TITLE:	ADVANCED DIAGNOSTIC TECHNIQUES FOR THREE PHASE BUBBLE COLUMN REACTORS
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ABSTARCT

OBJECTIVE

The overall objective of this collaborative project between Washington University, Ohio Sate 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 period the following has been accomplished at Washington University and Ohio State University,

1. The technical difficulties that were encountered in implementing computer automated radioactive particle tracking (CARPT) in high pressure slurry bubble column reactor (SBCR) have been successfully resolved. Inaccuracy in reconstruction of the position of radioactive particle was encountered due to the presence of stainless steel wall which causes high attenuation depending on the solid angle of the detectors. New strategy, data acquisition and calibration procedures have been implemented.
2. CARPT and computed tomography (CT) experiments have been performed using air-water –glass beads (150μm) in high pressure 6" column. The effects of reactor pressure and superficial gas velocity have been investigated using pressures at 0.1 MPa (14.7 psi), 0.4 MPa (58 psi), 1.0 MPa (145 psi) and superficial gas velocities of 8 cm/s (bubbly

flow regime) and 45 cm/s (churn turbulent flow regime). These experiments are time consuming and the work is in progress to process and interpret the data.

3. Dynamic pressure drop measurments set-up with its data acquisition system have been installed on the high pressure 6"column equipped with windows and ports. Pressure drop measurements are needed at the same level and conditions of the performed CT and CARPT experiments, for the developed methodology that combines CARPT, CT and ΔP to measure in a noninvasive manner the radial and axial distribution of the three phases in SBRC. Work is in progress to perform such measurements.
4. The effects of reactor pressure (0.1,0.4,1.36 MPa), solids loadings (20% and 40% by weight) and superficial gas velocity (up to 30 cm/s) on overall gas hold up, flow regime transition, bubble size and bubble rise velocity in 5 cm (2 in.) slurry bubble column have been investigated using a paratherm NF that mimic at room temperature the Fischer-Tropsch wax at FT reaction conditions of high pressure and temperature.
5. To improve the design and scale-up of bubble column, new correlations have been developed to predict the radial gas hold up profile and the radial profile of the time averaged axial liquid recirculation velocity in bubble columns.

SIGNIFICANCE TO FOSSIL ENERGY PROGRAMS

The work executed in this project represents a complementary effort to the DOE program on the hydrodynamics of slurry bubbles 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 of the selected fluid (EXXON Norpar 15) that mimic at room temperature FT wax at FT reaction conditions.
- Experimental investigations of the hydrodynamics of SBCR using the selected fluid-air-glass beads (150μm) in 2" diameter column.
- Experimental investigations of the hydrodynamics using CARPT, CT, ΔP techniques in the 6" diameter column using the selected-air-glass beads (150μm).
- Evaluation of the developed scale-up procedure and CFD against the newly obtained data.

ARTICLES, PRESENTATIONS AND STUDENT SUPPORT

Journal Articles (peer reviewed)

1. Y.Wu, B.C.Ong, M.H.Al-Dahhan, "Predictions of radial gas hold up profiles in bubble column reactors", Chem. Eng. Sci. 56, 3, (2001).
2. Y.Wu, M.H.Al-Dahhan , "Predictions of axial liquid velocity profile in bubble column", Chem. Eng. Sci. 56, 3, (2001).

Presentations

1. Y.Wu,B.C. Ong, Muthanna H. Al-Dahhan, Predictions of radial gas holdup profiles in bubble column reactors, 16th International Symposium on Chemical Reaction Engineering (ISCRE 16), Krakov, Poland, September 10-13 (2000).
2. Y.Wu, Muthanna H. Al-Dahhan, Prediction of axial liquid velocity profile in bubble columns, ICSRE 16, Krakov, Poland, September 10-13 (2000).

Students Supported Under This Grant

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