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Blast Furnace Ironmaking – A View on Future Developments

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Abstract

Within many industries there is a constant drive to reduce environmental impact and energy costs thereby ensuring maximum energy re-use. Within the iron and steel industry the ironmaking processes are acknowledged to be the focus area when the topic of energy saving arises.

A lot of attention has been applied to the ironmaking processes with regards to environment and energy saving, with established technologies being in place to reach these goals such that the process per se, is now at or very close to theoretical limits.

The following areas of the blast furnace process are currently the focus of Primetals activity with regards the target to further improve energy saving with incremental improvements:

- Flue gas recycling within blast furnace stoves
- MERIM dry gas cleaning process
- Dry slag granulation including heat recovery

This paper will present the concepts and latest status of the above technologies. The paper will review the progress to date of these development activities and thus present ideas on options for energy saving and re-use within the ironmaking system.

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Keywords: Ironmaking; Environment; Energy Saving; Energy Recovery

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1. Introduction

Within industry, there is a constant drive to reduce energy costs, reduce emissions and ensure maximum waste energy re-use. In the current economic climate of the world, optimum operation of any blast furnace installation requires the most efficient use in all applicable areas. To this end, Primetals maintains a high level of interest and support to any development opportunities that may provide assistance to our customers to reduce operating costs.

Within this paper, three technology improvements that can be added to the blast furnace process are reviewed. These improvements are at various stages of development up to and including full commercialisation. All of the technologies are supported within the Primetals organisation since they are seen as future opportunities for maintaining the strength of the company as part of a desire to be a full liner provider to the complete iron and steelmaking process.

Climate policy is an important driver for technology development within the sector however the EC's memo 'Ensuring a future for Steel in Europe' acknowledges that 'plants using best technologies are already operating close to their thermodynamic limits' [1]. This is particularly true of the ironmaking blast furnace which the World Steel Association confirms as the predominant energy consuming process in the production of steel. These facts mean that the application of enhancements of current Best Available Technologies to individual unit operations within the process chain can only modestly reduce the carbon intensity of integrated steelmaking. Significant reductions will require the development of 'breakthrough' technologies facilitating carbon capture utilisation or sequestration (CCUS) of the process emissions. The ULCOS project aims to demonstrate radical new ironmaking processes, that render CCUS economically and practically viable by generating a CO_2 rich effluent stream, but they all involve radical changes to, or abandonment of, the highly efficient blast furnace process [2]. They are also high technical-risk options and even if shown to be competitive with the blast furnace they would require potentially prohibitive levels of capital investment. Alternative solutions, compatible with existing plant infrastructures and proven operating practices, should accelerate adoption of CCUS and help the industry meet its climate change obligations.

To put into context the statements above we can note that published data [3,4] shows that the steel industry is responsible for 8% of the World's anthropogenic CO_2 emissions, with a modern integrated steel plant producing about 1.8 tons of CO_2 per ton of steel [5]. The emissions are mostly associated with ironmaking, which requires carbon as a fuel and reducing agent to convert iron oxide to the metallic state. This observation belies the fact that blast furnace ironmaking is a highly developed process operating close to thermodynamic limits of efficiency as previously noted. There are no obvious enhancements that will fundamentally reduce its carbon demand or significantly improve its thermal efficiency, but, since the blast furnace is the predominant emission generator, efforts to mitigate the environmental impact of the industry have, of necessity, focused on developing revolutionary new ironmaking processes [2]. The alternative approach to these revolutionary types of changes is to propose incremental improvements that offer steps to reduce emissions or to generate more from the potential that exists within the current process.

2. Flue Gas Recycling within Blast Furnace Stoves

Primetals with Linde are developing a novel technology for the stoves plant titled Flue Gas Recycling (FGR). This will involve conversion of the stoves, from air-fuel to oxy-fuel combustion increasing the CO_2 content of the flue gas. The flame temperature generated will be moderated by waste gas recirculation to the stove burners.

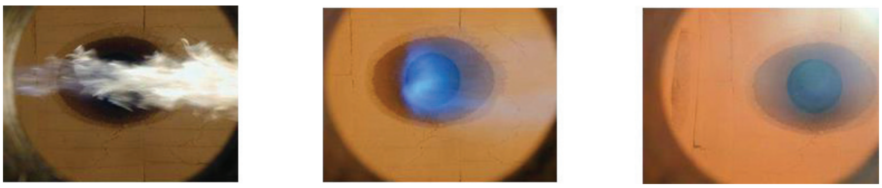

Fig. 1. Development of a near transparent flame during the transition from conventional oxy-fuel combustion to 'flameless' combustion.