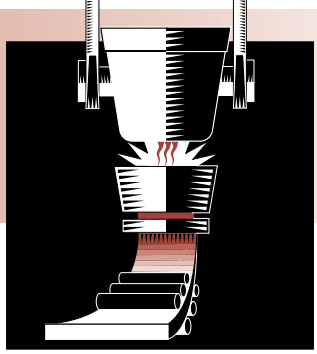
STEEL

Project Fact Sheet



Development and Demonstration of a High-Efficiency, Rapid-Heating, Low-NO_x Alternative to Conventional Heating of Steel Shapes

Benefits

- Estimated increase in energy efficiency by up to 35 percent
- Estimated decrease in NO_x emissions by up to 75 percent
- Estimated increase in production rates by up to 25 percent
- Reduced scale formation by 50 percent
- DFI may generate $100-to-$150 million per year in economic benefits

Applications

DFI is applicable to continuous furnaces that anneal ferrous steel strip, furnaces that heat round/square shapes, and coil box furnaces for transfer bars to name a few.

Direct flame impingement (DFI) technology should increase furnace productivity and energy efficiency while decreasing NO_x, carbon monoxide, and carbon dioxide emissions

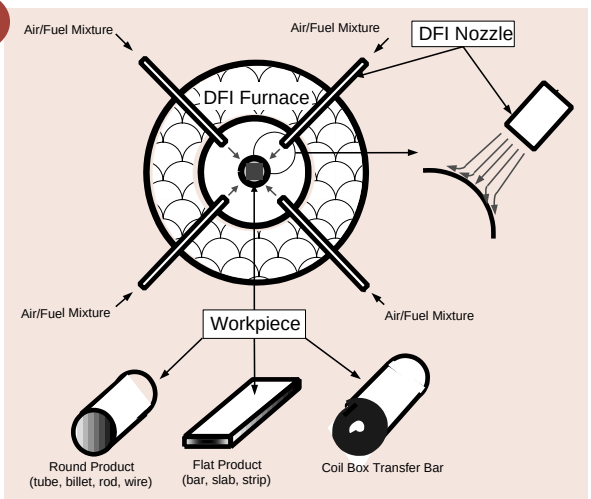
U.S. steel plants, like other heavy industrial facilities, are facing both increased regulatory pressures to reduce NO_x emissions and competitive pressures to reduce operating costs, both of which are expected to increase in the future. In order to remain competitive and continue to provide employment for the U.S. labor force, these industries must control emissions while minimizing operating costs.

DFI technology is a viable solution that should increase furnace productivity and energy efficiency and decrease NO_x emissions due to improved heat transfer, and reduce mill scale due to operation at nearly zero excess air.

DFI is applicable to the reheating of steel stock including strip, round/square shapes, coil box transfer bars prior to forming applications, and will also improve the temperature uniformity in the material being heated thereby improving product quality. These benefits are expected to produce a two-to-three-year payback.

The Gas Technology Institute (GTI) will demonstrate DFI combustion technology by building upon the current theoretical and experimental studies, GTI's applied combustion expertise and facilities, and knowledge of the steel industry. DFI is applicable to continuous furnaces that anneal ferrous steel strip prior to final processing operations, furnaces that heat round/square shapes prior to rolling or extruding, and furnaces that heat coil box transfer bars prior to finishing. DFI increases the thermal efficiency, reduces NO_x emissions, increases production, and increases product temperature uniformity.

Diagram of DFI Technology



DFI technology provides 5-10 times greater heat transfer rates, over 10 times lower NO_x emission and as much as 60-75% fuel savings with extremely rapid furnace startup and shutdown.

High-Efficiency, Rapid-Heating, Low-NO_x Alternative to Conventional Heating of Steel Shapes (Continued)

Based on existing data, a DFI furnace is expected to increase energy efficiency by up to 35 percent, reduce NO_x emissions by up to 75 percent, increase production rates by up to 25 percent, and reduce scale formation by 50 percent when compared to existing gas-fired heating furnaces.

Technology Description

Direct Flame Impingement technology involves placement of multiple nozzles (positions and sizes optimized) almost flush with the internal surfaces of the furnace walls to direct high-velocity flames (at stoichiometric conditions) up to Mach 1, directly at the load to ensure very high heat transfer rates. Since the nozzles are typically located only a few inches from the load, the furnaces size can be significantly reduced. The high heat transfer rates coupled with the very high recirculation levels of internal combustion products reduce NO_x formation (lower flame temperature) and virtually eliminates scaling as well as enhancing the uniformity of load temperature.

Project Description

Goals: 1) To develop and demonstrate DFI technology that can be applied to a broad range of steel mill furnaces; 2) to prove the economic, environmental, and productivity estimates; and, 3) to demonstrate the technology at a steel plant.

The objectives are to 1) optimize parameters such as DFI nozzle diameters, spacing, distances between nozzles and product surface, and the firing per unit area of the metal surface to achieve a temperature uniformity of 5° and for strip and 25° for rounds/squares, including transfer bars, while maintaining the necessary metallurgical properties; 2) to improve the furnace efficiency by up to 35 percent over the current technology; 3) dramatically increase the potential for productivity by up to 25 percent over the current technology; and, 4) substantially decrease the NO_x emissions by up to 75 percent over the current technology.

In order to achieve these goals, GTI will evaluate the following:

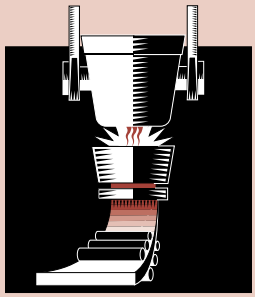
- Various design configurations, including variables of nozzle diameter, nozzle placement, nozzle patterns, recuperation methods, combustion chamber sizes, product size, product throughput; and, determining temperature uniformity, energy use, and predicted emissions using GTI two- and three- dimensional computational fluid dynamics capabilities.

- Demonstrate the predicted emissions reduction, energy efficiency, and productivity claims in a demonstration test located at a steel company site.

Progress and Milestones

The scope of work consists of three tasks that will require 36 months to develop.

- Project Start Date: September 2001
- Task 1: System Design Definition (Year 1)
- Task 2: Laboratory-Scale DFI Furnace Evaluation (Year 2)
- Task 3: Field Demonstration of a DFI Furnace (Year 3)
- Project End Date: September 2004



Project Partners

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