Engineering Development of Slurry Bubble Column Reactor (SBCR) Technology

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ENGINEERING DEVELOPMENT OF SLURRY BUBBLE COLUMN REACTOR (SBCR) TECHOLOGY

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Contract Objectives

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

Summary of Progress

- *Technique Development*
  The high-temperature, high-pressure bubble column was improved by adding differential pressure transducers with a computer data acquisition system, calibrating the high-temperature, high-pressure liquid flow meter and fabricating several distributor plates that can be easily interchanged.

  (The Ohio State University)

- *Data Acquisition*
  Measurements of density at high temperature and pressure were made. Fundamental physical property data for two- and three-phase systems are not well understood, but are vital to understanding the fluid mechanics of such systems. Thus, a program of measuring properties such as interfacial tension and density has been undertaken. Liquid density increased by about 5% when pressure was increased from 15 to 3000 psig at room temperature, while the increase was 6% at 250°F.

  (The Ohio State University)

  The study of two-dimensional flow sometimes simplifies flow problems and facilitates the understanding of the actual 3-D case. Thus, the effect of increasing scale on instantaneous flow structures in 2-D bubble columns was studied under a variety of flow rates using Particle Image Velocimetry (PIV). In columns larger than 8 inches, the 4-region flow structure (discussed in the last quarterly report) was found in the transition region, but only a 3-region flow structure was found in smaller columns. Gas holdup distribution also differed with increasing length. These detailed results will form the basis for validation of computational fluid dynamic codes for two-phase flow.

  (The Ohio State University)

- *Model Development/Data Prooocessing*

  Analysis of the tracer data fromm the hydrodynamic trial showed that:

  - The standard axial dispersiion model generally fits the tracer data well. Although one can calculate values for the coefficients in the axial dispersion model, the model itself is physically unreasonable. NNew models are needed to increase the accuracy of scaleup.
  - Liquid dispersion coefficierents can only be calculated reliably when the detector is far away from the injector. (This coonclusion was made previously by inspection of the data. It was incorporated in the planninng for the trial.)
  - Gas phase dispersion coefficients are strongly dependent on gas holdup. Gas holdup depends upon the extent ofof conversion at any point in the reactor, which in turn depends upon the flow characteristiics of the reactor (CSTR or PFR).
  - The calculated dispersion c coefficients are about 150% greater than predicted by the standard correlations (withh data measured at atmospheric pressure).
  - Gas phase dispersion coefficients are from 1-3.5 times lower than predicted by standard correlations (atmospheric p pressure).
  - Both liquid and gas axial didispersion coefficients increase with increasing gas velocity.
  - Additional work to developp a suitable data base is needed in order to characterize flow patterns in bubble column r reactors at high temperatures and pressures.

(Washington University in St. Louis)
(Air Products and Chemicals)