Centauro

The new reality for Glass furnace enhanced heat recovery

The previous state of the art of gas/air fired glass furnaces

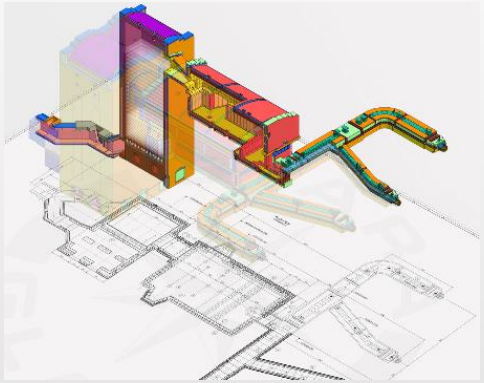
Regenerative (End Port) Furnaces

Furnaces where waste gas and combustion air alternatively use the same path, releasing and getting heat from the refractories they contact.

Benefits:
- Significantly lower consumption

Limits:
- Vertical space requirements
- Working discontinuity

Combustion air thermal recovery:
- 1100 – 1300°C
- Waste gas heat recovery: ≈ 65%



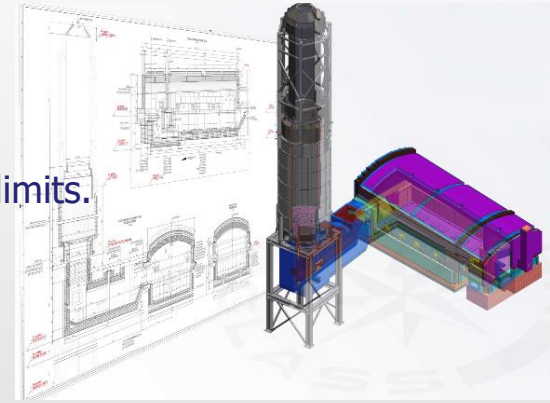
Recuperative (Unit Melter) Furnaces

Furnaces where waste gas and combustion air continuously pass through separate paths, directly exchanging heat through the separating metallic surfaces.

Benefits:
- Lower earlier investments
- Working continuity

Limits:
- High consumption due to metal technical limits.

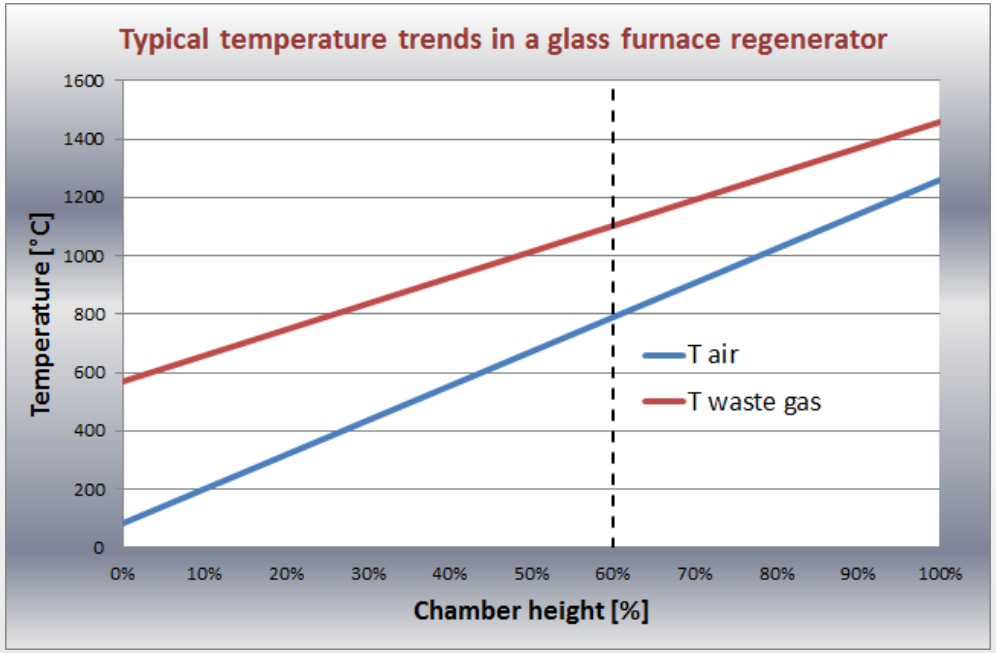
Combustion air thermal recovery:
- 500 – 800°C
- Waste gas heat recovery: ≈ 40%



In order to produce the glass type, at the same pull, a recuperative furnace has fuel consumption about 30-35% higher than a regenerative one.

Unit Melter (recuperative) furnaces, the performance is strongly penalized by high waste gas exit temperature, about 400°C higher than in regenerative furnaces, and by preheated air temperature, about 500°C lower.

The idea behind the concept of Centauro

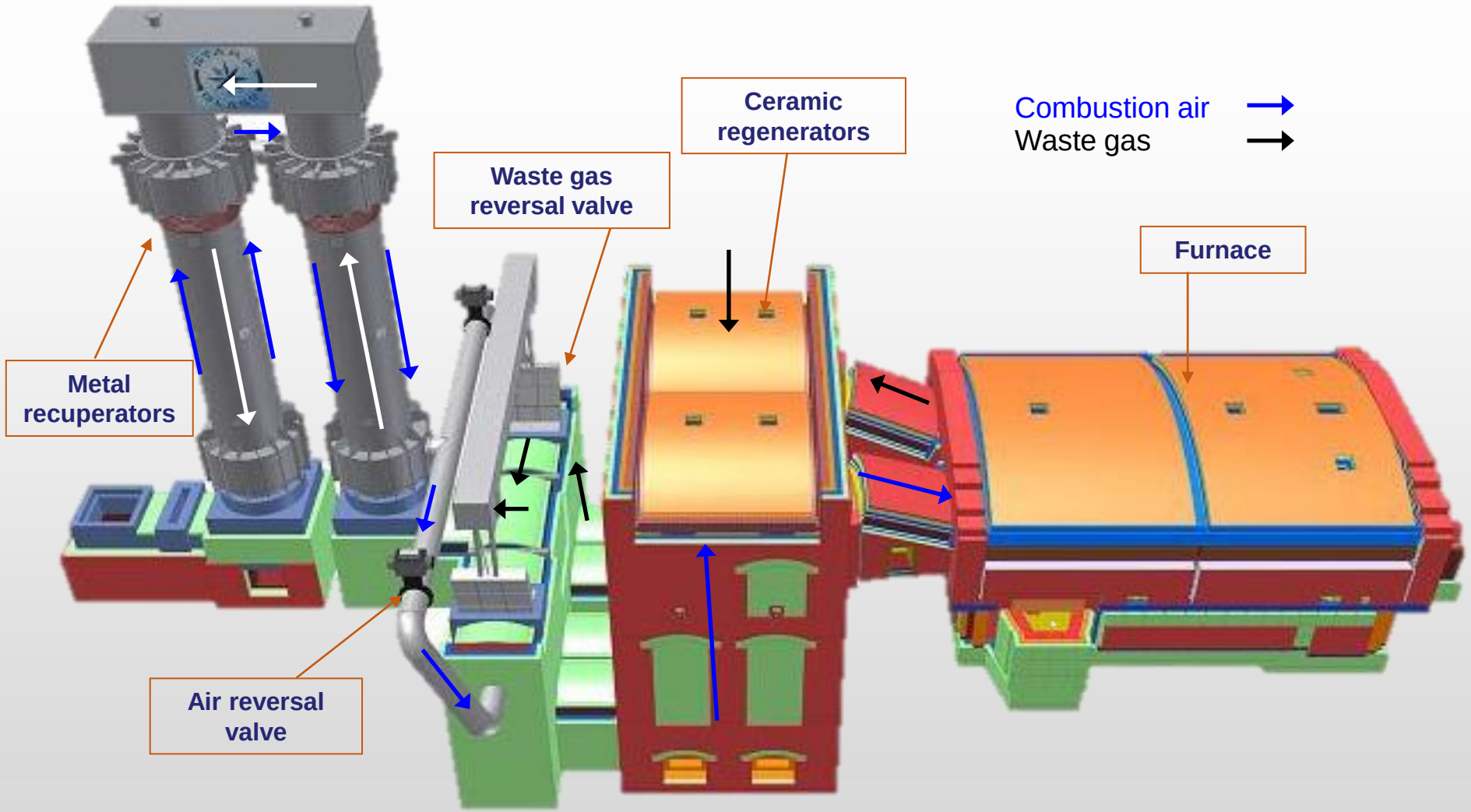


TYPICAL TEMPERATURES PROFILES ALONG A CERAMIC REGENERATOR

An observation of the air and waste gas temperatures profiles in a regenerator of an End Port furnace, shows how for a large part of the height (about 60%) the regenerator works at a preheated air temperature lower than 800°C.

It is subsequently possible to achieve that an important part of the heat exchange can be achieved by a simpler and more flexible metal heat exchanger, that substitutes the lower part of regenerators.

Centauro elements and flows



Combustion air →
Waste gas →

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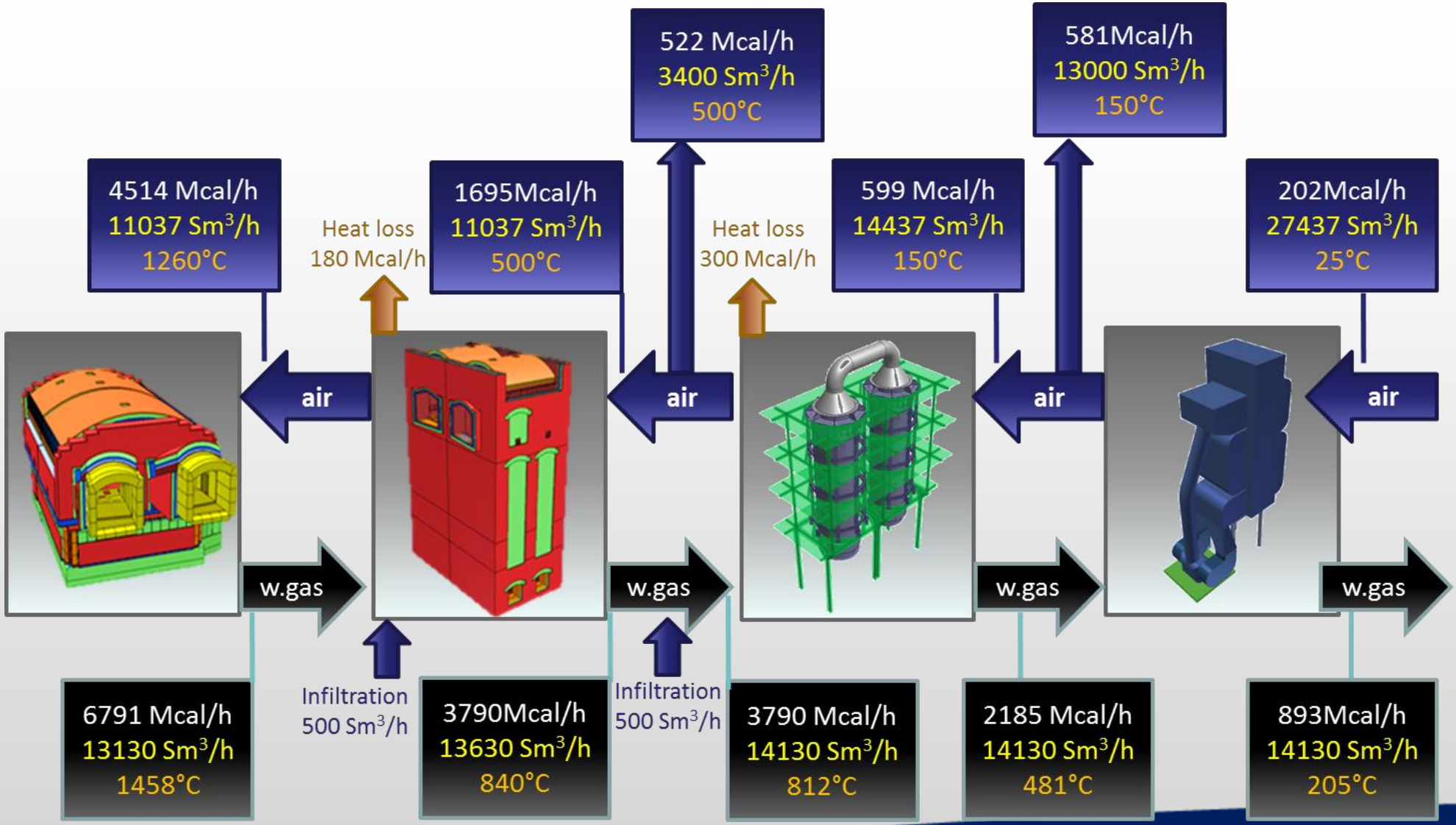
Centauro additional hot air

CENTAURO offers an important chance to improve the global efficiency of the glass production plant.

By oversizing metal heat recovery system in order to allow the flowing of a superior amount of air than what is requested for the combustion, and taking out the air excess before the refractory section of the system, it is possible to **extract an important additional part of the thermal energy stored in waste gas, reducing its temperature to the lowest required level** (usually about 200°C, to avoid acid condensation, instead of about 500°C, typical of a regenerative furnace or 800°C and more for recuperative furnaces). This way **the additional energy will be available as an hot clean air flow**, easily extractable at the end of each stage of the metal part of the recovery system, that can be useful both in process and in services.

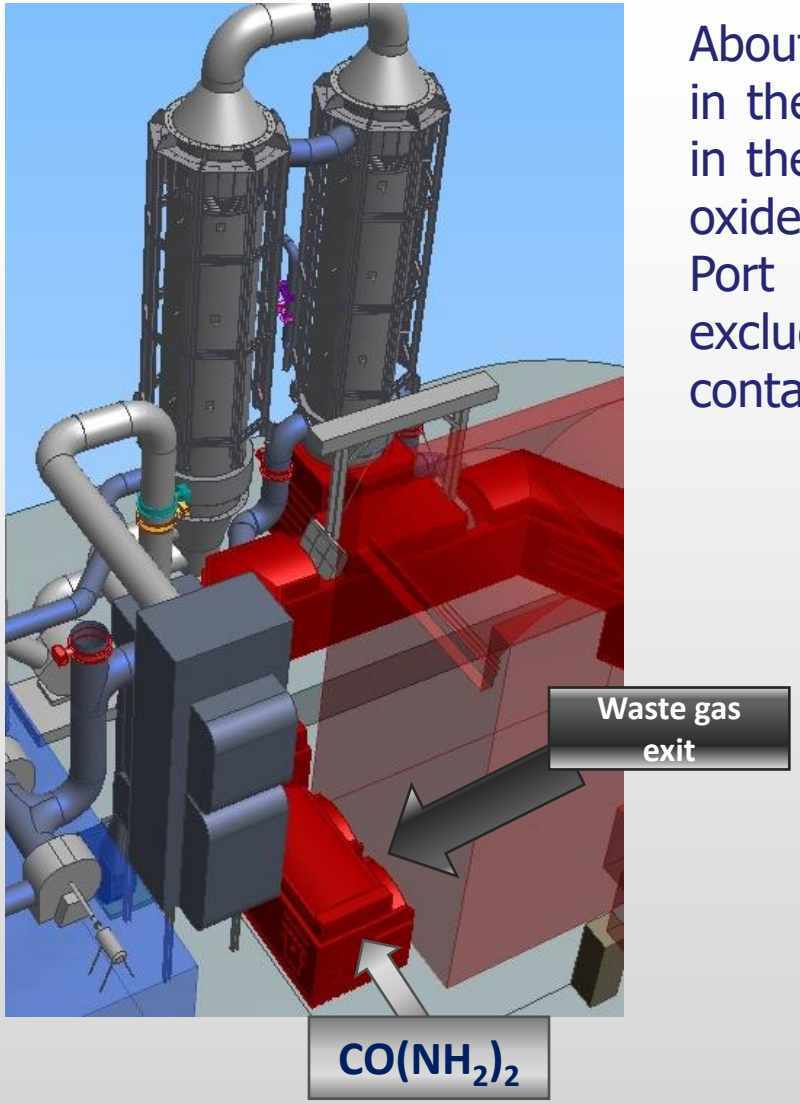
In the red circle on the side, the pipe to extract the air excess at the end of the hottest metal heat recovery stage of a Centauro system, photographed during the construction of the plant.

Typical temperature, flows and energy profile of Centauro, including additional hot air



In order to optimize the thermal exchange in lower temperature zones, it is usual to add a convective heat exchanger to the radiating ones. This kind of component guarantees a high efficiency at low thermal levels and a noticeable design flexibility, and its physiological stops for maintenance and cleaning, thanks to a proper bypass system, penalize the plant efficiency only for a few percent point, commonly for a few days a year.

Centauro SNCR system



About **NO_x abatement**, Centauro thermal profile can be designed in order to have, in the waste gas duct that connects regenerators and recuperators, a temperature in the window of **850-950°C**, that allows the non-catalytic abatement of nitrogen oxides, by the injection of ammonia or, more conveniently, urea. In traditional End Port furnaces this window remains inside the regeneration chambers, actually excluding the possibility of using a SNCR system and imposing, for nitrogen oxides containing, the usage of a more expansive and complicated catalytic system.

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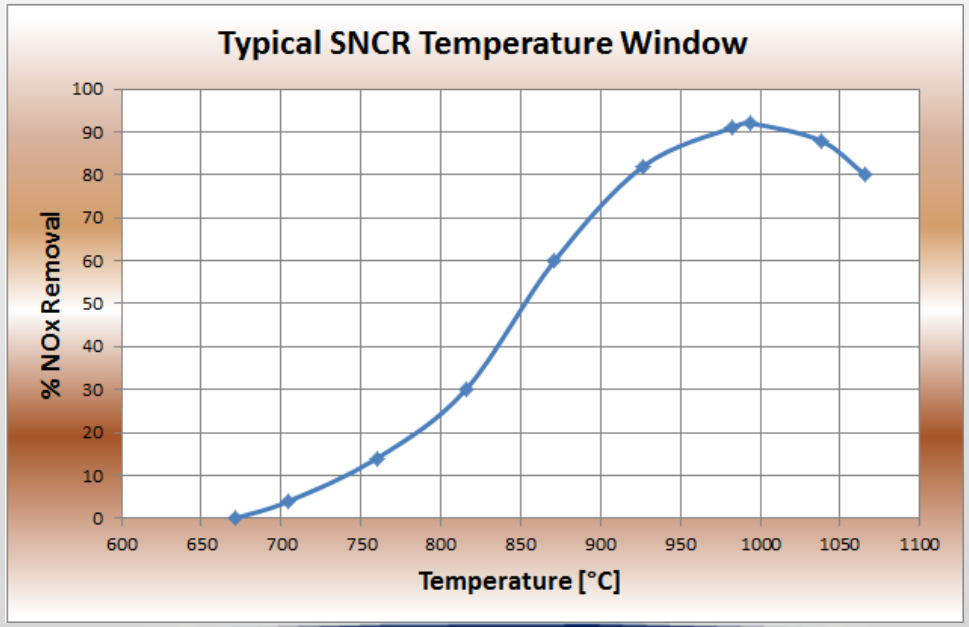
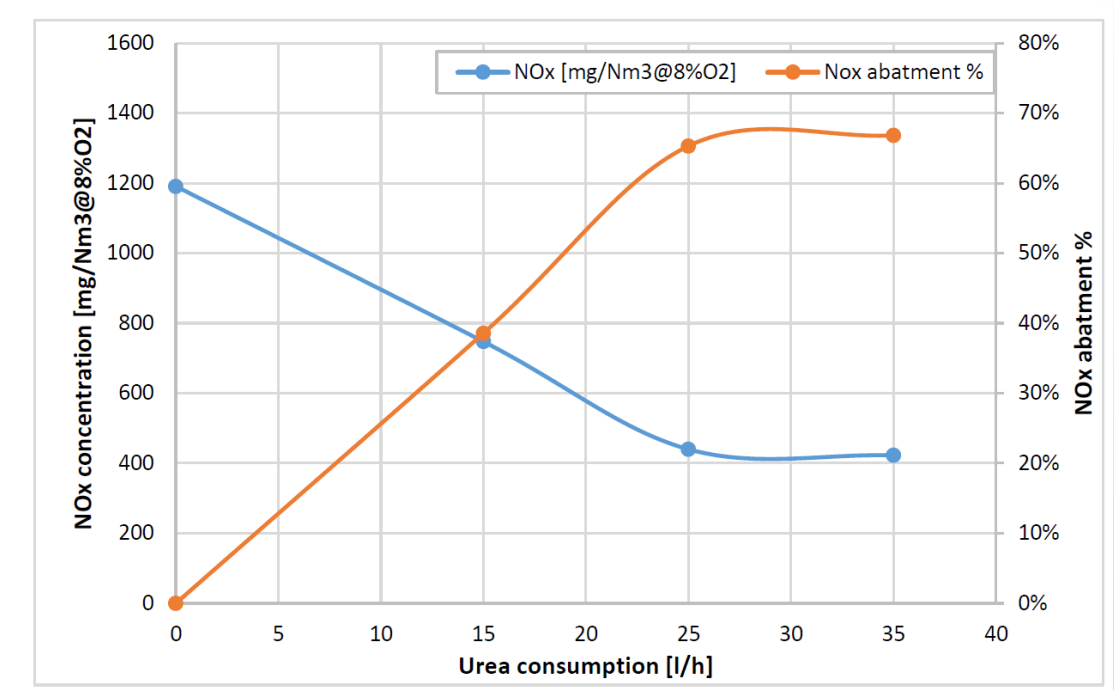


Centauro SNCR system: abatement exaple

	NOx [mg/Nm^3@8%O2]			NOx abatement %		
Urea [liter/h]	Flame Left	Flame Right	AVG	Flame Left	Flame Right	AVG
0	1150	1232	1191	-	-	-
15	725	770	747,5	37%	40%	39%
25	400	480	440	65%	65%	65%
35	395	450	422,5	66%	68%	67%



Centauro solidity

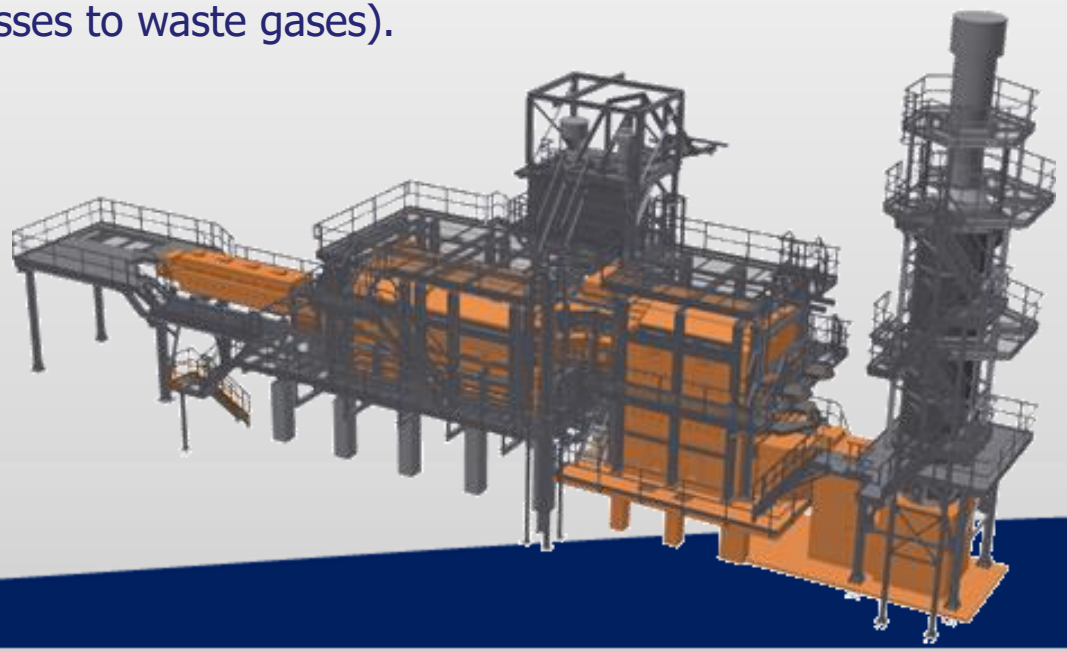
Centauro is a **Stara Glass patented** innovative glass furnace with a **hybrid regenerative/recuperative heat recovery system**.

Centauro is a **new conception** furnace which **uses consolidated** and **field tested technical solutions:**

- **Metal Recuperators** work in a less severe conditions than in a common *Unit Melter.*

- **Regenerators** in the top part (high temperature zone) work exactly as standard End Port ones, while in the bottom part they work at higher temperature conditions than in a standard End Port furnace, allowing the reduction or elimination of sulphates condensation (depending on regenerator height), with consequent lower losses in performance and elimination of related problems.

- **Reversal valves** for high temperature application guarantee the **highest reliability and duration** in time together with high seal performances (reduced air losses to waste gases).



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Centauro key features

Centauro system guarantees **at least** the performance of a well dimensioned End Port furnace with some additional **advantages**:

- Flexibility in lay-out
- Reduced depth of regenerators
- **SNCR system**
- Better working conditions of regenerators (higher thermal homogeneity / reduced condensation)
- Reduced cleaning period during reversal phase
- Clean hot air stream available (additional free thermal power)
- Flexibility in temperature *cut* level between regenerative and recuperative cycles

Centauro is a new conception furnace with high thermal performances united to geometrical advantages, that gives an **important chance** for **rebuilding / converting / empowering** a furnace, minimizing the surrounding impacts and costs.

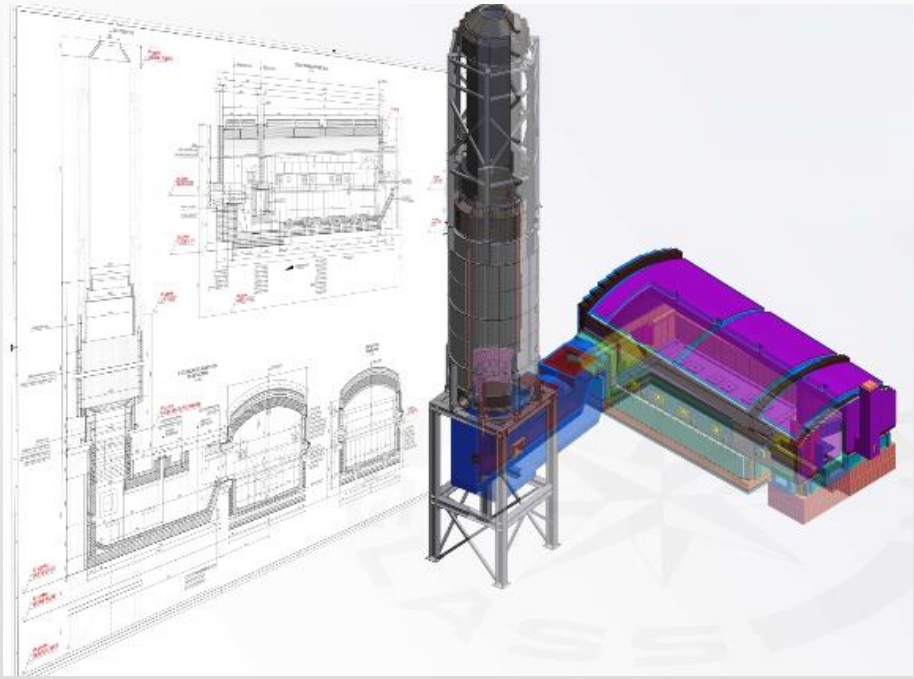
Unit Melter conversion

The main problems/limitations that arise for a **Unit Melter to End Port conversion** are typically:

- Lack of technical space needed for realization
- Construction time
- Civil works investment
- Furnace investment
- Presence of ground waters

With **Centauro** it is possible to:

- Reduce regenerators height and excavations
- Modulate regenerators height based on actual needs
- Choose and optimize the position of metal recuperators in the existing layout of the plant



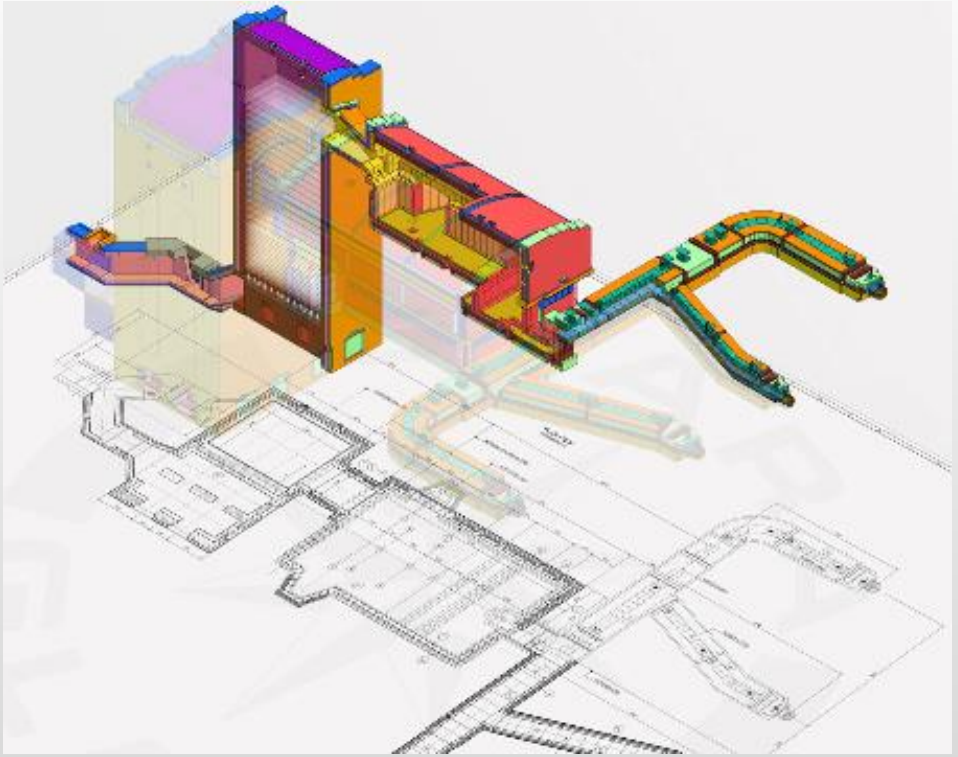
End Port optimization

Enlargement of EP furnace: for increasing productivity, often an enlargement of the heat recovery system is not allowed by layout constraints, requiring huge civil works. Often the subsequent decision is to increase the pull through the addition of an electrical booster system (high operational costs).
The flexibility of Centauro often allows to find a **winning solution**.

End Port furnaces with double pass chambers: Centauro allows the **elimination of second chamber** and of all the well-known related problems.

End Port furnaces with checkers with undersized height: Centauro allows to improve the heat recovery system **significantly reducing the amount of civil works**.

End Port furnaces with checkers of undersized section: in case of necessity of increasing the productivity with constraint on modification of the chambers geometry, Centauro allows to modify checkers' geometry **reducing waste gas velocity in the checkers** and **moving a part of the heat recovery to the metal recuperators**.



Centauro: real case 1

DOUBLE PASS END PORT CONVERSION

The **Bormioli Luigi furnace** in **Abbiategrasso (Milan – Italy)** represents the first example and real case of the advantages that Centauro can offer.
The furnace, that produces extra-white perfumery ware, has been built by **Stara Glass** making a complete conversion and rebuilding of a formerly double chambered End Port.
To obtain the pull requested by the customer, **the regenerators pit wasn't deep enough (-3000 mm) to allow the construction of a performing single pass regenerator**, while the rebuilding of a double pass regenerator was expensive and technically not satisfactory for the company.

A deeper excavation being disadvantageous in the location, while the company was already resigned to installation of a multiple chambers furnace, Stara Glass' proposed the **Centauro solution**.
The Centauro system was designed and optimized, using the existing height of regenerators and eliminating the second pass, substituted by a properly dimensioned metallic part. **The important reconstruction savings joined the significant energy savings deriving from this solution, due to the higher energetic efficiency achieved in the heat recovery system**.

Centauro: real cases 2 & 3

UNIT MELTER CONVERSION

The **O-I furnaces in S. Polo (TV - Italy)** represent the second and third examples and real cases of the advantages that Centauro can offer.

The first converted furnace, that produces colored glass for container, has been built by Stara Glass on an formerly Unit Melter furnace, which had to be completely rebuilt.
Due to the land situation, a deep excavation for a transformation to traditional End Port technology was considered not applicable.
Stara Glass' technicians proposed to solve the problem with a Centauro, with the target to limit at minimum the excavation work. The design choice of the system allowed to have a **bottom floor of regenerator only 1,5 m below machine floor.** The glass production started in May 2011 and the **saving aspects deriving from this solution resulted hugely significant**, keeping same productivity of previous furnace.
O-I plant managers, according to a suggestion by Stara Glass engineers, decided to use the hot air excess to warm the factory.
After 3 years of operation, O-I decided to convert to Centauro another Unit Melter furnace that was present on the plant, thus achieving the same extremely brilliant results.

Centauro: real case 4

UNIT MELTER CONVERSION

The **Seves Vitrablok furnace (Duchcov – Czech Republic)** represents the fourth example of the advantages that are offered by a Centauro system.
The plant produces glass brick, a production that requires a very good refining. The system has been built by Stara Glass as a complete rebuilding of a unit melter furnace. The savings that derived from the application of Centauro technology resulted extremely significant and the required high quality has been obtained.

GREENFIELD CENTAURO

The **Vetreria Etrusca furnace (Altare – Savona, Italy)** represents the fifth example of the advantages that are offered by a Centauro system.
The plant, that produces special and high quality bottles, represents the **first Centauro that has been built from the greenfield: the glass makers have in fact chosen this solution for its energy and environment advantages** (SNCR system in particular), and not for the opportunity of easily converting another type of furnace. The high production quality standards of the plant have been met by the Centauro technology.

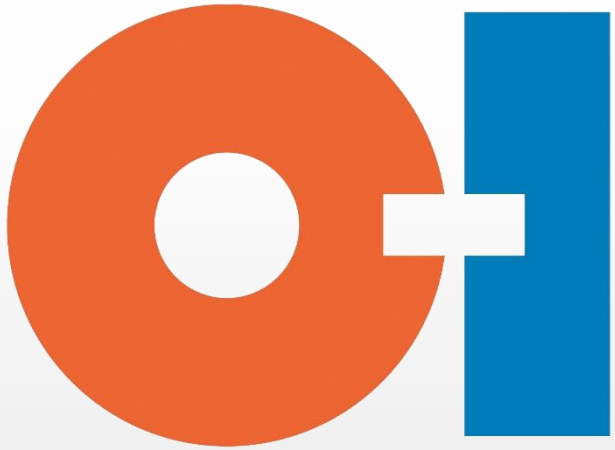
Centauro: real case 6

UNIT MELTER CONVERSION

The **Vetrerie Riunite furnace (Colognola ai Colli – Verona, Italy)** represents the sixth example of the advantages that are offered by a Centauro system.
The plant produces washing machine port-holes and high quality tableware, a production that requires a very good refining. The system has been built by Stara Glass as a complete rebuilding of a unit melter furnace.
The savings that derived from the application of Centauro technology resulted extremely significant and the required high quality has been obtained.

8 Centauro furnaces are currently installed and operating

Centauro references



SEVES

Vetrerie Meridionali

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