STAGED IMPLEMENTATION OF ALTERNATIVE PROCESSES IN AN EXISTING INTEGRATED STEEL MILL FOR IMPROVED PERFORMANCE AND REDUCED CO₂ EMISSIONS

Name(s) of author(s): Kristin Onarheim, Antti Arasto
Affiliation: VTT Technical Research Centre of Finland
Corresponding author's e-mail address: kristin.onarheim@vtt.fi

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ABSTRACT

As climate change requires more and more urgent actions to reduce the concentration of CO₂ in the atmosphere, cost competitive options to enable actions also in carbon intensive industries are necessary in order to avoid carbon leakage and to enable shifting to a low carbon society. Concepts enabling staged investment and deployment of CCS lower the threshold for implementing low carbon technologies in heavy industries. In this paper a concept of staged implementation of an alternative processes in an existing steel mill for improved performance and reduced CO₂ emissions has been evaluated. The process concept involves replacing the existing power production unit with a gas turbine combined cycle and CO₂ removal from process gases. The paper describes the techno-economic evaluation of this process concept. The results of deployment and optimization of the process to the integrated mill are decreased coke consumption, increased power to heat ratio and reduced CO₂ emissions.

The CCS concept evaluated in this paper is based on the Blast Furnace Plus process concept developed by Air Products and Danielli Corus. The heating value of conventional blast furnace top gas is too low to be applied in a gas turbine. In the Blast Furnace Plus concept the blast furnace has been modified in order to enhance the calorific value of the blast furnace top gas. Replacing expensive coke with less expensive pulverized coal and increased oxygen content of the blast increase the heating value of the blast furnace top gas. The increased heating value of the blast furnace top gas enables the application of a high-efficiency combined power cycle. It has been shown that replacing the conventional gas boiler and steam cycle-based power plant with a low-BTU gas turbine can improve the process performance and reduce the specific CO₂ emissions associated with iron production through allocating the emission on both hot metal production and power production. Adding a water-gas shift reactor for increased CO₂ and H₂ content prior to the gas turbine combined cycle further increases the top gas fuel value and facilitates the CO₂ capture downstream. CO₂ separation technologies chosen for this evaluation are MEA-based chemical absorption and Selexol-based physical absorption.
By optimizing the integrated steel production plant it has been shown that a significant additional electric output can be achieved in addition to reduced CO$_2$ emissions. The staged deployment of the concept (see Figure 1) minimizes the investment risk and burden of implementation by spreading the investment and the actual implementation over a longer period of time. The feasibility of this solution is estimated based on calculation of plant balance and the costs of CO$_2$ mitigation from the operator perspective are estimated. Results show a cost competitive option for reducing CO$_2$ emissions of an integrated iron and steel mill.

**Figure 1** Description of staged application of blast furnace gas fired gas turbine with CCS