SCIENCES & BIOENGINEERING SCIENCES

The Research Group
Chemical Engineering and Separation Sciences

has the honor to invite you to the public defence of the PhD thesis of

Maxim De Belder

to obtain the degree of Doctor of Bioengineering Sciences

Joint PhD with KU Leuven

Title of the PhD thesis:

Magnetic adsorbents for temperature swing adsorption processes with inductive heating

Supervisors:
Prof. dr. Joeri Denayer (VUB)
Prof. dr. Johan Martens (KU Leuven)
Dr. Eric Breynaert (KU Leuven)

The defence will take place on

Wednesday, April 23, 2025 at 4 p.m.
in ELEC.00.0024 **aula L**
Kasteelpark Arenberg 10
3001 Heverlee

Members of the jury

Prof. dr. Johan Buyse (KU Leuven, chair)
Prof. dr. Johan Martens (KU Leuven, secretary)
Dr. Mohsen Gholami (VUB)
Prof. dr. Maarten Roeffaers (KU Leuven)
Prof. dr. Margriet van Bael (KU Leuven)
Prof. dr. Christine Kirschhock (KULeuven)
Prof. dr. Hannes Jónsson (University of Iceland)

Curriculum vitae

- In 2016 begonnen aan de opleiding Chemie aan de KU Leuven
- In 2021 afgestudeerd als master in de Chemie aan de KU Leuven met grote onderscheiding
- In September 2021 begonnen aan PhD bij COK-KAT onder prof. Johan Martens en dr. Eric Breynaert.
- In januari 2022 werd het een joint PhD met de VUB onder prof. Joeri Denayer.
- (in April 2024 gestart als ingenieur bij Fluxys)

Volledig CV op Linkedin:
https://www.linkedin.com/in/mdbchem/

Abstract of the PhD research

Global warming caused by human CO2 emissions is one of the greatest challenges of our time. The industrial sector contributes 24% to these emissions, with heating processes—often powered by fossil fuels—being a major culprit. These processes consume one-third of industrial energy and are particularly CO2-intensive.

To reduce this impact, fossil fuels must be replaced with sustainable alternatives such as hydrogen and electrical technologies. Additionally, capturing the remaining CO2 emissions through technologies like Carbon Capture is crucial. This research focuses on these solutions, with a particular emphasis on inductive heating.

Inductive heating is an efficient and rapid way to heat materials locally and without contact. This is achieved by converting a magnetic field into heat using a susceptor material. To make this technology widely applicable, existing processes and materials must be adapted.

Ferrite nanoparticles have proven to be the ideal material for this purpose. Their properties can be precisely tailored to the application. This research extensively examines how ferrites can achieve maximum heat generation.

A promising application of inductive heating is in gas separation processes, such as in Carbon Capture. Conventional techniques often waste more than 41% of the usable heat. Inductive heating can make this process more efficient. A new technology, Inductive Heating Swing Adsorption (IHSA), uses hybrid materials that combine ferrites with adsorptive substances like zeolite.

Beyond Carbon Capture, ferrites offer potential in other fields such as catalysis, medical treatments (hyperthermia), and new production methods. Their versatility makes them an important building block for sustainable technologies.