

STEEL REHEAT BULLETIN COMBUSTION OPTIMIZATION

PROBLEM:

In any combustion reaction, theoretically there is a required volume of oxygen to react with a given amount of fuel. Typical combustion systems mix a fuel, such as natural gas or oil, with air. Unfortunately, air contains only 20.9% oxygen. The remaining 79.1% consists of nitrogen and other gases that are not required for combustion. These detract from the combustion process by having to be heated and causing lower efficiency.

A combustion process may run with high levels of excess air and still heat the billets. However, this wasted fuel contributes to pollution and causes quality defects: metallurgical and high scaling. On the other hand, running at too low a level of excess air will create problems at the other end of the spectrum. Insufficient oxygen causes raw fuel to flow up the stack. This situation creates waste and air pollution, damages the refractory, and contributes to quality defects. In most combustion processes, it is safest running with excess oxygen. The level of waste is about twice as high on the fuel rich side of stoichiometric combustion as it is on the fuel lean side. Therefore, it is best to run with slightly excess oxygen to ensure against the possibility of the more wasteful, reducing conditions.

SOLUTION: Measure where it matters!

There are two major types of oxygen analyzers found in the steel industry: low temperature, sampling types (extractive) and low/high temperature in-situ sensors. Both types work in steel reheat furnaces, but excessive maintenance limits the usefulness and reliability of the extractive units. Heaters, pumps, sample lines, and cells require continuous attention. Regular calibration services are a must. The filter system of the pumps must be cleaned periodically due to moisture in the hot gases.



The low temperature in-situ unit is a direct reading sensor without pumps and sample lines. Temperature limitations of the sensor require that it be installed in an area downstream

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MASTERING STRENGTH. WORLDWIDE. from the combustion zones. The measurements include the combustion excess oxygen plus all air leakage in the ductwork. This does not allow the accuracy required for very efficient tight control. Maintenance is also required because of heaters and regular calibration services.

The introduction of the high temperature in-situ sensor has virtually eliminated these problems. High temperature in-situ oxygen sensors do not require pumps, heaters, filter systems, calibration, etc. The sensor must be in the furnace where the combustion is complete. The locations preferred are in the heating zone and soak zone. Proper installation of the sensor will insure its performance. Continuous oxygen monitoring will improve the consistency of product quality and reduce maintenance costs by highlighting faults and burner imbalance.

RESULTS

The cost of sensors is generally very low compared to the operating expense of the reheat furnace. Fuel savings are established by using a well-accepted rule of thumb from burner manufacturers. Above 1500°F, approximately 1.0 to 2.0% in fuel will be saved for every 1% reduction in excess oxygen. Generally, savings of 1 - 3% in fuel costs can be expected. Continuous excess oxygen measurement will provide a tighter, more responsive air/fuel ratio to be maintained. The result is more consistent quality.

Reducing conditions are controlled to preserve the furnace refractory and the steel metallurgy. Air pollution is another big advantage of using sensors. NOx formation is influenced by exhaust temperature, fuel level, and excess oxygen. Lowering excess oxygen will lead to lower emissions.

High excess oxygen conditions are controlled to reduce surface scale that is produced on the billets during reheat. This will reduce furnace maintenance, steel cleanup, and metallurgical problems.

The high temperature oxygen sensor has been established as dependable and simple to use. It is considered a good choice to insure consistent excess oxygen in the reheat furnace. With the uncertainty of the gas composition being delivered to a facility, it is essential to control the air/fuel ratio to minimize emissions, maximize fuel efficiency, lower surface scale production, and maintain the standard of quality required by the steel industry.