Dipartimento
di Ingegneria Chimica,
dei Materiali e della
Produzione Industriale
Università degli Studi
di Napoli Federico II

Thesis Projects for Erasmus Traineeship student

The STEEL Group of DICMaPI offers a great opportunity for Erasmus Traineeship students to prepare their Master's thesis in the laboratories of the Technische Universität Dresden - TU Dresden (Germany) on different topics of Chemical Engineering.

We have direct contact with Prof. Markus Schubert and his assistant Sara Marchini from the TU Dresden, who will supervise you during the thesis period.

The available projects are:

- Development of a New Reactor Concept for Hydrogen Production using immobilized metal powders;
- Development and Evaluation of a Recovery Process for Liquid Waste Streams of a Cellulose and Lignin Production Process;
- Development and Characterization of Innovative Ceramic Packings for Unit Operations;
- Enhancing Gas-Liquid Interaction in Bubble Columns using Innovative gas modulation;
- Effect of liquid conductivity on gas-liquid interactions in bubble columns.

Interested students can contact Prof. Domenico Flagiello by e-mail or Teams to discuss about thesis projects and arrange a call-meeting with Sara Marchini, who is the direct contact with Italian student for these activities at TU Dresden, and also to ask about further information for the facilities and organization of your accommodation in Dresden.

Contact:
Prof. Domenico Flagiello
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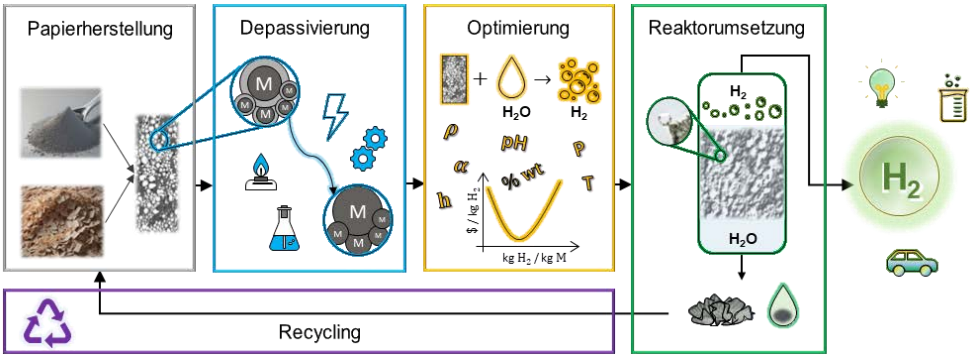
Development of a New Reactor Concept for Hydrogen Production using immobilized metal powders

Our current focus is on advancing hydrogen generation technologies through novel reactor designs that utilize reactive metal powders such as aluminum and magnesium. These metals, known for their exothermic reactions with water, offer a promising avenue for efficient hydrogen production. In collaboration with our research partner, the project's goal is to develop a new reactor concept that maximizes the hydrogen production rate from metal powders immobilized on special technical paper while overcoming the challenges posed by their surface passivation and the difficulties in handling of fine powders.



This involves starting from laboratory-scale experiments to design, optimize and scale up a reactor that can efficiently produce hydrogen in a safe, autonomous and decentralized manner, suitable for applications in various sectors, including mobility and energy storage.

Tasks and Objectives

- To experimentally investigate the hydrogen production efficiency of various metal powders, focusing on the effects of particle size, metal type and reaction conditions.
- To design and test a lab-scale reactor prototype that addresses the challenges of surface passivation and optimizes hydrogen generation rates.
- To systematically vary reactor parameters, such as temperature, pressure and metal surface treatment methods, to enhance the efficiency and scalability.
- To model the reactor performance to predict scalability and industrial applicability.

Requirements

- A solid understanding of reactor design, chemical kinetics and process engineering principles.
- Strong analytical and problem-solving skills.
- Passionate about sustainable energy technologies and innovation.

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Development and Evaluation of a Recovery Process for Liquid Waste Streams of an Cellulose and Lignin Production Process

In collaboration with partners, who have developed an innovative method for producing cellulose and lignin from agricultural or forest residuals, our research initiative aims to support the scale-up to a pilot plant. A crucial step for this scale-up is the effective treatment and recovery of the waste liquid streams , integrating principles of the circular economy. This project will focus on establishing a recovery process involving a catalytic bed reactor and a thermal separation unit, addressing the complex composition of the outlet stream. This work presents an opportunity to engage in cutting-edge research that addresses critical sustainability issues in the chemical production industry. The student will gain valuable experience in pilot plant development and process optimization, while working closely with both academic and industry experts.

Objectives and Tasks:

Process Design: Assist in the design and setup of the recovery system, focusing on optimizing the integration of catalytic and thermal separation steps.
Experimental Characterization: Perform detailed experimental studies to characterize the efficiency and effectiveness of the proposed recovery steps.
Feasibility Analysis: Evaluate the technical and economic feasibility of the recovery process, considering operational costs and environmental impacts.

Requirements:

Experience in reactor engineering and separation technologies is beneficial. Candidates should be motivated to support sustainable process development, have strong problem-solving skills, and be capable of working both independently and as part of a team.

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Development and Characterization of Innovative Ceramic Packings

Our research group is dedicated to advancing technologies in chemical process engineering, focusing on the development of sustainable and efficient material solutions. The use of ceramic packings for absorption and distillation processes is limited by their current design, which is often thick, heavy and costly, leading to decreased hydrodynamic efficiency in industrial applications. Together with our research partner, we want to implement and test novel packings from ceramic sheets based on a novel manufacturing process that are thinner, lighter and more cost-effective . This thesis will explore the potential of these novel ceramic packings and quantify the improvement that they will bring to column operations.

Thesis Objectives:

- Assess the downsides of currently available ceramic packings in a comprehensive literature review.
- Conduct detailed experimental studies to assess the pressure drops and mass transfer coefficients of the newly developed ceramic packings. Comparisons will be made with traditional packings to highlight improvements.
- Evaluate packings of different geometries and porosity.
- Evaluate the structural integrity and durability of the lighter, thinner ceramic materials.

Requirements:

- Currently enrolled in a Master's program in Chemical Engineering, Materials Science or a related field.
- Familiarity with fluid dynamics and chemical process equipment.
- Detail-oriented with analytical thinking, proactive in problem-solving, and motivated by innovation in engineering solutions.

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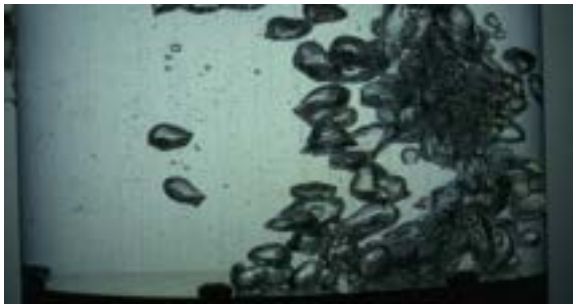
Start: at any time

Enhancing Gas-Liquid Interaction in Bubble Columns using Innovative gas modulation

The project focuses on improving the performance of bubble columns, particularly in addressing the gas maldistribution issue associated with conventional perforated plate gas spargers at low flow rates. The positive effects of vibrations applied to bubble columns is already reported in the literature in terms of improved mass-transfer rates (up to 30%) and reduced bubble size. However, these findings have only rarely been applied in column design due to excessive energy input required. Our lab has developed a novel technical solution to obtain comparable effects with a minimum energy input. Preliminary results are available to interested candidates and their supervisors. These results show the potential of our innovative solution to significantly improve gas-liquid interactions within bubble columns. We have observed a notable increase in gas holdup, reduced bubble size, and enhanced mass transfer rates, all achieved with minimal energy consumption.



The student will verify the applicability of the proposed technical solution to columns of several diameters equipped with perforated plates of different characteristics. Gas holdup, bubble rise velocity, bubble size distribution, regime transition velocity and mass-transfer rates will be measured with and without modulation. Results will be compared to assess the effectiveness of the proposed modulation. In addition, the required energy input will be measured for each tested configuration.

Requirements:

- Enrolled in a Master's program in Chemical Engineering, Industrial Chemistry or a related field.
- Strong background in fluid dynamics.
- Enthusiasm for research and scientific inquiry.
- Ability to work collaboratively within a research team.
- Good communication skills in English or German

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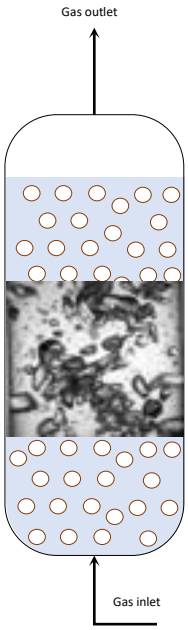
Effect of liquid conductivity on gas-liquid interactions in bubble columns

The project aims to investigate the influence of water conductivity on gas-liquid interactions within bubble columns. Preliminary studies have already been conducted, and the results are available for interested candidates and their supervisors. These preliminary findings have revealed significant differences in gas holdup, particularly at low conductivity range. Interestingly, existing literature often discusses gas-liquid interactions in deionized water without providing further details. This lack of specificity has led to inconsistencies in reported results, which we aim to solve with this study.



The student will conduct experimental studies to measure gas holdup, bubble rise velocity, and bubble size distribution in bubble columns under varying conditions, including water conductivities, dissolved species and gas sparger types. Measurements will be performed at different column heights. Due to the multiplicity of variables involved, the experiments will be planned applying the principles of design of experiments.

Requirements:

- Enrolled in a Master's program in Chemical Engineering, Industrial Chemistry or a related field.
- Strong background in fluid dynamics.
- Enthusiasm for research and scientific inquiry.
- Ability to work collaboratively within a research team.
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