Advantages of a periodic anamnesis of glass furnaces

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The pursuit of well-being

STARA GLASS

Sustainable technology, innovative solutions

SGRPRO

The science behind the glass

A Hydra Group Company

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The pursuit of well-being

No matter what if you are a human being or an industrial system, the purpose is common, and always the same:

“…you have to function as best as possible…”

The pursuit of well-being – WHY & WHEN:

Western “why”:

“…I go to the doctor when I'm sick to get back to feeling well…”

Eastern ”why”:

“…I go to the doctor when I feel well to avoid feeling sick…”

The Western way focuses on the symptoms to be treated while the Eastern way tends to maintain balance and the state of well-being for as long as possible.

Western “when”:

EMERGENCY

Eastern ”when”:

PREVENTION

The pursuit of well-being – Back to the furnaces:

EMERGENCY

- Fault
- Lost production
- Higher intervention costs
- Higher repair costs
- More impactful interventions

PREVENTION

- No fault
- No lost production
- Lower intervention costs
- Lower repair costs
- Less impactful interventions

SAVINGS

Heat Balance

The furnace anamnesis will enable you to:

1. **Check the general plant conditions.**
2. **Maximize performance, in terms of consumption and quality.**
3. **Identify strength and weakness of the furnace.**
4. **Check the instruments installed on the plant.**

Heat Balance

The purpose of calculating the heat balance of the furnace is precisely **the detailed analysis of all the energy contributions entering and leaving the plant,** validated by verifying the energy balance equation.

...
End-port

Main data	
Pull [t/day]	**320**
Melting area [m2]	**100**
Boosting [kW]	**700**
Cullet %	**70**
Specific pull [t/m2day]	3,2 (3,03 fuel)
Preheated air temperature [°C]	1280

Glass temperature at the throat [°C]	1380
Furnace waste gas outlet temperature [°C]	1540
O2 excess at the port [%]	1,5
Room air temperature [°C]	25
Mix humidity %	3,5

Fuel: CH4 = 1 ; Dense oil = 2 ; CH4-Oxy = 3	1
NCV [kcal/Sm3]	8200

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Heat balance

Input heat	kcal/kg	GJ/ton	Gcal/h	%
Fuel	842	3,525	11,226	94,1
Electrical power	45	0,189	0,602	5,0
Air	8	0,034	0,108	0,9
Total input heat	**895**	**3,748**	**11,936**	**100,0**
Output heat				
Glass	439	1,840	5,859	49,1
Chemical reactions	41	0,173	0,551	4,6
H2O evaporation	22	0,093	0,296	2,5
Waste gas and leakage	248	1,039	3,309	27,7
Holes and air leakage	6	0,026	0,082	0,7
Thermal loss	138	0,578	1,840	15,4
Total output heat	**895**	**3,748**	**11,936**	**100,0**

Fuel [Sm3/h]	**1369,0**	± 5%
[Nm3/h]	**1297,7**	± 5%
Specific consumption [kcal/kg]	**887**	± 5%
Specific consumption [GJ/ton]	**3,714**	± 5%
Specific useful heat [Mcal/m2h]	69,2	± 5%

This table represents the typical output of Stara Glass activities of heat balance detection and furnace design. In fact, FurnaceMaster©, Stara Glass furnace design software, is a physical model mirroring the one used for heat balance detection. The specific useful heat is the ratio between the heat fuel yields to the melting glass and the melting area. This parameter gives more solid indications than specific pull (ton/m2day), since it is also affected by boosting and cullet utilization

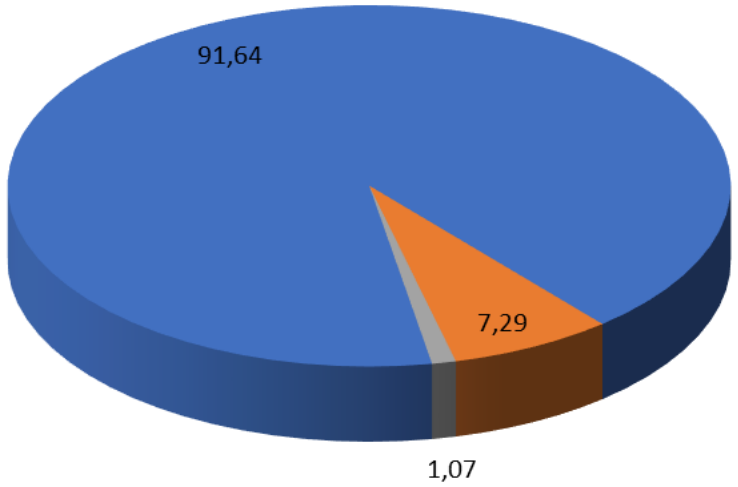
Heat Balance – Input & Output

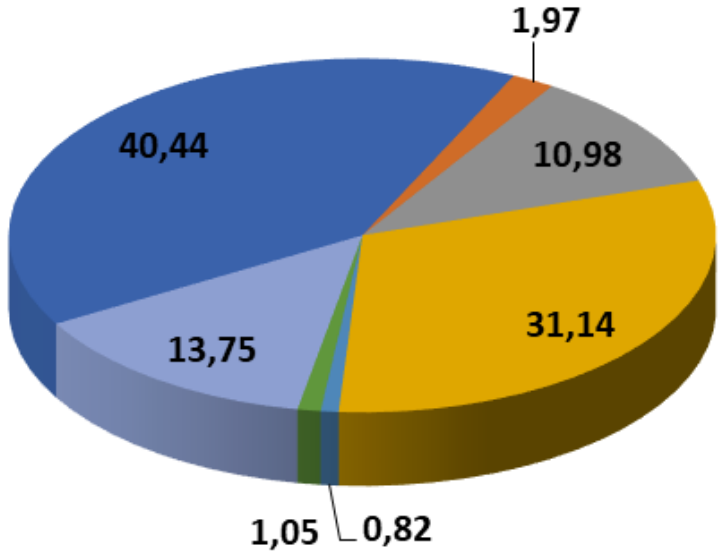
INPUT

- Fuel
- Electric boosting
- Air
- Row material chemical composition
- Batch humidity
- Cullet

OUTPUT

- Glass
- Chemical reactions
- Water evaporation
- Waste gas
- Holes and leakages
- Thermal loss





$$\boldsymbol{Heat\ Balance} = f(\boldsymbol{Input}; \text{Output; Laws of conservation of mass and energy})$$

Field measurements

1. **Pressure**

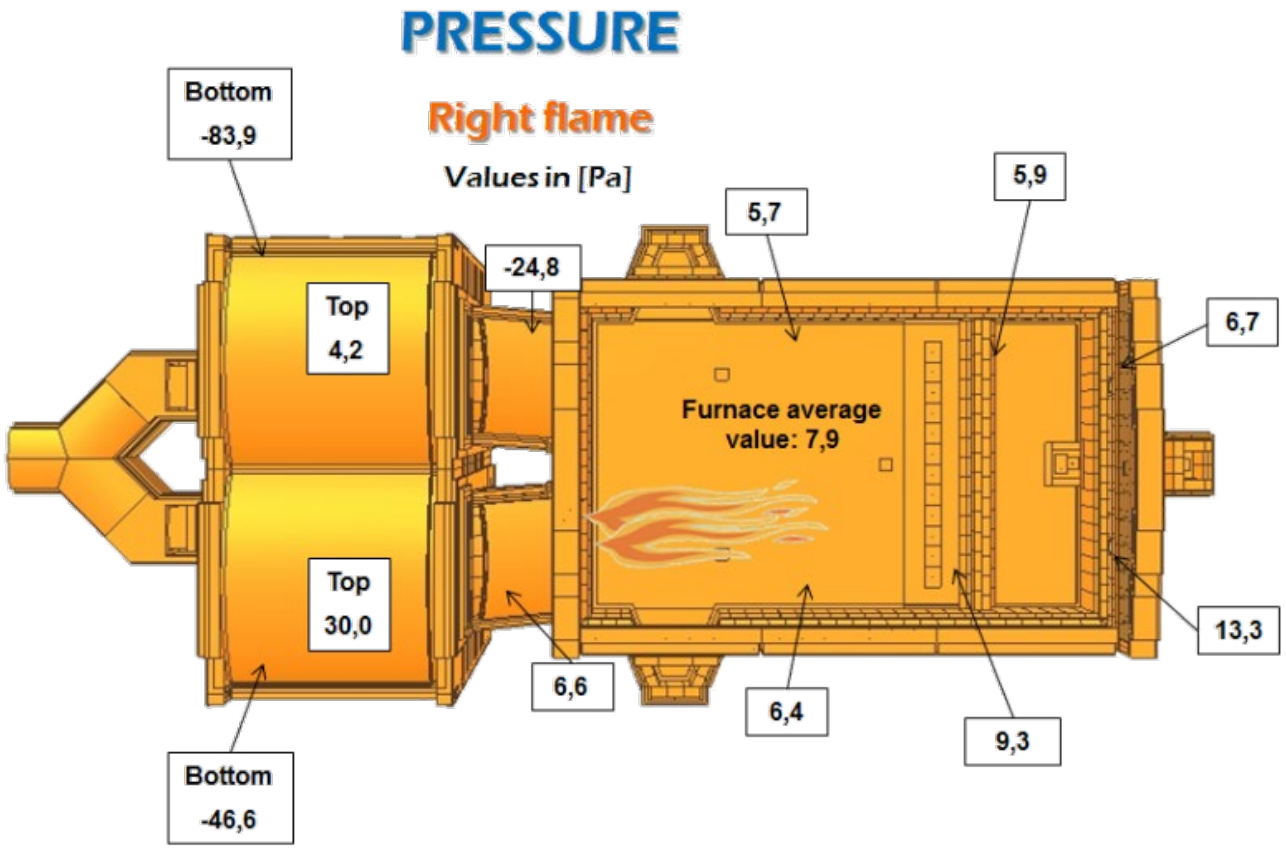
2. **Temperature**

3. **Chemical analysis**

4. **Thermography and other measures**

Measurements: Pressure

It is the first parameter that is measured because it immediately returns very useful information on:

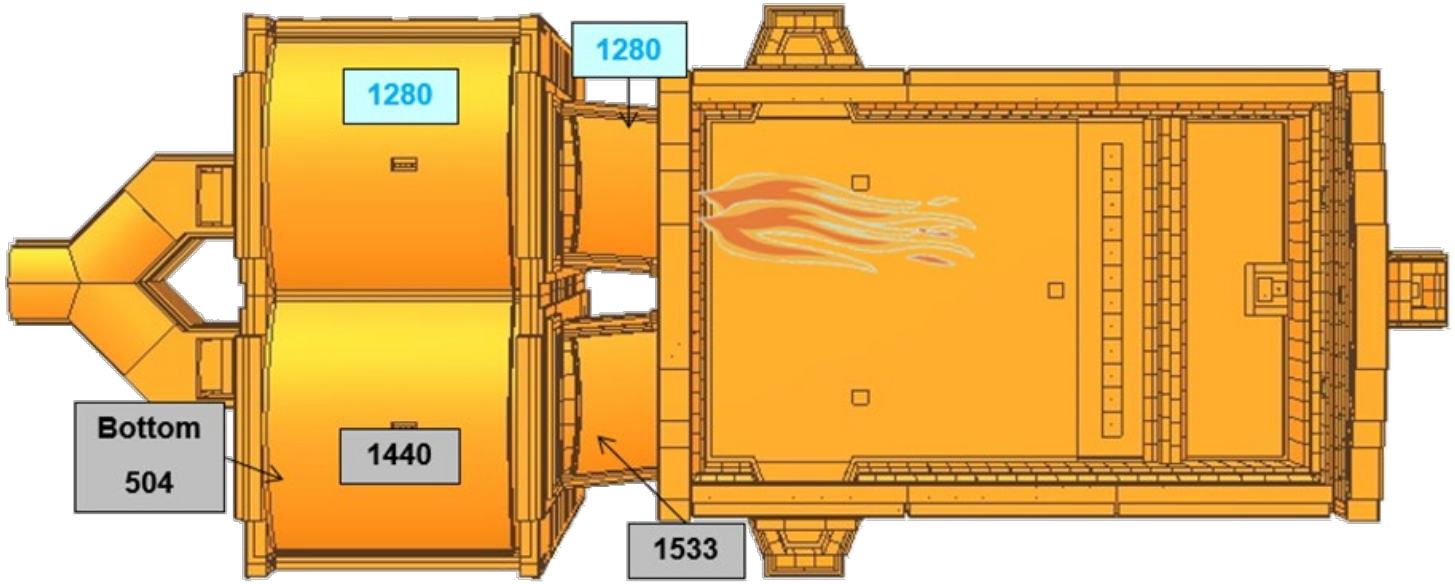


- Furnace stability
- Symmetry
- Heat recovery system anomalies

Measurements: Temperature

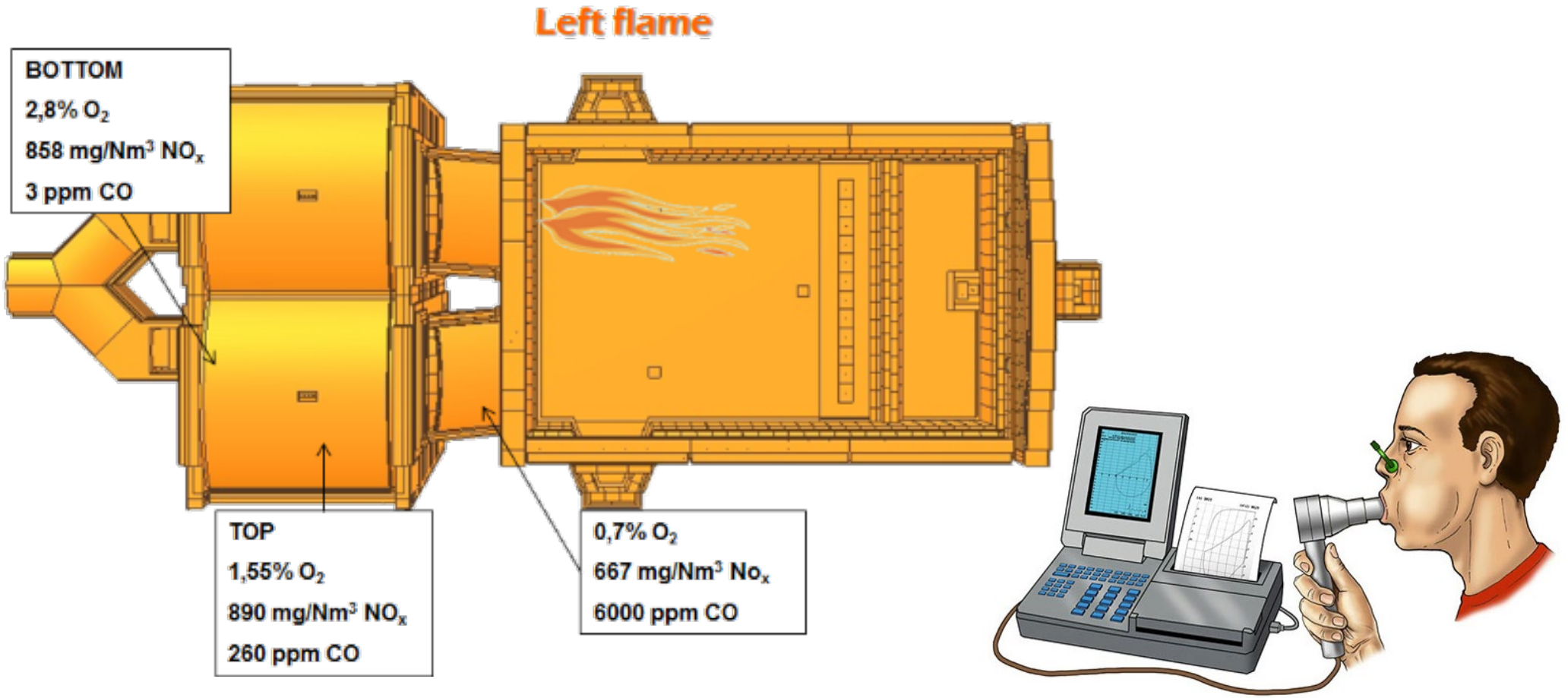
The measured data are considerably more precisely than plant equipment.

Temperature measurements enable you to test the heat recovery system and furnace performance.



Measurements:
Chemical analysis (O2, CO, NOx)

The procedure foresees the sampling of O2, CO and NOx concentrations at the furnace exit, in various points of the heat recovery system and in ducts.



Thermography and measurements:

The following measurements are also taken:

- **Oxygen percentage** in waste gas under different conditions of furnace pressure set point, to evaluate the furnace permeability.

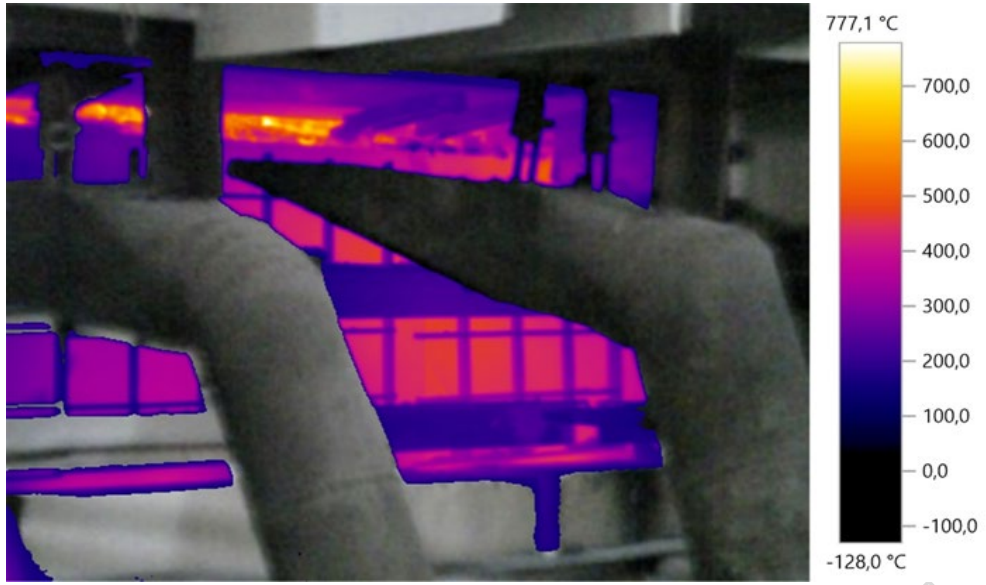
- **Flow and temperature of cooling waters**, for a proper balance closure.

- **Mix humidity** and other functional parameters.

- Thermography; the crucial check:

Coupling a thermography with an energy balance allows to:

  - **See relevant points of infiltration**
  - **Detect hot-spot**
  - **Evaluate the performance of air-cooling**: this image speaks more than words.



Thermographic image mixed with its photographic twin

Benefit examples

...the devil hides in the details…

Customer #1

The correction of air/fuel ratio made the company save 70.000 €/year for natural gas and significantly reduced NOx production.

Customer #2

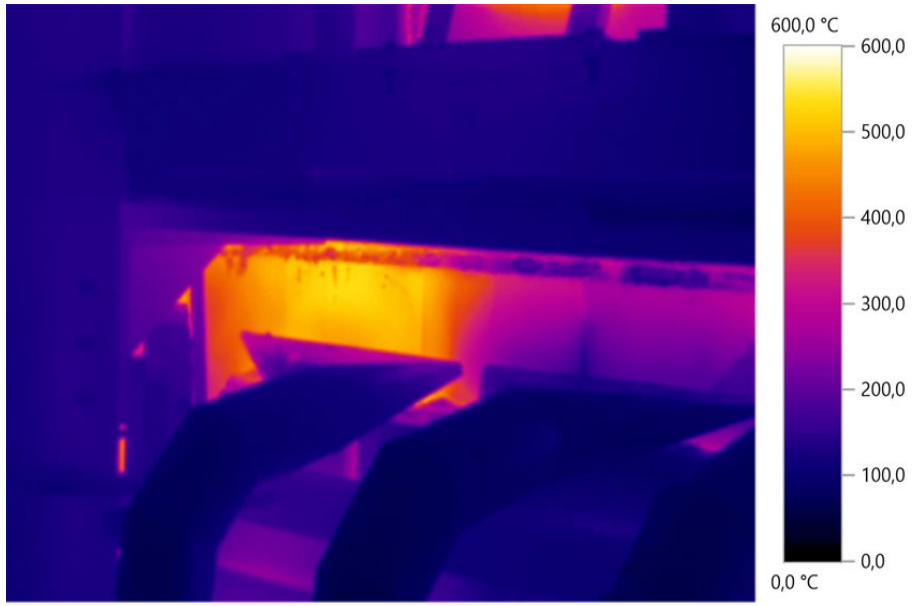
The pressure tuning and a sealing operation preserved the furnace from the cold air infiltration saving 120.000 €/year for natural gas.

Customer #3

The analysis of the insulation allowed to optimize the next campaign design and saved 130.000 €/year for natural gas.

Benefit examples

...the devil hides in the details...



Customer #4

The thermographic analysis showed the cooling system was not correctly operating. The corrective action extended the life expectation of the furnace and with a related saving we'll let you estimate.

Customer #5

During the activity we found a severe problem of regenerator plugging happened too early in the furnace campaign. The observation of drawing and the detected measures pointed out a mistake in regenerator design. While the furnace was an end-port, the regenerator appeared to be more side-port-like.

The customer did a checker cleaning operation, plus the installation of a SWGR system (Stara Glass's patent), that is meant to primarily contain NOx, but it also has the effect of increasing the volumes of fluids evolving inside the chambers, thus increasing the velocity homogeneity.

Evolution of the activity

The heat balance analysis we are currently providing considers all mass and thermal power inlets and outlets of the thermo-dynamical control-volume constituted by furnace up to the throat and heat recovery system.

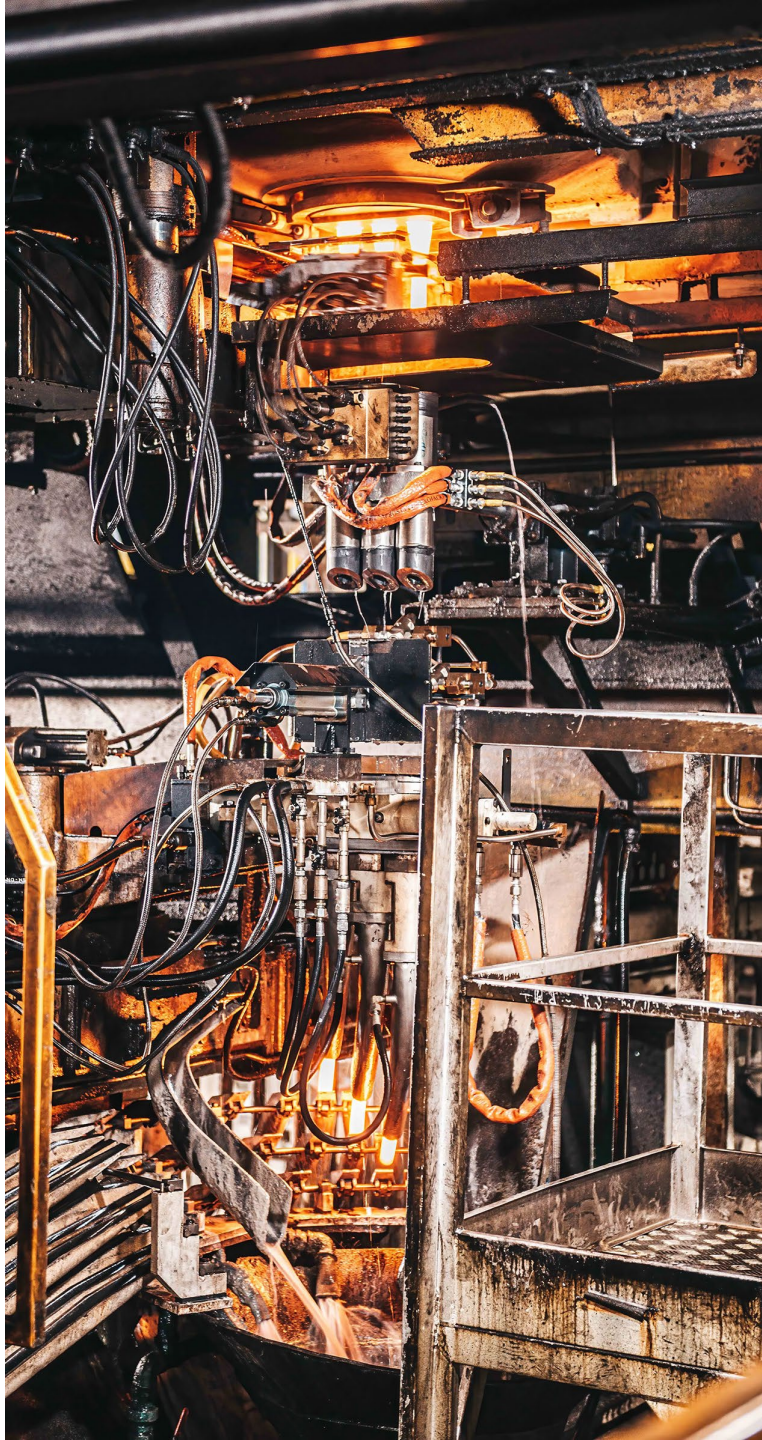
We are in the process to improve the service to analyze a wider system, including working end / forehearths and furnace equipment, like fans, cooling systems, etc., in order to move from a systemic approach to an holistic one.

Even if a regenerative furnace is a very efficient device (about 70% fuel efficiency), in an average furnace, **around 2-3 MW of thermal power is lost with the fumes.** This quota can be recovered and used outside the production process. The heat balance calculation determines how much power and under what conditions this heat is available, so that we can aggress it with the most proper recovery system.

Conclusion

As our doctor would say to you:
It is critical to assess the furnace health condition on a frequent basis, because furnace optimization can result in significant energy and emission reductions together with a life extension, with the related economical savings.

Prescription:
The activity is recommended to be conducted at least twice for each furnace campaign. We recommend every glass producer to periodically check its furnace park: the average consequent savings are way more relevant than the cost of the operation.



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