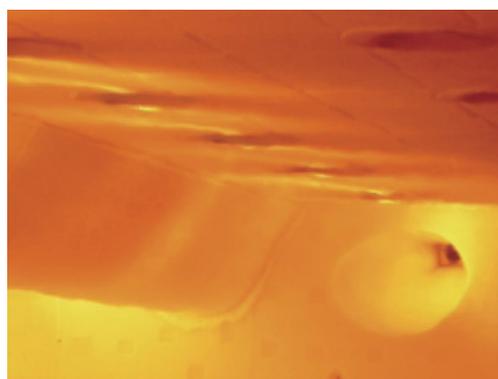
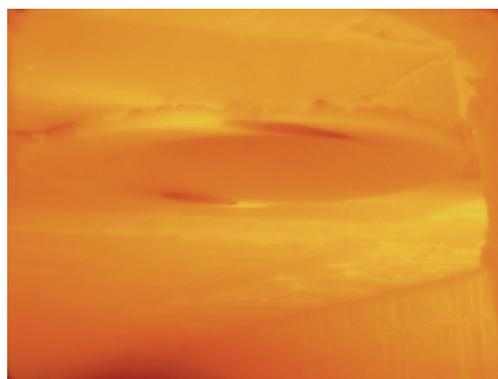
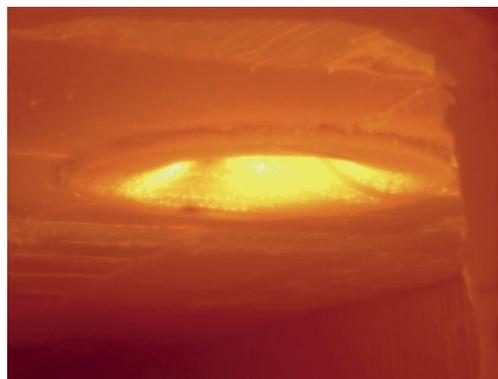


# NEW GENERATION ULTRA-LOW NO<sub>x</sub> WALKING-HEARTH FURNACE

at Hadeed, Saudi Arabia

In 2009, Sabic Hadeed contracted Danieli to supply a second wire rod line, similar to the one commissioned in 2004. The new line features a Danieli Centro Combustion (DCC) heating furnace that duplicates the one supplied in 2004, i.e. a walking-hearth type furnace (radiant-roof type) with a maximum production rate of 120 tph. The 25-long, 14.8-m wide furnace heats 130- and 150-mm billets in lengths ranging from 8.8 to 14 m. The furnace is equipped with four moveable and five fixed hearths. Considering the predominant maximum billet width, it is also equipped solely with radiant burners to ensure uniform thermal feedstock heating, and discharging temperatures ranging from 1,050 to 1,150 °C. Burners are fed with natural gas and air preheated from 400 to 450 °C via a central recuperator installed in the waste-gas flue. During the five-year period between the two orders, Saudi Arabia introduced stricter limits on pollutant emissions: in particular, the allowance for nitrogen oxides has been reduced from 86 g/GJ to 43 g/GJ (based on gross calorific values), corresponding respectively to 260 and 130 mg/Nm<sup>3</sup> @ 3% O<sub>2</sub>, considering wet waste gas. However, DCC's R&D department has made considerable advances since 2006, especially in the field of combustion, and two new types of radiant burners designed and tested for the new Hadeed furnace guarantee NO<sub>x</sub> emissions lower than 100 mg/Nm<sup>3</sup> @ 3% O<sub>2</sub> with a furnace chamber temperature of 1,250 °C, fed with combustion air preheated to 450 °C, and requiring use of flameless combustion. The following burners are installed on the furnace roof:

- > Pre-heating zone: 27 RAD-FL6 burners (three rows of nine), with maximum power of 610 Mcal/h;
- > Heating zone: 27 RAD-FL6 burners (three rows of nine), with maximum power of 750 Mcal/h;
- > Equalizing zone, right and left: 15 + 15 (on three rows) RAD-VGL4 ULNO<sub>x</sub> burners

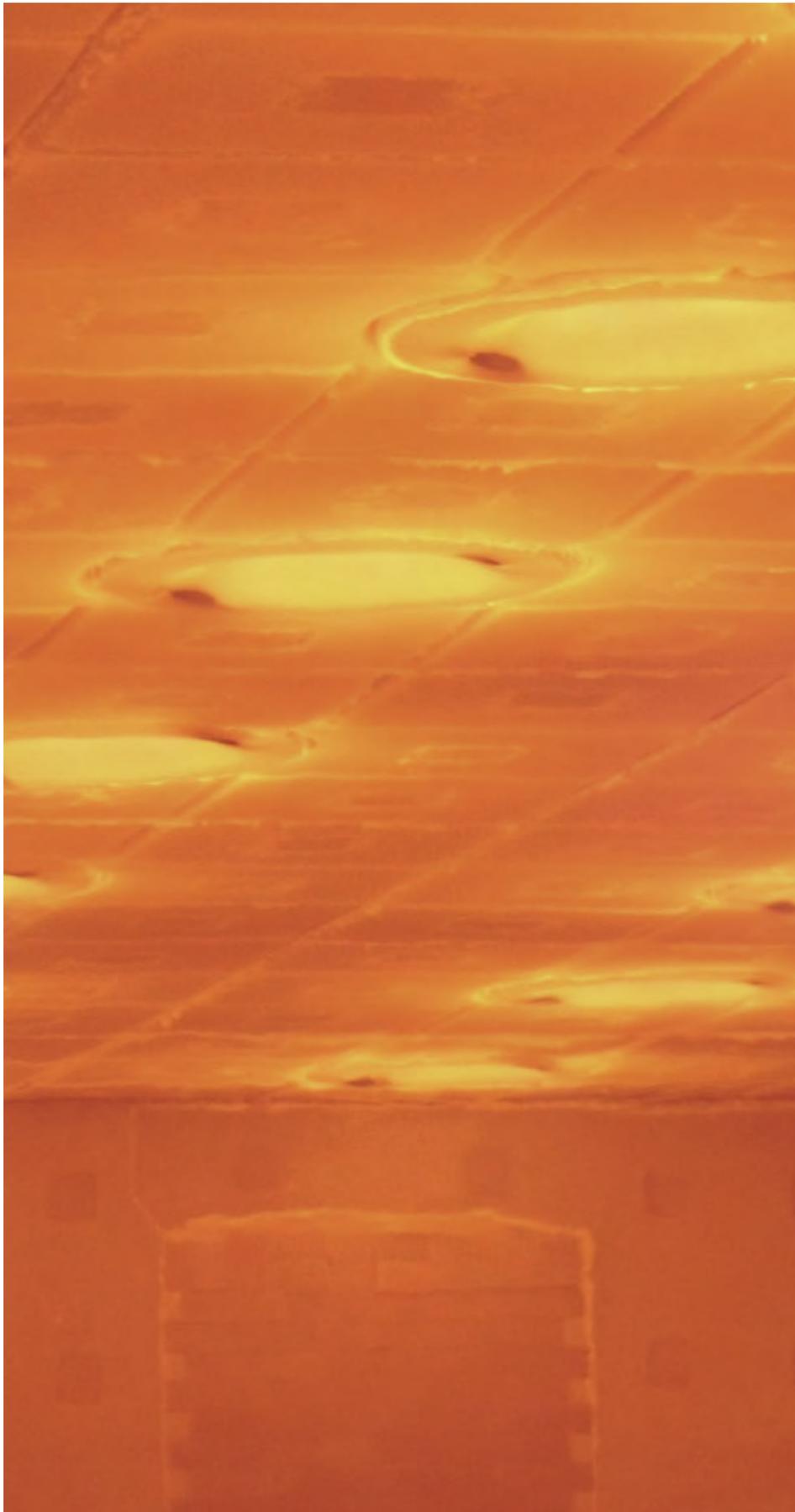


Tests in the DCC Lab: RAD-FL6 in flame mode (top) and in flameless mode (middle).

Zone 1 Shortening: RAD-FL6 burner in flameless mode in the third row (first two rows switched off).

**LIMITATIONS TO NO<sub>x</sub> CONCENTRATIONS IN EXHAUST FUMES ESTABLISHED BY NATIONAL AND INTERNATIONAL REGULATIONS IMPOSE A REQUIREMENT FOR SUBSTANTIAL REDESIGN OF NEW BURNERS.**

**THE CHALLENGE IS TO ACHIEVE OPTIMAL EFFICIENCY AND AT THE SAME TIME TO ENSURE THAT EMISSIONS PRODUCED REMAIN WITHIN THE SET RESTRICTIONS. DANIELI CENTRO COMBUSTION ACCOMPLISHED THIS TASK IN ITS DEVELOPMENT OF THE REHEATING FURNACE FOR HADEED'S NEW WIRE ROD MILL.**



Customer inspection at DCC's R&D center. From left: C. Iernetich (DMH); D. Astesiano (DCC - R&D); Tawfeek Shammasi, Hadeed Environmental Dept.; M. Rocca (DCC).

with maximum power of 200 Mcal/h. Each zone is equipped with a single air-feeding line and two gas-supply lines, one dedicated to the flame mode function, the other to the flameless mode. Once the combustion zone reaches automatic ignition temperature (800-850 °C), gas flame alimentation closes automatically and switches over to flameless mode. Registered toxic waste, and NOx emissions in particular, are extremely low and the percentage of unburned hydrocarbons (CO) is virtually nil. In the preheating zone there is an option to switch off first- and second-row burners according to thermal request in the zone, and to further reduce fuel consumption when the furnace is functioning in low production mode. Furnace performance tests were carried out from March to April 2013, with extremely successful results:

> Specific consumption: 219 kcal/Nm<sup>3</sup> against 242 kcal/Nm<sup>3</sup> of contractual requirements, discharging temperatures of 1,050 °C with 150-mm billets;

> Billet temperature uniformity: DeltaT less than 10 °C on the section and less than 15 °C on the length; contract requirements of 25 and 30 °C, respectively.

> Scale loss: 0.55% on total weight with 150-mm billets discharged at 1,150 °C compared to 0.7% in the contract.

The outstanding performance regarding nitrogen oxides must be highlighted too. Considering the limit of 43 g/GJ @ 3% O<sub>2</sub>, 29 g/GJ (equal to 93 mg/Nm<sup>3</sup>) was recorded in flameless mode, that is 33% less than the guaranteed limit - also considering billet discharging temperature of 1,150 °C.

In flame mode this value was 63 g/GJ equivalent to 202 mg/Nm<sup>3</sup>.

By way of comparison, the furnace installed in 2004, at a billet discharging temperature of 1,050 °C, produced NOx emissions of 61 g/GJ, equivalent of 194 mg/Nm<sup>3</sup> ■