# TUSTP NEWS – December 1998

## TUSTP LEVERAGES FUNDS, TRANSFERS TECHNOLOGY TO SUPPORTING COMPANIES

### BACKGROUND

The petroleum industry has relied in the past mainly on conventional, vessel-type separators to process wellhead production of oil-water-gas flow. However, economic and operational pressures continue to force the petroleum industry to seek less expensive and more efficient separation alternatives in the form of compact separators. One such attractive alternative is the Gas Liquid Cylindrical Cyclone (GLCC). Compared to the bulky, heavy, and expensive vessel-type separator, the GLCC is simple, low-cost, low-weight, requires little maintenance, and is easy to install and operate. However, a lack of understanding of the complex multiphase hydrodynamic flow behavior in the GLCC inhibits complete confidence in its design and necessitates additional research and development. The Tulsa University Separation Technology Projects (TUSTP) was established in 1994 to fulfill this objective.

The mission of TUSTP is to advance the state-of-the-art of compact separation technology for gas/oil/water flows. Emphasis is placed on the measurement and understanding of the hydrodynamic flow behavior in compact separators and the development of design tools for the industry. Long-term cooperation with the industry is envisioned in conducting projects to better understand, analyze, and design compact separators and compact separation systems.

### LEVERAGE OF FUNDING

In an effort to leverage TUSTP funding and to expand the JIP activities, TUSTP has submitted proposals to the Department of Energy (DOE) and to the Oklahoma Center for Advancement of Science and Technology (OCAST). Both proposals were funded and are ongoing.

The DOE project on "Design and Development of GLCC Compact Separators for Three-Phase Flow" is aimed at the extension of the JIP research to three-phase gas/oil/water flow.

TUSTP wishes to thank Ms. Rhonda Lindsey from the DOE National Petroleum Technology Office in Tulsa for her guidance and support of the proposal. In Phase-I of this proposal, the existing two-phase GLCC facility will be expanded to three-phase flow, data will be acquired, and a mechanistic model and CFD simulations will be conducted. Phase-II will include high pressure testing of the GLCC at LSU. The total budget is $766,063 for five years, namely, October 1, 1997 - September 30, 2002. Efforts in the first year of the project were aimed at the design and fabrication of the new three phase-flow GLCC loop. The loop is now under construction and will be in operation in Fall 1998. The new facility is modular including four test sections. Testing of different systems at the same time would be possible, as well as through several components in series. The new system is located in the College of Engineering and Natural Sciences Research Building on the North Campus.

The OCAST proposal is titled, "Performance Enhancement of GLCC Compact Separators" with a budget of $290,475 for the period August 1, 1998 - July 31, 2001. The research tasks of the project are divided into three parts. The first task is the development of mechanistic and computational fluid dynamic models for liquid carry-over and gas carry-under conditions for a GLCC equipped with active control system. This activity will simultaneously be accompanied by identification of target designs for the GLCC adaptive feedback control system and formulation of control strategies through computer simulation. The second task is an experimental program that includes the design and fabrication of a compact GLCC separator for data acquisition and study of the hydrodynamic flow behavior in the separator through local measurement. Control valves on the liquid and gas legs equipped with separate controllers will be employed to enhance the GLCC performance by liquid level and pressure control respectively. The experimental data gathered at TUSTP and from field operation will be used in the third task to evaluate and refine the proposed models and to develop final design methodology for the GLCC.

## TECHNOLOGY TRANSFER

Technology transfer and helping member companies implement the new Gas-Liquid Cylindrical Cyclone (GLCC) technology are important aspects of the TUSTP joint industry project. TUSTP and the supporting member companies aim at rapid deployment of GLCC

systems in the field. Recently, TUSTP personnel have been involved in several field application design for member companies, as described below:

- *Multiphase Metering Loop*: In this application, the GLCC is used as an integral feature of a multiphase metering loop. This type of measurement loop configuration affords several advantages over either conventional separation and single-phase measurement or non-separating multiphase meters. The compactness of the GLCC allows the measurement loop to weigh less, occupy less space, and maintain less hydrocarbon inventory than a conventional test separator. Furthermore, complete or even partial gas-liquid separation can improve the accuracy of each phase rate measurement in a multiphase metering system. About 60 GLCC multiphase metering loops are being operated by Chevron in Oklahoma and other locations. Texaco tested the GLCC in a multiphase metering loop under field conditions at the Humble facility in Houston and installed a similar unit in the Eugene Island 354 platform. PDVSA, Venezuela, recently commissioned a GLCC multiphase metering system on a Lake Maracaibo platform. The GLCC system, shown in the photograph, is used to test 24 wells with flow rates ranging between 43-3033 bbl/d and 683-4597 Mscf/d. A TUSTP team visited the site in July 1998 in order to help implement a control system for the GLCC.
- *Partial Separation:* A compact GLCC is often very appropriate for applications where only partial separation of gas from liquid is required. One such application is the partial separation of raw gas from high pressure wells to use for gas lift of low pressure wells. The GLCC is a central feature in the design for raw gas lift system operated by Chevron in Okan, Nigeria. The use of GLCC eliminated gas compressors and pipelines to and from the wells. Separating a significant portion of the gas will reduce fluctuations in the liquid flow and may result in improved performance and smaller units of other downstream separation devices. Krebs Petroleum Technologies has conducted field studies on the use of a GLCC in series with other compact separation devices such as a wellhead desanding hydrocyclone in order to reduce the required size of the desander and improve its performance. Recently, TUSTP designed a GLCC for Arco Alaska, to be used as a gas knockout to remove gas partially from a high GOR crude oil system upstream of a multiphase flow meter. This system, which reduces the size of the multiphase meter and improves accuracy, is now under construction.

- *GLCC as an External Pre-Separator*: As an added apparatus upstream to an existing separator, the GLCC can enhance the performance of the separator and increase its throughput capacity. Schlumberger, Etudes et Productions, France, a member company of TUSTP, is evaluating the possibility of incorporating GLCCs upstream of their test separators. A GLCC has been designed for Petrobras, Brazil and installed upstream of an existing vessel-type separator located in a jungle, in order to attenuate the effect of slugging. This eliminated the need to replace the existing separator with a larger one, saving millions of dollars.
- *GLCC as a Primary Separator*: GLCCs can also be used as primary full separators. The function of GLCC as a full separator needs separate gas and liquid legs, without recombination. For such applications, liquid level control is essential for the GLCC in order to reduce or eliminate liquid carry-over into the gas stream or gas carry-under into the liquid stream. The performance of the control system required for such application cannot be simulated directly using the existing TUSTP computer code. The control system simulation for this field application was carried out by analyzing the response of the liquid level for different conditions of constriction in the gas and liquid legs. This field application of GLCC as a full separator was designed for Unocal overseas. The GLCC is capable of handling liquid flow rate of 59800 bbl/d and gas flow rate of 67180 Mscf/d, at 600 psig. A relatively large GLCC, 26-in I.D. and 10-ft height, is needed for this application.

## LONG TERM PROJECTS

Possible future long term projects of compact separators include the study of other compact separator configurations such as tee junctions, auger, vortex tube, etc., enhancement of convective heat transfer, down-hole configurations, variable inlet area, modern control systems, compact separation systems, including several separation units in series such as a GLCC with a hydrocyclone etc., high pressure real crudes field testing, handling foam and emulsion, and sand handling capabilities and the effect of solids in erosion of compact separators.

PDVSA GLCC Metering Loop Offshore Lake Maracaibo, Venezuela