System modeling and optimization of co-SOE/FT system for e-fuels production

Master Project (30 ECTS)/Semester Project (10 ECTS)

Administrative

Supervision: Dr. Du Wen, Prof. J. Van Herle
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Location: Sion or remotely (travel allowance offered)
Remarks: If interested, please send your CV, with a short motivation letter, to Du Wen.

Project description:

The transition toward sustainable energy systems has accelerated the development of highly efficient electrochemical technologies, including solid oxide electrolysis (SOE). Owing to its high operating temperature and multifunctional modes, SOE, particularly in co-electrolysis mode (co-SOE), offers an efficient, flexible pathway to convert renewable electricity, steam, and CO_2 into syngas. This syngas serves as a key intermediate for Fischer–Tropsch (FT) synthesis of e-fuels, positioning co-SOE as a promising technology for circular fuel production.

Among FT fuels, sustainable aviation fuel (SAF) has attracted exceptional attention because of the aviation sector's limited alternatives. In Europe, meeting ambitious SAF deployment targets set by the European Union, including the ReFuelEU Aviation initiative, will require major advances in cost-effective, large-scale SAF production.

SOE is particularly well suited for integrated co-electrolysis due to its superior efficiency, ability to utilize waste heat, and flexibility in tailoring the H_2/CO ratio for FT synthesis. Compared to alternative electrolysis technologies, SOE enables direct CO_2 conversion and avoids other challenges related to corrosion, system complexity, and gas separation. Nevertheless, large-scale integration of co-SOE with FT synthesis also faces critical challenges, including heat integration, cell degradation and coking (carbon deposits in the electrode), cost reduction, and understanding the impacts of direct reactor coupling and feedstock impurities.

This project will address these challenges from system level modeling and optimization and will be done in collaboration with GEM and IPESE.

Your tasks:

- Understanding co-electrolysis and Fischer–Tropsch processes.
- Modeling the co-electrolysis and Fischer–Tropsch system with consideration of different operating conditions, industrial constraints, and configurations for efficiency improvement.
- Optimizingthe system through multi-objective optimization.
- Conducting uncertainty and sensitivity analyses.

Skills:

- Backgournd of chemical engineering
- Familiar with Aspen Plus and process simulation
- Results interpretation and report writing