TITLE PAGE

ENGINEERING DEVELOPMENT OF SLURRY BUBBLE COLUMN REACTOR (SBCR) TECHNOLOGY

Quarterly Technical Progress Report No. 23
For the Period 1 October – 31 December 2000

FINAL

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Comprehensive Table of Contents

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Project 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.

Abstract

Washington University's work during the reporting period involved the implementation of the automated calibration device, which will provide an advanced method of determining liquid and slurry velocities at high pressures. This new calibration device is intended to replace the original calibration setup, which depended on fishing lines and hooks to position the radioactive particle. The report submitted by Washington University contains a complete description of the new calibration device and its operation. Improvements to the calibration program are also discussed. Iowa State University utilized air-water bubble column simulations in an effort to determine the domain size needed to represent all of the flow scales in a gas-liquid column at a high superficial velocity. Ohio State's report summarizes conclusions drawn from the completion of gas injection phenomena studies, specifically with respect to the characteristics of bubbling-jetting at submerged single orifices in liquid-solid suspensions.

Executive Summary

Washington University's newly developed automated calibration device is described in this quarter's report, and its theory of operation is explained. With the commissioning of the new calibration equipment, the Washington University group was prepared for high-pressure CARPT experiments. Successful testing of the equipment confirmed this. Stepper motors have been added to the calibration device to provide the most accurate positioning of the tracer particle. A C++ program has been developed to control the movement of the calibration device and has been incorporated in the principal calibration program. A new robust and accurate tracer reconstruction approach has been developed based on a better understanding and modeling of the physics behind the photon emission phenomenon. A new tracer data acquisition strategy has been implemented that contains the spread in the calibration curve in a stainless steel column. This new strategy enables the usage of the existing spline-based reconstruction method to provide reasonable estimates of the tracer location in a stainless steel column.

Iowa State's work for the quarter began with a set of simulations, which were divided on the bases of grid and domain sizes. All earlier simulations depended upon the sequential version of CFDLIB code. The parallel version of this code, which has been put into practice, has limitations, however. Consultants have begun work with the Iowa State team to resolve the problem. As a means of preparation for an Alpha cluster machine, scaleup studies of the Ames Laboratory Intel cluster were performed for three-dimensional simulations.

Ohio State reported the completion of the study of high-pressure gas injection from a single orifice submerged in a liquid-solid suspension. The Ohio State research group found that there is a decrease in bubbling-jetting transition velocity with increases in pressure and velocity when particles are present. Ohio State also reported on its studies of axial liquid-phase mixing, beginning with a review of the significant literature on the subject.