

TULSA UNIVERSITY  
FLUID FLOW PROJECTS

NEWSLETTER  
February, 1984



#### ADVISORY BOARD MEETING

The Spring, 1984 TUFFP Advisory Board meeting will be held at the Sheraton Airport Inn in Tulsa, Oklahoma on Tuesday, May 8, 1984. The meeting will begin at 8:30 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 7, 1984. Members wishing to tour TUFFP test facilities are urged to do so Monday afternoon from 3:00 - 4:30 p.m.

The Advisory Board meeting will unfortunately conflict with the Offshore Technology Conference which is May 7-9, 1984. The OTC moved its meeting to a week later this year. Our meeting dates had already been set and could not be changed without selecting a different hotel. Also, other Tulsa University cooperative programs (TUDRP - May 9, TUALP - May 7, and TURRP - May 10) are meeting the same week to accomodate companies with multiple memberships.

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 10, 1984 to determine attendance at the meeting.



## STATUS OF RESEARCH PROJECTS

### HORIZONTAL SLUG FLOW MODELING/METERING (Kouba)

Much of the work done since the November Advisory Board meeting has been instrumentation related. Some modifications to the patch panel have been made to reduce erratic noise. Another experiment is being planned to use the weighing tank to determine liquid delivered during the time period of a slug. If this experiment is successful, it would provide a means of determining the flow distribution coefficients without the numerous internal measurements required to obtain velocity and void fraction profiles.

### CAPACITANCE SENSOR DEVELOPMENT (Edmondson)

Static tests are nearing completion to determine the sensitivity of the spiral and ring type sensors to dielectric material placed in different regions within the capacitor field. These static tests fall into three major categories: axial, radial, and angular sensitivity. Various shapes of PVC (disks, tubes and rods) are placed into the sensor and the capacitor response is measured. Ideally, the sensor should be as indifferent as possible to the location of the dielectric in order to accurately detect the liquid holdup. Electronics used are the Moran capacitance bridge configuration developed by Moran and Kouba. Preliminary analysis suggests that both sensors are stable, reproducible and require finite entrance and exit lengths to obtain meaningful results. Several sensor geometries will



be tested to determine the shortest possible sensor length for 3 in. diameter pipe without sacrificing accuracy.

Dynamic tests of the two sensors will begin later this spring on the 1400 long ft 3 in. diameter pipeline to verify conclusions reached with the static tests. Since the dynamic tests will include kerosene as the liquid phase, static tests will be completed with calibrations for liquid holdup using kerosene as the dielectric instead of PVC. Quick-closing ball valves and nuclear densitometers will also be used in the dynamic tests.

#### TWO-PHASE FLOW THROUGH CHOKES (Sachdeva)

Methods based on first principles have been developed to predict the critical flow boundary and both critical and subcritical total mass flow rates. The main assumptions are: no slippage between phases in the choke; heat transfer is confined to the throat; and, upstream quality equals throat quality. Results obtained when comparing predicted total mass flow rates to experimental data for kerosene and air follow.

<u>Flow Type</u>	<u>Average % Error</u>	<u>Average Absolute % Error</u>	<u>Standard Deviation</u>
Critical	-11.4	16.1	not available
Subcritical	-15.1	17.5	17.4
*Subcritical ( $C_D=0.85$ )	2.2	9.1	9.1

\*Discharge coefficient was arbitrarily selected.

Final analysis is underway and report completion is now anticipated in April, 1984.





#### TWO-PHASE FLOW SPLITTING IN A HORIZONTAL PIPE TEE (Shoham)

A draft of the final report on the current phase of this study has been completed. The report will be distributed to TUFFP members in early April, 1984. A mechanistic model based on first principles has been developed that successfully predicts flow splitting for a regular horizontal pipe tee for the annular and stratified wavy flow patterns. The report will include all experimental data, model descriptions and computer programs.

#### TWO-PHASE FLOW THROUGH A CONCENTRIC VERTICAL ANNULUS (Caetano)

Data acquisition for the current study has been completed and includes determination of flow pattern maps and the measurement of average volumetric holdup and pressure drop for air-water and air-kerosene flow. The Taitel and Dukler model was modified to predict the flow patterns in an annulus configuration. Separate flow pattern dependent models for prediction of average liquid holdup and average pressure gradient were also developed. Comparison between the predicted two-phase flow variables and experimental results shows good agreement. A report on the current completed study is under preparation and is scheduled for distribution in late April. Future work will include extension of the investigation to a different casing-tubing diameter ratio and also to inclined configurations.



#### MODELING TRANSIENT TWO-PHASE FLOW (Sharma)

Since the November, 1983 Advisory Board meeting, priority was given to preparation for Ph.D. comprehensive examinations. These examinations were administered in late January and early February and were completed successfully.

Presently, technical literature is being reviewed prior to developmental work on a mathematical model to describe transient two phase slug flow in pipelines. Modeling should begin in March.

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

The final report on transient two-phase flow in pipelines has been submitted to the Ph.D. Advisory Committee and a final oral defense will occur in early March. The report includes transient models for homogeneous, stratified and annular mist flow, a computer program that couples the models, and comparison with experimental data. Distribution of the final report to TUFFP members is scheduled for April, 1984.

#### DYNAMIC SIMULATION OF SLUG CATCHER BEHAVIOR (Gencelli and Kuenhold)

The Giozza computer program for dynamic simulation of a horizontal gas-oil separator has been modified as follows:

1. The level and pressure controllers are now optional.



2. The number of slugs in the input line may be varied.

At present, various input conditions are being tested, and minor bugs in the program corrected. It is hoped that the program can be tested with real data in the near future.

#### EQUIPMENT AND FACILITIES

A major overhaul is nearing completion for the Joy compressor. Included was cleaning and repairing of all unloading valves and installation of a new operating panel donated by Murphy Switch Co.

Tulsa University is negotiating the possible purchase of a Harris 800 computer system from Scientific Software-Intercomp to replace the Harris /7 system now used by TUFFP and selected other graduate students. The new system would provide greatly expanded computing capabilities for TUFFP and other cooperative research programs on the North Campus. TUFFP would be required to pay a proportionate share of the annual maintenance agreement costs that could not be recovered from contract research and consulting projects. In addition, Scientific Software-Intercomp might donate a significant amount of computer related equipment for use with the new system.



Delays in furniture delivery have prevented completing a move of the TUFFP Director and Administrative Assistant to offices in the new Keplinger Hall on the Main Campus.

TUFFP has requested additional space in the Model Lab building on the North Campus to house a small scale flow loop for testing capacitance sensors. The space would also include graduate student offices and a place to perform fluid physical property measurements.

No modifications have been started on the oil-water flow loop. A decision on this project will be delayed until negotiations are completed with a TUFFP member for performing proprietary oil-water flow research.

#### PERSONNEL

Illness has required Betty Pence to take a sick leave of approximately 6 to 8 weeks. She will be replaced during this period by Rosa Jackson, who is familiar with most TUFFP procedures from past summer employment with TUFFP.

Elisio Caetano has received permission from Petrobras to extend his graduate studies at the Ph.D. level. He will continue working on two-phase upward flow in an annulus.

Research assignments for J. C. Goyan of Elf Aquitaine and A. Martinez of Intevep have not yet been finalized. There is a possibility that S. Arirachakaran will return to TUFFP to pursue a Ph.D. degree in Petroleum Engineering in the Fall, 1984.





Interviewing has begun to find a full time electronic technician for TUFFP. This position was budgeted to begin June 1.

#### MEMBERSHIP

It was not possible to finalize all details with Nippon Kokan K.K. and Britoil in time for them to become TUFFP members in 1983. Consequently, their membership officially began in January, 1984. Notification has also been received that both TransCanada Pipelines and Natural Gas Pipeline Co. of America will join TUFFP.

Scientific Software-Intercomp has assumed the Kanab membership following Kanab's sale of Intercomp to Scientific Software.

Notification has been received that Camco and Consumers Power Co. have terminated their membership after 1983.

Possible additional TUFFP members include: Bidas, Delta-X Corp., Dresser Industries, Japan Oil Energy Co., JGC Corp., Southern California Gas Co., and Williams Brothers Engineering.

#### FINANCIAL

All members have paid 1983 membership fees. Membership fees for 1984 have been paid by 32 members. It is assumed that payment from the remaining eight members will be received in the near future.



The official TUFFP reserve fund balance on January 1, 1984 was \$10,073 rather than the projected balance of \$11,547. The major reasons for the difference are one less membership and information fee than anticipated and total expenditures of \$366,370 rather than \$385,009.

Expenditures are on schedule for 1984. With 40 members and four new information fees, our projected income of \$420,000 for 1984 has been met.

#### MISCELLANEOUS

Enrollment in the May 21-25, 1984 TUFFP short course in Tulsa on Two-Phase Flow in Pipes currently stands at 6 enrollees from 5 members and none from non members. A second mailing of the announcement brochure is scheduled for early March. Members are reminded that all receive one free enrollment and additional enrollments at \$995 each. Telephone inquiries should be directed to (918) 592-6000, extension 2347.

Negotiation delays with BHRA forced changing the scheduled TUFFP short course at Woburn Abby near Bedford, England from June 11-15, 1984 to tentative dates of October 8-12, 1984. As soon as all details are finalized, brochures will be printed and distributed to all TUFFP members.

Magnetic tapes containing 17 files that include the TUFFP Well Data Bank and computer programs developed for past TUFFP research projects were mailed in late February. The tape was sent to all members that designated on the 1983



TUFFP Questionnaire that they wanted one or more of the 17 files.

The first Advisory Board meeting for Tulsa University's newest cooperative research program on Erosion or Erosion/Corrosion in piping systems in the oil and gas industry will be held in Tulsa on March 12-13, 1984. Companies that did not join the Phase I portion of this study but wish to consider the Phase II cooperative program should contact Dr. Ed Rybicki, Chairman of Mechanical Engineering at (918) 592-6000, ext. 2521.

Minutes from the November 8, 1983 TUFFP Advisory Board meeting are attached.

