Master's thesis

Dynamic simulation of a Power-to-X plant

Contact: M.Sc. Andrés Lagos, andres.lagos@hifglobal.com

Background

The utilization of hydrogen and e-Fuels is crucial for reducing emissions in the transport sector, especially in areas where direct electrification is not possible. Ideally, renewable energy sources such as solar and wind power are used to minimize greenhouse gas emissions during production. However, this means that continuous stationary operation is not possible, and a highly dynamic mode of operation is required for the hydrogen and e-fuel production plants.

As the plant equipment is very capital-intensive, the system layout must be adapted to the local wind and solar radiation conditions. This dimensioning is done with the help of optimization algorithms that use the local wind and solar conditions over longer periods as input and determine the ideal system layout based on the technical boundary conditions. One problem here is that the optimizer has so-called "perfect foresight", whereas a real plant can only plan its operation based on weather forecasts for the next few hours or days.

In real operation, a control agent manages the ramping up and down of the plant components. This control agent can be rule-based (storage thresholds activate component's behaviors) or optimization-based (cost/revenue are minimized/maximized for the next few hours). A rule-based controller is probably not as good as an optimization-based one; but the implementation of the last one is a challenge in a real-world setting.

This master's thesis objective is twofold: first, the development of a heat and material balance model of an e-Fuel plant in Python or a similar programming language with the objective of assessing the efficiency of different control strategies for the e-Fuel plant's operation. Second, compare two different approaches for the plant's control: rule-based and optimization-based.

Our team

HIF Global is the world's leading e-Fuels company, developing projects in different parts of the world to fight climate change by producing fuels with renewable energy.

You as a master's student will work in HIF's Innovation Team in Berlin. The team is an interesting mix of chemical, electrical, and mathematical engineers with a background in chemical processes, process simulation, robust optimization and machine learning models.

We support HIF's projects worldwide and provide feedback on new technologies, project ideas, and business case studies that can be interesting to the company in different regions (LATAM,

US, EMEA, APAC). We bring out-of-the-box ideas into the box, providing them with solid evidence and technical background so that we can bring them forward.

Task description

The master thesis comprises the following work packages:

- Literature review on control strategies and simulation software for dynamic operation of chemical plants.
- Development of simulation environment.
- Development and tunning of control strategy.
- Documentation and evaluation of the results.

Some of these tasks (simulation environment and control strategy) already have a preliminary design developed by our team, you'll be free to either continue with those models and improve on them or start from scratch.

Requirements

- Degree in chemical engineering, process engineering, or comparable.
- Programming skills (Python intermediate or comparable).
- Fluency in English.
- Experience in dynamic simulation desirable (but not required).
- Knowledge of mathematical optimization or Machine Learning is desirable (but not required).

Modalities

- Workplace in HIF's office (Lennéstr. 3, Berlin)
- Student reimbursement from HIF
- Start date: February - April 2025

For an application, please send your CV and current grade list to andres.lagos@hifglobal.com