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# Oxy-fuel can Increase Production and Reduce Costs

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With today's high fuel costs, suppliers often get asked if oxygen can save processors money. The economics depends on plant operations and particular business needs, but usually oxygen makes sense when a production increase is desired or environmental limits for NO<sub>x</sub> and particulates require improved operation. For an operation that can take advantage of 20 to 30% more production at 15 to 20% lower cost per pound of product, oxygen technologies are a great fit. If the only goal is to reduce fuel costs, the cost of oxygen will usually exceed the fuel savings achieved.

## Oxygen and Combustion

Combustion is the chemical reaction between fuel and oxygen that leads to the generation of heat. When the oxygen concentration is raised above the 20.9% present in air, the air is said to be oxygen-enriched.

In industrial heating applications enriching the air reduces the amount of inert nitrogen gas flowing through the combustion process. This change makes the process more thermally efficient. Less energy is wasted to heat the nitrogen, which is eventually emitted through the stack. The reduction in nitrogen flow has two environmental benefits: lower NO<sub>x</sub> emissions and lower particulate emissions.

Although oxygen must be purchased (while air is available for the cost of running a blower) its proven benefits can result in immediate cost savings. Oxygen enrichment can increase production rates without the costly addition of another furnace, thanks to increased thermal efficiency. Furnace consolidation is also possible—processing the same amount of material in fewer furnaces offers plant managers more flexibility and reduced costs.

There are a variety of techniques for implementing oxygen enrichment. Oxygen may be mixed with the combustion air stream, strategically injected through lances into the furnace, or used in burners designed especially for higher oxygen concentrations. Choosing the optimal technique depends upon the type and the size of furnace, the operating benefits desired, capital cost considerations, and supplier experience.

## Oxygen use in reverb furnaces

Recently both full oxy-fuel and air-oxy-fuel technologies have been applied to reverb furnaces. Because reverb furnace design is based on air-fuel firing, the combustion space is often large, allowing for the significant volume of the combustion gases. For furnaces that need maximum production rates and that have molten metal pumps, full oxy-fuel can deliver the best economics. However, if done incorrectly, 100% oxy-fuel can drastically reduce the gas flow patterns and can lead to uneven heating. For furnaces with limited metal movement or significant holding and casting times, air-oxy-fuel techniques often deliver the best results. Having experience with both types of systems allows a supplier to custom fit the solution to the user.

Performance results using oxygen in reverb furnaces vary according to many factors. At a typical operation range from 20 to 35%, results can include increased production fuel savings per pound of metal of 20% to 40%, reduced flue gas volume by up to 60%, and reduced total melting cost of 20%, all while maintaining or increasing metal yields.

### **Proven oxy-fuel success with rotary furnaces**

Rotary furnaces are much more efficient than reverb furnaces since they transfer heat both via radiation and direct contact between the melt and the refractory as it passes beneath the charge material. The constant mixing and motion of the charge material maximizes the heat transfer within the scrap. Experience with rotary furnaces has shown that the furnaces are efficient enough to take full advantage of 100% oxy-fuel.

Aluminum dross and non-ferrous scrap (aluminum, copper, lead-tin solder, brass, etc.) have traditionally been melted in gas fired rotary furnaces. The furnace arrangements come in two variants: single pass and double pass. The single pass furnace has a burner at one end and a flue at the other. The combustion gases flow straight through the furnace-melting chamber, resulting in a lower thermal efficiency than double pass furnaces. The double pass furnace has the flue and the burner at the same end. The combustion gases in a double pass furnace have a very uniform residence time, which significantly improves efficiency. Having a furnace that tilts to pour out the metal and waste speeds up the tap-to-tap cycle and increases overall productivity.

Many double pass furnaces do not have a furnace door, which limits the operator's ability to control the furnace atmosphere, pressure and emissions as well as allowing significant heat loss via radiation. One advantage of these furnaces, however, is that the operators can see into the furnace during the whole cycle. With a properly designed door and control system, the furnace can be much more efficiently operated and by monitoring flue gas emissions, temperatures, and furnace rotation parameters, the operation can be run efficiently without the luxury of seeing into the furnace. Adding a door and control system to an oxy-fuel double pass rotary can often increase production 15%. Other advantages of a properly designed door include reduced heat loss by radiation of almost 1 million btu/hr, improved control of free oxygen by eliminating air entrainment, reduced dusting and noise, and improved fuel efficiency of up to 20%. These benefits can cut processing cost by a further 10% compared to a furnace without a door.

### **Oxy-fuel burner technology**

The transition from air-fuel to oxy-fuel is easier than most people think. A major step involves retrofitting the burner or installing a new one designed for high oxygen concentrations. Air Products' CLEANFIRE® HR™ flat flame (reverb), M64 (rotary) and EZ-FIRE™ (reverb and rotary) burners have been shown to outperform other burners by more than 10% in fuel efficiency and productivity.

The CLEANFIRE HR burner has several benefits including lower maintenance costs, high flame radiation, more uniform heating, larger flame covered area, and minimized pollutant emissions. This oxy-fuel burner has been successfully implemented in several high production reverb furnaces.

The M64 burner is widely used in rotary melters in the United States and Europe. The burner design generates a very luminous and large flame envelope with very tight oxygen retention, ideal for medium and large single and double pass rotaries.

EZ-FIRE air-oxy-fuel combustion technology was developed by Air Products in the late '80s. The burners are retrofitted to the user's system between heats without any downtime. EZ-FIRE technology features the integration of an oxy-fuel burner with an air-fuel burner, providing the user with the flexibility to select the heat input from air fuel and oxy-fuel independently. In this way, the melt rate can be optimized to take into account constraints of the existing operation such as baghouse capacity and materials handling. Most air-fuel combustion systems are compatible with EZ-FIRE technology. Ignition, flame supervision, and cascading flow controls are integrated to provide a safe and efficient air-oxy-fuel combustion system. This burner-in-burner concept provides an air-fuel envelope around the hot oxy-fuel flame, protecting the burner tile and charge material from the hotter inner flame. The system has been used with both nozzle-mix and pre-mix burners.

### **Implementing oxy-fuel technology takes know-how**

Experience in the applications is as important as the equipment. Knowing which burners and control system to use in which furnaces and how to maximize melt rates and minimize oxygen usage are the keys to achieving lower costs while maintaining a safe environment. When choosing an oxygen supplier, the most important question to ask is who has the experience, know-how and technology to help you achieve all the benefits.

### **Conclusion**

Oxy-fuel, correctly applied, increases production, fuel economy, and lowers costs in rotary and reverb furnaces. Air Products has experience with single and double pass rotaries as well as direct charge and side-well reverbs. The major cost benefit from using oxygen comes from increased production, which lowers the fixed cost per pound of material processed. NO<sub>x</sub> and

particulate emissions can be greatly improved—and the installation of a new, high-efficiency burner allows matching the technology to your operation and your needs. If extra production or current air emissions are not an issue, oxygen may not be the best fit.

Air Products has over 30 years of experience helping melting operations become more productive and efficient. Proprietary technologies and unrivaled metals expertise allow Air Products engineers to evaluate and implement a variety of process improvements. Our patented burner systems for both full oxy-fuel and air-oxy-fuel technologies — CLEANFIRE HR flat flame (reverb), M64 (rotary) and EZ-FIRE (reverb and rotary) — consistently outperform other burners by more than 10% in fuel efficiency and productivity. Many Air Products' customers have doubled profits and realized a two-month payback on Air Products' technologies.

## **For More Information**

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