AIR LIQUIDE

Creative Oxygen

Reducing Energy Consumption with innovative technology

Air Liquide's Heat Oxy-combustion :

An Innovative Energy Saving Solution for Glass Industry

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Life

ŞİŞECAM

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Market Trends & Needs

Statement with glass

- Reinforced regulations on hazardous emission and carbon footprint
- The melting representing 60 to 80 % of total energy consumption
- Demand in term of short payback time

Ambitions

Cost savings and efficiency

- **Energy reduction**
- NOx and CO_2 emissions reduction
- **CAPEX** <3 years payback

Oxygen and natural gas preheated at high temperature

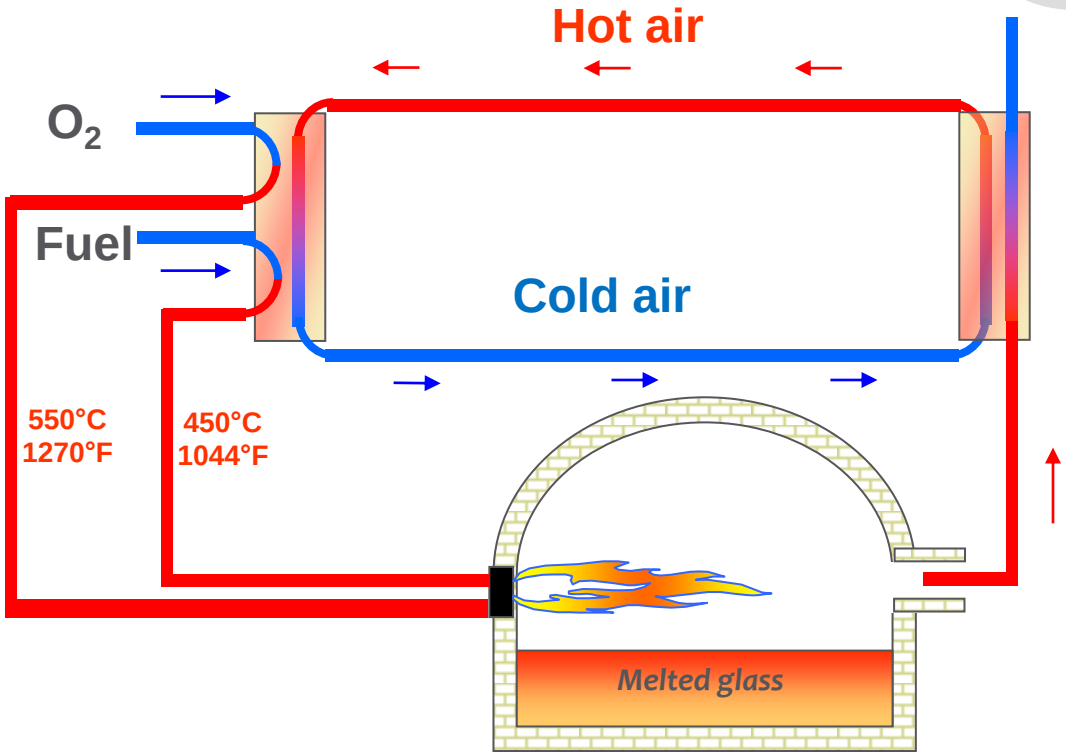
Air Liquide's Heat Oxy-combustion (HeatOx)

GREEN SOLUTION

NOx & CO2 reduction

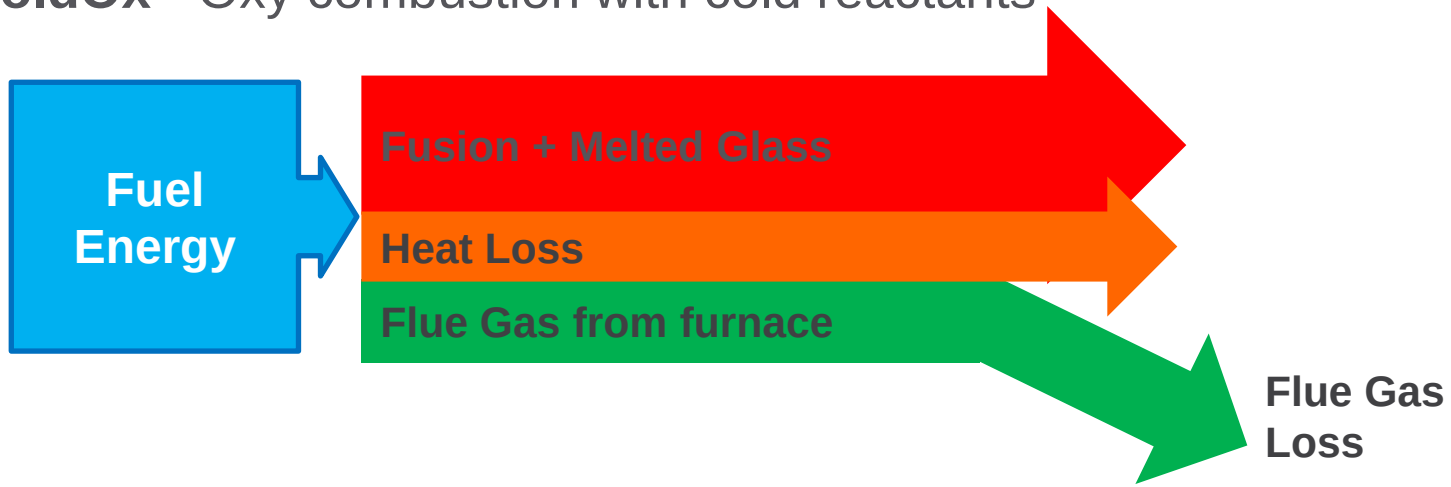
A COMPETITIVE SOLUTION…

Mixing advantage of oxy-fuel and heat recovery

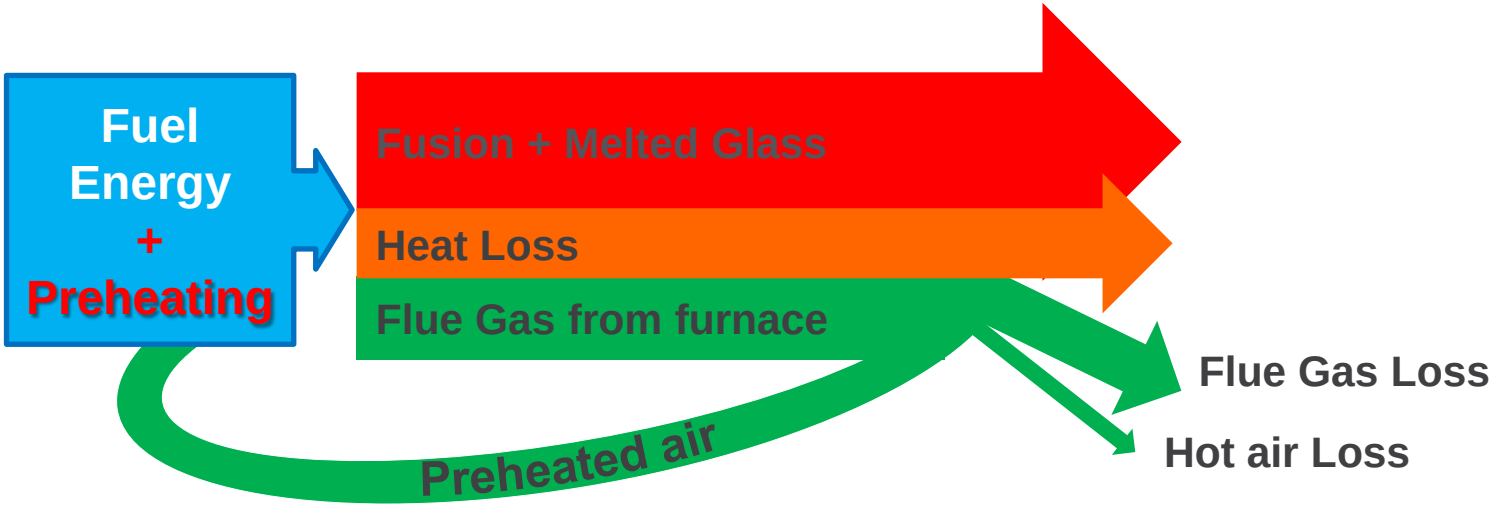


ColdOx vs. HeatOx efficiency comparison

- **ColdOx** - Oxy combustion with cold reactants



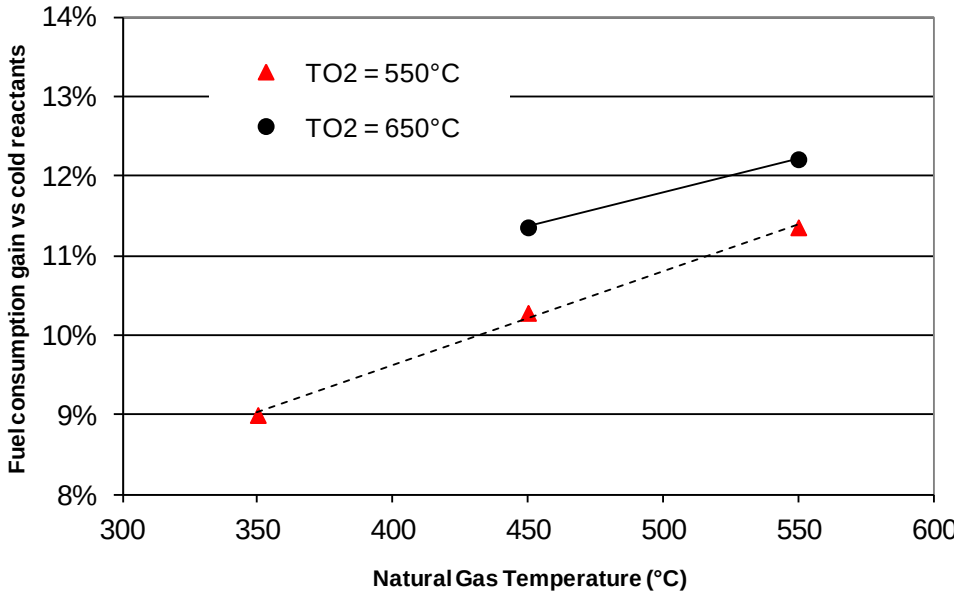
- **HeatOx** - Oxy combustion with Hot reactants (550°C O2, 450˚C NG)

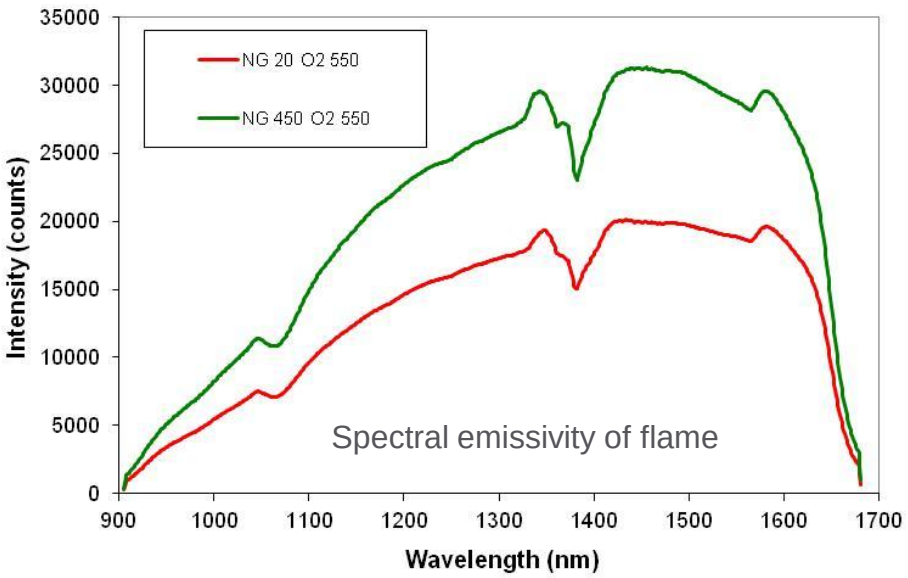


HeatOx efficiency breakdown

- Savings:
  - Reactants enthalpy (Preheating) → 6-7 %
  - Less flue gas flow (-7.5% mass flow) → 2-3 %

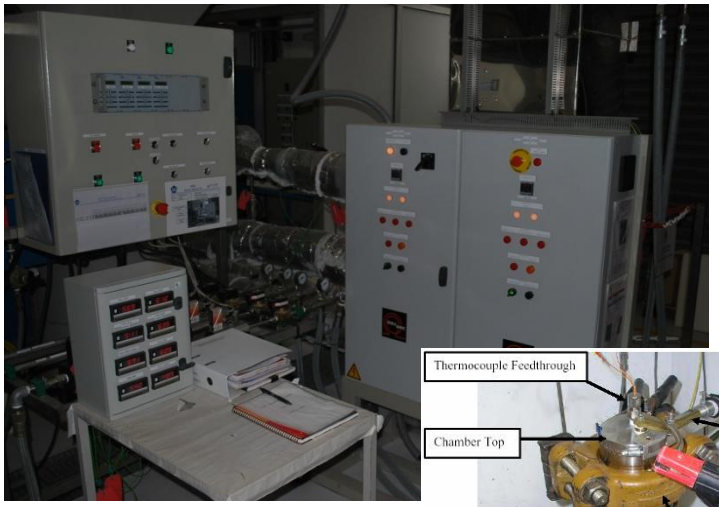
HeatOx ~10% additional savings vs. ColdOx

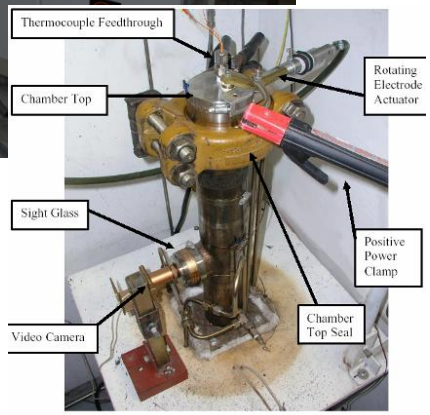




Background : 10 years of experience

- One challenge of heat recovery project at the beginning was related to the evaluation of the preheated oxygen/natural gas hazards.
- Main risks :
  - Ignition & Flame propagation:
    → Promoted combustion study
  - Corrosion:
    → Cyclic oxidation tests
    → Long term exposure tests



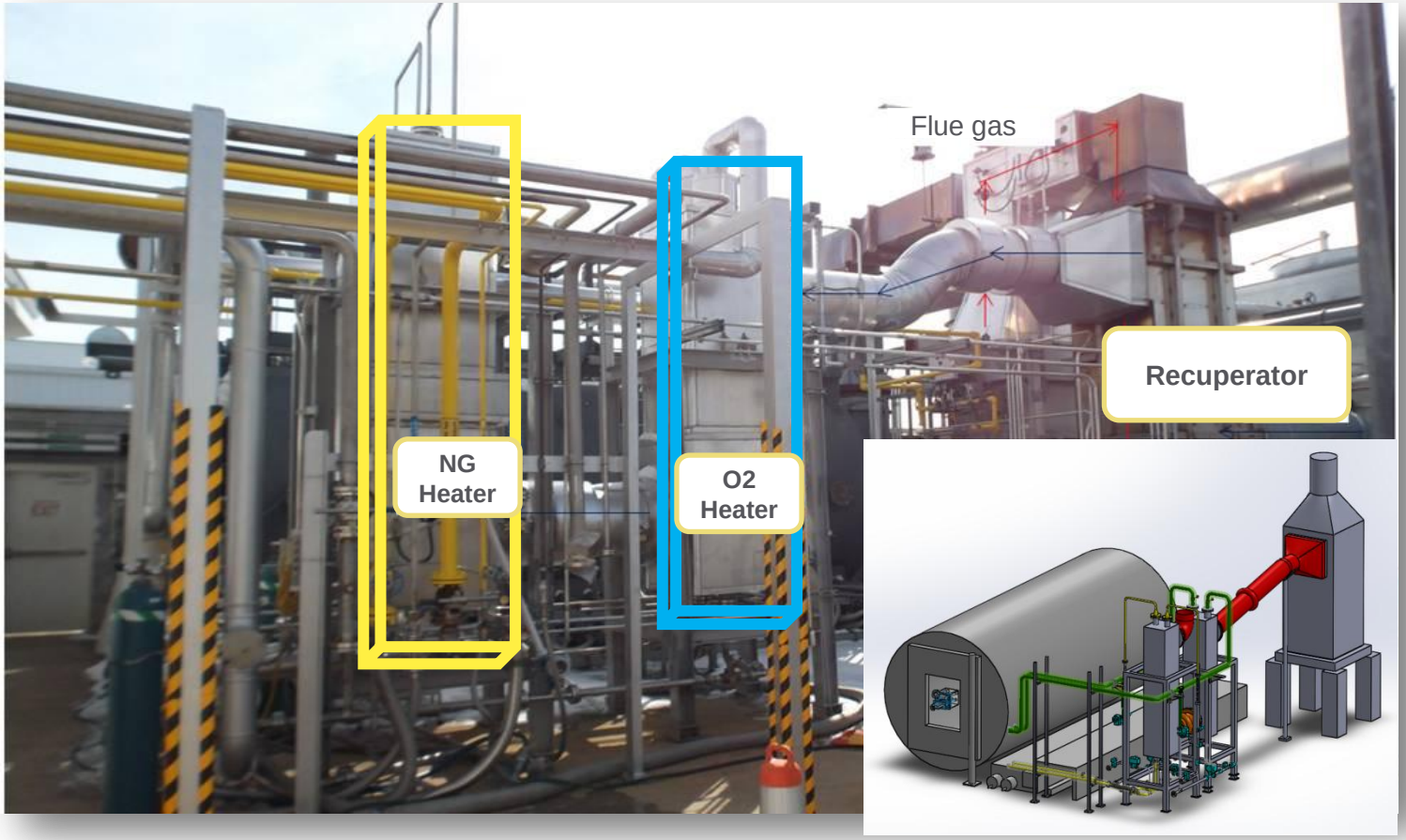


➡ *Specific Technology Design* :

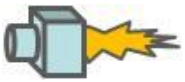
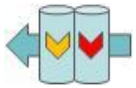
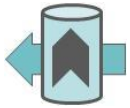
- ❖ Material selection for all equipments
- ❖ Flange & piping design / Gaskets and leaks control
- ❖ Automatic control and regulation of reactants temperature
- ❖ Design requirements & manufacturing process for the O2 exchangers

Background : 10 years of experience

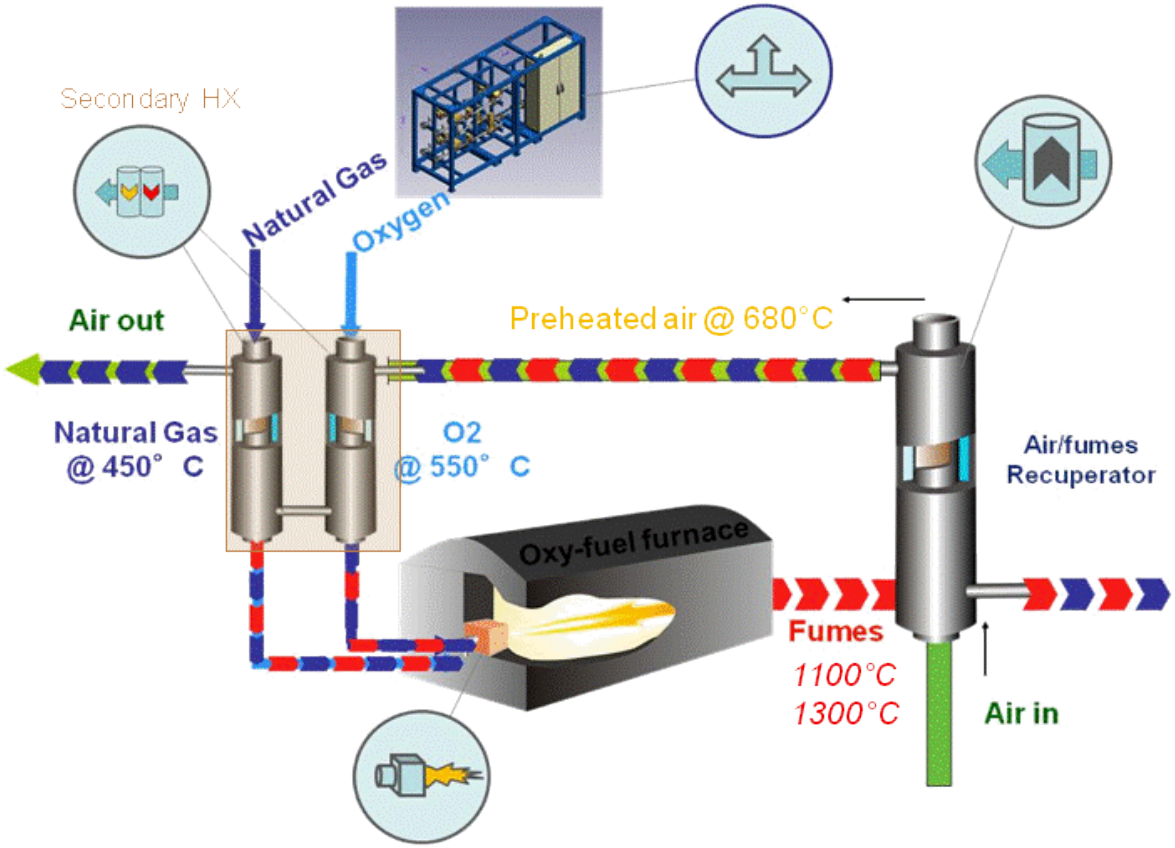
- **HeatOx Platform** – USA: fumes heat recovery & reactant preheating
- **1-2MW burners**
- **Heaters with temperature control schemes**



HeatOx: Features

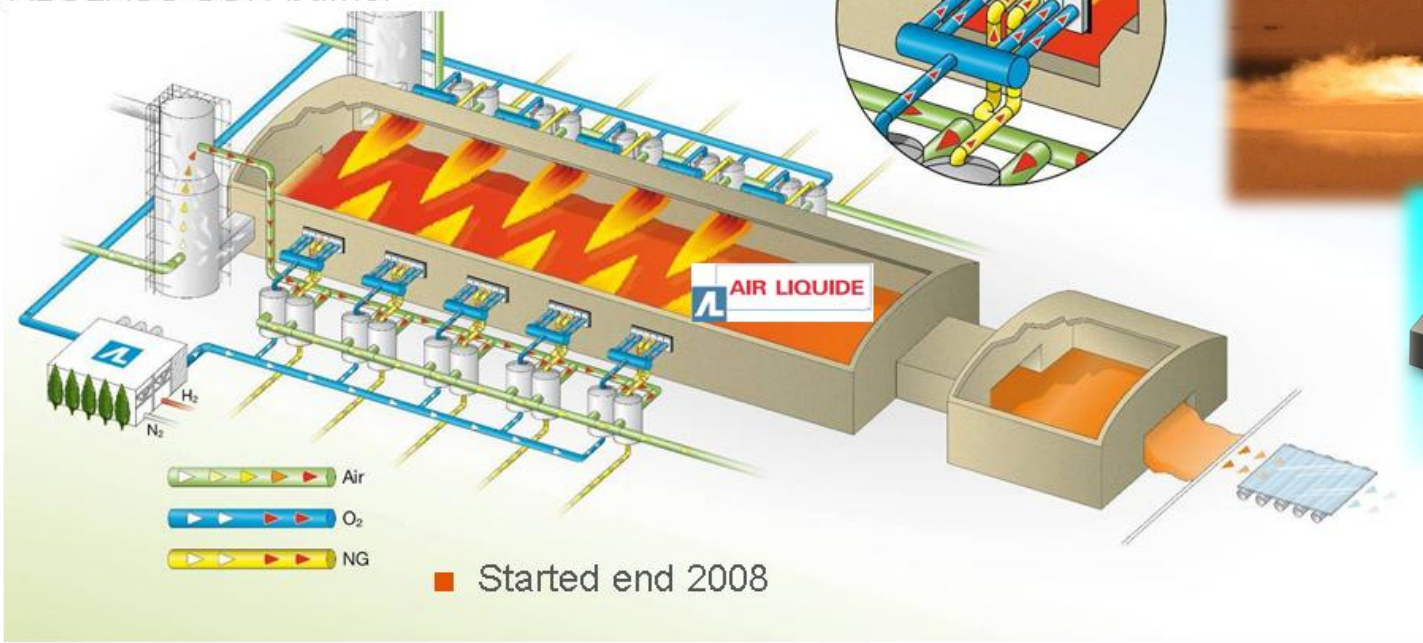
Components	Item
	Burners
	Valve train
	O2/NG Heaters
	Heat recuperator
	Engineering, installation and integration

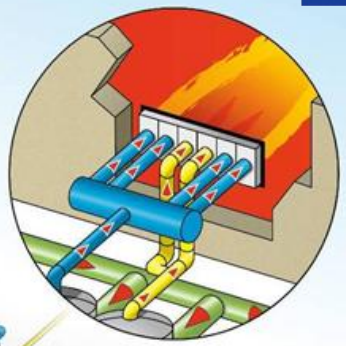
✓New Patented AL Technology: Oxygen preheating in glass melting



HeatOx : Proven on float glass

- Air/fumes recuperator
- Air/Reactants exchangers
  - Oxygen T ~ 550°C
  - Gas T ~ 450°C
- ALGLASS SUN burner



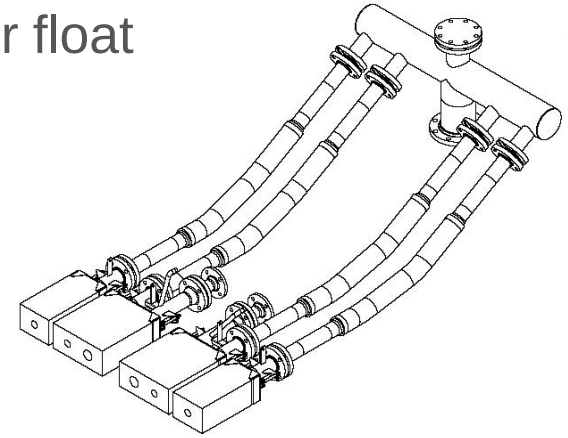


- Started end 2008

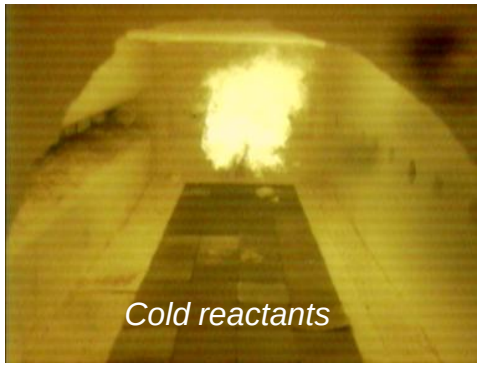
- **HeatOx** 20 to 25% fuel saving is validated with **two** float glass tanks.
  - Burner ALGLASS SUN HeatOx
  - Parallel hot air flow distribution & 2 secondary HX per burner

Proven on float glass

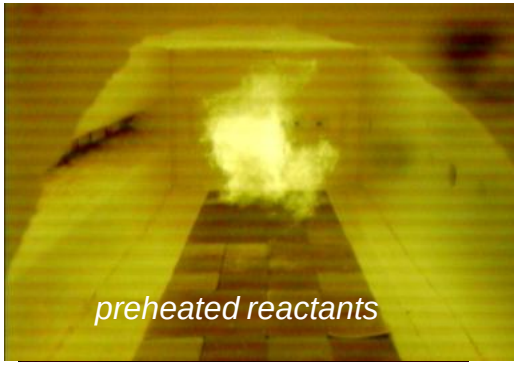
- Highly separated jets burner adapted to HeatOx for float
  - Ultra low Nox (~ 0,1 kg Nox / t SLS glass)
  - Long and wide flame
  - Manage hot & cold reactant
  - Highly flexible
    - Bi-fuel (oil & gas)
    - Easy to implement (multi-block design)
    - Compatible with air (back-up)
    - Variable flame length with dispatching of O2 flow
    - High turndown ratio (50-150% of nominal power)
    - Large capacity: 0,5 – 1 – 2 – 4 MW



SUN Burner schematic view



Cold reactants



preheated reactants

HeatOx process versus Air-fired furnace

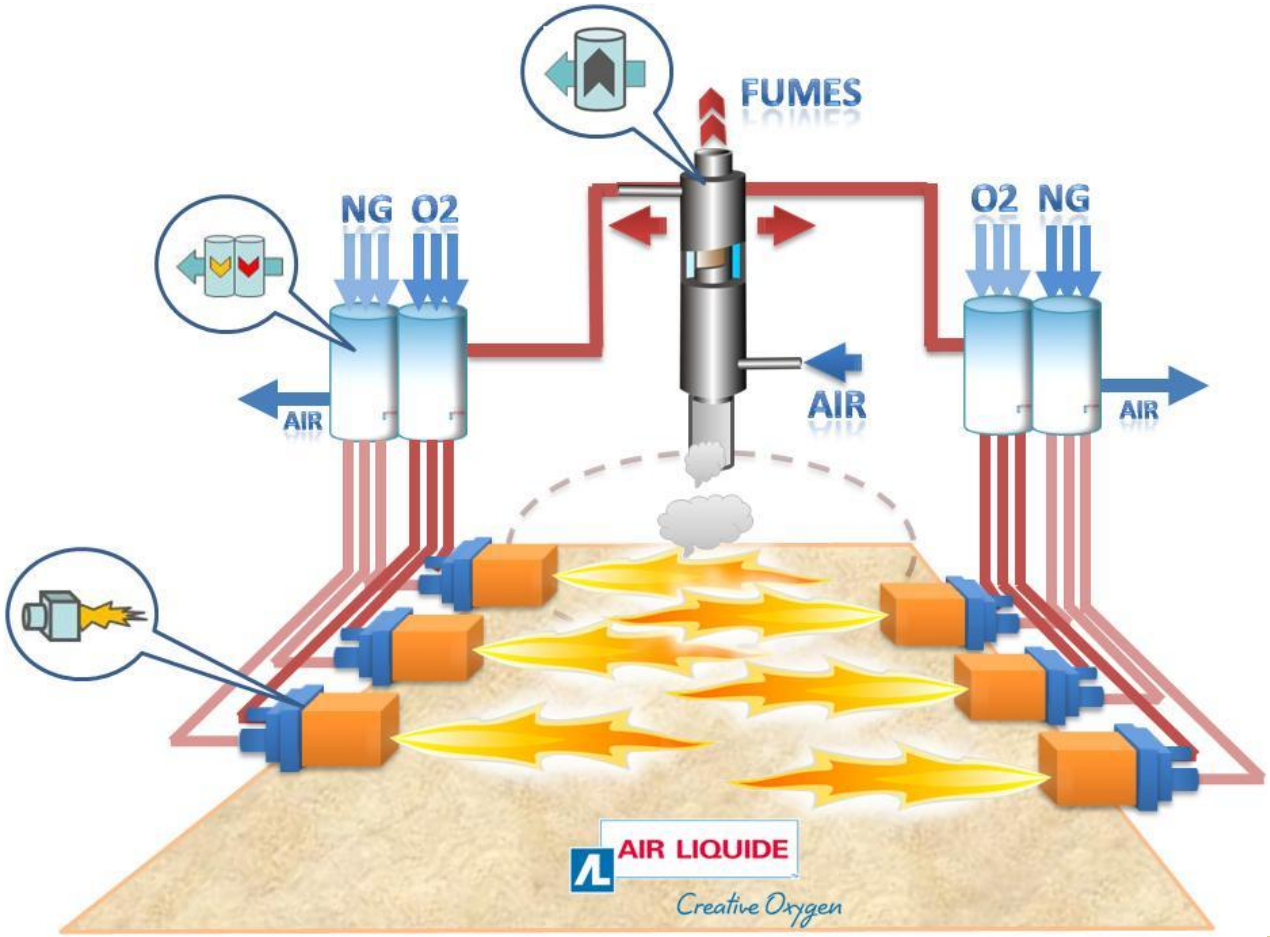
- Performance of **HeatOx** versus state of the art air-fired furnace on float furnace (AGC)
  - Energy consumption - 25%
  - CO2 emission - 15%
    * *Taking into account CO2 emission from oxygen production*
  - NOx emission - 83%
  - SOx emission - 38%

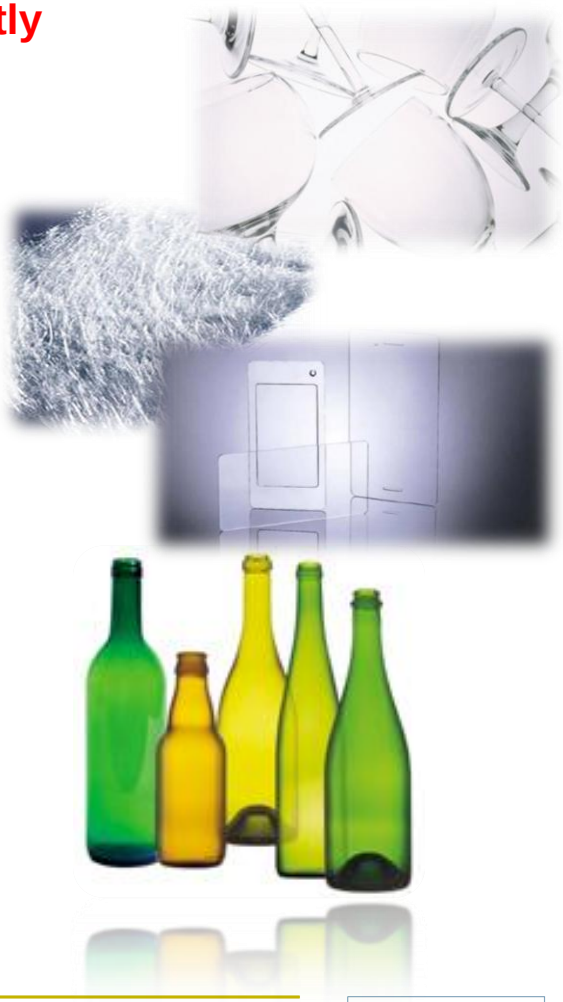
- No effect on other Furnace performances
  - Batch and foam behavior
  - Crown temperatures
  - Glass quality
  - Furnace refractory
  - No moving parts

HeatOx for small-medium size furnaces

HeatOx tailored for **mid-size furnaces (50-400tpd)** as glass packaging or fiber furnace.

Burner managing **cold & hot reactants**
Heat exchangers which could **feed multiple burners independently**

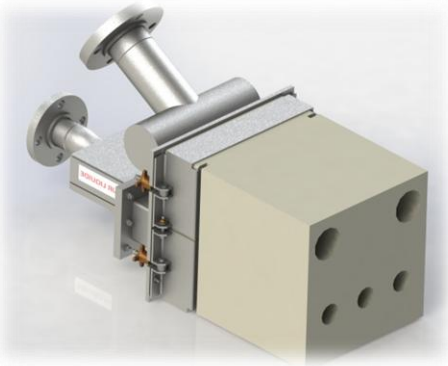


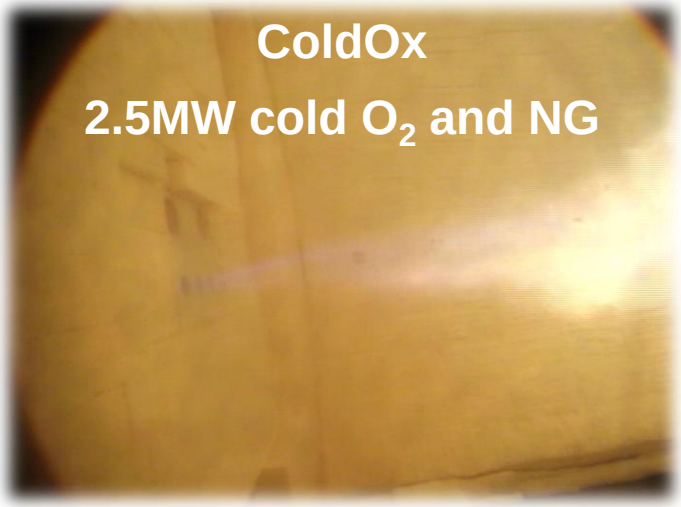


HeatOx solution for small/medium furnaces

HeatOx burner

- Compact and operable with **hot Oxygen** and **hot Natural gas**
- Enable to operate cold reactants (automatic setting) *patent pending*
- Constant flame length (~3m)
- Could be operated with Hot Air back up



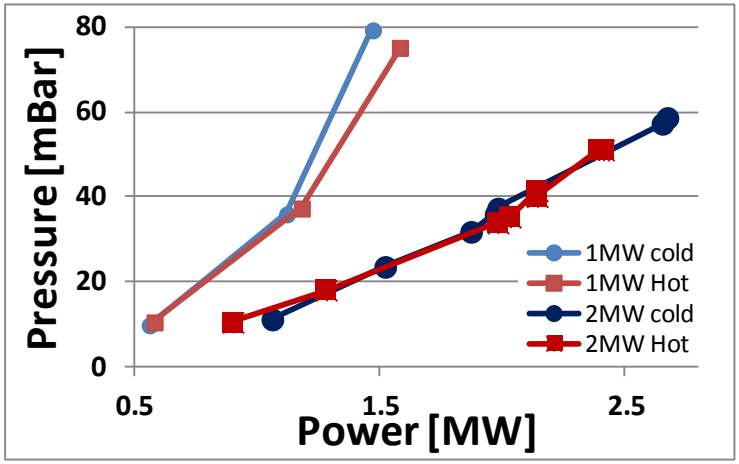


From 500kW to 4MW - NOx emissions : 0.3kg / tSLS glass - Particulate emissions < 0.2kg / tSLS glass

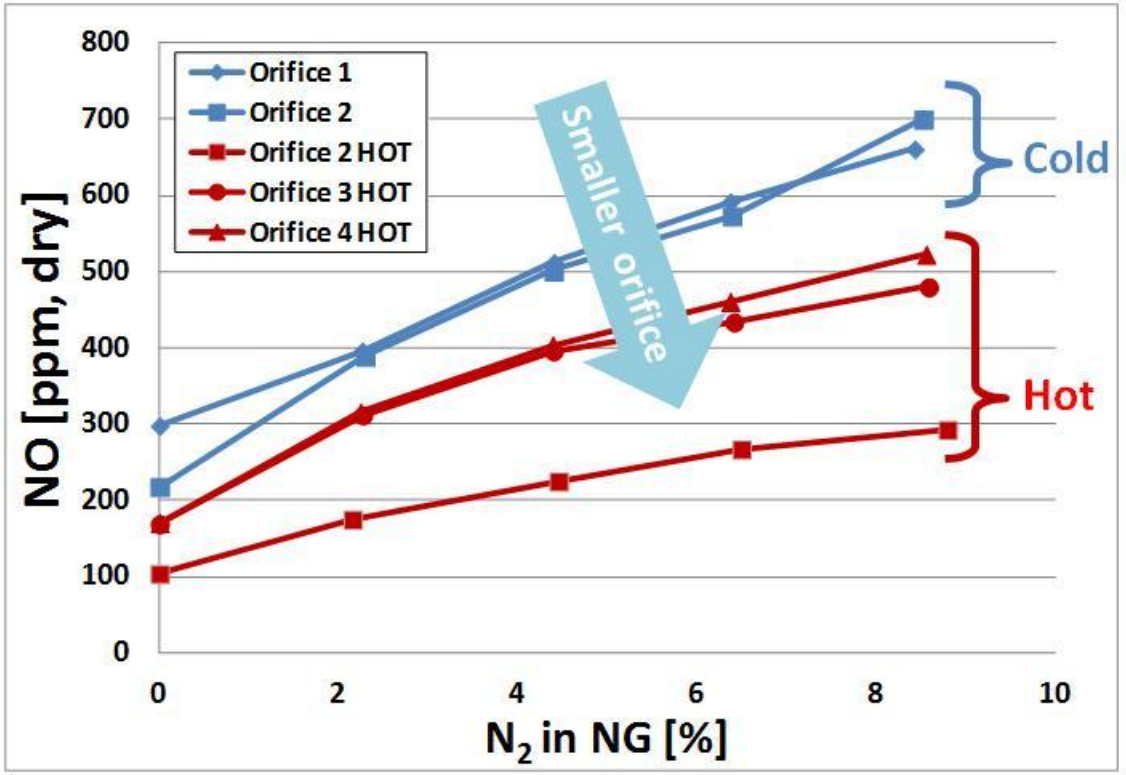
HeatOx solution for small/medium furnaces

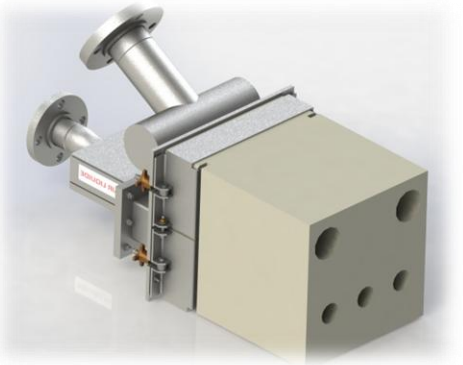
HeatOx burner

- Compatible pressure drop between cold and hot operation
- Minimal pressure fluctuation during the transition



- Flexible Oxygen staging ratio
- NOx emission control





Visit www.ecoheatox.com

New HeatOX

- **New Patented AL Technology**: Oxygen preheating in glass melting for small/medium furnaces
  - One heat exchanger (O2/NG) can accommodate multiple burners (patent pending)
  - CAPEX savings and smaller footprint
  - Flowrate and temperature can be controlled individually (patent pending).
  - New burner for preheated reactant (patent pending)

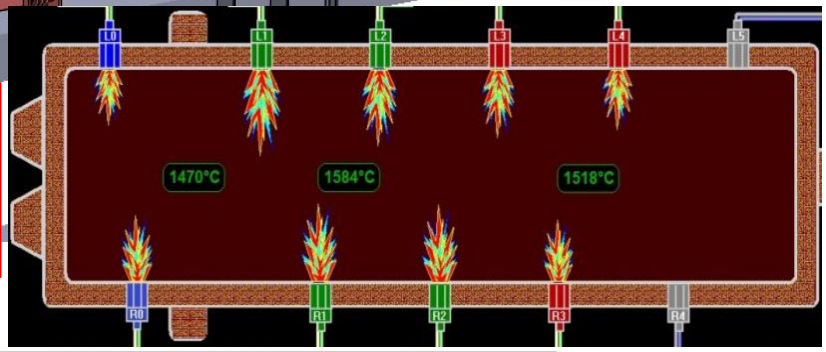
LIFE+ Eco-HeatOx ŞIŞECAM

- LIFE+ Eco-HeatOx a project granted by LIFE European commission
- Demonstration of the operation of a full industrial facility with the new Burner and Heat Exchanger at Trakya plant Bulgaria
- Process benefit targets
  - Reduction of GHG emissions linked to tableware glass production: **15% less CO2 and 90% less NOX**
  - Increase of thermal efficiency in tableware glass plants**: 22.6%**
- Status of project
  - Start-up of furnace (ColdOx) in 2014
  - Detailed design of HeatOx process & heat exchangers done
  - Manufacturing of equipment on-going
  - HeatOx FC burner already in operation with cold reactant
  - Installation on-fly and start-up in Sept 2015

LIFE+ HeatOx ŞIŞECAM : Implantation

Hot Air

HX on each side of furnace
4-5 burners / HX



Customer benefits

1. Reduction in energy costs
2. Flexible energy sourcing
3. Limited additional CAPEX with less than 3 year payback
4. Compliance with new environmental regulations
5. Reliable suppliers capable of offering complete solutions
6. Energy performance commitment

Thank you

Please visit our website : ***www.ecoheatox.com***

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