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CO_2 Emission Reduction Potential in the Steel Industry by Integration of a Direct Reduction Process into Existing Steel Mills

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Abstract

To meet the environmental goals of the Paris agreement, namely the reduction of fossil fuel dependence, alternatives to the use of coke in steel production have to be found. An alternative route to the common blast furnace (BF)/converter route is the direct reduction plant (DRP)/electric arc furnace (EAF) route. The DRP/EAF route enables the use of natural gas (NG) or even hydrogen as reducing agent instead of coke and coal. A direct switch between the named routes would be an enormous technical and economic effort for the steel industry. Therefore, a stepwise transition towards a more sustainable steel production process should be taken into account. One attractive opportunity is the use of direct reduced iron (DRI) from the DRP to partly substitute the iron ores loaded into a BF and consequently substitute the reducing agents coke and coal partly by NG or hydrogen.
Related to the use of DRI in BFs various studies have been conducted [1]. The results show, that the use of pre-reduced burden materials like DRI has a positive influence on fuel consumption. The possibility of using hydrogen as a reducing agent to produce DRI has only rarely been examined [2]. For the evaluation of the influence of hydrogen on CO_2 emissions and specific energy consumption as well as on DRI quality, process modeling is a viable approach. So far, literature offers no suitable process model for a DRP. Therefore, process models of a DRP and a BF have been developed. They allow for the evaluation of the use of NG and hydrogen in a DRP as well as for the derivation of reliable information about fuel consumption, CO_2 emissions and primary energy input of the DRP/BF route. Within the simulated range a CO_2 mitigation potential of 23.5% relative to the standard hot metal production via BF was found. Considerably higher emission reduction is possible for the DRP/EAF route.

Literature

[1] A. Chatterjee, Sponge Iron Production by Direct Reduction of Iron Oxide, PHI Learning Private Limited, New Delhi, 2014.

[2] M. Hölling, M. Weng, S. Gellert, Bewertung der Herstellung von Eisenschwamm unter Verwendung von Wasserstoff (Evaluation of Hydrogen-Based Production of DRI), Stahl und Eisen 137 (2017) 47–56.