Engineering Development of Slurry Bubble Column Reactor (SBCR) Technology

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Contract Objectives

The major technical objectiveses of this program are threefold: 1) to develop the design tools and a fundamental underrstanding of the fluid dynamics of a slurry bubble column 0reactor to maximize reactor r productivity, 2) to develop the mathematical reactor design models and gain an understandding of the hydrodynamic fundamentals under industrially relevant process conditions, arand 3) to develop an understanding of the hydrodynamics and their interaction with the chemmistries occurring in the bubble column reactor. Successful completion of these objectivess will permit more efficient usage of the reactor column and tighter design criteria, increasese overall reactor efficiency, and ensure a design that leads to stable reactor behavior when s scaling up to large diameter reactors.

Summary of Progress

Task 2: Technique Developsment

Computer Tomography (CCT) scans of a large-diameter column with internals were completed and analysis wavas begun. These are the first CT scans in a large bubble-column with internals. Soome problems (shadows) were experienced in the reconstructions. Work to o understand if this is caused by the large diameter or the internals continues. In spipite of the problems, some conclusions could be drawn (see Task 4).

(Washington University in St. Louis)

Bubble size distribution isis a useful parameter for both computer modeling and understanding physical prarocesses inside a bubble column. The dynamic gas disengagement technique c offers potential as a way of measuring bubble size distribution. Additionally,y, dynamic gas disengagement can be measured in high-pressure, reacting columnsns using differential pressure measurements. A reliable correlation for bubble rise e velocity is essential to the dynamic gas disengagement technique. A correlation h has been developed to calculate the rise velocity of single bubbles in the high-pressuure and high-temperature slurry bubble column. Predictions of the correlation are satisisfactory.

(The Ohio State University)

Task 3: Model Developsment

The standard axial dispersrsion model (ADM) for the liquid phase in a bubble column was revisited, since it wasas realized that this model could describe the overshoots in tracer concentration that v were seen during the LaPorte tracer trials. While the analysis shows that the model can n fit the overshoot shape, the model still appears inadequate to model liquid flow. Consisistent dispersion coefficients could not be found when the region close to the injecticion points (i.e., the region where overshoots exist) was included in the analysis.

(Washington University in St. Louis)

One method of gaining innsight into the effect of variables and of various closure methods for numerical moodeling is to use the closure method in a simplified model. A one-dimensional gas phasese model was used to test the effect of changing mixing length. It was shown thatit the equations can capture some of the essence of bubble-driven flow as found in buubble columns.

(Washington University in St. Louis)

Task 4: SBCR Experimentahl Program

CT measurements using DDrakeoil in a 44-cm diameter bubble column fitted with internals to simulate a heaat exchanger have shown that:

a. Gas holdup increases wwith increasing superficial velocity.
b. Gas holdup increases (s(slightly) axially up the column.
c. Gas holdup is higher wwith internals than without.

Interpretation of the resultlts continues.

(Washington University in St. Louis)

The differential pressure s signals during bed collapse processes have been converted to the variation of gas holddup with time. From the variation of gas holdup with time, bubbles are divided into fifive groups based on bubble size. The bubble rise velocity and initial gas holdup in each a group are obtained.

(The Ohio State University)