Strategic waste gas recurculation

A simple and effective primary NO_x containment technique
for regenerative glass furnaces

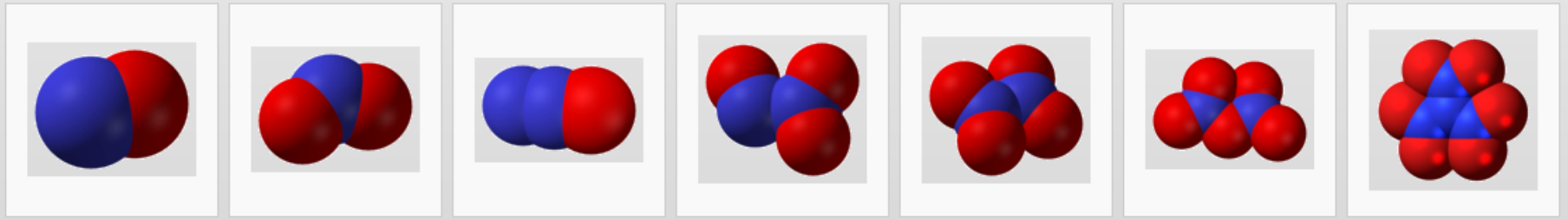
S.W.G.R. - Background

Nitrogen oxides are atmosphere pollutants and it is believed that they aggravate the conditions of people suffering of asthma. Some of them, in presence of solar radiation, can react with oxygen forming ozone and other compounds of the so called photochemical smog, if in presence of unburned hydrocarbons (HC). Nitrogen trioxide and pentoxide can form nitrous and nitric acid, responsible of *acid rains*.
To protect environment and life, the legislation on industrial NOx production is worldwide becoming more and more restrictive.

The two conditions that increase the NOx production in a combustion are:

- **Oxygen concentration**
- **High temperature**

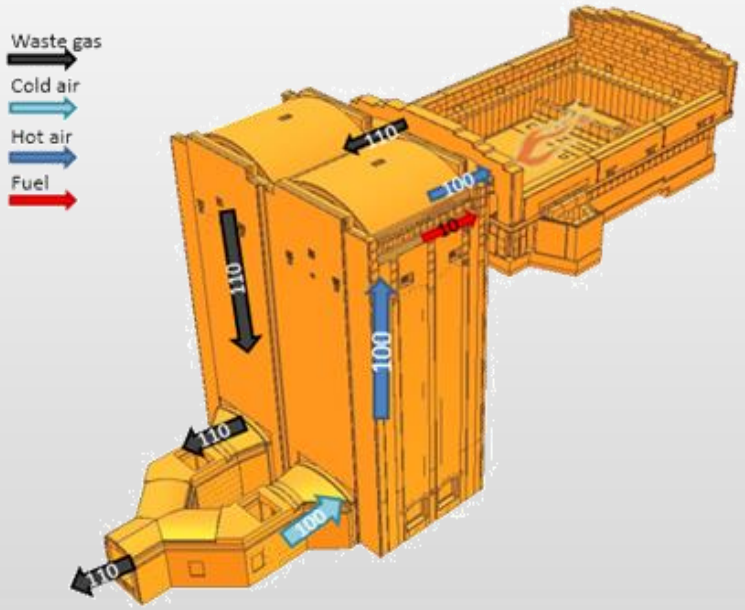
Very high temperature combustions, like the one happening in a regenerative furnace for glass production, where combustion air is preheated beyond 1200°C, generate high concentrations of **thermal type NOx**. It is scientifically known that a combustion, even at very high temperature, if it is developed in **ambient that presents an oxygen concentration which is lower than the 21% atmospheric one, will produce a lower amount of NOx**. In different industrial fields, it is very common to lead a part of combustion gas flow inside the combustion air flow, in order to reduce oxygen concentration and, consequently, NOx production.



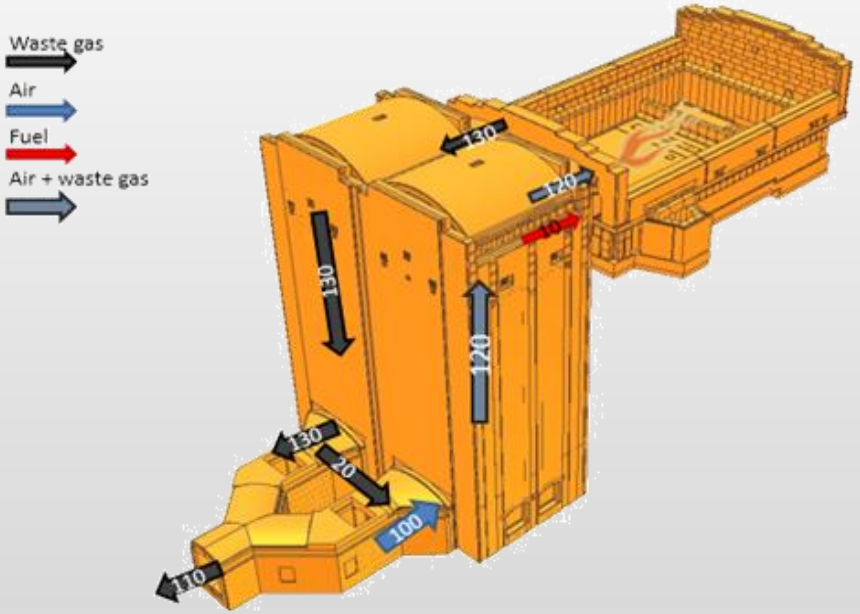
Strategic waste gas recirculation

Stara Glass developed a method that allows to **apply the waste gas recirculation technique to regenerative glass furnaces** (the state of the art of glass production), maximizing the benefits of this technology: if the recirculation is performed in the zone at the bottom of regenerative chambers, beyond conveniently limiting the oxygen level in the combustion zone, molecules of CO2 e H2O are introduced in the combustion air flow. These molecules, characterized by a polarity, allow the flow to receive heat for radiation, with the effect of **maximizing chamber efficiency (+40/60°C – field results**).

Common end-port furnace



Strategic waste gas recirculation

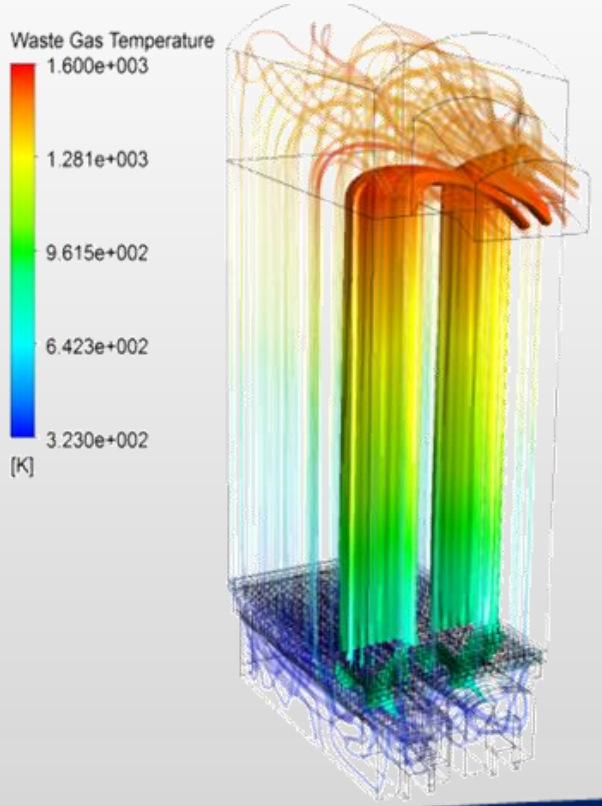


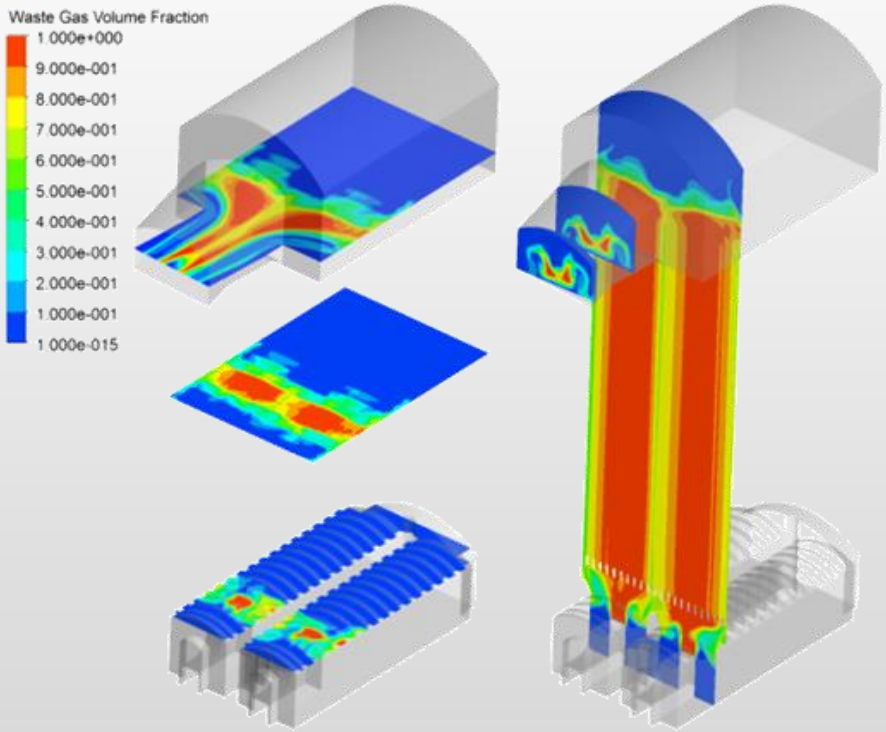
The reported numbers refer to air flow percentages and they ae purely indicative

SWGR: *why "strategic"?*

Within the Prime Glass project (www.primeglass.it) , many CFD studies have been performed and a technique has been developed to make the computing and the field tests comparable, and we have been able to come to an interesting conclusion: since the air and the air + recirculated waste gas flows in the chambers follow quite even paths, such as shown in the images, it is possible to **modulate the injection of waste gas inside the air flow between two different strategies**:

- Bringing the lowest oxygen concentration at the bottom of the port, and therefore achieving the highest abatement
- Distributing the flow in the chamber in a more uniform way, and therefore optimizing the chamber efficiency increase.

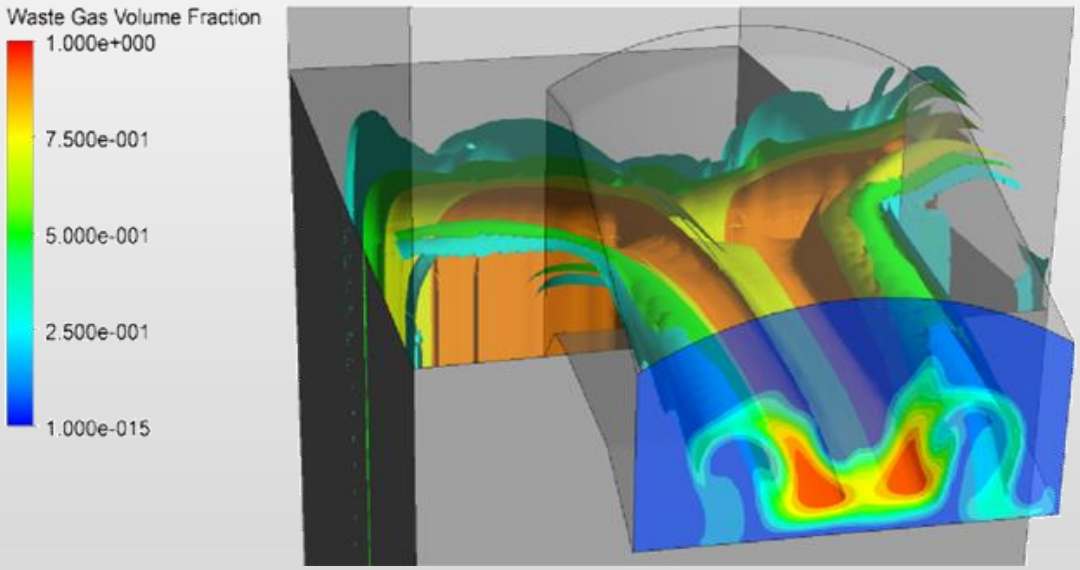




SWGR: plant

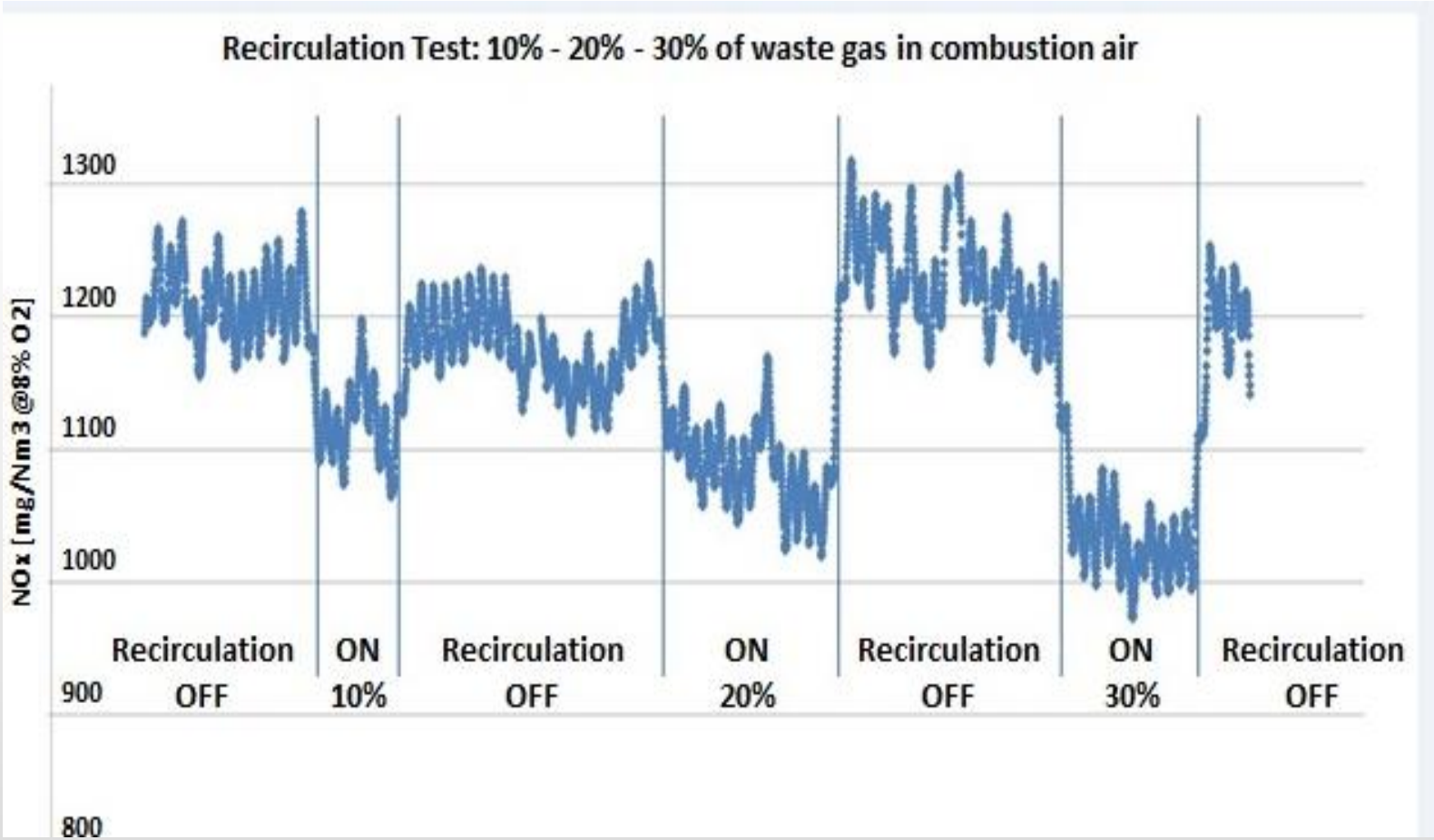
The system, that is custom-designed and **CFD-optimized** for every installation, and **can be installed on operating furnaces**, consists of:

- High temperature fan for gas extraction,
- High temperature reversal valves,
- Insulated and/or protected piping,
- CFD optimized nozzles/fins,
- Control panel connected to the furnace control system.



SWGR: abatement results

For reasons connected to the chemistry of the thermal NOx generation, the quota of recirculated gas is almost directly proportional to the abatement levels and therefore, **the abatements raise as much as we push the recirculation**, which we can do up to the limits the velocities inside the checker packs recommended by the checker producers.



The obtained abatement levels have been > 35%.

Plants / References

The SWGR technology has been used for:

- **Bormioli Rocco** (2 plants)
- **Vetropack**
- **Vetri Speciali**

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