PROJECT **facts**

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Petroleum Exploration and Production

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DE-FG26-97BC15024

DESIGN AND DEVELOPMENT OF GAS LIQUID CYLINDRICAL CYCLONE (GLCC)

Compact separators for three-phase flow

PARTNERS

University of Tulsa
Tulsa, OK

Joint Industry Project
ChevronTexaco
Bakersfield, CA

Premier Instruments, Inc.
Houston, TX

Caltex
Indonesia

PDVSA
Venezuela

MAIN SITE

University of Tulsa
Tulsa, OK

GLCC field protype installed by Chevron in Oklahoma.

Background/Problem

The production of oil is almost inevitably accompanied by gas and water, making it necessary to separate the three fluid phases for accurate measurement, and to separate the water from the hydrocarbons for more cost-efficient transportation and refining. For many years the petroleum industry has used bulky, heavy and expensive separators, which do not completely separate the gas and liquid phases. The petroleum industry needs less expensive, more efficient separation alternatives to reduce the cost of handling, transporting and processing. The Gas Liquid Cylindrical Cyclone (GLCC) separator is increasingly coming into use, as it is simple, compact, low weight, low cost, requires little maintenance, and is easy to install and operate. The lack of complete understanding of its hydrodynamic flow behavior and the ability to predict its performance hinders the application of this separation technology.

Project Description/Accomplishments

Tulsa University's Separation Technology Projects (TUSTP), established in 1994 as a 15-company Joint Industry Project is developing the GLCC concept to achieve optimal separation of gas and liquids. A mechanistic model, and computational fluid dynamic simulation model developed to understand the hydrodynamic behavior of the fluids in the GLCC and multiphase flow systems are powerful analytical tools that reduce experimental costs associated with testing a variety of different operating conditions.

The GLCC test unit built in this project is a vertical pipe with outlets at top and bottom. It has no moving parts or internal devices. A swirling motion formed in the fluid flow by a downward-inclined, tangential inlet produces centrifugal forces that separate the incoming fluid mixture into liquid and gas. The heavier liquid phase, forced toward the walls of the cylinder, exits at the bottom, while the lighter gas phase moves to the center of the cyclone and exits at the top.

A new integrated liquid/gas control system regulates the liquid level and GLCC pressure over a wide range of flow conditions, enabling the unit to operate at a constant pressure so that well flow is not restricted and the intermingling of the liquid and gas phases is prevented. TUSTP is currently engaged in the extension of the gas-liquid separation in the GLCC to three-phase flow separation of gas-oil-water. Two configurations are being developed: 1) A one-stage unit, the Gas-Liquid-Liquid Cylindrical Cyclone (GLLCC). 2) A two-stage unit, with a GLCC as the first stage to separate the gas from the liquid, followed by a Liquid-Liquid Cylindrical Cyclone (LLCC) as a second stage to separate the oil from the water.

Design and Development of Gas Liquid Cylindrical Cyclone (GLCC)

Compact separators for three-phase flow

CONTACT POINTS

Ram S. Mohan
Principal Investigator
University of Tulsa
Phone: (918) 631-2075
E-mail: ram-mohan@utulsa.edu

Roy Long
Technology Manager
U.S. DOE
Phone (918) 699-2017
E-mail: roy.long@netl.doe.gov

Jim Barnes
Project Manager
U.S. DOE
Phone: (918) 699-2076
E-mail: jim.barnes@netl.doe.gov

TOTAL ESTIMATED COST

$1.4 million

COST SHARING

DOE	- $0.8 million
Non-DOE	- $0.6 million

WEBSITE

www.netl.doe.gov

Benefits/Impacts

Tulsa University's work on GLCC separators has been rapidly adapted and used by industry. In excess of 120 units operating in the field can be tied directly to the University's consortia activities. Chevron has built several prototype GLCC separators in California and over 50 in Oklahoma, and has designed others for use in Canada and the Gulf of Mexico. Petrobras in Brazil is retrofitting a separator to reduce water content. Company officials at INTEVEP in Venezuela predict savings of tens of thousands of dollars in reduced equipment costs from the use of compact separators on platforms in Lake Maracaibo in a multiphase flow loop configuration.

Successful application of GLCC technology by Caltex Pacific Indonesia in the light oil steam flood project in Minas, Indonesia, will prolong the producing life of the Minas field and help postpone Indonesia s becoming a net importer of oil. Comparison with conventional separators demonstrated that GLCC application for the Duri Area-10 alone is estimated to save about $3.2 million. A Texaco application of GLCC separation in the Gulf of Mexico for well test measurement of oil, gas, and water provided low-cost testing, capital savings from reduced weight, a compact offshore installation footprint, multiple-use mobile installation, and improved reservoir management from increased frequency of well testing and greater accuracy of measurement. A single Gulf Coast well was brought back to 1,000 bopd production, yielding $821,250 in royalties to the Mineral Management Services, plus $791,138 in Federal taxes.

World's largest GLCC unit, Indonesia.

Three-fold cost saving are achievable for GLCC separators as compared to a conventional separator. For offshore operations with high flow rates, a conventional separator may cost $180,000 whereas a comparable cyclone separator would cost $60,000. In an application in the North Sea, four GLCC separators were used which resulted in cost savings of $250,000.

The GLCC system has increased environmental benefits and is less hazardous in the event of fire or explosions, particularly on offshore platforms. The system also has a smaller footprint, and reduces environmental damage with a a space savings of 10:1 and a weight savings of 4:1 compared to conventional units.

Over 100 GLCC units are presently in use in fields in the United States, and another 250 in foreign countries.