Dephosphorization When Using Direct Reduced Iron (DRI) or Hot Briquetted Iron

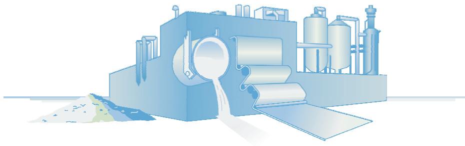
Real-time, online process model optimizes phosphorus removal

The increase in high quality steel production in electric arc furnaces (EAFs) requires the use of scrap substitute materials, such as Direct Reduced Iron (DRI) and Hot Briquetted Iron (HBI). Although DRI and HBI products have lower copper and nickel contents than most scrap materials, they can contain up to ten times more phosphorus. This project, led by Carnegie Mellon University's Center for Iron and Steelmaking Research, improves the understanding of how phosphorus behaves when DRI and HBI melt. The research has also allowed researchers to develop a real-time, online process model to optimize phosphorus removal.

Analysis of phosphorus removal during melting

In laboratory tests, researchers characterized phosphorus levels in DRI and HBI samples, conducted fast melting experiments to determine whether the phosphorus would transfer to the slag or metal, and performed fundamental laboratory experiments on the kinetics of the reactions. Afterward, a series of trials were conducted at Pennsylvania Steel Technologies to determine the mass transfer parameters occurring between slag and metal in EAFs. Other trials were conducted by North Star Steel to study the impact of different types of DRI and HBI materials on the furnace yield, slag chemistry, and metal phosphorus behavior. Finally, researchers used the data from the laboratory experiments and plant trials to create a real-time, online process model optimizing phosphorus removal.

Overall, this technology provides energy savings by broadening the range of products for EAFs. Direct benefits of this research include increased iron yields due to minimized slag flushing, reduced greenhouse remissions because natural gas is used to produce DRI and HBI, and reduced costs owing to the greater availability of DRI and HBI.



Benefits for Our Industries and Our Nation

- Increases iron yields
- Lowers costs
- Reduces greenhouse emissions
- Reduces phosphorous reversion from the slag to the steel
- Expands availability of materials suitable for use as EAF feed

Project Participants:

Carnegie Mellon University, Center for Iron and Steelmaking Research (Lead Organization)

North Star Bluescope Steel, LLC

American Iron and Steel Institute

Cleveland-Cliffs, Inc.

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Project Plans and Progress

This project was completed in November, 2001 and had four basic components:

- Investigation of Commercial DRI/HBI. Researchers investigated the physical and chemical attributes of different commercial DRI/HBI materials in order to understand the behavior of phosphorus in these materials upon melting.
- Laboratory Phosphorus Kinetics Study. Phosphorus transfer between metal and slag was studied in the laboratory.
- EAF Plant Trials. A series of electric furnace trials were conducted at Pennsylvania Steel Technologies in order to determine the mass transfer parameter for that furnace. Additional trials were conducted by North Star Steel to examine the effects of different types of DRI/HBI materials upon the furnace yield, slag chemistry, and metal phosphorus behavior.
- Process Model for Phosphorus Control in the EAF. A series of trials were conducted at Pennsylvania Steel Technologies to determine mass transfer parameters for electric furnaces. Additional trials were conducted by North Star Steel to examine the effects of different types of DRI/HBI materials upon furnace yield, slag chemistry, and metal phosphorus behavior. A process model based upon the plant trials and laboratory experiments was developed and tested using the plant data from the trials at North Star and data from trials conducted at BHP Steel Sydney.

Project Partners

The Steel Industry of the Future (IOF) subprogram is based in the Industrial Technologies Program (ITP) within the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy. The subprogram works with the steel industry to promote development of more energy-efficient and environmentally sound technology for steel processing. Guided by industry-identified research and development priorities, ITP's steel portfolio addresses those priorities that offer the greatest potential for energy savings in cokeless ironmaking, next-generation steelmaking, and yield improvement. To learn more about Steel IOF activities, visit the program web site at:

www.eere.energy.gov/industry/steel/

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