New concepts for improved gas utilization in integrated steel making


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Abstract

Integrated steelmaking generates energy rich by-product gases from coke ovens, blast furnace and oxygen converter amounting to 7-8 GJ/t steel. A large portion of this energy is used today instead of externally supplied energy or reducing agents. The usability and fields of application of the process gases are limited in terms of availability and heating value. The main purpose of this study was to develop opportunities to expand the uses of internal process gases. The concepts studied were reforming of gases using an electrically heated shaft and CO₂-capture through membrane technologies. The concepts have been evaluated technically as well as from a systems perspective for integrated steel making. The project shows the following main conclusions;

- By utilization of an electrically heated shaft, it is possible to reform 100 % of the ingoing CO₂ in blast furnace gas to CO. The heating value of the gas is then increased from around 3 to roughly 6 MJ/Nm³
- Separation of CO₂ with a zeolite membrane achieved good results in testing with synthetic blast furnace gas. High CO₂/H₂-selectivity was achieved with dry as well as moist gas. Calculations show that it is possible to increase the heating value of the gas from 2.8 to 3.7 MJ/Nm³ and from 6.6 to 10.1 MJ/Nm³ for conventional blast furnace gas and gas from oxygen blown blast furnace, respectively. The required electricity consumption is around 84 kWh/ton CO₂, which is significantly less compared to separation through VPSA or amine technology.
- For the first time ever tests of zeolite membrane with real blast furnace gas were executed. The tests however were unsuccessful with probable causes of too high moisture content in the gas due to insufficient (inappropriate) design of test equipment.
• Through evaluation by system analysis of the investigated concepts and the resulting increased utilization options of the process gas, it is possible to estimate the theoretical potential for increased energy efficiency to 147 GWh/year, with a consequent annual CO$_2$-abatement of 123 kton.