

# 9718 Hot Oxygen Injection into the Blast Furnace

## Benefits

- Increased coal injection leading to decreased coke consumption
- Ability to increase the extent of oxygen enrichment in the vicinity of the injected powdered coal plume
- Increased coal injection leading to an increase in the net amount of fuel gases generated in the mill
- Direct savings at the blast furnace of \$2.24 million per year
- Reduction of fugitive emissions from coke-making due to reduced coke requirements

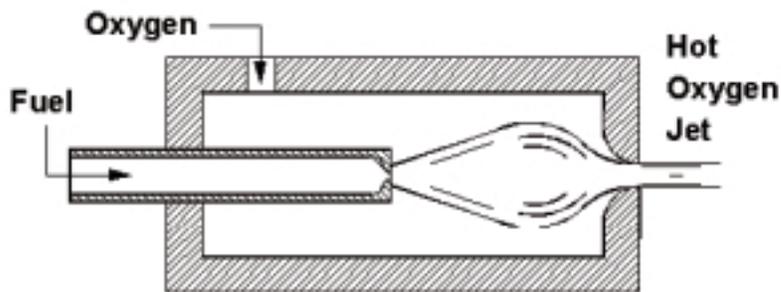
## Applications

Projected savings for a typical 4,000 ton per day blast furnace are up to \$930,000 every year. This represents the value of lower coke consumption less the incremental costs of coal and oxygen. The resultant acceleration of coal ignition and burnout is expected to increase the level of coal injection from the current limit of 400 pounds per therm (lbs/thm) to at least 475 lbs/thm, resulting in decreases in coke consumption.

## Direct injection of hot oxygen into blast furnace tuyeres yields improvements in operating cost, energy consumption, and emissions

Direct oxygen injection into the tuyere, rather than further enrichment of the hot air blast, provides the ability to increase the extent of oxygen enrichment in the vicinity of the injected powdered coal plume. Materials and energy balances on the blowpipe/raceway zone of the blast furnace show that injection of ambient temperature oxygen offers little overall benefit, but hot oxygen injection offers several mechanisms for improving burnout.

Praxair, Inc. has developed a Thermal Nozzle which generates a high-temperature, high-momentum oxygen jet that should provide superior mixing and combustion conditions for blast furnace coal injection. Oxygen and fuel are introduced to a combustion chamber where they react to produce a hot oxygen gas at temperatures up to 3,000 degrees Fahrenheit. This hot oxygen then passes through a nozzle to produce a high-velocity jet, the momentum of which ensures penetration of the oxygen jet into the blast stream and good coal mixing.



Oxygen and fuel are introduced to a combustion chamber at the end of a lance where they then react with one another to produce a hot gas made up mostly of oxygen. The hot oxygen passes through a nozzle to produce a high-velocity jet.

## **Project Description**

**Goal:** To demonstrate the economic, environmental and energy saving benefits of direct injection of hot oxygen into blast furnace tuyeres combined with fossil fuel injection, and to increase the capability of coal injection from 400 lbs/thm to 475 lbs/thm at high furnace production rates.

During Phase I, tests involved injecting hot oxygen into two tuyeres of a commercially operating blast furnace to verify that the injection lance is commercially viable and to determine any furnace operating problems likely to be encountered with hot oxygen injection.

Phase II will involve injected hot oxygen on all tuyeres (typically around 20) of the furnace and gradually increased coal injection rates. Stable furnace operation and a reduction in coke rate of 60 to 75 lb/thm are anticipated.

## **Progress and Milestones**

- ❖ Project start date: March 1998.
- ❖ Phase I testing began in January 2000, injecting hot oxygen on two tuyeres of a commercially operating blast furnace at U.S. Steel's Gary Works.
- ❖ Phase I testing has shown:
  - no furnace operating problems from hot oxygen;
  - an estimated 30 percent increase in the rate of coal ignition with hot oxygen;
  - acceptable lance performance with modifications to the original lance design.
- ❖ Additional lance modifications were tested in January 2001.
- ❖ Phase I testing is expected to be completed in June 2001.
- ❖ Project completion date: March 2002.

## **Total Project Cost/Duration**

\$841,000/four years. (Phase I)

### **Research Organization**

Praxair, Incorporated  
Tarrytown, NY

### **Industry Participants**

Bethlehem Steel Corporation  
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USX Corporation - U.S. Steel  
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