TULSA UNIVERSITY

FLUID FLOW PROJECTS

N E W S L E T T E R

February, 1985

STATUS OF RESEARCH PROJECTS

HORIZONTAL SLUG FLOW MODELING/METERING (Kouba)

Several approaches for modeling the C_{sl}/C_o ratio have been examined by testing simple mathematical models of the flow distribution at various cross sections in slug flow. The central idea in each of the models is to predict the velocity and void fraction distributions at a particular cross section, given the translational velocity and an average holdup. When compared to the limited available data, these models are not necessarily accurate, but some do offer encouraging trends. Refinements to the models await comparison with more detailed data. Unfortunately, more detailed data awaits a suitable data acquisition system. The delivery of the IBM AT has again been delayed. The latest estimate is an early February delivery date. Meanwhile, with all the IBM AT rumors being expressed, alternatives to the AT are being investigated.

CAPACITANCE SENSOR DEVELOPMENT (Edmondson)

Jay Edmondson has decided to terminate his graduate program and seek employment. He has agreed to continue working as a full time consultant for two months to finalize an internal report documenting the current status of the capacitance sensor. This will permit Gene Kouba to evaluate the possible use of the latest sensor design and determine if the project should be assigned to another student.

TWO-PHASE FLOW THROUGH CHOKES (Sachdeva)

The final report has been sent to the printer and will be distributed to members in early February.

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

Data acquisition for flow splitting in a reduced tee (2 in. x 1 in.) has been completed. The data include splitting ratios and pressure drop distributions for the stratified wavy and the annular flow patterns. Gas and liquid superficial velocities are the same as those taken in the regular tee study to make comparison easier.

The following can be concluded from the data:

a) Under stratified wavy flow conditions, considerably less liquid is diverted into the reduced branch arm as compared to the regular tee for the same inlet conditions. For low inlet liquid flow rates, the diverted liquid flow rate is reduced by about 10%. However, as the inlet liquid rate increases, the reduction in the branch liquid intake becomes more substantial, up to 50%.

b) Under annular flow conditions, a systematic but rather small difference can be seen between the data of the regular tee and the reduced tee. In general, the liquid flow rate intake through the branch arm is reduced by less than 10%. For low inlet liquid flow rates, the branch flow rate reduction occurs only at low gas fraction intake ($F_{BG} < 0.4$). For higher values of F_{BG} the difference is insignificant. At high inlet liquid flow rates, the reduction is almost the same for all gas fraction intake.

The effect of the branch arm diameter on flow splitting in a tee junction has recently been studied by Azzopardi (1984) for annular flow in a vertical tee. Although the published data do not agree with this study, they show the same trend of slight reduction of branch liquid intake in reduced tees.

Future work will focus on the extension of the model developed for flow splitting in a regular tee, to include branch arm diameter changes.

Reference

Azzopardi, B. J.: "The Effect of the Side Arm Diameter on the Two-Phase Flow Split at a "T" Junction", Int. J. Multiphase Flow, Vol. 10, No. 4, pp. 509-512 (1984).

TWO-PHASE FLOW THROUGH A VERTICAL ANNULUS (Caetano)

Data acquisition for Phase II of the study has been completed. It includes flow pattern definitions, flow pattern maps, liquid holdup and pressure gradient measurements for all existing flow patterns in an eccentric annulus. The data also include friction loss measurements for single-phase flow to evaluate the friction factor behavior for this configuration. It was found that friction factors for an eccentric annulus are smaller than friction factors for a concentric annulus with the same pipe diameters.

The model for flow pattern prediction in the concentric configuration has been extended to the eccentric configuration. Currently, efforts are underway to predict friction factors in the eccentric configuration. Also under way is an attempt to

improve the models for slug flow and annular flow in an annulus.

MODELING TRANSIENT TWO-PHASE FLOW (Sharma)

A mathematical model for simulating transient two-phase flow in a slug flow pattern has been proposed. The numerical solution procedure has been developed and the FORTRAN coding has been completed. Currently, example simulation runs are being carried out in order to debug the model. On completion of these initial simulation runs, the simulator will be used to provide insight into the nature of transient two-phase slug flow.

DYNAMIC SIMULATION OF SLUG CATCHER BEHAVIOR (Gencelí/Kuenhold)

The simulator program CATCHER has been completed and several sample cases are being tested. The first draft of a final report is being developed.

COMPOSITIONAL TWO-PHASE FLOW NEAR THE CRITICAL POINT (Goyon)

Since the last Advisory Board meeting, priority has been given to course work. This semester, with only three semester hours of courses, much more time will be dedicated to research.

The computer program needs to be tested with fluid compositions that will allow calculations near the critical point. Field data have been provided by one of the members and are now under examination. The program will soon be run with these data to determine what kind of problems will be encounterd near the critical point.

OIL-WATER FLOW IN PIPES (Martinez)

The design of a skid mounted pipe flow viscometer for studying oil-water flow in pipes has been completed. All components of the facility (pumping system, temperature control

equipment, batch tank, mixing and metering devices) have been ordered. Assembly of the facility is scheduled to begin in approximately four weeks. The approach to the problem will be the following:

1. Selection of a water fraction
2. Selection of a system temperature
3. Gathering of pressure drop vs. flow rate data in laminar and turbulent flow. A shear stress vs. shear rate analysis can be performed from these data.
4. From the rheological analysis, parameters required for the computation of generalized Reynolds numbers will be obtained.
5. Friction factors will then be plotted against Reynolds numbers.
6. For the given water fraction, the analysis will be performed over a wide range of temperatures.
7. A new water fraction will be selected and the entire procedure repeated.

EQUIPMENT AND FACILITIES

The replacement Worthington compressor has not yet been received. Work will soon begin on site preparation to accommodate the new compressor.

The Harris 800 computer continues to operate extremely well; however, not all of the communication ports have yet been made operational. Only TUFFP personnel have used the Harris computer until now. We anticipate making the computer available to other graduate students in Petroleum Engineering during 1985. A

proposal to raise funds for the Harris 800 result in obtaining $13,500.00 in donations. This money will help pay maintenance costs and possible future costs for upgrading communication ports. The magnitude of maintenance costs to TUFFP for 1984 has not yet been determined but should be approximately the $20,000.00 estimated in Table 4 of the November 7, 1984 Advisory Board meeting brochure.

Delivery of the two IBM PC AT computers has again been delayed. We now anticipate taking delivery of both computers during February, 1985.

Remodeling of TUFFP offices in the Drill Building has begun. This work will continue throughout 1985. In addition, an electronic workshop will be constructed in the machine shop building for an office, storage, and repair area. This addition is necessary to better coordinate utilization of the extensive TUFFP electronic equipment and to provide work space for the new TUFFP electronics technician.

Work has begun by the University of Tulsa on expansion and paving of a new parking lot west of the Drill Building. Improvements to access roads will also be made.

PERSONNEL

Several changes will occur in graduate students in TUFFP during the remainder of 1985. Mr. Arirachakaran has arrived from Thailand and been placed on a partial TUFFP assistantship. When funds permit he will be awarded a full assistantship. His research project will involve oil-water flow through pipes. The possible return of Mr. K. Minami of Petrobras to pursue a Ph.D

program in Petroleum Engineering has been delayed until at least 1986. Mr. J. C. Goyon has been asked to conduct TUFFP research at the Ph.D level. Upon completing his M.S. degree this Spring, he will return to France for the summer and hopes to begin his Ph.D program in September, 1985. Mr. Jay Edmondson has decided to terminate his graduate program and seek employment. Mr. T. Tianlu, of the People's Republic of China (PRC) has been selected to conduct a TUFFP research project on slug flow in upward inclined pipe. A 100 ft long transparent inclined test facility will probably be constructed on the previous pipeline-riser pipe structure. Mr. Tianlu is sponsored by the PRC. Mr. G. Zheng, also sponsored by the PRC, will arrive in February or early March to begin his M.S. program in Petroleum Engineering. He will work on a TUFFP research project that has not yet been selected. Mr. H. Meng, also of the PRC, will be considered for a TUFFP research project pending receipt of his GRE scores and admission for the Fall Term, 1985. Mr. Meng is sponsored by Arco China. An Application for Admission to the Graduate School has been received by Mr. K. Tanaka of Japan. Mr. Tanaka will be supported by Nippon Steel Corporation and has an outstanding academic record at both the B.S. and M.S. level in Civil Engineering from the University of Tokyo. A research project has not yet been selected for Mr. Tanaka.

A decision was made to not accept Dr. Al-Attar for a sabbatical during the 1985-86 academic year. It was concluded that only limited benefits could be obtained in a 9 to 12 month period.

The TUFFP Graduate Seminar has been expanded to include presentations by TUFFP personnel in addition to selected Distinguished Lecturers from outside the University. Scheduled to participate during the remainder of 1985 are: Dr. T. Hanratty, Dr. K. Aziz, Dr. Lee Norris, and Dr. A. Dukler.

An extensive search for a qualified electronics technician for TUFFP has resulted in the hiring of Mr. Douglas Robinson. He will begin work February 1, 1985.

MEMBERSHIP

In addition to the membership terminations reported in the November, 1984 Advisory Board brochure, we have been informed that Bechtel, Inc. and Gulf Research and Development Company will terminate their memberships for 1985. This brings to five the number of companies that terminated membership for 1985. The current 1985 membership level is 38 companies. Three new members must join to meet 1985 income projection levels. Discussions are underway with several potential new members, but no committments have been received.

FINANCIAL

All members have paid 1984 membership fees. Membership fees for 1985 have been received from 27 members. It is assumed that payment from the remaining 11 members will be received in the near future.

The official TUFFP Reserve Fund Balance as of January 1, 1985 is not yet available. Expenditures are on schedule for 1985. If income projections for 1985 are not met, a deficit will be carried over to 1986. Preparations are underway for a new

Three Year Plan covering the period 1986-1988. The Three Year Plan is scheduled for completion in early April, 1985 and would be mailed with the May, 1985 Advisory Board meeting brochure. The 1986 Preliminary Budget, which will be included in the Three Year Plan, will inform members of the 1986 membership fee.

MISCELLANEOUS

Enrollment in the March 11-15, 1985 TUFFP/BHRA short course in London now stands at 4. Enrollment for the Tulsa course May 20-24, 1985 is 2. Members are urged to support these two short courses to prevent a financial loss that would further contribute to the deficit carried over to 1986. A contract has been signed with Willis Division of Smith International Inc. to conduct two-phase flow tests through a Willis needle-seat valve. Work will begin very soon and will be completed during 1985. These tests should generate a small amount of facility rental income for TUFFP. A final report to Willis will also be distributed to TUFFP members.

Confirmation has not yet been received from the Prudhoe Bay unit co-owners regarding release to TUFFP of two-phase flow data in larger diameter pipelines from the Prudhoe Bay field.