Tulsa University Separation Technology Projects
(TUSTP)
Joint Industry Project (JIP) on
Design and Performance of Compact Separators for
Multiphase Production Systems

Spring 2000 Newsletter
TUSTP Research and Development Program

Following is the list of projects and a brief summary of TUSTP program for 2000:

❖ Control System Design and Experimental Results – Shoubo Wang

Several GLCC© control strategies have been developed based on the liquid level control by controlling the liquid leg valve, pressure control by controlling the gas leg valve, integrated level and pressure control, and integrated liquid level control by controlling both the liquid and gas leg valves. Mathematical models have been developed for these strategies and computer-based dedicated simulators have been built. Simulation studies indicated that the integrated control strategies are more suitable for slug flow due to faster response. The set point pressure control is crucial for integrated liquid level and pressure control. Preliminary experimental investigations indicated that the operational envelope for liquid carry-over is significantly improved by control system in the high liquid flow region and high gas flow region. Detailed experimental investigations are in progress to evaluate the sensitivity of the control parameters on the GLCC performance and optimization of control strategies.

❖ Oil/Water Separation in LLCC© Separators – Edelmira Afanador/Carlos Oropeza

The preliminary phase of this project is completed. The feasibility of utilization of the Liquid-Liquid Cylindrical Cyclone (LLCC©) compact separator for free water knockout bulk separation of oil-water mixtures has been established by experimental testing of the lab LLCC© prototype, with measured efficiencies greater than 90% for some flow conditions. In 2000 a mechanistic model for the LLCC© will be developed. The model will be used to design LLCC© field applications for our member companies, in return for field data. These data will be used to improve the developed model and LLCC© design.

❖ Three-Phase GLCC© Separators – Carlos Oropeza

The design, fabrication and installation of the three-phase GLCC© prototype have been completed. At the beginning of 2000 experimental testing of the 3-phase GLCC© will be conducted. The data will help in the development of a mechanistic model for the GLCC©.

The model will be computer coded which, could be used for design of 3-phase GLCC© units by the member companies.

❖ Gas Carry-under in GLCC© Separators - Luis Gomez

A mechanistic model is underway for the prediction and quantification of gas carry-under and separation efficiency for the GLCC©. The model will be tested against air-water data collected by TUSTP and high viscosity data with real crudes to be collected by PDVSA. The model will be incorporated into the TUSTP code.

❖ Local Velocity Measurement and CFD Simulations - Ferhat Metin Erdal

A portable, single-phase test facility for local measurements has been constructed. Local axial and tangential velocities and turbulent kinetic energy along the GLCC© diameter were measured at 24 different axial locations (12.5″ to 35.4″ below the inlet) by using a Laser Doppler Velocimeter (LDV) for a water flow rate of 72 GPM. In 2000, local velocity measurements will be continued for different flow rates, inlet configurations, and fluid properties. The CFD simulations show the overall trend of experimental data. Local measurements and CFD simulations will be used to verify, improve, and develop mechanistic models and model correlations (e.g., velocity profiles, turbulent intensities, bubble trajectories).

❖ Predictive Control of GLCC© Using Slug Detection – Shankar Earni

A strategy for GLCC© predictive control has been developed which incorporates the slug characteristics in terms of holdup, length and velocity, and calculation of the volumetric liquid flow rate. This predictive control system is designed to operate only when huge slugs are encountered. Based upon the design, a predictive control model has been simulated in MATLAB-Simulink integrating feedback and feed forward control systems. The results obtained from the simulations demonstrated that the proposed strategy is a viable approach for GLCC© predictive control. Experimental investigations are in progress to verify the strategy.

❖ A Mechanistic Model for Hydrocyclones – Juan Caldentey

As a part of the detailed study of compact separation systems, investigations are in progress to develop mechanistic model for liquid hydrocyclones (LHC). During the first part of 2000, a velocity field correlation will be completed for the LHC. The velocity field will be incorporated into a mechanistic model for prediction of separation efficiencies in the LHC.

❖ Experimental Testing of Hydrocyclones – Carlos Gomez

Modular Production Equipment (MPE), a TUSTP member company has provided us with two 2-inch LHCs, one of them fabricated from transparent plastic and the other from steel. The modular construction of the TUSTP 3-phase flow loop will be capitalized to enable easy installation of both LHCs. Subsequently, data acquisition on separation

efficiency of oil/water flow in the LHC will be conducted. The data will be used to test and refine the mechanistic model for the LHC.

❖ GLCC© Inlet Flow Conditioning Utilizing Helical Pipes - Reyes Ramirez

The helical pipe test section is now in operation. Experimental data will be collected at the beginning of 2000 to measure slug dissipation in the helical pipe. The data will be analyzed, and used to develop a preliminary model for the prediction of slug dissipation and pre-separation. Recommendations of the utilization of the helical pipe as an inlet to the GLCC© will be given.

❖ Three-Phase GLCC© Control – Rajkumar Mathiravedu

Control of 3-phase GLCC© is becoming an important issue. TUSTP has already identified a student to work in this area. Initial studies will involve LLCC© control using water-cut/oil-cut probes, which will be extended for 3-phase GLCC©. 3-phase control system studies will also focus on identifying/developing suitable tools for locating the oil/water interface.

❖ Finite Element Modeling and Stress Analysis of GLCC©s – to be identified

A new study has been initiated to conduct Finite Element Modeling and Stress Analysis of GLCC© separators for field applications. The primary objective of this study is to optimize the inlet configuration, provide specific design recommendations and conduct residual stress analysis of GLCC© separators, which will enable the member companies to design and fabricate GLCC©s as per ASME pressure vessel code. This investigation will also provide a suitable framework for providing design modifications of an existing separator if the actual field conditions happen to be different from original design base case.

❖ GLCC© Simulator Development – Luis Gomez

The TUSTP code GLCC© vx5.6 has been updated to GLCC© vx6.0 incorporating the following features:

- GLCC© Evaluation Code - This is a new capability for long term evaluation of GLCC© Performance for minimum, maximum, mean and base case flow rate conditions for a given GLCC© geometry (totaling 64 cases).
- Control Valve Iteration - Iterate on the CV position (in terms of pipe contraction) for the given flow conditions and output the result to the GLCC© design wizard.
- Gas Carry-under correlation - Incorporating the Gas Carry-under correlation developed from Texaco data for design of the lower part of the GLCC©, in place of Bubble trajectory analysis. The Texaco correlation is more realistic.
- Redesigned and streamlined GLCC© toolbar incorporating the capability of GLCC© Evaluation code.
- GLCC© vx 6.0 is released in a CD-ROM with the manuals and the release notes.