Economic and environmental consequences of industrial CO2 mitigation projects considering future energy market conditions

Brief background

Heat integration is one of several options for improving the energy efficiency of industrial plants in energy-intensive sectors such as the chemical and oil refining industries as well as the pulp and paper and steel industries. Heat integration implies that excess heat from one part of a process is recovered and re-used elsewhere to replace external heating, thereby improving the energy efficiency. The assessment of heat integration retrofit proposals requires adopting a wider perspective than including only the energy savings. Practical considerations, operability issues, non-energy benefits, costs and climate consequences need to be accounted for. Previous studies have investigated operability and practical aspects of selected heat exchanger network retrofits at the Preem oil refinery in Lysekil. One major cost and environmental benefit of the energy savings that needs to be further investigated is the reduction in CO_2 emissions.

In an ongoing carbon capture and storage (CCS) project, Chalmers and Preem are investigating how heat integration could reduce the operating costs of CCS by utilizing excess process heat to regenerate the chemical solvent that captures the CO2 from process gases. The design of a heat exchanger network for either low-pressure steam extraction or hot water collection in combination with a heat pump are promising options. These options need to be compared with using utility steam with respect to costs and CO2 emission savings.

To fully evaluate potential benefits of CO_2 emission savings in both cases, it is necessary to consider future scenarios for energy market prices and policy instruments. This can be done using the ENPAC tool, which provides fuel prices, CO_2 prices as well as prices and emissions associated with marginal electricity production under different future energy market scenarios.

Aim

This project aims to investigate the potential future value of CO_2 emission savings resulting from heat exchanger network retrofits and CO_2 capture and compare avoided emissions and cost benefits under future energy market scenarios. The work includes the following steps:

- Selection of suitable heat exchanger network retrofit proposals to for further in-depth evaluation
- Evaluation of the costs and changes in on-site and off-site CO_2 emissions and for the selected retrofit proposals for current and future energy markets generated using the ENPAC tool
- Evaluation the changes in on-site and off-site CO_2 emissions and fuel costs for at least one CO_2 capture case for current and future energy market scenarios

Additional information

The master thesis project will be conducted within the framework of an ongoing PhD research project. The project will preferably be carried out by two students. The work corresponds to 30 ECTS credits (approximately 20 weeks).

Prerequisites

The students are expected to have a background in chemical engineering or mechanical engineering, preferably from master programs Sustainable Energy Systems or Innovative and Sustainable Chemical Engineering. The course Industrial Energy Systems or equivalent is required.

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