Deutsches Zentrum
DLR für Luft- und Raumfahrt

Institut für CO_2-arme Industrieprozesse
Cottbus & Zittau
Institutsdirektor Prof. Dr. Uwe Riedel

Influence of Realistic Pellet Geometry on Fixed Bed Reduction of Iron Ore with Hydrogen

Master thesis/Internship at Zittau

Background

Hydrogen-based direct reduction of iron ore is a key technology for significantly reducing CO_2 emissions in future steel production. A detailed understanding of gas flow, heat transfer, and chemical reactions within fixed beds of iron ore pellets is essential for improving reactor design and process performance.

High-resolution CT scans can be used to capture realistic packed-bed geometries, but generating CT data for entire beds is time-consuming and costly, especially when multiple configurations or operating conditions are required. As a result, many numerical studies rely on simplified spherical particles, which may not adequately represent real pellet behavior.

A practical and scalable alternative is to use CT scans of representative individual pellets to capture realistic particle shapes once, and then generate fixed beds numerically using the Discrete Element Method (DEM). This approach enables the creation of realistic packed beds without repeated full-bed CT scans, while still moving beyond idealized spherical assumptions.

Work steps

1. Perform CFD simulations of H_2-based direct reduction in fixed beds.
2. Extend an in-house OpenFOAM solver by adding the energy equation.
3. Simulate beds generated by DEM using spherical and CT-based pellet shapes.
4. Compare conversion vs. time and thermal behavior between both beds.
5. Validate simulations against in-house reactor experiments.

Skills required

- Currently studying physics, chemistry, mechanical engineering, aerospace engineering or a comparable field
- Interest in theory, modeling and simulation of physical processes
- Knowledge of fluid dynamics and CFD. Experience in OpenFOAM is a big plus.
- Programming experience in C++, Python or other scientific programming languages is preferable

Start: 01.06.2026

Place: Zittau

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