TITLE:	ADVANCED DIAGNOSTICS TECHNIQUES FOR THREE-PHASE SLURRY BUBBLE COLUMN REACTORS (SBCR)
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ABSTRACT

OBJECTIVE

The overall objective of this collaborative project between Washington University, Ohio State University and Air Products and Chemicals is to advance the knowledge and understanding of the hydrodynamics of Fischer-Tropsch (FT) slurry bubble column reactors at FT synthesis conditions.

ACCOMPLISHMENTS TO DATE

During the present reporting period the work was dedicated to designing, constructing and testing the needed experimental facilities to perform the tasks set for the project. At Washington University and Ohio State University the following has been accomplished:

1. The experimental and modeling studies of the FT-SBCR have been reviewed, analyzed, and summarized in the state-of-the-art technical review.
2. A new methodology has been developed that combine computer automated radioactive particle tracking (CARPT), computer tomography (CT) and pressure drop (ΔP) techniques to measure in a non-invasive manner the radial and axial distribution of the three phases in SBCR.
3. Evaluation of the implementation of CT and CARPT techniques in the 6" stainless steel slurry bubble column reactor operated at high pressure has been performed. CT technique has been implemented successfully using an air-water-glass beads system at high pressure (up to 150 psig) and high superficial gas velocity (up to 30 cm/s). However, for CARPT, due to first time use of a stainless steel reactor for high pressure operation, technical difficulties were encountered in the reconstruction of the position of the radioactive particle. Work

is in progress to overcome this problem in order to implement CARPT properly in a high pressure slurry bubble column. The high pressure CARPT calibration device that has been developed under the DOE program on hydrodynamics of SBCR (DE-FC2295PC95051) has been utilized at high pressure operation.

4. High temperature (up to 250 °C) and high pressure (up to 200 bar) column of 5 cm in diameter and 80 cm in height has been designed, constructed and tested to measure in situ the intrinsic density, viscosity and surface tension of FT waxes and/or comparable fluids at FT operating conditions. The reactor is equipped with 3 pairs of quartz windows (each window is 15 mm wide and 180 mm long). Work is in progress to measure these properties and to identify a suitable system that mimic FT hydrodynamics at pressures up to 150 psig and room temperature for CARPT/CT experiments in 6" SBCR.
5. A new procedure has been developed to estimate mass transfer coefficient ($k_l a$) in a high pressure slurry bubble column based on the data of $k_l a$ obtained at atmospheric conditions.

SIGNIFICANCE TO FOSSIL ENERGY PROGRAMS

The work executed in this project represents a complementary effort to the DOE program on the hydrodynamics of slurry bubble columns in conjunction with the operation of the advanced fuels development unit (AFDU) in LaPorte, Texas, operated by Air Products.

PLANS FOR THE COMING YEAR

- Evaluation of physicochemical properties in FT wax or a comparable fluid.
- Evaluation of various diagnostics techniques in FT wax or a comparable fluid. Experimental investigation of the hydrodynamics of SBCR using FT wax or a comparable fluid in 2" diameter column operated under FT operating conditions.
- Implementation of CARPT technique in high pressure slurry bubble column.
- Experimental investigation of the hydrodynamics using CARPT, CT and ΔP techniques in the 6" diameter column.
- Initiation of hydrodynamic parameters modeling and CFD work.

ARTICLES, PRESENTATIONS AND STUDENT SUPPORT

Journal Articles (peer reviewed)

- Y. Wu and M.H. Al-Dahhan, "Prediction of Mass Transfer Coefficient in Bubble Columns at High Pressure Based on Low Pressure Data", *submitted to I&EC Research*, (2000).
- L.-S. Fan, G. Q. Yang, D. J. Lee, K. Tsuchiya, and X. Luo, "*Some aspects of high-pressure phenomena of bubbles in liquids and liquid-solid suspensions*", Chem. Eng. Sci., 54, 4681, (1999).

Students Supported Under This Grant

- J. Weng, graduate (Ph.D.) student in chemical engineering, Washington University
- R. Lau, and W. Peng graduate (Ph.D.) students in chemical engineering, Ohio State University