

## Reference Installation Summary

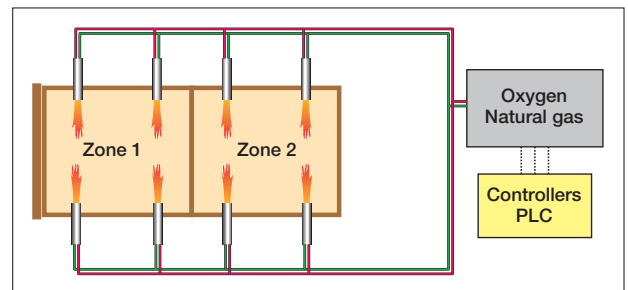
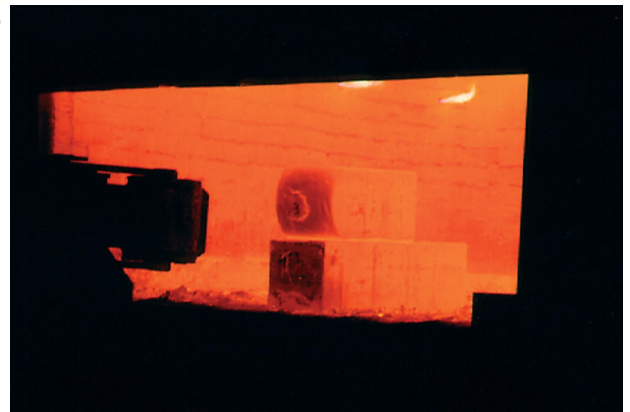
**Customer** North American Forgemasters, New Castle Pa., USA

**Equipment** Oxy-fuel system and PVSA On-site oxygen generator

**Fuel** Natural gas

**Installation Date** 1999

**Background** North American Forgemasters is a joint venture company formed by the Ellwood Group, Ellwood City Pa and Scot Forge, Spring Grove Il. They operate with a 4,500 ton forging press and have six forging furnaces each capable of heating up to 500 tons of forgings at a time. As part of a strategy of continuous improvement they evaluated oxy-fuel combustion for the forging furnaces as a means to reduce energy consumption and NO<sub>x</sub> emissions. The evaluation showed that oxy-fuel combustion would be an economically beneficial method to control energy consumption and furnace emissions as compared to the alternative air-fuel combustion system.



**The burner positioning strategy in the furnaces**

### Customer Objectives

- ▶ Reduced energy consumption
- ▶ Reduced emissions of NO<sub>x</sub>
- ▶ Quicker furnace heat recovery during forging
- ▶ Reduce operating costs

### Oxy-fuel - Leading Edge Technology

AGA, a member of the Linde group, was selected to be part of the project to install oxy-fuel on each of the 6 box forge furnaces. A complete assessment of the furnaces was carried out including energy balance and heat transfer calculations, and flame flow pattern analyses in order to optimise oxy-fuel power input distribution and burner positioning. As part of the total oxy-fuel system, AGA commissioned an on-site oxygen generation plant capable of producing 105 tons of 90% purity oxygen. This oxygen plant services requirements at Ellwood Quality Steels as well as North American Forgemasters.

Oxy-fuel combustion involves the combustion of the natural gas with pure industrial grade oxygen as opposed to air using specially designed burners. The advantages of higher productivity, improved thermal efficiency of the furnace, reduced specific fuel consumption and lower emissions stem from two main attributes of oxy-fuel combustion. The first is the

increase in available heat of combustion. By replacing the air with oxygen to combust the fuel, you eliminate nitrogen which means that flue gas volumes that carry away valuable energy are substantially reduced, thus increasing the available heat.

The second benefit from oxy-fuel combustion is due to the mechanism of heat transfer. Due to the elimination of nitrogen, the flue gases consist of CO<sub>2</sub> and H<sub>2</sub>O, both of which have excellent radiant heat transfer characteristics. N<sub>2</sub> does not transfer heat by radiation. Thus, the predominant mode of heat transfer with oxy-fuel is that of radiant heat transfer from the exhaust gases compared with air-fuel combustion which relies largely upon convective heat transfer. By ensuring good circulation of the furnace gases using high velocity burners and/or specially developed re-circulation burners, an improvement in the temperature uniformity of the product can be achieved.

### The Equipment Installation

The equipment installed was as follows:

- ▶ 8 ceramic low NO<sub>x</sub> burners in each furnace.
- ▶ A PVSA (pressure vacuum swing absorption) on-site oxygen production plant capable of producing 105 tons per day of industrial grade oxygen.
- ▶ A complete flow train system and control system for the control of burners in two zones.

### Results

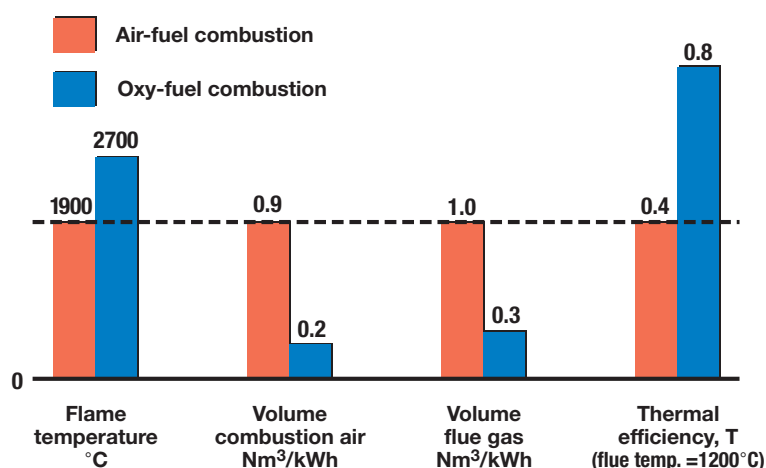
The following performance results have been achieved in this furnace:

- ▶ 10% increase in heating rate.
- ▶ 56% reduction in fuel consumption.
- ▶ 50% reduction in NO<sub>x</sub> production compared with air-fuel.

### Customer Benefits

Several key benefits have been achieved as a result of the use of oxy-fuel combustion technology in this furnace:

- ▶ Low specific fuel consumption.
- ▶ Increased furnace production capability.
- ▶ A cleaner environment with lower noise generation from the furnace operation.
- ▶ Substantial reductions in fuel borne emissions such as SO<sub>x</sub>, CO, NO<sub>x</sub> and CO<sub>2</sub>.
- ▶ Reduced electrical energy consumption as a result of the elimination of air blowers.
- ▶ Reduced overall flue gas volumes.



Comparison between air-fuel and oxy-fuel combustion

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Our experts are available for consultation.