ELECTRICAL ENERGY LABORATORY
Technologiepark 131, 9052 Gent, Belgium

Supervisor(s)	Period	Funding
Prof. Luc Dupré Dr. Annelies Coene	4 year	FWO-MACBED

Magnetically driven material (re)organization in a reactor for intensified CO_2 conversion

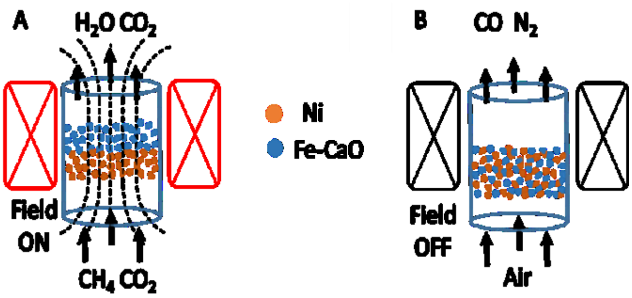
Aim

The aim of this project is to develop and optimize a reactor that utilizes magnetic fields for intensified CO_2 capture and conversion. By employing time and spatially varying magnetic fields, materials with different functionalities and magnetic properties, are driven towards a specific spatial organization in the reactor, leading to an intensified CO_2 conversion. This type of reactor is also referred to as a magnetic field assisted fluidized bed reactor (MAFB). The project will investigate the optimal magnetic fields and coil design required to achieve this behavior through a combination of experiments and computational modeling. You will work closely with fellow researchers who will model the reactor's hydrodynamics, with inclusion of reaction kinetics. Moreover, they will obtain data by testing the experimental reactor in-situ to support the modelling results for the hydrodynamic and magnetic model.

Motivation

Vast amounts of energy are needed to synthesize megatons of chemicals used in everyday life. To meet that demand, the chemical industry uses energy from fuel combustion, thereby producing one seventh of the anthropogenic greenhouse gas emissions. This project seeks to provide a more sustainable alternative by utilizing Chemical Looping (CL), an emerging technology that produces heat, fuels, chemicals, and electricity with extremely low emissions and important energy savings. The efficiency of CL can be increased by combining different functionalities in one reactor bed. Clever organization of these functional materials, as a mixture or in distinct reactor zones, can further improve the overall performance.

Program



We are looking for a computationally oriented PhD student with a mechanical engineering degree (or equivalent) to join the MACBED team. The student will conduct experiments to obtain the magnetic characteristics of the materials and measure their resulting movement for specific magnetic fields using a magnetic targeting setup. Based on these experiments and the Ampère model, a dynamic 'magnetic targeting model' will be developed. This model will indicate the requirements for bringing particles to a specific position. Using dynamic optimization techniques from optimal control, the desired organization of different particle types will be translated into requirements for the applied magnetic field. A coil configuration will then be designed to meet these requirements for proper magnetic force generation inside the reactor bed. The quartz reactor to be built (1x4cm², 30cm high) and particles to be used define the domain size and particle loading of the reactor. Magnetic and cohesive 'cold flow' data (i.e. no heating in the reactor) will allow for experimental validation. Eventually, kinetics will be included and validated with 'hot flow' data. The project will also study, particle demixing/mixing and break-up using magnetic fields, as these can enhance the performance of the functional materials in the MAFB under reaction conditions, leading to higher CL efficiency.

If you are interested in pursuing a PhD in mechanical engineering in a multidisciplinary setting, please contact Prof. L. Dupré (Luc.Dupre@UGent.be) or dr.ir. A. Coene (Annelies.Coene@UGent.be) for more information.