Linde Gas

# REBOX®

## Direct Flame Impingement in a catenary furnace

**Customer**

Turnkey project for Outokumpu Stainless AB, Coil Products Nyby, Sweden

**Equipment**

- Direct Flame Impingement (DFI) oxyfuel burners in one compact unit
- Control system
- Furnace rebuilt to fit DFI unit

**Fuel**

LPG

**Installation date**

2002

**Background**

Outokumpu Stainless (formerly AvestaPolarit Stainless) is a world leader in supplying different grades of stainless steel material to customers with high standards of quality. In the final annealing-pickling line, the strip is between 0.4 and 3 mm thick and up to 1,550 mm wide. The existing catenary furnace is 19 m long and produces 23 tons/hour. Oxygen enrichment was applied in this furnace until 1995 when it was converted to oxyfuel.

In 2001, Outokumpu set itself the goal of increasing the capacity in their catenary furnace for strip annealing at the Nyby works. Production staff required more throughput capacity and flexibility in the annealing process to handle a growing number of orders and shorter delivery times. Authorities did not object to increased production but stipulated that $NO_x$ emissions were to be lowered.

Outokumpu, and the Nyby site in particular, has a wealth of experience with oxyfuel applications from AGA, a member of the Linde Group.

**Customer objectives**

- Increase capacity in existing furnace (not possible to increase length of furnace)
- Reduce fuel consumption
- Improve temperature control, uniformity of the material
- Lower $NO_x$ emissions
- Secure total turnkey commitment from Linde

**REBOX® – leading-edge technology**

Since the beginning of the 1990s, AGA has pioneered the use of 100 % oxyfuel applications in reheat furnaces in close cooperation with customers such as Outokumpu. The furnace already contained oxyfuel combustion technology installed by AGA. The objective of this project was to create necessary additional capacity in a compact solution to the existing furnace where there was extremely limited physical space available.

## DFI – maximizing power in a minimum of space

Direct Flame Impingement (DFI), where an oyxfuel flame directly heats a moving metal strip, has proved to be the most effective way to increase heat flux (kW/m$^2$). It is by far the most effective way of heating, the principle taken from preheating metal surfaces by torching prior to welding. AGA has integrated the patented DFI solution into a compact solution. It is well-suited to retrofitting existing furnaces in need of higher production throughput but lacking additional space for a longer furnace. Production and lab results have shown that DFI technology has no negative effects on the material properties or surfaces. It reduces heating time, thus limiting possible scale formation.

In general terms, the use of oxyfuel combustion substantially increases the thermal efficiency of a furnace. This is primarily due to the fact that radiant heat transfer of furnace gases produced by oxyfuel combustion is significantly more efficient than those of airfuel. And due to the absence of nitrogen in the combustion mixture, the volume of exhaust gas is also substantially reduced, thus lowering total heat loss through the exhaust gas. Thanks to improved thermal efficiency, the heating rate and productivity are increased and less fuel is required to heat the product to a given temperature, i.e. specific fuel consumption is reduced. This makes a valuable contribution to reducing the impact of company operations on the local environment.

## Equipment installation

- Old furnace adopted to fit the DFI unit
- 4 MW installation in a compact 1.8 m long, 2.4 m wide and 1 m high DFI unit
- 120 burner nozzles in 4 cassettes (Picture at top right overleaf shows one such cassette from below)
- Separate flow trains for both oxygen and fuel
- Complete control system for controlling DFI unit
- Automatic width adjustment
- Oxygen supply from ECOVAR® oxygen plant with liquid back-up

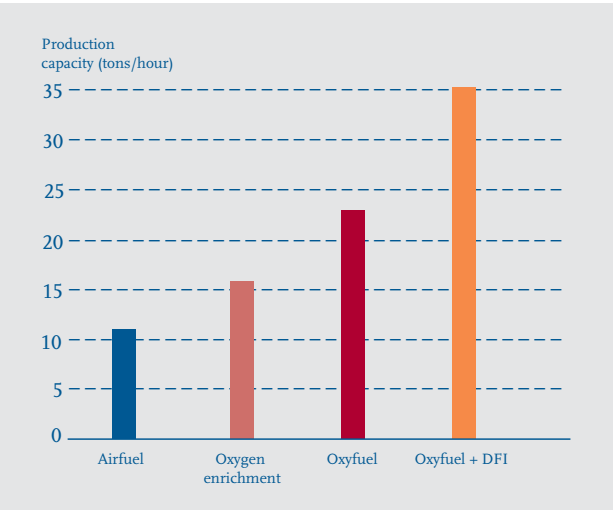
## Results

- 50 % increased heating capacity in existing furnace
- Total furnace length only increased by 10 %
- Improved temperature control
- Total turnkey commitment from Linde

## Customer benefits

- Increased production capacity and flexibility in existing furnace to handle swift changes in incoming orders

Reduced fuel consumption, emissions and flue gas systems were already achieved when the furnace was converted to oxyfuel in 1995.

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