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ADVANCED DIAGNOSTIC TECHNIQUES FOR THREE-PHASE SLURRY BUBBLE COLUMN REACTORS (SBCR)

Annual Technical Progress Report No. 1
for the Period July 1, 1999 – June 30, 2000
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Principal Investigators:

M.H. Al-Dahhan
Assistant Professor and Associate Director
Chemical Reaction Engineering Laboratory

Washington University
Department of Chemical Engineering
Campus Box 1198
One Brookings Drive
St. Louis, Missouri 63130
Fax: 314-935-4832
Phone: 314-935-7187
E-mail: muthanna@che.wustl.edu

M.P. Dudukovic
The Laura and William Jens
Professor and Chairman
Director, Chemical Reaction Engineering
Laboratory

Washington University
Department of Chemical Engineering
Campus Box 1198
One Brookings Drive
St. Louis, Missouri 63130
Fax: 314-935-4832
Phone: 314-935-6021
E-mail: dudu@wuche3.wustl.edu

L.-S. Fan
Distinguished University Professor
Chairman, Department of Chemical
Engineering

Ohio State University
Department of Chemical Engineering
140 West 19th Avenue-Room 125
Columbus, Ohio 43210-1180
Fax: 614-292-3769
Phone: 614-292-7907
E-mail: FAN@er6s1.eng.ohio-state.edu

Industrial Collaborator

B. Toseland — Air Products and Chemicals

Co-Investigators

Washington University: N. Rados, Dr. A. Kemoun, Dr. Y. Wu
Ohio State University: R. Lau, W. Peng

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ABSTRACT

This report summarizes the accomplishment made during the first year of this cooperative research effort between Washington University, Ohio State University and Air Products and Chemicals. A technical review of the variables affecting SBCR performance, some aspects of bubble dynamics and hydrodynamics properties and physical properties of FT waxes and catalyst have been performed. The needed experimental facilities and measurement techniques have been evaluated and prepared. Exxon Norpar 14 has been suggested as a solvent to be used that mimics at room temperature and pressure up to 200 psi the hydrodynamics of FT waxes. A new correlation has been developed and tested to predict gas-liquid mass transfer coefficient at high pressure operation based on high pressure gas holdup and atmospheric data of gas-liquid mass transfer coefficient.

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EXECUTIVE SUMMARY

The objective of this cooperative research effort between Washington University, Ohio State University and Air Products and Chemicals is to advance the understanding of the hydrodynamics of Fischer-Tropsch (FT) Slurry Bubble Column Reactors (SBCR) via advanced diagnostics techniques. The emphasis during this first year was: i) on technical review of the variables affecting SBCR performance, some aspects of bubble dynamics and hydrodynamic properties and the physical properties of FT waxes and catalyst, ii) on preparation of the experimental facilities and the advanced measurement techniques, iii) on identifying the solvent that mimic FT waxes at FT operating conditions and the gas and solid phase to be used in the hydrodynamics investigation, v) on development of a new procedure to estimate the mass transfer coefficient at high pressure based on atmospheric pressure data.

This report summarizes the accomplishments made during the first year of this project. The report is organized in individual sections. Each section represents a distinct task.

Section 1 provides an introduction, a review of the objectives and tasks set for the project, list of accomplishments during the first year and plans for the second year.

Section 2 summarizes the technical review made. However, the detailed review of the aspects of high-pressure phenomena of bubbles in liquids and liquid-solid suspensions is discussed in Appendix A.

Section 3 describes the preparation made for the advanced techniques that will be used in the hydrodynamic investigations and for the in-situ physical properties (density, viscosity and surface tension) measurement of the selected solvent that mimic the FT waxes at FT operating conditions.

In section 4, the suggested system of air-Exxon Norpar 14-glass beads has been identified. Exxon Norpar 14 mimics at room temperature and pressure up to 200 psi the hydrodynamics of FT waxes.

Section 5 discusses the development of a new correlation to predict gas-liquid mass transfer coefficient at high pressure operation based on high pressure gas holdup and atmospheric data of gas-liquid mass transfer coefficient. This is part of the attempt to improve the scale-up procedure of bubble column reactors.