Novel Technology Yields High-Quality Iron Nuggets

Steel manufacturing involves many energy-intensive steps to process raw or recycled materials, such as iron ore and scrap metal. Global competition requires steelmakers to apply new technologies that can produce high-quality steel with lower capital and manufacturing costs, faster production times, and reduced emissions.

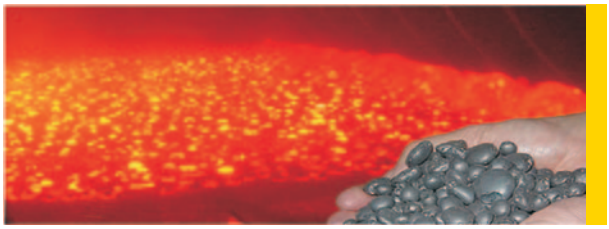
Pig iron, traditionally produced in the blast furnace, is used in integrated mills to make steel in the basic oxygen furnace. It is also added to steel scrap to improve product quality in electric arc furnace (EAF) "minimills". However, environmental regulations, aging furnaces, and plant shutdowns have reduced production capacity. These factors, combined with price fluctuations and supply problems, affect global demand for scrap and create the need to develop metallic iron sources other than pig iron and scrap.

ITP Supports New Process to Supply Iron to All Steelmakers

The U.S. Department of Energy's Industrial Technologies Program (ITP) supported the pilot-scale operation of a remarkable new process for making high quality iron. The ITmk3® Process has the potential to revolutionize ironmaking. The ITmk3® Process is capable of using low-grade ore fines and pulverized coal to produce iron nuggets of high purity (96-98% metallic iron content). Reduction, melting, and slag removal occur in only 10 minutes as compared to hours for the traditional blast furnace process.

Iron nuggets produced with the ITmk3® Process are superior in quality to direct reduced iron (DRI) and similar in quality to pig iron. The iron nuggets are suitable for use in electric arc furnaces (EAF), basic oxygen furnaces (BOF), and foundry applications.

The first plant to use this technology has been constructed by Mesabi Nugget, LLC and is now in operation, near Hoyt Lakes Minnesota.



Top: Aerial view of the first commercial-scale iron nugget production facility
Above: Iron nuggets produced by the ITmk3® pilot plant

Pilot Plant Partners (2004)

Mesabi Nugget, LLC
(Lead Organization)

Ferrometrics, Inc.

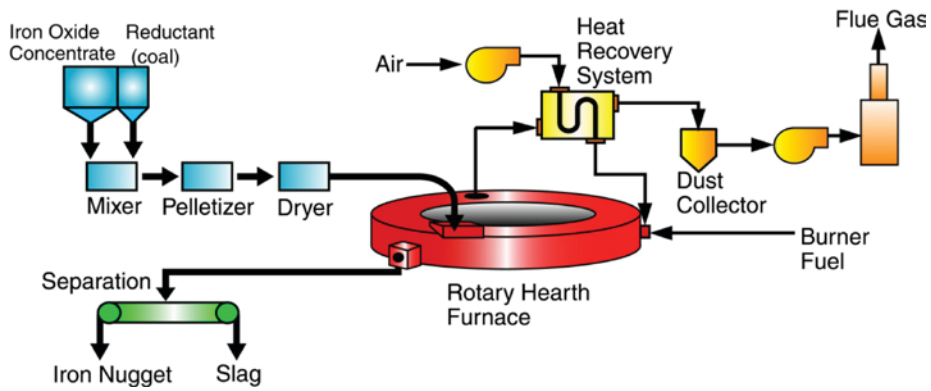
Cleveland-Cliffs

Kobe Steel

Steel Dynamics, Inc.

Minnesota Iron Range Resources Agency

Minnesota Department of Employment and Economic Development



ITmk3® Process flow sheet reveals a one-step furnace operation

The ITmk3® Process in Brief:

- Produces pig iron-quality nuggets using 30% less energy than blast furnaces
- Creates new market for abundant, low-grade taconite ore as a new source of iron for EAFs, providing economic stimulus and creating jobs in a depressed area
- ITmk3®/EAF steelmaking reduces pollutants relative to the coke/BF/BOF route:

Pollutant	Reduction
CO	96%
NOx	65%
SO_2	77.7%
VOCs	86.5%
CO_2	41.1%
Mercury	58%

- Iron nuggets suitable for use in all melt shops at BOF, EAF, and foundry operations
- Production process generates an excess of heat that could produce electric power for mining or other iron ore processing operations
- Will replace higher cost pig iron currently purchased by Steel Dynamics, Inc.

Technical Accomplishments

The ITmk3® Process holds the potential to produce dramatic improvements in energy efficiency, environmental performance, and product yield. DOE cost-shared the operation of a pilot plant to demonstrate and optimize this new ironmaking technology and to confirm the benefits of the process in North America.

ITmk3® Pilot Plant

- DOE participation attracted support from multiple industrial companies and the Minnesota State government.
- Produced high-quality, iron nuggets (96-98% metallic iron content)
- Achieved four individual production months with availability in excess of 93% and two months at 99%
- Capable of producing 25,000 metric tones of iron nuggets per year, an amount 10 times greater than a previous pilot test plant
- Operated continuously for 81 days

Iron nugget performance in a modern EAF steel making melt shop

- At 30% scrap usage, emissions reductions are greater than 40% for all emission components considered: CO, NOx, PM10, SO_2, VOC and CO_2
- Excellent operational reliability
- Improved yields and increased output by reducing tap-to-tap times

Commercialization Activities:

- Steel Dynamics, Inc. (SDI) and Kobe Steel are equity partners for the first commercial plant. (ITP has no investment in this facility.)
- SDI plans to use substantially all the output of the plant in its EAF facilities.
- In 2009, the first commercial 500,000-ton annual capacity plant that uses the ITmk3® process was completed near Hoyt Lakes, Minnesota. The plant shipped the first commercial batch of iron nuggets in February 2010.
- Additional commercial plants are being planned by other companies.
- SDI acquired a 6,000-acre mining site, formerly owned by LTV, located in the Mesabi Iron Rage in Minnesota. This site is expected to provide a long-term supply of iron concentrate for use in the current and possible future nugget plants.

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