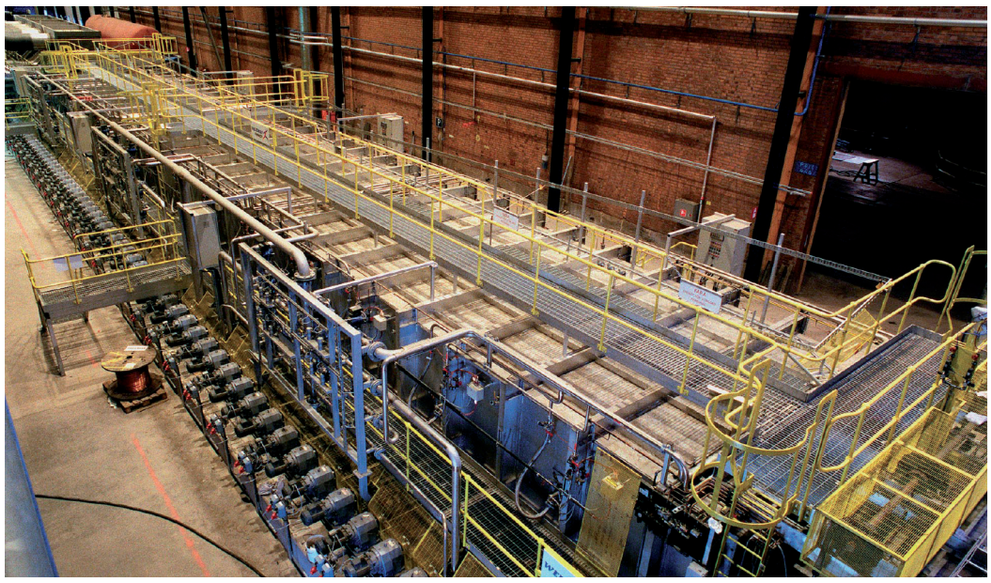
→ Reference sheet.

THE LINDE GROUP

REBOX® oxyfuel solutions in reheating. Oxyfuel combustion in a new roller hearth heating furnace.



Roller hearth heating furnace with REBOX® oxyfuel solution including ceramic oxyfuel burners and Linde control system.

Summary

- Productivity max. 23.5 t/h
- Fuel consumption 235 kWh/t
- Discharge temperature 1140°C
- Substantial reduction in NO_x emissions
- Overall flue gas volumes have been reduced by 75% when compared with a comparable furnace that is heated using an air-fuel combustion system

Customer

Outokumpu, Hot Rolled Plate Division, Degerfors, Sweden.

Outokumpu is a leading international stainless steel producer with production plants in Finland, Sweden, the UK and the US. At the Degerfors plant in Sweden, Outokumpu produces stainless slabs, blooms, billets, bar and plate.

Customer objectives

For this project Outokumpu had the following objectives:

- Increased productivity as a result of moving from a batch to a continuous process
- Increase capacity
- Reduced operating costs
- Maintain or reduce emissions emanating from the heat treatment process
- Improve product quality (particularly on the Duplex grades)
- Reduce surface markings/imperfections on the heat-treated plate.

Background

Linde was invited to work with Outokumpu and the furnace designers to provide an oxyfuel combustion system that would help Outokumpu achieve their stated objectives.

In 1998, the result of the co-operation was a new furnace, 35.4 m long (inside chamber), 3.5 m wide and 2 m high that is equipped with an oxyfuel combustion system that uses 59 of the latest Linde designed ultra-low NO_x staged ceramic burners controlled independently in each of the 13 zones. As the name indicates, these burners are designed to minimise the formation of NO_x. However, the design offers several other benefits. They are easy to handle and maintain, and as they are self cooling they require no cooling water which can be a common source of problems with many burners. Each burner is equipped with a flame-watch detection system and a pilot burner for auto ignition.

The total power input capability is 16.5 MW which allows hot or cold material to be charged and heated to a maximum temperature of 1150°C before quenching. The burner power in each zone can be controlled independently

via set temperature loops that follow temperature measurements from three thermocouples in each zone. Good flow control accuracy is very important and this is achieved by using a differential pressure V-cone orifice which is then recalculated to a temperature and pressure compensated mass flow. This, coupled with state of the art Bi-linear Generalized Predictive Controllers (BGPC) that work with conventional PID's, take account of non-linear characteristics and minimise deviations from the set-point. The resulting benefits are the ability to more accurately control the flows of oxygen and propane when changing power levels. As a result, this allows better control of the resulting atmosphere and ultimately lower NO_x values coupled with improved thermal efficiency.

Installation/scope

The equipment installed was as follows:

- 59 ceramic low NO_x burners.
- Separate flow trains for both oxygen and propane to the main burners and pilot burners individually to each zone.
- A complete control system allowing individual control of each zone using PID in conjunction with bi-linear generalized predictive controllers for optimum control for 12 of the 13 zones.

Results

The following performance results have been achieved in this furnace:

- Productivity max. 23.5 t/h
- Fuel consumption 235 kWh/t
- Discharge temperature 1140°C
- Substantial reduction in NO_x emissions.
- Overall flue gas volumes have been reduced by 75% when compared with a comparable furnace that is heated using an air-fuel combustion system.

Customer benefits

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

- High productivity furnace when compared with an air-fuel alternative due to faster heating capability.
- Low specific fuel consumption.
- More accurate temperature control of the plate material.
- A cleaner environment with lower noise generation from the furnace operation.
- Reduced overall flue gas volumes when compared with an alternative air-fuel fired furnace.
- Substantial reductions in fuel borne emissions such as SO_x, CO, NO_x and CO_2.

Ultra low NO_x ceramic burners.
– A selection from the family of Linde-designed oxyfuel burners.

REBOX® oxyfuel solutions

In more than 110 fully converted reheating and annealing furnaces, Linde's REBOX® oxyfuel solutions provide more throughput and flexibility at lower total costs.

- Up to 50% more furnace throughput capacity
- Up to 50–60% specific fuel savings
- More uniform heating and reduced scale formation
- Reduced emissions of such as CO_2 and NO_x

The broad REBOX® technology and application experience combined with long and detailed customer process experience results in fast and safe project implementation, also as turnkey and with guaranteed performance.

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