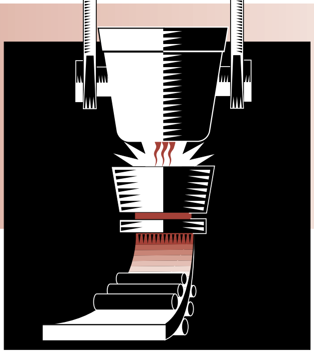
# STEEL

Project Fact Sheet



## Nitrogen Control in Electric Arc Furnace Steel-making by Direct Reduced Iron Fines Injection

### Benefits

- Energy savings of 12 GJ per ton of product
- Reduced carbon dioxide emissions
- Faster kinetics
- Steel scrap may be used thus reducing the consumption of virgin iron

### Applications

Introduction of this new technology may be applicable to bar and flat-rolled products. The capital cost of injection equipment is not excessive and may be added to existing furnaces with little alteration. This technology uses materials already in production and does not require any new production process.

### New technology may reduce operating costs and increase productivity in bar and flat-rolled products for the steel industry

Nitrogen, even in small quantities, is detrimental to the quality of steel. Traditionally, the blast furnace/basic oxygen furnace steelmaking route has been favored over the electric arc furnace route for the production of high-quality steels, partially because of the lower nitrogen level. Steel produced from a basic oxygen furnace contains 10-to-40 parts per million (ppm) of nitrogen, compared to 70-to-120 ppm of nitrogen in an electric arc furnace. This research is aimed at overcoming the nitrogen hurdle for the production of low nitrogen steel in an electric arc furnace.

Specifically, the aim of this project is to develop a technique from nitrogen removal from liquid steel by the injection of direct reduced iron fines. Direct reduced iron fines, generated either from direct reduced iron processes or by attrition in transport and handling, contain significant quantities of carbon and oxygen. Studies have shown that upon heating these elements react rapidly inside the direct reduced iron particles to form fine CO bubbles. Fine CO bubbles are very effective in removing nitrogen dissolved in steel. Unfortunately, this potential benefit is largely lost when direct reduced iron enters a steel bath in the form of pellets and briquettes, as they float to the surface of the melt. The evolved CO has insufficient contact with the melt to allow significant removal of dissolved nitrogen.

The injection of direct reduced iron fines by pneumatic lancing will allow the fine CO bubbles formed from heating the direct reduced iron to be released deep in the melt, thus improve nitrogen removal. Experiments are being conducted at McMaster University's 60-kilogram induction furnace to establish the relationships between solid injection rates, particle size, direct reduced iron composition, lance depth, sulfur content, temperature, starting nitrogen levels, and the removal of nitrogen from molten steel. A mathematical model will be developed to determine if such practices are economically attractive.

**Photograph of McMaster University's Induction Furnace Facility**

**Researchers at the induction furnace facility at McMaster University study the injection of DRI fines into steel to reduce the nitrogen content. Here powder is being injected into 60-kg heats of steel.**

## Project Description

**Goal:** To develop a technique for nitrogen removal from liquid steel using injection of direct reduced iron fines.

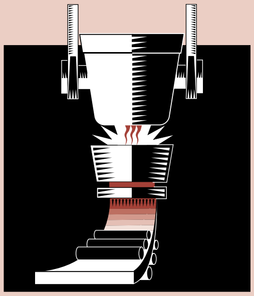
This project will characterize direct reduced iron fines, inject fines, and develop a mathematical model fro nitrogen removal. Characterization will be accomplished by using direct reduced iron from industrial sources using sieving, microscopy, X-ray Diffraction, X-ray, and thermo-gravimetric analysis.

The iron fines will be injected into a steel melt in a 60-kilogram induction furnace. The nitrogen content of the steel along with the carbon and oxygen content will be analyzed. The major independent variables that will be studied are: particle size distribution, solid injection rate, gas injection rate, lance depth, sulfur content of the steel, temperature, and the initial nitrogen content of the steel.

The result from these experiments will be used to develop a predictive mathematical model for nitrogen removal based on the injection parameters and chemical composition of the iron fines.

## Progress and Milestones

- Project Start Date: 3 Quarter 2001
- Start Furnace Injections 1 Quarter 2002
- Complete Furnace Injections 3 Quarter 2002
- Complete Mathematical Model 3 Quarter 2003
- Project End Date: 3 Quarter 2003



### Project Partners

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American Iron and Steel Institute
Washington, DC
(Project Manager)

Dofasco, Inc.
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Gallatin Steel Company
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