

Paired Straight Hearth Furnace

A Coal Based DRI and Molten Metal Process for Long Range Replacement of Blast Furnaces and Coke Ovens

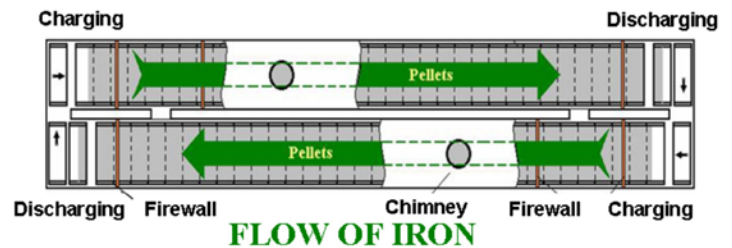
The U. S. steel industry has reduced its energy intensity per ton of steel shipped by 33% since 1990. However, further significant gains in energy efficiency will require the development of new, transformational iron and steelmaking processes. The Paired Straight Hearth Furnace (PSH) process is an emerging alternative high productivity, direct reduced iron (DRI) technology that may achieve very low fuel rates and has the potential to replace blast furnace ironmaking. The PSH furnace can operate independently or may be coupled with other melting technologies to produce liquid hot metal that is both similar to blast furnace iron and suitable as a feedstock for basic oxygen steelmaking furnaces.

The PSH process uses non-metallurgical coal as a reductant to convert iron oxides such as iron ore and steelmaking by-product oxides to DRI pellets. In this process, a multi-layer, nominally 120mm tall bed of composite “green balls” made from oxide, coal and binder is built up and contained within a moving refractory hearth. The pellet bed absorbs radiant heat energy during exposure to the high temperature interior refractory surfaces of the PSH while generating a strongly reducing gas atmosphere in the bed that yields a highly metalized DRI product.

The PSH concept has been well tested in static hearth experiments. A moving bed design is being developed. The process developers believe that if successful, the PSH process has the potential to replace blast furnaces and coke ovens at a fraction of the operating and capital cost while using about 30% less energy relative to current blast furnace technology. DRI output could also feed electric arc furnaces (EAFs) by displacing a portion of the scrap charge.

Benefits for Our Industry and Our Nation

The PSH furnace will allow steelmakers to produce iron with approximately 30% less energy per ton compared to the traditional blast furnace route. An important benefit of the new technology is that it can use high-volatile coals to produce direct-reduced iron pellets from virgin iron ores and from steelmaking waste products. This is a very important strategic raw materials issue for domestic integrated steelmakers as a result of the scarcity of high quality, low volatile matter metallurgical coals.



The PSH will use two linear tunnel hearth furnaces that share a common translating pallet train and which are aligned in parallel and run in opposite directions. Pellets are loaded and unloaded at opposite ends of each furnace and the pallet train moves in a circuit that passes from one furnace to the other in a continuous moving bed process.

Image courtesy of McMaster University.

Applications in Our Nation's Industry

This process can provide liquid hot metal on-site to BOF steelmaking operations that require a source of low residual alternative iron and could eventually replace the blast furnace.

Project Description

The goals of the project are to design, develop, and evaluate the scalability and commercial feasibility of the PSH Paired Straight Hearth Furnace alternative ironmaking process.

Barriers

- Technology integration issues related to materials handling, furnace and waste treatment control systems
- Pellet quality, multilayer bed stability, DRI quality, material throughput, and process economics
- Long-term furnace performance, reliability and stability

Pathways

Researchers initially conducted a study to develop design criteria for a scalable raw materials preparation, blending and conveyance process to feed coal/oxide pellets to the PSH. Acceptable “green ball” quality, strength and handling characteristics were established and assessed for both taconite and waste oxide bearing composite pellets to support the pilot plant demonstration effort.

The team will solicit, select and undertake collaborative DRI technology and process development activities with commercial furnace designers and experts. Existing fundamental data on the kinetics and mechanisms of DRI synthesis, as well as experimental research results from the McMaster University deep pellet bed studies, will support the development of the PSH design concepts produced by the equipment builders.

As needed, the team will undertake additional targeted bench scale testing to develop critical information and data that may be required by the design firm to establish a commercially robust PSH pilot plant and process. Issues identified in earlier studies including continuous pellet feeding and discharging, location of flue gas stacks, burner configuration, furnace sealing, pallet train design, air emissions, and water treatment will be investigated to provide a comprehensive battery limit estimate for the pilot-scale PSH facility.

The finalized PSH engineering design and estimate will serve as the platform to initiate construction of the PSH pilot plant.

Milestones

- Development of pelletizing and pellet handling system and process.
- Solicitation and selection of engineering design proposals from highly qualified equipment vendors.
- Technical exchange and collaborative efforts leading to comprehensive PSH design concepts.
- As required, execute verification studies and targeted bench scale testing to develop detailed engineering design specifications for the complete pilot plant.
- Development of full battery limit and engineering estimates for the best candidate PSH pilot plant design.

Commercialization

AISI, acting on behalf of its member companies, will be responsible for preparing and organizing the commercialization plan. AISI will market the resulting intellectual property to potential licensee(s) who will then be responsible to deliver the PSH technology to the market.

The most likely point of initial entry into the mainstream market is integrated steel making facilities that might be looking for an alternative source of hot metal. Such plants could include producers of coil, slab, long or specialty steel products.

Project Partners

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