CHALMERS

MASTER THESIS PROJECT/RESEARCH INTERNSHIP – SPRING 2020

CO_2 CAPTURE POWERED BY INDUSTRIAL HEAT – SEASONAL EFFECTS ON CAPTURE PROCESS DESIGN AND HEAT INTEGRATION OPTIONS

Carbon capture and storage (CCS) plays an important role in achieving the long-term CO_2 emission targets, see for example the IPCC's report on the 1.5 C target (IPCC SR15, 2018). The EU as well as Swedish national agencies stress the importance of CCS for emission intensive industries. The value of a broad implementation of CCS is however still far from a level acceptable to the market and to ease the introduction of the technology the concept of partial capture has been discussed. Partial capture aims at capturing at a level that is cost-effective rather than making the emission source CO_2 neutral. For industries such as waste incineration, iron&steel, and pulp&paper combined heat and power (CHP) plants are commonly applied to valorise from the excess energy at the plant by producing electricity and heat to the power grid and municipal district heating. Other sectors, like petroleum refining in Sweden, do not generate power on site but partly deliver heat to the local district heating network. Since the main value is in the main industrial product, high utilization of the main process is required throughout the year, even though electricity and district heating demand varies significantly between hours of the day and season. Carbon capture is a heat demanding process that could constitute a new way to valorise heat. However, from an investment cost perspective, a merely seasonal operation of CCS is more costly than a continuous operation throughout the year. Possibilities to lower cost are the heat integration between the capture process and the steam cycle/district heating system, and the design of the partial capture process that balances the CO_2 capture rate with cost and available heat. The proposed project will focus on the design of a process for seasonal partial capture and on how heat can be made available cost-efficiently to compensate for the high investment costs.

AIM

The overall aim is to evaluate how an absorption-based CO_2 capture process should be designed cost-effectively when powered by a heat source with varying seasonal availability. More specifically the project will investigate how to integrate CCS and district heating from industrial plants, for example by utilizing heat from the CO_2 condenser or the intercooling in the CO_2 compression. Options such as back-pressure steam and heat pumps come at the expense of electricity but could be considered as well. The work will include process modelling and design as well as dimensioning of process units in process simulation software, e.g., Aspen Plus or Ebsilon Professional. Cases based on real plants will be examined. A final economic assessment of the studied designs for seasonal partial capture, in collaboration with an industry partner, is desirable as a performance indicator.

PRELIMINARY STRUCTURE OF WORK

Below is a tentative structure of the work, which of course may change after initial discussions. Also, results of the initial work may change focus of the work. The aim is to make a new contribution and to limit the work to be within the scope of a MSc Thesis/research internship while maintaining a high quality.

- Establishing a time plan of the work
- Initial literature review of amine-based CO_2 capture and integration options of with CHPs
- Establishing a modeling framework (Aspen Plus and/or Ebsilon Professional) and a process model of one or several cases

- Evaluation of designs and heat integration options towards cost-efficiency (economic assessment)
- Reporting

ORGANISATION

The proposed project may be performed by one or two students with a chemical or mechanical engineering (or similar) background at the Division of Energy Technology at Chalmers. The research group has a long history in working with carbon capture processes and process simulations. The following persons will be supporting the work at Chalmers:

Supervisor: Max Biermann, max.biermann@chalmers.se
Examiner: Fredrik Normann, normann@chalmers.se

Timeframe: 5 months for M.Sc.; 4-6 months for research internship

Start: January 2020

Requirements: Background (B.Sc.) in chemical or mechanical engineering (or similar), knowledge of Aspen/Ebsilon is welcomed.

For more information about the Divisions of Energy Technology check out our website:

http://www.chalmers.se/en/departments/see/research/energy_technology/Pages/default.aspx