Evaluation of integration schemes in post-combustion capture in Natural Gas Combined Cycle power plants

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Introduction

Natural gas combined cycles with CO_2 capture is predicted to be an important part of the solution in the future low-emission energy scenario. Post-combustion absorption of CO_2 using chemical solvents is likely to be the near term solution for CO_2 capture from a natural gas fired power plants. While research focus has been on developing advanced solvents and process design of the capture unit to reduce the efficiency penalty (~8-10 % points) associated with CO_2 capture and compression, integration of CO_2 capture unit and the power plant has been receiving increased attention over the past few years. An overview of the literature related to the integration of post-combustion capture plant with the power plant shows that while there has been a recent effort to develop systematic methods to integrate the different process units, engineering judgment and trial & error methods are being used for integration between the power plant, CO_2 capture and compression units.

Methodology overview

A systematic methodology for the integration of post-combustion capture plants with NGCC is important to ensuring better overall plant efficiency. All process units can be either a heat/work source or sink and is thus important when developing such a methodology to incorporate process streams from each process unit to achieve the best possible integration. A visualization of the interaction between the different process units of the NGCC power plant with CO_2 capture is shown in Figure 1.

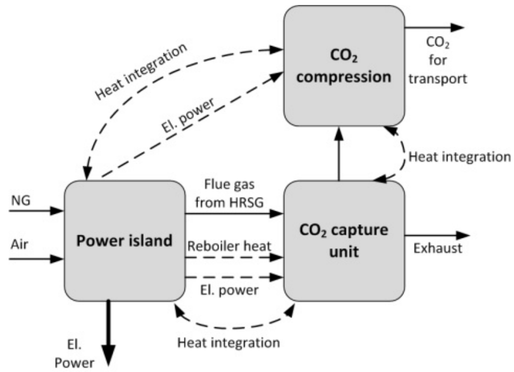

Figure 1: Interaction between different process units in an NGCC with post-combustion CO_2 capture

With this in mind, a systematic methodology for energy integration is presented in this work that uses process simulation and optimization models. The optimization scheme is based on the Sequential Framework for heat exchanger network synthesis. The framework is an iterative and sequential consisting of three math programming models where the solution to each step is used as an input to the subsequent step. The energy targeting is done in the first step of the framework and is modelled as a mixed integer linear programming (MILP) transhipment model to include all possible integration options between the process units. The integration options to be considered are specified by the user. Specific product and component considerations, such as steam turbine considerations, are also included as constraints in the model.

Results and discussion

The methodology is applied to greenfield and retrofit case studies to evaluate different integration options for each of these cases. Application of this work results in novel integration schemes with reduced overall energy penalties for the plant.

The methodology presented in this work can be used to evaluate different solvents on a consistent basis given reboiler requirements for each case. Further, it can be used to integrate other capture methods by including appropriate constraints in the model. However these are not included as part of this work.