

Efficient NOx reduction strategies implemented by STARA GLASS

Nitrogen oxides (NOx) emissions pose significant health risks, contributing to ground-level ozone formation, photochemical smog, acid rain and secondary particulate matter, while also affecting climate dynamics. Consequently, increasingly stringent emission limits are being enforced worldwide. NOx emissions are regulated through frameworks that establish maximum allowable concentrations. In Europe, limits for glass plants typically range from 500 to 800 mg/Nm³ at 8 percent O₂. The lower value applies to plants equipped with abatement systems, while the higher value applies to those relying solely on primary measures. Local authorities may impose stricter thresholds. Technologies for NOx mitigation are generally classified into primary (preventive) and secondary (destructive) measures. Primary solutions aim to limit NOx formation at the source by acting directly on the combustion process. Stara Glass has developed primary NOx reduction technologies including HEAS (High Efficiency Air Staging)

and SWGR (Strategic Waste Gas Recirculation). Although based on different principles, both approaches operate the main high-temperature combustion phase under oxygen-poor conditions, limiting the availability of excess oxygen to react with nitrogen and thereby reducing thermal NOx formation. Secondary technologies include Selective Non-Catalytic Reduction (SNCR) and Selective Catalytic Reduction (SCR). Both involve injecting a reducing agent, typically ammonia or urea, into flue gases, where it reacts selectively with NOx to form nitrogen and water. SNCR relies on direct injection within a temperature window of approximately 800°C to 1,100°C, while SCR uses a catalyst to enable the same reactions at lower temperatures, typically between 250°C and 400°C. SCR systems are more complex and capital-intensive, requiring additional operational considerations such as catalyst replacement, pressure drop management, maintenance and ammonia handling. By contrast, SNCR systems are mechanically simpler, more compact and

less costly in both capital and operating terms. However, their effectiveness depends on accurate control of the thermal profile, requiring specific expertise in heat exchange systems.

SNCR APPLICATION IN THE GLASS INDUSTRY

Stara Glass has developed SNCR technologies tailored to the requirements of the glass industry.

SNCR FOR UNIT MELTER FURNACES

In unit melter furnaces, reagent injection occurs in the high-temperature flue gas stream after heat recovery. These systems operate with lower combustion air temperatures compared to regenerative furnaces, resulting in lower flame temperatures and reduced thermal NOx formation. This makes compliance with the 800 mg/Nm³ limit more achievable. However, overall consumption and NOx emissions are typically around 40 percent higher than in regenerative systems, and future regulatory changes cannot be excluded.

Addressing tightening emissions regulations, advanced furnace solutions are enabling effective NOx reduction and energy recovery. As explained here by STARA GLASS R&D engineers Elisa Gerali and Ernesto Cattaneo, the company is developing tailored SNCR technologies and heat exchange expertise to ensure controlled thermal conditions - all to deliver measurable emission reductions, operational efficiency and reliable performance across a range of glass furnace configurations.

SNCR FOR CENTAURO FURNACES

Centauro furnaces are particularly suited for SNCR integration due to their hybrid heat recovery configuration. Heat recovery is divided into a regenerative section with short regenerator chambers and a metallic system comprising two double-shell recuperators

and one convective exchanger. This configuration results in flue gas temperatures of approximately 800-850°C at the regenerator outlet, which falls within the optimal SNCR operating range.

INSTALLATION

The system includes storage tanks, metering pumps, flow control and monitoring of flue gas

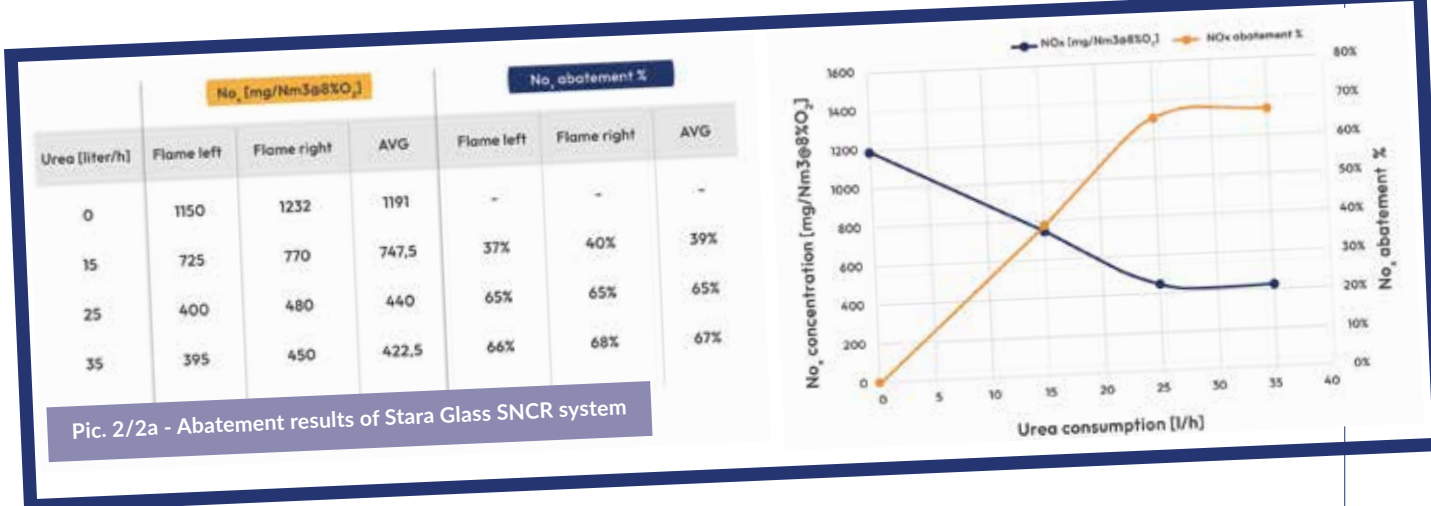
temperature and NOx concentration. The reducing agent is delivered through a network of injection lances optimised using computational fluid dynamics.

Field validation supports this design approach. To date, eight SNCR systems have been installed by Stara Glass, demonstrating consistent performance under real operating conditions.

Pic.1 - The installation of Stara Glass SNCR systems is performed while the furnace is running



DECARBONISATION



Pic. 2/2a - Abatement results of Stara Glass SNCR system

The graphs and reported data indicate that SNCR systems can achieve NO_x reductions of up to approximately 70 percent, confirming their effectiveness as a solution for emission control in glass furnaces.

METAL RECUPERATORS

Stara Glass draws on decades of experience in furnace and heat exchanger design, supported by systematic field data acquisition, to refine thermal calculation models. Expertise in the dimensioning of regenerators and metal recuperators enables precise control and prediction of flue gas temperatures

throughout the system, a critical factor for SNCR efficiency. This analytical approach is particularly relevant in oxygen-fired furnaces, where flue gas composition differs from conventional air-fuel combustion. By incorporating actual gas composition and temperature-dependent specific heat integration into its calculations, Stara Glass achieves accurate thermal balance evaluations and reliable performance predictions - even in non-standard configurations. Fouling of metal components represents a key limitation to long-term heat exchange performance. To address this, Stara Glass has developed cleaning systems and

procedures for recuperators that restore original performance when fouling occurs, using operations that are rapid, simple and cost-effective. ■

Pic. 4 - The authors, Elisa Gerali and Ernesto Cattaneo, from Stara Glass Innovation Department



Pic. 3 - example of Stara Glass double-shell recuperators for Centauro furnaces



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