World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:12, No:05, 2018

Evaluation of the Integration of a Direct Reduction Process into an Existing Steel Mill

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Abstract : In the context of climate change, the reduction of greenhouse gas emissions in all economic sectors is considered to be an important factor in order to meet the demands of a sustainable energy system. The steel industry as one of the large industrial CO_2 emitters is currently highly dependent on fossil resources. In order to reduce coke consumption and thereby CO_2 emissions while still being able to further utilize existing blast furnaces, the possibility of including a direct reduction process (DRP) into a fully integrated steel mill was investigated. Therefore, a blast furnace model, derived from literature data and implemented in Aspen Plus, was used to analyze the impact of DRI in the blast furnace process. Furthermore, a state-of-the-art DRP was modeled to investigate the possibility of substituting the reducing agent natural gas with hydrogen. A sensitivity analysis was carried out in order to find the boundary percentage of hydrogen as a reducing agent without penalty to the DRI quality. Lastly, the two modeled process steps were combined to form a route of producing pig iron. By varying boundary conditions of the DRP while recording the CO_2 emissions of the two process steps, the overall potential for the reduction of CO_2 emissions was estimated. Within the simulated range, a maximum reduction of CO_2 emissions of 23.5% relative to typical emissions of a blast furnace could be determined.

Keywords : blast furnace, CO_2 mitigation, DRI, hydrogen
Conference Title : ICCD 2018 : International Conference on Carbon Dioxide
Conference Location : Amsterdam, Netherlands
Conference Dates : May 10-11, 2018