

LISTING OF ACTIVE PROJECTS (2004/2005)

Projects active during the period June 1, 2004 through May 31, 2005 are classified into categories of the current active projects on multiphase reactors and processes, and the past active project on the preparation of new materials, and process monitoring and control. The working titles of all active projects and the names of graduate students or researchers involved are listed below:

Name

Title: key words

AREA I. MULTIPHASE REACTORS AND PROCESSES: EXPERIMENTS AND MODELS

BUBBLE AND SLURRY BUBBLE COLUMNS

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| J. Xue
(graduate student) | I-1. Investigation of Bubble Properties with Four-Point Optical Probes in Bubble Columns: A four-point optical probe has been implemented in bubble column for the investigation of bubble dynamics (bubble rise velocity, size, interfacial area and local gas holdup distribution). |
| A. Shaikh
(graduate student) | I-2. Modeling of Liquid Phase Methanol Synthesis in Slurry Bubble Column Reactors: A mixed cell model for slurry bubble column has been developed to study the performance of liquid phase methanol synthesis in slurry bubble columns. |
| K. Ruthiya
(research associate) | I-3. Mass Transfer and Hydrodynamics in Catalytic Slurry Reactors: The influence of catalyst particle characteristics, and liquid properties on the mass transfer, hydrodynamics and reaction rate in catalytic slurry reactor has been studied in this work as part of the PhD degree obtained at Eindhoven University. |
| P. Chen
(research associate) | I-4. Implementation of Bubble Population Balance Model in CFD: Breakage and coalescence models have been implemented into the bubble population balance equation which is used with CFD code of Fluent to predict the bubble sizes on which for the drag calculations are based. The simulation results are compared with experimental data obtained by CARPT, CT and optical probe. |
| M.H. Al-Dahhan
(faculty) | I-5. High Pressure Slurry Bubble Column Reactor Consortium: The tasks have been set for the 3-year extension of the high pressure slurry bubble column consortium (2003-2005). The consortium is sponsored by Conoco Phillips (USA), Eni Technologie (Italy), Sasol (South Africa) and Statoil (Norway). The overall objective is to advance the understanding and modeling of FT slurry bubble column reactor. The tasks are performed in a collaborative effort between Washington University, Ohio State University and Rensselaer Polytechnic University. |
| A. Shaikh, L. Han, W. Chen,
(graduate students) | |

The results are only reported to the consortium members.

- A. Shaikh**
(graduate student)
- I-6. Solids Flow Visualization in Slurry Bubble Columns using Computed Automated Radioactive Particle Tracking (CARPT) and Computed Tomography (CT):** As a part of the tasks set for the high pressure slurry bubble column reactor consortium, solids flow field has been investigated using CARPT (A-5).
- A. Shaikh**
(graduate student)
- I-7. Hydrodynamics Similarity in Bubble Column Reactors:** A new hypothesis for flow dynamics similarity in bubble columns has been proposed, validated, and investigated using both CARPT/CT (A-5).
- A. Shaikh**
(graduate student)
- I-8. Combination of Computed Tomography (CT) and Electrical Capacitance Tomography (ECT) for Flow Visualization Investigation in Slurry Bubble Column Reactors:** Combination of CT and ECT and related algorithm and procedure for data processing has been developed. The three phases distribution in a slurry bubble column has been investigated at various solids loading using such combination of CT/ECT (A-5).
- L. Han**
(graduate student)
- I-9. Hydrodynamics and Mass Transfer in Slurry Bubble Columns:** Two mass transfer measurement techniques have been developed to investigate mass transfer coefficient and gas phase dynamics. Hydrodynamics have been investigated using CARPT/CT in high pressure slurry bubble column reactors as a part of the tasks set for high pressure slurry bubble column reactor consortium (A-5).
- C. Wu**
(graduate student)
- I-10. Heat Transfer Coefficient Measurements in a High Pressure Slurry Bubble Columns:** Heat transfer probes have been developed to investigate the heat transfer coefficient in high pressure slurry bubble column reactor as a part of the tasks set for its consortium (A-5).

CIRCULATING FLUIDIZED BEDS

- S. Bhusarapu**
(graduate student)
- I-11. Solids Flow Mapping in Gas-Solid Risers: Velocity Field:** The solids velocity, turbulence and backmixing of the solids in the fully developed region of a gas-solid riser have been studied using CARPT.
- S. Bhusarapu**
(graduate student)
- I-12. Solids Flow Mapping in Gas-Solid Risers: Concentration Field:** The time averaged solids holdup distribution has been investigated using CT.
- N. Subramanya**
(graduate student)
- I-13. Modeling of Vaporization and Cracking of Liquid Oil Injected in a Gas-Solid Riser:** Momentum transfer, heat transfer, catalytic cracking reaction and droplet vaporization are integrated to model FCC riser reactor.

TRICKLE BEDS

- J. Guo**
(graduate student)
- I-14. Catalytic Wet Air Oxidation of Phenol in Packed-Bed Reactors Over Pillard Clay Catalyst:** Experimental and modeling study has been performed to treat industrial waste with phenol compound via catalytic wet air oxidation in packed bed reactors over pillared clay catalyst.
- M. Capitaine**
(visiting researcher)
- I-15. Experimental and CFD Study of the Liquid Flow Distribution in Trickle Bed Reactors:** Liquid flow distribution in a trickle bed reactor has been measured by CT and by collecting the flow at the reactor bottom using a collector with 25 compartments. CFD modeling using Fluent is being developed for the trickle bed reactor.
- C. Boyer / A. Koudil**
(IFP)
- I-16. Study of Liquid Spreading from a Point Source in a Trickle Bed via Gamma-Ray Tomography and CFD Simulation:** Gamma-ray CT and a liquid collecting device have been used to study the flow distribution in a trickle bed reactor. The results have been used to evaluate 2D CFD modeling.
- P. Chen**
(research associate)

STRUCTURED BEDS

- S. Roy**
(graduate student)
- I-17. Effect of Flow Maldistribution on Monolith Reactor Performance: A Modeling Approach:** A new model has been developed that integrate hydrodynamics with kinetics to predict the performance of monolith reactors.

PACKED BEDS

- R. C. Ramaswamy**
(graduate student)
- A-18. Modeling of Catalytic Partial Oxidation of Methane to Syngas in Short Contact Time Packed Bed Reactors:** Steady state and transient heterogeneous models for the short contact time packed bed reactors producing syngas have been developed.
- R.C. Ramaswamy**
(graduate student)
- A-19. Reactor Models for Coupling Exothermic and Endothermic Reactions:** Steady state and transient homogeneous and heterogeneous reactor models have been developed and implemented to compare the different modes of coupling. The models have been used to assess the effects of various parameters on the conversion of the endothermic reactions and temperature peak.

STIRRED REACTORS

- D. Guha**
(graduate student)
- I-20. CFD-Based Compartmental Mixing Model for Stirred Tank Reactors:** Compartment based model is being developed for single phase stirred tank reactors that uses the detailed flow field obtained by CFD.

PROCESSES and MINI and MICROREACTORS

- R. Jevtic**
(graduate student)
- I-21. Mini and Micro Reactors Study for Liquid Hydrocarbons Oxidation:** a set of mini and microreactors are being developed to investigate the effects of temperature and the availability of oxygen on the oxidation of liquid cyclohexane with and without superficial CO₂.
- K. Ruthyia**
(research associate)
- I-22. Modeling the Effects of Temperature, Pressure, and Oxygen Solubility on Liquid Phase the Oxidation of a Cyclohexane:** A model for liquid phase oxidation of cyclohexane that includes kinetics, transport and hydrodynamic parameters is being developed.
- R. Jevtic**
(graduate student)
- I-23. Mathematical Modeling and Experiments to Study Effective Diffusivity and Break-Through Curves for Alkylation Processes:** The break-through curves (adsorption, desorption and reaction) of various catalyst for alkylation process in packed bed will be evaluated and studied. For this purpose experimental facilities (mini packed bed reactor and autoclave mixed reactor) and mathematical models are being developed.
- N. Subramanya**
(graduate student)
- I-24. The Integrated Struvite-CANON System:** Various factors were taken into account for design of the integrated Struvite-CANON system.
- F. Mei**
(graduate student)

AEROSOL / PARTICULATE REACTORS

- P. Kumar**
(graduate student)
- I-25. Aerosol Routes for Synthesis of Nanostructured Magnetic Oxides: Characterization and Transport Behavior:** The effects of flame temperature profile and residence time on the shape, size and crystallinity of synthesized γ -Fe₂O₃ have been investigated. The mechanism of the formation of the magnetic oxide has been studied.

MEASUREMENT TECHNIQUES and STATISTICAL METHODS

- Z. Zuzeljevic**
(graduate student)
- I-26. Reduced Tomography For Industrial Application:** Using a packed bed with various phantom objects, reduced tomography is evaluated for industrial application and its results are compared with CT results.
- S. Roy**
(graduate student)
- R. Varma**
(graduate student)
- I-27. Development of Dual Source Computed Tomography for Imaging Three Phase Systems:** Dual dynamically modality CT is being developed to visualize flow distribution of dynamically moving three phases systems.
- M. Vesvikar**
(graduate student)
- I-28. Development of Multiple Particle Tracking (MP-CARPT):** Multiparticle CARPT is being developed to track more than one radioactive particles to visualize the various phases and flow of particles group simultaneously by multiphase reactors.

- S. Mueller**
(graduate student)
- I-29. Testing Optical Probes for Phase Transition and Volumetric Expansion at Subcritical and Supercritical Conditions:** Optical probe based techniques are being developed to measure online phase transition and solvent expansion in subcritical and supercritical CO₂ conditions.
- Miryan Cassanello**
(visiting faculty - Argentina)
- I-30. Time Series Analysis in Multiphase Reactors:** Using tools from the theory of non-linear dynamics and symbolic dynamics, experimental time series in multiphase reactors are analyzed to obtain information on the dynamics of multiphase reactors.

BIOREACTORS AND BIOPROCESSES ENGINEERING LABORATORY (BBEL)

- H. Luo**
(graduate student)
- I-31. Analyzing and Modeling of Photobioreactors for Microalgal and Cyanobacteria Cultures:** A novel modeling approach has been developed that combines cells' movement, hydrodynamic parameters, dynamic photosynthesis and irradiance field to predict and investigate the photobioreactor performance for the growth of high value products microalgae and cyanobacteria.
- M. Vesvikar**
(graduate student)
- I-32. Shear Mapping in Impeller Mixed Anaerobic Digester Using CARPT:** Flow dynamics and shear mapping have been investigated using CARPT in impeller mixed anaerobic digester mixed at different rpms and mixing intensities.
- R. Varma**
(graduate student)
- I-33. Hydrodynamics Study of Gas Recirculation Bioreactors Using Radioactive Particle Tracking and Gamma Ray Tomography:** The effects of gas phase distribution on the flow dynamics and phase distribution have been investigated in anaerobic bioreactor mixed by gas recirculation.
- M. Vesvikar**
(graduate student)
- I-34. Performance Study of a Pilot Plant Scale Anaerobic Digester:** The effects of mixing on the performance scale anaerobic digester have been investigated. The impact of the digester size on the role of mixing in the anaerobic digester performance has been evaluated.
- R. Hoffman**
(graduate student)
- I-35. Effect of Shear on Performance and Microbial Community in Anaerobic Digesters Treating Cow Manure:** The study focuses on how the shear rate affects the microbial community and digester performance, and if increasing shear rate disrupt the spatial orientation of syntrophic partners.
- K. Karim**
(senior research associate)

USER FRIENDLY MODULES FOR MULTIPHASE REACTORS MODELING

- C. Tunca**
(research associate)
- I-36. Developing User Friendly Modules for Modeling Multiphase Reactors:** User friendly software-based simulations are being modulated for multiphase reactor performance, evaluation, design and scale-up.

AREA II. PREPARATION OF NEW MATERIALS

M.P. Dudukovic, **II-1. Semiconductor Grade Silicon:** CREL know-how reviewed.
P.A. Ramachandran
(faculty)

AREA III. PROCESS MONITORING AND CONTROL

G. McMillan **III-1. Process Monitoring and Control:** A HYSIS plant dynamic
(adjunct faculty) model is available together with the newest Delta-V Pro control
system.