Paired Straight Hearth Furnace-Transformational Ironmaking Process

DE-FG36-08GO18133

American Iron and Steel Institute/McMaster University

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The New Steel

American Iron and Steel Institute

Project Objective

- To develop the next generation of ironmaking process for sustainable steel industry, based on the Paired Straight Hearth Furnace (PSH) for iron ore reduction
  - PSH is a coal and natural gas coke-free process most suitable for American fine concentrates
  - PSH is a fundamentally innovative approach - the concerned thermal-chemical phenomena have been confirmed on campus and in industrial scale labs
- Objectives of current phase
  - Define the best approach for discharging the PSH furnace
  - Define the environmental emissions rates associated with the PSH
  - Perform preliminary engineering of a demonstration facility including costing

The Challenge

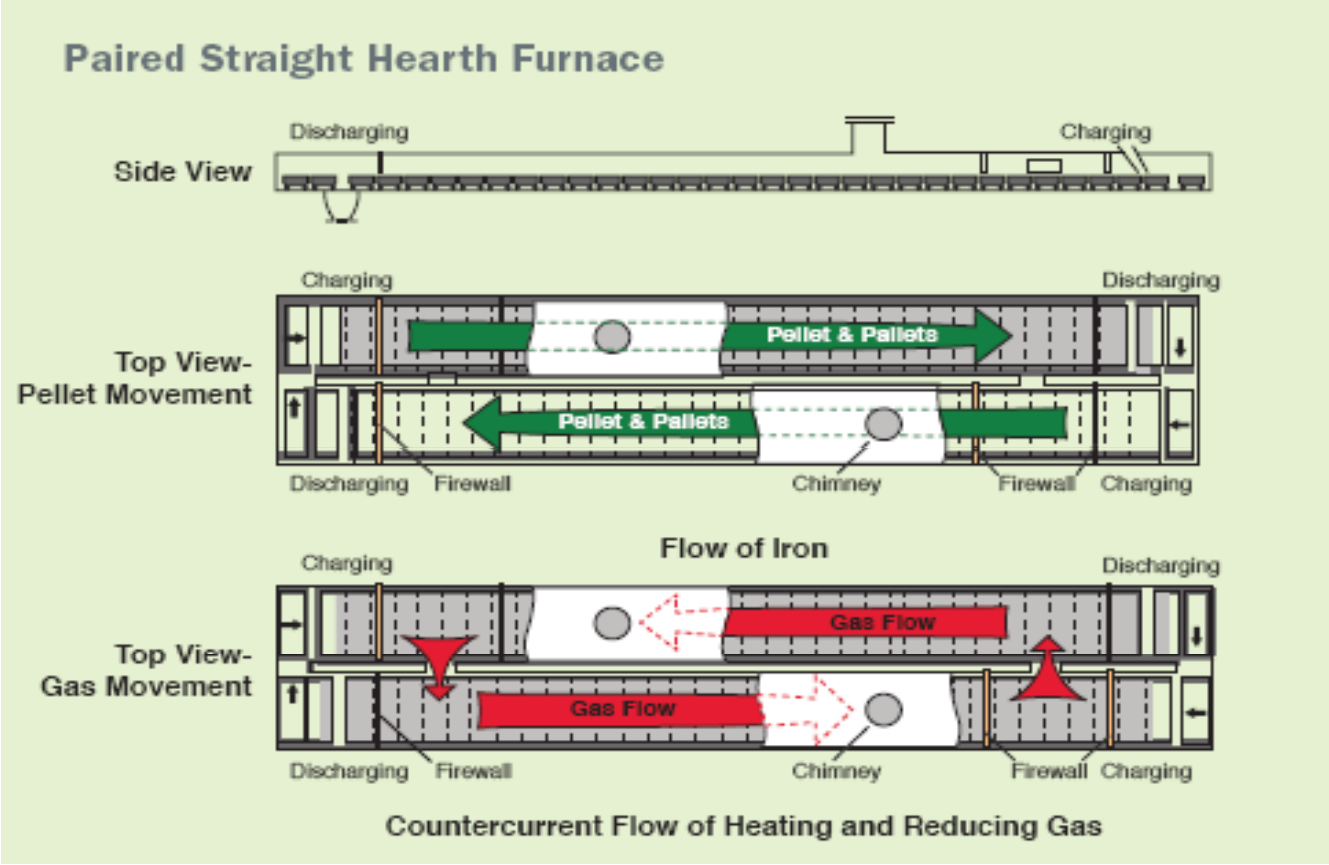
- Blast Furnace practice is threatened by lack of coke/coke plant capacity, CO_2 emissions and high cost of modernization
- Natural Gas reserves in USA have made direct-reduced iron [DRI] viable. This is high-productivity DRI
- A new efficient process needs to address the following limitations of Blast furnace
  - The carbon is not fully utilized as reductant or fuel
  - Raw material preparation required for BF operation consumes energy and also has environmental impacts

Proposed PSH Furnace

- The innovative approach of PSH Furnace is in the change of using carbon as reducing agent first and fuel second as compared to that of Blast Furnace which is in reverse
- The benefits include
  - Elimination of agglomeration and coking processes thereby avoiding environmental problems and costs
  - Energy consumption and CO_2 emission would be about 2/3 of good Blast Furnace practice
  - The carbon leaving the system is 100% CO_2
- The PSH Process does not have a new technology barrier; it is a new combination of conventional reactors to be operated under new conditions

Technical Approach

- Flow line of PSH Furnace



Source – AISI Technology Roadmap Program Final Report – December 2010

Technical Approach

- Current Phase involves
  - Large batch furnace designed to heat a 2'x2' bed of pellets and discharge by raking or tilting
  - Projecting emissions for the design of the demonstration plant using emissions measured from the batch furnace
  - Demonstration plant design incorporates knowledge learned from these investigations as well as pellet making and raw material drying tests

Transition and Deployment

- Steel industry: The successful deployment of PSH process provides liquid iron of excellent qualities to BOF and EAF steelmaking operations with more environment friendly process with lower operating and capital costs.
- Mining industry: American iron ore mining industry could send their concentrates to far away plants and international markets as DRI made in PSH Furnace.
- In a steelworks, DRI from PSH furnace could be hot charged to a melter and de-sulfurized to be charged to BOF or EAF.
- On a mining site, PSH furnace may be free standing to produce DRI safe to be shipped to customers overseas or domestic.

Measure of Success

- After establishing PSH technology by operating a demonstration plant of annual capacity of 50,000 tons, a commercial plant of ironmaking with a further scale up to 5 to 10 times could be built in a steelworks or mining site.
- Over years aging coke ovens and blast furnaces could be replaced by PSH-Melter so that integrated steelworks will leapfrog to the next generation of sustainable technology with one third energy savings.
- American steel industry will benefit from cheaper raw materials due to less preparatory processing and lower capital and manufacturing costs.
- For mini mills, availability of liquid iron will
  - Decrease power consumption
  - Increase EAF productivity of quality steel
  - Provide effective control on the volatility of scrap quality and price.

Project Management & Budget

Proof of Concept at Lab Scale - *DE-FC36-97ID13554 (Apr99 – Oct01)*

Feasibility and Preliminary Engineering - *DE-FC36-97ID13554 (Nov04 - Feb06)*

Current Project:

- Task 1.0 Raw Materials Investigation *(Start - October 2008)*
- Task 2.0 DRI Pelletizing Process (by Mars Mineral & Coleraine)

Go/No-Go Decision - Manufacturing of Green Ball Pellets *(Go - August 2009)*

- Task 3.0 Raw Material Handling and Transport System
- Task 4.0 Paired Straight Hearth Furnace Design
- Task 5.0 Auxiliary Systems
- Task 6.0 Verification Studies and Experimentation *(December 2013)*

Total Project Budget	
DOE Investment	$ 1,757,807
Cost Share	$ 753,346
Project Total	$ 2,511,153

Results and Accomplishments

- Key conclusions of current phase
  - Tilting discharge is the most appropriate method to get pellets out of the furnace
  - Particulate emissions from the demonstration facility will require a bag house to meet standards. No other emissions require abatement to meet standards.
  - The design of a demonstration facility has been completed and the expected cost is $28,842,000
- Non-proprietary reports from earlier phases have been published and the current phase report is being drafted