

TULSA UNIVERSITY
FLUID FLOW PROJECTS

NEWSLETTER

February, 1983

ADVISORY BOARD MEETING

The Spring, 1983 TUFFP Advisory Board meeting will be held at the Sheraton Airport Inn in Tulsa, Oklahoma on Tuesday, May 10, 1983. The meeting will begin at 9:00 a.m. and adjourn at 4:30 p.m. A pre-meeting cocktail party will be held in the same hotel from 5:00 - 7:00 p.m. on Monday, May 9, 1983. Members wishing to tour TUFFP test facilities are urged to do so Monday afternoon.

An Advisory Board meeting brochure will be mailed to all members prior to the meeting. It will contain sufficient information to prepare each attendee for active participation in discussions on current and future research projects, financial matters and operating procedures.

A REQUEST FOR INFORMATION form will be mailed to all members on April 12, 1983 to determine attendance at the meeting.

STATUS OF RESEARCH PROJECTS

HORIZONTAL SLUG FLOW MODELING/METERING (Kouba)

A literature search continues on modeling and instrumentation for local velocity and void fraction measurements. Some literature search has also been done on the concept of dissipative structures and its application to slug flow.

A miniature resistivity probe has been built by Jeff Maas and will be tested with the CTA and the optical probe for response to bubble size. The CTA has been repaired and is in good working order. Much time is presently being devoted to testing the vertical calibration test facility. Several programs have been written on the Heath computer system for high and low speed data acquisition, data reduction and statistical analyses.

Dr. Moran has acquired 4 nuclear densitometers for use in measuring global holdup. These devices will be installed along the 3 in. TUFFP pipeline to permit comparing measurements with capacitance sensor results.

PERFORMANCE AND CALIBRATION OF CTA PROBE (Sadeghzadeh)

Progress on the vertical calibration facility continues. Three flow nozzles were made to broaden the velocity range for calibrating the CTA.

Velocities of up to 19 ft/sec for liquid and 30 ft/sec for gas are now possible without changing flow meters. A major concern with the system is the flow "noise" or velocity fluctuations. These should be minimized to improve our ability to detect small fluctuations due to small bubbles. Modifications made to reduce the system noise and improve the "signal to noise ratio" include:

- 1) mechanically isolating pump from system;
- 2) installing a low pass pressure fluctuation filter on the flowline; and,
- 3) maintaining smooth walls in front of probe.

In addition, several capillaries of different sizes have been acquired for producing controlled bubble sizes.

TWO PHASE SPLITTING AT A TEE (Shoham)

Modification of the existing experimental system has been completed. The improved measurement techniques enable the measurement of the two-phase splitting process accurately.

Over 50 experimental runs have been completed covering stratified smooth and stratified wavy flow conditions. A computer program was constructed in order to process the data. Future runs will be conducted under annular flow regime conditions.

FLOW IN PIPING COMPONENTS (Sachdeva)

Severe weather, the need to share compressor time with another project and academic priorities have delayed progress. A few initial tests have been conducted to check the system for leaks and to establish an efficient test procedure. Minor modifications were made and data acquisition will begin in February, 1983.

LIQUID HOLDUP IN WET-GAS PIPELINES (Minami)

All testing, analysis of data and preparation of the first draft of a report have been completed. Final editing will permit distribution to members in late

March, 1983.

The holdup data were compared with the holdup predicted by the correlations of Eaton et al., Dukler, Beggs and Brill, and Mukherjee and Brill. The data were also used to evaluate the mechanistic model of Taitel and Dukler for stratified flow. It was found that none of them could accurately predict liquid holdup in this low holdup region.

Two additional empirical liquid holdup correlations for horizontal flow are proposed. The first is strictly for wet-gas pipelines ($0 < H_L < 0.35$). The second is for any horizontal two-phase pipeline ($0 < H_L < 1.0$), and involved using both the new data and data from Beggs, with the Eaton et al. correlating parameter as the basis.

OIL-WATER FLOW IN PIPES (Arirachakaran)

The heating problem of the system has not been completely solved. Use of cooling equipment is prohibitive from a cost standpoint. Installation of the Moyno pump solved the heating problem but resulted in an inadequate mixing of the liquids and an inability to maintain an emulsion. Thus, the system still requires the centrifugal pump to circulate the mixture in the batch tank for mixing purpose. Modifications must be made to the system before the Moyno pump can be fully operable over the range of flow rates desired.

Rather than delay data acquisition any longer, a decision was made to take pressure gradient data versus both flow rate and temperature and to work with only two of the oils with no blending. The selected range of temperature is 75-95 °F and hopefully avoids any permanent changes in the oil-water emulsion rheology. The reproducibility of data was tested and is satisfactory. Data acquisition is 50% completed. The remaining data should be obtained by the third week of February. The completion date of the revised project is rescheduled to be the middle of March.

HEADING WELL BEHAVIOR (Torre)

All testing, analysis of data and developing a model based on first principles for simulating heading phenomenon is complete. Final editing of a

report is nearing completion with distribution to TUFFP members scheduled for March, 1983.

ANALYSIS OF PLUNGER LIFT DYNAMICS (Rosina)

Preliminary data obtained with the 60 ft high test facility helped define the possible range of flow variables. It was determined that the short length of the test facility required placing all the liquid above the plunger to simulate initial lifting conditions.

A series of tests were conducted using water and air in which lifting pressure, lifting time, load and liquid distribution above and below the plunger, and type of plunger were changed. On the basis of these tests, the following can be concluded:

- 1) Lifting efficiency is similar for gas lift and plunger lift at high differential pressures. At low differential pressure, plunger lift is much more efficient.
- 2) Lifting efficiency is greater if more liquid is placed above the plunger at initial lifting conditions.
- 3) A significant amount of liquid develops behind the plunger, although all the liquid was initially above the plunger.
- 4) The efficiency of lifting can be improved by drilling a small hole in a solid plunger.

Further work will involve developing a mathematical model to describe the physical behavior of a plunger lift operation.

TRANSIENT PHENOMENA IN TWO-PHASE PIPELINES (Dutta-Roy)

Progress on this project since the November Advisory Board meeting has been restricted by academic priorities. The homogeneous flow models representing the central gas core and surrounding liquid film during annular, horizontal, two-phase flow had been formulated earlier. The coupling equations representing the boundary conditions at the interface are expected to complicate the solution procedure. Currently, the work done by other researchers in this area is being reviewed.

MODELING TRANSIENT TWO-PHASE STRATIFIED FLOW (Sharma)

A computer program has been written which simulates transient phenomenon in a gas-liquid stratified flow. Results have been obtained and compared with existing models' predictions and actual field data. Writing of the report has begun and will be available for distribution to TUFFP members in April, 1983.

EQUIPMENT AND FACILITIES

A glycol system was installed in the Joy compressor to remove water vapor from air used to operate the instrumentation panel. Prior to this, use of the compressor was curtailed during freezing weather.

The Moyno pump used in the oil-water flow project is no longer supported by the manufacturer and was designed for high pressure use (i.e. 500 - 1000 psi). It may be necessary to purchase a new pump with fewer stages and lower operating pressure. Also, the variable speed drive with the pump does not permit adequate flow rate control over the full range of data desired.

Experience with the Harris computer continues to be encouraging. Most TUFFP researchers now use the Harris in both their academic and research work. TUFFP will have to pay at least the \$10,000 budgeted for 1983 to maintain the computer. Every TUFFP research office now has a CRT terminal connected to the Harris.

Development of an improved plot program for use with the Tulsa University Honeywell computer system's Hewlett Packard plotter has been authorized by TUFFP. The Houston Instrument plotter still works, but is obsolete and no longer produces the quality of graphs desired. It may be necessary to purchase a matching Hewlett Packard plotter for use with the Harris computer.

In June, 1983, Tulsa University will begin moving the Engineering College to its new building on the main campus. When this occurs, additional space will become available for TUFFP offices and laboratories on the North Campus. The impact of the move on support services such as cleaning, security, building maintenance, etc. is not yet known.

PERSONNEL

No major changes have occurred in personnel. Mr. H. Genceli has been offered a Research Assistantship beginning Summer, 1983 pending no further losses in TUFFP membership. Mr. Genceli is a triple undergraduate major (Petroleum Engineering, Chemical Engineering and Mathematics) with an approximate g.p.a. of 3.9. Mr. A. Martinez has arrived from Venezuela and will pursue his M.S. degree on the oil-water flow project. His personal support is provided by the Venezuelan government.

Dr. Shoham plans to teach a graduate course next Fall on Two-Phase Flow Pattern Modeling for TUFFP and other interested students. Dr. Y. Taitel from the U. of Tel Aviv presented a seminar on the same topic to TUFFP researchers at Tulsa University on February 18, 1983.

The proposed new cooperative research program on Artificial Lift is tentatively scheduled to begin operation in May, 1983. This would require Dr. Schmidt and Dr. Doty to reduce their level of activity in TUFFP.

MEMBERSHIP

The worldwide recession, membership fee increase, mergers, etc. have resulted in a loss of nine TUFFP members for 1983. These include: Arabian Gulf Exploration Co., Cities Service Oil Co., Det Norske Veritas, Dresser Industries Inc., Fluor Ocean Services, Norsk Hydro a.s., Otis Engineering Corp., Texas Eastern Transmission Corp., and Williams Brothers Engineering Co. Several of these companies have also indicated that they hope to reinstate their memberships as soon as finances permit.

Pertamina of Indonesia has joined TUFFP as a new member for 1983. Other likely prospects are Scientific Software, Britoil Ltd., and Nippon Kokan K.K.

FINANCIAL

All members have paid 1982 membership fees. Membership fees for 1983 have been paid by 23 members. Four additional members have informed us that payment is being processed. It is assumed that payment from the remaining 11 members will be received in the near future.

A decision was made to charge a reinstatement back information fee of \$5,000 for all members who terminate their membership after January 1, 1983 and later rejoin after a lapsed period of at least one year. Hopefully this --will help stabilize membership and provide an incentive to reinstate membership as soon as possible.

The official TUFFP reserve fund balance on January 1, 1983 was (\$18,256) rather than the projected deficit of (\$33,661). The major reasons for the difference are: 1) a profit of \$800 was made on the erosion research meeting; 2) facility rental income was \$4,665 more than projected; 3) posting of \$4,495 in Fall, 1982 tuition charges was done in 1983 rather than 1982; and 4) unbudgeted overhead credits of \$1,251 for 1981 and \$1,550 for 1982 were granted by Tulsa University.

Expenditures for 1983 are on schedule. The proposed 1983 budget projected a net loss of four members. The actual net loss of eight will require revising research schedules and budgets. Any revisions will be delayed until final membership figures are confirmed and staffing impacts due to the new Artificial Lift research program are established.

MISCELLANEOUS

Enrollment in the May 23-27, 1983 TUFFP short course on Two-Phase Flow in Pipes currently stands at 5 members and one non-member. A second mailing of the announcement brochure is scheduled for late February. Members are reminded that all receive one free enrollment and additional enrollments at \$850 each. Telephone inquiries should be directed to (918) 592-6000 extension 2347.

Plans are progressing rapidly for defining needed research on erosion in pipes. Dr. Rybicki and Dr. Shadley have mailed a proposal to numerous companies for developing a detailed plan to define erosion problems related to the production of oil and gas and to establish a cooperative program to perform needed research.

Tentative plans have been made to hold the second TUFFP Research Application Conference in May, 1984. This will be discussed at a later Advisory Board meeting.

