Brill

In January, Jim and Marilyn Brill moved temporarily to Golden, Colorado for the second half of Jim's 1999-2000 sabbatical leave. He is now teaching a multiphase flow in pipes course to 22 students at the Colorado School of Mines. Since the course is taught one afternoon a week, eventually Jim and Marilyn will find time to enjoy the skiing and biking joys of the Colorado Mountains. Unfortunately, ETCE, BHRG and SPE paper editing, e-mail, wax JIP final report preparation, new wax consortium proposal preparation, planning for the 2000 SPE Forum on Flow Assurance and some TUFFP duties are interfering with his sporting activities. Nevertheless, they have already skied several days and will get several more in before the end of his leave. *Life is good!*

Web Page Progressing

The TUFFP web page is located at www.tuffp.utulsa.edu. If you have not visited the site, please take a few minutes and tour the site. Here are the latest updates.

In the "Members Only" section, several research reports have been added such as the TUFFP Core Software User's Manual Version 2.0, the Ph.D. dissertation of Weihong Meng entitled "Low Liquid Loading Gas-Liquid Two-Phase Flow in Near-Horizontal Pipes" and the M.S. thesis of Eissa Al-safran entitled "An Experimental Study of Two-Phase Flow in a Hilly-Terrain Pipeline". Each research report includes the reports in pdf format and the Fortran source code in plain text format. The Fortran source code of the research report by JinJiang Xiao – entitled "A Comprehensive Mechanistic Model for Two-Phase in Pipelines" has also been uploaded. More research reports will be added in the near future.

In the "Research Projects" section, a list of all completed research projects is given in both chronological and subject order. The purpose of this list is to give visitors of TUFFP web site a feel of what kind of work we have been doing since 1975.

The work on generating the flow regime map is still in progress.

Please continue to send us your suggestions on how to make your visits to our web site profitable.

TUFFP Financial Status

By aggressive cost cutting, the projected TUFFP reserve fund balance at the end of 1999 is approximately $200,000 or about the same level as the 1998 reserve balance. We were successful in maintaining the reserve balance despite the loss of members for 1999 coupled with capital expenditures necessary for the hilly terrain pipeline and oil-water flow research projects.

Because of the significant merger activity that has adversely impacted our membership over the last two years, we have no choice but to raise our membership fee from $30,000 to $35,000 per year staring next year.

Every attempt will be made to continue aggressive cost control during 2000 to improve this financial picture. In addition, efforts are underway at TUFFP to broaden our customer base by visiting companies in the E & P service sector and gas transmission companies.

Consolidation Impacts TUFFP Membership

Five companies have indicated that they will be dropping their 2000 membership, Amoco Production Company, Pertamina, Saudi Arabian Oil Company, Petrobras and Total. One company has informed us that they will terminate their 2001 membership, Simulation Science Inc. Because of mergers, we anticipate losing Mobil Research and Development Company in the year 2001. Feedback from member companies have indicated the cause of termination was a tightening business climate and not dissatisfaction with the TUFFP program.

With oil prices recently over $30 per barrel, we are optimistic that we will be successful in bringing in new member companies to TUFFP. Current discussions are underway with the U.S. Department of Energy, Statoil, Norsk Hydro and Schlumberger. We will also be soliciting membership in E&P construction companies and software development companies.

Plans Progressing for BHR Group Conference in Banff, Canada

Since 1983, BHR Group has organized a series of successful International Conferences throughout Europe on Multiphase Technology which have drawn senior industry professionals from across the world. In 1998, BHR Group was invited to initiate a Multiphase Conference in North America, in collaboration with TUFFP, USA and Neotechnology Consultants Ltd, Canada. Following this successful debut Conference, the sponsors resolved that Multiphase North American should be a bi-annual event to complement the long established European Conference.

Final plans are underway for the BHRG's 2nd Multiphase North American Conference in Banff, Canada, June 21-23, 2000. Approximately 30 excellent technical papers have passed a rigorous peer review process on a variety of subject areas ranging from multiphase pumping, multiphase metering, multiphase modeling, transient flow, separation, emulsions, flow assurance and others. This conference promises to be another excellent technical event that will be of strong interest to TUFFP member companies. A registration brochure is enclosed with this newsletter.

Advisory Board Meetings

Final plans have now been made for the Spring 2000 TUFFP Advisory Board and related meetings. The Advisory Board Meeting will be held at the Doubletree Hotel at Warren Place. This is our fifty-fourth semi-annual Advisory Board meeting. A Request for Information form is enclosed with this Newsletter together with information on hotel reservations and travel to and from the airport. This information was also distributed earlier in the year by email for your convenience. Persons attending the meeting should complete the form and return it to us as soon as possible if you have not responded to the earlier email request. Information on the Advisory Board meeting 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 and the Hotel Reservation form. The Request for Information form is an online form that is submitted via the internet. The Hotel Reservation for is a word document for downloading and faxing to the hotel.

The TUFFP Advisory Board meeting will begin at 8:30 a.m. on Wednesday, May 24, 2000 and will adjourn at 4:30 p.m. A joint tour of test facilities for persons attending the TUFFP Advisory Board meeting and/or the Paraffin Deposition Prediction Research and Model Validation Consortium kickoff meeting will be held at 4:00 p.m. on Tuesday, May 23, 2000. Following the Paraffin kickoff meeting on Tuesday, May 23, 2000, there will be a joint reception at the Doubletree Hotel at Warren Place – Two Warren Place – 19th Floor from 6:00-9:00 p.m. Facilities available to see at the tour include the hilly terrain pipeline, the low liquid holdup and both paraffin deposition test facilities. In addition, construction is underway on the BP-Amoco six inch flow loop.

A summary of the dates for the Spring and Fall 2000 Advisory Board meetings are shown in the table below. The hotel for the Fall meeting will again be the Doubletree Hotel at Warren Place.

TUFFP Advisory Board meeting brochures will be available for members at the meeting and will be 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 to actively participate in discussion on current and future research projects, financial matters, and operating procedures. The brochure will also contain slide copy for all presentations.

Future Advisory Board Meeting Schedule

May 23, 2000
Kickoff Meeting
Paraffin Deposition Prediction and Model Validation
The University of Tulsa
Allen Chapman Activity Center - South Campus
President's Lounge

Tour
TUFFP/Paraffin Deposition Research Test Facilities

Reception
Joint TUFFP/Paraffin Deposition Prediction and Model Validation
Doubletree Hotel at Warren Place
Two-Warren Place - 19th Floor

May 24, 2000
Advisory Board Meeting
TUFFP
Doubletree Hotel at Warren Place

November 16, 2000
Advisory Board Meeting
Paraffin Deposition Prediction and Model Validation
The University of Tulsa
Allen Chapman Activity Center - South Campus
President's Lounge

Tour
TUFFP/Paraffin Deposition Research Test Facilities

Reception
Joint TUFFP/Paraffin Deposition Prediction and Model Validation
Doubletree Hotel at Warren Place
Two-Warren Place - 19th Floor

November 17, 2000
Advisory Board Meeting
TUFFP
Doubletree Hotel at Warren Place

2000 Short Course

With the hectic pace of reorganization and restructuring in the industry, people are moving into and out of work groups at lightening speed. Do you have new team members that need to come up to speed on multiphase flow in pipe and wells? Have your company's recent discoveries in deepwater forced you to have to pay more attention to flow-line and export pipeline designs? Are, do you just need to hone your skills in a competitive work environment. In all cases, we have a solution for you. The University of Tulsa Fluid Flow Projects (TUFFP) is again sponsoring a one-week short course titled "Two-Phase Flow in Pipes". Over the last several years we held the short course in Tulsa, Oklahoma. This year, based on a survey from our member companies, we have move the year 2000 short course to Houston, Texas, on May 8-12th. The course will be taught by Drs. Jim Brill and Cliff Redus. For more information on the course, please see the TU Continuing Education web site at www.conted.utulsa.edu/.

Production Program for ETCE 2000 Great Success

The final tally for the Petroleum Production Technology Symposium at the ASME Energy Technology Conference and Exhibition (ETCE) was fantastic. ETCE 2000 was held February 14-16, 2000 at the New Orleans Sheraton Hotel. 85 technical papers were scheduled in 28 technical sessions, with 3 concurrent sessions occurring throughout the Symposium. These include five multiphase flow sessions comprising 16 excellent papers and a keynote talk by Cliff Redus. Also included were: 4 papers on pumping, 5 papers on flow assurance, 9 papers on separation, 4 papers on IPR, 5 papers on formation damage, 3 papers on metering, 4 papers on optimization plus a keynote talk, 8 papers on horizontal wells, 9 papers on erosion, 6 papers on simulation, 4 papers on artificial lift plus a workshop, and 8 papers on pollution and environmental issues.

The symposium was chaired by Jim Brill, and key players include 21 Steering Committee members and 17 additional professionals that served as Session Chairs or Vice-Chairs.

ETCE Awards

The University of Tulsa was wonderfully represented and received several awards at the ETCE Conference held on February 14 - 16, 2000 at the New Orleans Sheraton Hotel. Dr. James P. Brill received the *Frank Walk Service Award* in the Petroleum Production area and he received the *Collier Service Award*. The University of Tulsa also received the *Jacobson Best Paper Award* for the paper entitled "Investigation of Paraffin Deposition during Multiphase Flow in Pipelines and Wellbores - Part 1 - Experiments" by A. Matzain, M. Apte, H. Zhang, M. Volk, J. Brill and J. Creek. *Congratulations, everyone!*

Two Phase Flow in Hilly Terrain Pipeline

Eissa Al-safran

A hilly-terrain pipeline consists of interconnected horizontal, uphill, and downhill sections. Both offshore seafloor and onshore land exhibit such configurations. The prediction of long slugs generated in these is important. These 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.

In this study, two phase-flow in hilly terrain pipelines will be investigated experimentally and theoretically. The objectives of this project are four fold:

- Investigate slug initiation at the bottom elbow and slug dissipation at the top elbow.
- Develop closure relationships for slug tracking models.
- Generate data to evaluate the developed models.
- Develop a model to simulate two-phase flow in hilly terrain pipelines.

The experimental program is a major part of this project. The test facility will be used is a TUFFP flow loop located at the North Campus of The University of Tulsa.

This test facility is a 420-m (1378-ft) long, 50.8-mm (2-in.) diameter, horizontal steel pipeline that was recently modified to conduct the preliminary experimental part (phase I) of this study.

A new test section made of 2-in. diameter transparent acrylic pipe, which simulates a single hilly-terrain unit of 70-ft uphill (downhill) and 70 ft downhill (uphill) sections. The inclination angles to be investigated are $+1^{o}$, $+2^{o}$ from horizontal (valley configuration) and $+1^{o}$, $+2^{o}$, and $+3^{o}$ from the horizontal (hill configuration). The test section contains four measurement stations to monitor the change in slug flow characteristics along the test section.

A total of 125 tests will be conducted with hills and valleys configurations. The superficial liquid and gas velocities will range from 0.2 to 4 ft/s and 2 to 10 and 15 ft/s, respectively.

A two-phase flow mechanistic model to predict slug flow characteristics along a hilly-terrain pipeline will be developed. The model will be an integrated model that mainly consists of four major mechanisms: slug dissipation in the downhill section, slug growth in the uphill section, slug initiation at bottom elbow, and slug dissipation at top elbow. The film hydrodynamics will be thoroughly investigated because of its crucial role in the above mentioned mechanisms.

Significant progress has been made since the last advisory board meeting in September 1999. Phase I of this project was completed in which the facility was constructed and validated, the instruments were calibrated, limited preliminary data was acquired and analyzed and

proposed modifications were stated for phase II of this project. Currently, these modifications are underway. For example, the capacitance sensors (CS) performance has been improved by studying the temperature effect on the output signal. Temperature/voltage characterization of each capacitance is underway. Also some of the CSs have been shifted to more critical location along the test section in an effort to maximize the data out of the capacitance sensors. Furthermore, some of the differential pressure transducers have also been shifted along the test section trying to cover a longer pipe section. A new measurement station was installed in the horizontal section further downstream of the hilly terrain test section to investigate the impact of the test section on slugs characteristics. An attempt will be made to measure the liquid film velocity in the film zone of the slug flow. This certainly will enhance the film hydrodynamics modeling. A detailed progress report will be presented at the next Advisory Board meeting in May 2000.

A Comprehensive Mechanic Heat Transfer Model and High Pressure Flow Pattern Validation for Inclined Two Phase Flow

Ryo Manabe

Estimating heat transfer, including the prediction of convective heat transfer coefficients, for gas-liquid two-phase flow is a main concern in modeling thermal behavior of petroleum multiphase systems. However, the petroleum industry has paid less attention to heat transfer in multiphase flow than to the hydrodynamics, such as flow pattern, pressure drop and liquid holdup. Thus, the heat transfer for crude oil – natural gas two phase flow is not well understood, and a robust prediction method for all possible operating conditions in petroleum multiphase systems does not exist.

Flow pattern is a central issue in two-phase hydrodynamics. Obviously, two-phase heat transfer strongly depends on the existing flow pattern. Although existing flow pattern models have been well validated in low-pressure systems, the validity of these models under high-pressure conditions has not been adequately documented in the literature.

The objectives of this project are

1) to acquire experimental data on high pressure flow pattern transition boundaries and heat transfer for high pressure gas-liquid (natural gas - crude oil) two-phase flow in inclined pipes,
2) to extend the mechanistic flow pattern transition models to high pressure conditions, if necessary,
3) to develop a comprehensive mechanistic heat transfer model, and
4) to validate the proposed model with experimental data.

The trend for multiphase flow modeling is moving from correlative approaches to mechanistic ones, due to their improved accuracy and their ability to apply for a wide operational range. Prediction of two-phase heat transfer by mechanistic approaches in conjunction with the hydrodynamics will improve the reliability of the models.

The objectives of the experimental study are to acquire experimental data for two-phase flow behavior and heat transfer, including flow pattern transition boundaries, and heat transfer under high pressure in a natural gas - crude oil system. The existing high pressure multiphase test facility of the Tulsa University Paraffin Deposition JIP will be utilized for this experimental study. The facility will be operated as a natural gas - crude oil system at high pressure.

High Pressure Capacitance Sensor

A comprehensive literature survey has been completed. Also, a research proposal has successfully been defended in December, 1999. Now designing and manufacturing a new spool piece for measurements are underway. The plan is to start acquiring the data on March, 1999. Hopefully, a part of the data will be presented at the next Advisory Board Meeting.

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

Gas-liquid two-phase flow exists extensively in the transportation of hydrocarbon fluids. Low liquid loading two-phase flow occurs when only a small amount of liquid is transported with a large volume of gas in a pipeline. Past experience shows these flows to be different from two-phase flows with a relatively large amount of liquid. A more precise prediction of liquid holdup in near-horizontal, wet-gas pipelines is needed in order to better size downstream processing facilities.

The overall objective of this study is to investigate low liquid loading gas-liquid two-phase flow in near-horizontal pipes and to develop improved design models for wet-gas pipelines. The specific objective of this portion of the project is to study the effects of fluid properties on the low liquid loading two-phase flows.

A previous study dealing with low liquid loading gas-liquid flow was carried out by Weihong Meng using air and a mineral oil. A 50.1-mm inner diameter, 19-m long test facility was used for his study. This recently completed project showed an unexpected behavior in low liquid loading flows under certain conditions and it will be interesting to study the effect of fluid properties (different viscosities, surface tensions and wall wetabilities) on those. The fluids used for this present study will be air and water and the data collected will be compared with previous data to observe the effect of liquid properties.

BP Loop

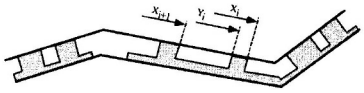
Nicolas Olive

Nicolas Olive, a Visiting Scholar from Elf Aquitaine, is involved in the process design of the 6" diameter horizontal two-phase flow loop donated by BP-Amoco. Nicolas is doing the process calculations to design the BP flow loop. He is using the Pro II simulation software package from Simulation Sciences, Inc., to do these calculations using air and water as working fluids. Air will be delivered by the existing Joy air compressor and an existing pump will be used for water. After the sizing of the facility, the BP flow loop is expected to be commission in June 2000. The basic instrumentation will be installed for the commissioning. Nicolas will also recommend the various components need to be purchased to carry out future projects on this flow loop.

Slug Tracking in Hilly Terrain Pipelines

THEORETICAL:

The recent efforts on the development of the slug-tracking program were to cleanup the program, formalize the different options, add comment statements and continue with the debugging process. Although it is not yet ready for distribution (even as a beta version) it will be submitted to the member companies in its present form for inspection and possibly trial runs.



The following options of operation were implemented:

Property Options:

1. Black oil properties using "TUFFP CORE SOFTWARE USERS MANUAL".
2. Black oil properties with the neglect of mass transfer.
3. Black oil properties with constant gas density (takes less time to run).

A second possibility is to input your own properties with the options:

1. Constant gas density.
2. Compressible gas given compressibility factor and ideal gas constant.

Initial Slug Length Distribution:

In the program the slug length distribution at the inlet is an input variable. Few options are possible:

1. Constant slug length.
2. Random uniform distribution given range of maximum and minimum values.
3. Random normal distribution given an average and standard deviation.

Note however that, based on previous studies, we believe that the exact inlet distribution has little effect on the distribution far downstream. Nevertheless this possibility is implemented.

Bubble Translational Velocity:

The dependence of the slug translational velocity, that is the velocity of the slug tail (the bubble front), on the slug length ahead of it is an input variable. It is assumed to follow the relation:

$V_{t\infty}$ is the slug translational velocity for very long slugs. The default at the present is C_1=8, C_2=1.5 and C_3=0.

$$V_{t\infty} = 1.2U_S + 0.35\sqrt{gD}\sin\beta + 0.54\sqrt{gD}\cos\beta$$

$$V_t = V_{t\infty}\left[1 + C_1 \exp(-C_2 \ell_S / D) + C_3 / (\ell_S / D)\right]$$

Output Options:

1. Front and back position of each slug as a function of time, $X_i(t)$, $Y_i(t)$.
2. Inlet pressure variation with time $P_{in}(t)$ (Separator pressure is an input).
3. Cumulative output of liquid and gas masses to the separator, m_L,m_G.
4. Slug length distribution at pre-selected locations.
5. Liquid holdup of the films and slugs along the pipe during a pre-selected time span.
6. During the run of the program screen output is presented of major properties, input variables and front X_i and and back Y_i positions of 3 selected slugs (only 3 can be viewed conveniently). This screen text output can be viewed later also on an output file.
7. An option to get full details of all variables on screen and on a file is built in.

At the present the code has about 5000 lines. Although it is suited to simulate slug motions it has the capability to handle stratified flow for the case when slugs dissipate in downwards inclined pipes. The Code's main design capability is to handle slug behavior at top and low elbows, including the case of terrain slugging. At the present the change of pipe angle which are not of this type is not yet implemented.

Input variables are simply inputted in the program. Since compilation takes about 1 sec (on 450 MHz Pentium III) and we do plan to release the source Code we do not see this as an inconvenient mode. Obviously this procedure can be easily changed.

EXPERIMENTAL:

The experimental program is now in the process of taking data. It is part of Rene van Hout's Ph.D. project entitled "Investigation of the hydrodynamic and kinematic parameters in gas liquid undeveloped slug flow" supervised by Prof. Shemer and Prof. Barnea. The experimental apparatus consists of 2 pipes of 10 m long. One pipe of 24 mm diameter and the other 54 mm diameter. The test pipes are inclineable in the range 0^0 to 90^0 (horizontal to vertical). A set of three fiber optical probes is placed in a single module and the distance between them is known with high accuracy. The module is placed at 4 to 5 different stations along the pipe in order to obtain statistical parameters of the slug evolution along the pipe. At each location the measurement allows to determine the front and back velocities as well as slug and bubble lengths. Amount of data obtained is quite considerable and special programs were written to analyze the data and obtain correct and useful statistical information.

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2000 Membership

Arabian Oil Co., Ltd.
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Ecopetrol
Elf Exploration
Exxon Production
Institut Francais du Petrole
Intevep
Japan National Oil Corp.
Marathon Oil Co.
Minerals Management Service
Mobil
Pemex
Phillips Petroleum Co.
Simulation Sciences, Inc.
Texaco
Unocal

Calendar

2000

May 8 - 12
The University of Tulsa Two-Phase Flow in Pipes Short Course - Houston, Texas

May 23
Paraffin Deposition Prediction Research and Model Validation Consortium Kickoff Meeting - Tulsa, Oklahoma

May 24
Tulsa University Fluid Flow Projects (TUFFP) Advisory Board Meeting - Tulsa, Oklahoma

June 21 - 22
BHRG 2nd North American Conference on Multiphase Technology - Banff, Alberta, Canada

October 1 - 4
SPE Annual Technical Conference and Exhibition - Dallas, Texas

November 16
Paraffin Deposition Prediction Research and Model Validation Advisory Board Meeting

November 17
Tulsa University Fluid Flow Projects (TUFFP) Advisory Board Meeting

2001

May 27 - June 1
4th International Conference on Multiphase Flows - New Orleans, Louisiana

June 13 - 15
BHRG Conference on Multiphase Production - Cannes, France