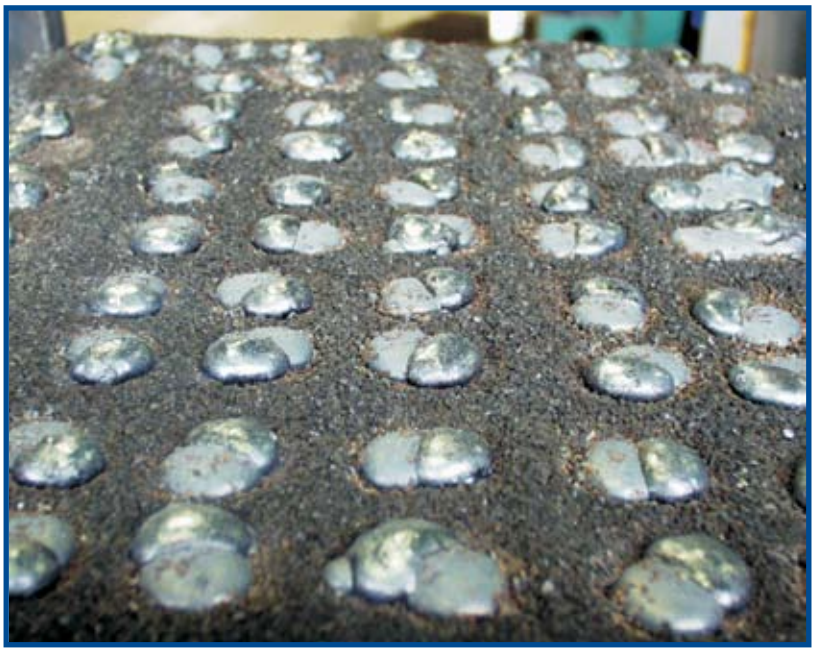
Next Generation Metallic Iron Nodule Technology in Electric Furnace Steelmaking

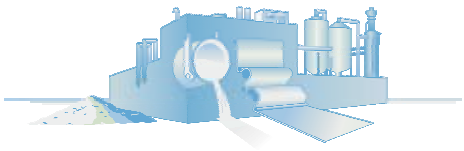
Lowering Production Costs of High-quality Iron Nodules Will Enable More Efficient Steelmaking

A current trend in the steel industry is a gradual decline in blast furnace/coke oven steel production and an increase in electric furnace steel production. To ease this transition, this project will explore an alternative ironmaking technology that can process available raw materials into a value-added iron product and is compatible with existing transportation infrastructure.

This project investigates ways to lower the production costs of high-quality metallized iron nodules as feedstock for both basic oxygen furnaces and electric arc furnaces. Furnace atmospheric control methods are being explored to counteract the oxidizing effect of carbon dioxide and the high turbulence of combustion gas. In addition, researchers are investigating how to overcome the operational difficulties of using sub-bituminous coal as the reductant in the production process. Medium-volatile bituminous coal is currently the most desirable and commonly used reductant in this process, but sub-bituminous coal is a more economically attractive alternative.



High quality iron nodules produced from North American iron ore concentrate using the experimental linear hearth pilot furnace (>97% Fe in nodules). Nodules and exuded slag are shown.



Benefits for Our Industry and Our Nation

Metallic iron nodule technology produces a high quality scrap substitute, reduces production costs, increases steel quality produced by electric arc furnaces, and enables more effective use of sub-bituminous coal.

Applications in Our Nation's Industry

Successful development of this new ironmaking process will produce potentially lower cost steel scrap substitutes. Also, greater availability of high-quality iron nodules will increase the quality of steel and the competitiveness of mini-mills and other steel producers.

Project Description

The objective of this project is to investigate reducing processing temperature, controlling the gas temperature and gas atmosphere over metallized iron nodules, and effectively using sub-bituminous coal as a reductant for producing high quality metallized iron nodules at low cost.

Barriers

Major barriers to be overcome include:

- Simulation of the Linear Hearth Furnace operating conditions.
- Lack of specific knowledge about furnace atmosphere parameters such as size constraints, proximate analyses of the coal/char, and time at temperature.
- Chemical make up of iron nuggets

Pathways

The objectives of this project will be achieved through (1) modifying the linear hearth furnace, (2) a series of reduction and smelting tests to verify the utility of the processing conditions, and (3) quantifying overall economics predictions for full scale implementation.

Progress and Milestones

This project involves modifying linear hearth furnace conditions and conducting a series of reduction and smelting tests to verify the efficacy of processing conditions required for high-quality iron nugget production.

Phase I

- Investigate burner and oxygen supply options (Complete)
- Explore chemistry of iron nuggets (Complete)
- Characterize char and carbonization of the coal (Complete)
- Perform tests in box furnace (Complete)

Phase II

- Reduce turbulence with current air fuel burners in pilot-scale linear hearth furnace (LHF)
- Optimize new furnace configuration and establish parameters for routine production of high quality iron
- Evaluate sub-bituminous coal as a fuel and reductant.
- Develop energy and mass balances of the process and establish process economics

Commercialization

The testing phase involves quantifying overall energy use characteristics, types of material that can be processed, fuels needed for successful operation, and the overall economics predicted for full-scale implementation. Upon successful demonstration, the project team will begin plans to transition the technology for industrial use. Iron nodule technology could potentially use up to 30% less energy than rotary hearth furnace technology.

Project Partners

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