AIR LIQUIDE

Creative Oxygen

OXYCOMBUSTION INNOVATION

Reducing Energy Consumption with innovative technologies

Market Trends & Needs

Statement with glass

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

Ambitions

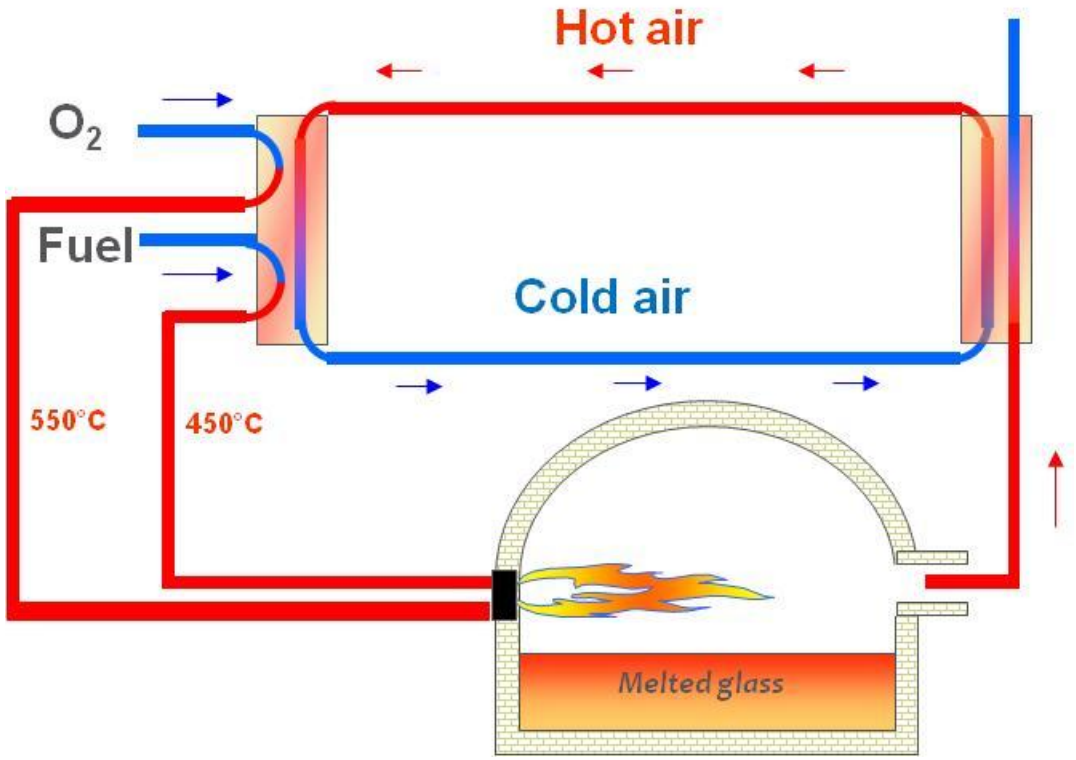
Cost savings and efficiency

- Energy reduction: electric boosting, fuel and oxygen
- NOx and CO_2 emissions reduction
- CAPEX <3 years payback

Oxygen and natural gas preheated at high temperature

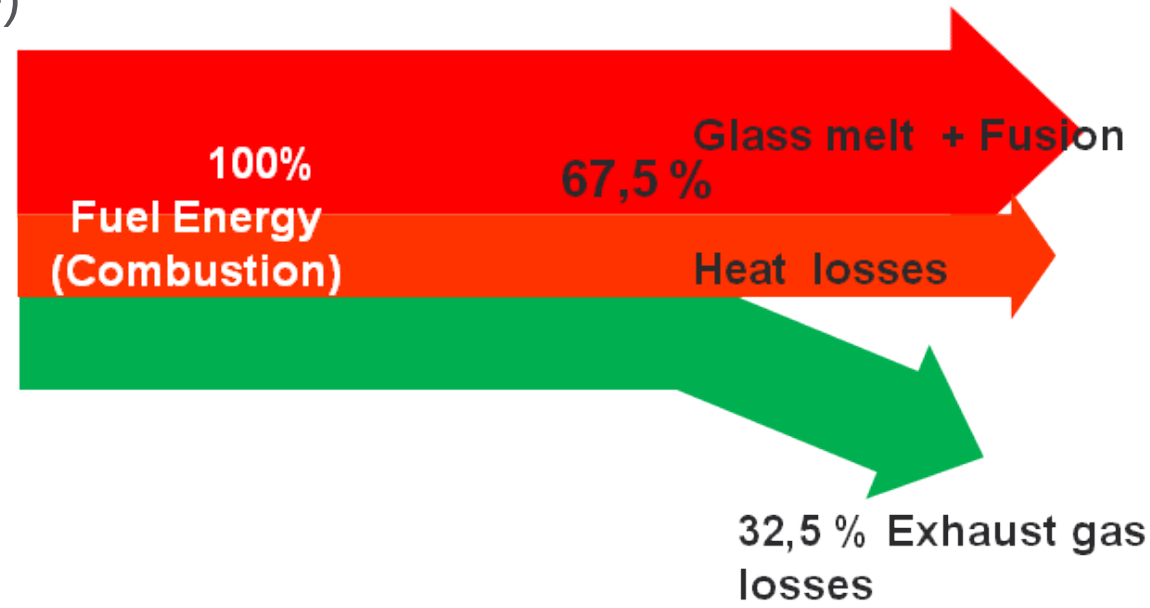
HeatOx

A COMPETITIVE SOLUTION



ColdOx efficiency

- Oxy combustion with cold reactants – real case (-15% vs air regenerative furnace)

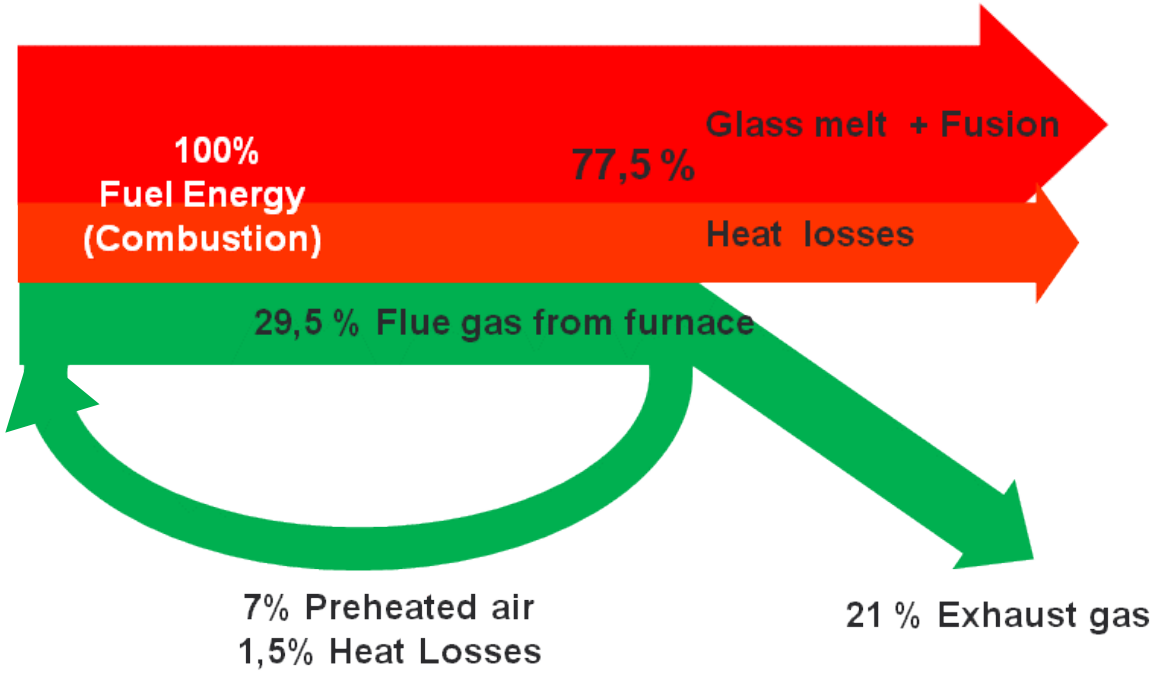


$$\text{Combustion efficiency Coldox} = \frac{\text{Fuel Energy at the burner} - \text{Exhaust gases losses}}{\text{Fuel Energy at the burner}}$$

$$\text{Combustion efficiency Coldox} = 67{,}5\ \%$$

HeatOx efficiency

- Oxy combustion with Hot reactants (550°C - O2, 450°C NG) real case



$$\text{Combustion efficiency Coldox} = \frac{\text{Fuel Energy at the burner} - \text{Exhaust gases losses}}{\text{Fuel Energy at the burner}}$$

$$\text{Combustion efficiency Coldox} = 77{,}5\ \%$$

HeatOx efficiency

- Additional Savings vs cold oxy combustion :
  - Reactants enthalpy → -6.3 %
  - Less fumes flow (-7.5% mass flow) → -2.2 %
  - Higher flame emissivity / Fumes T decreasing (-50°C) → -1.5 %

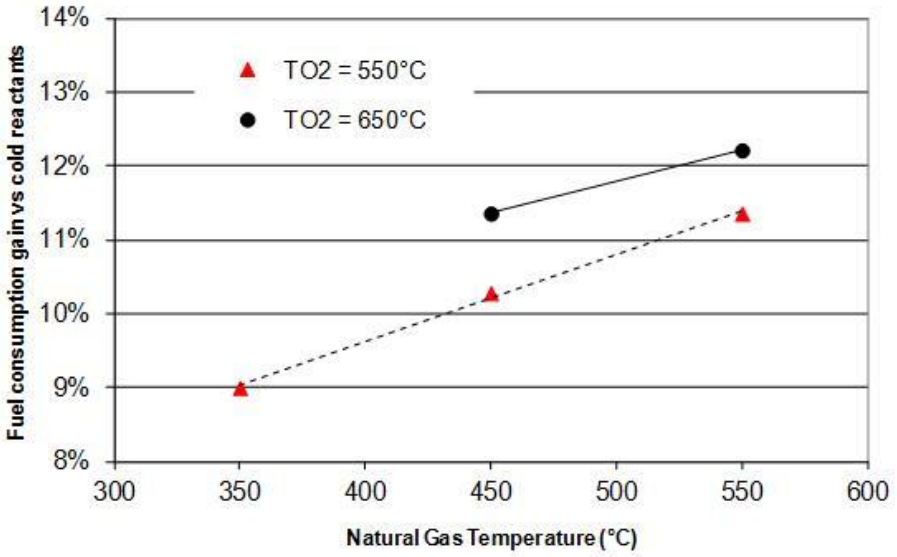
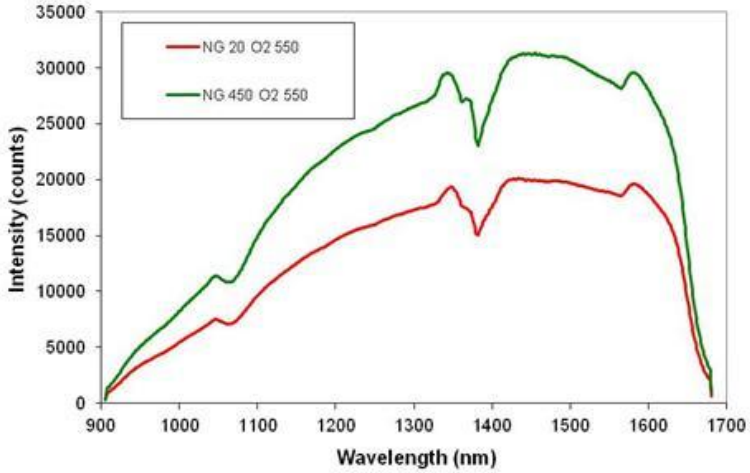
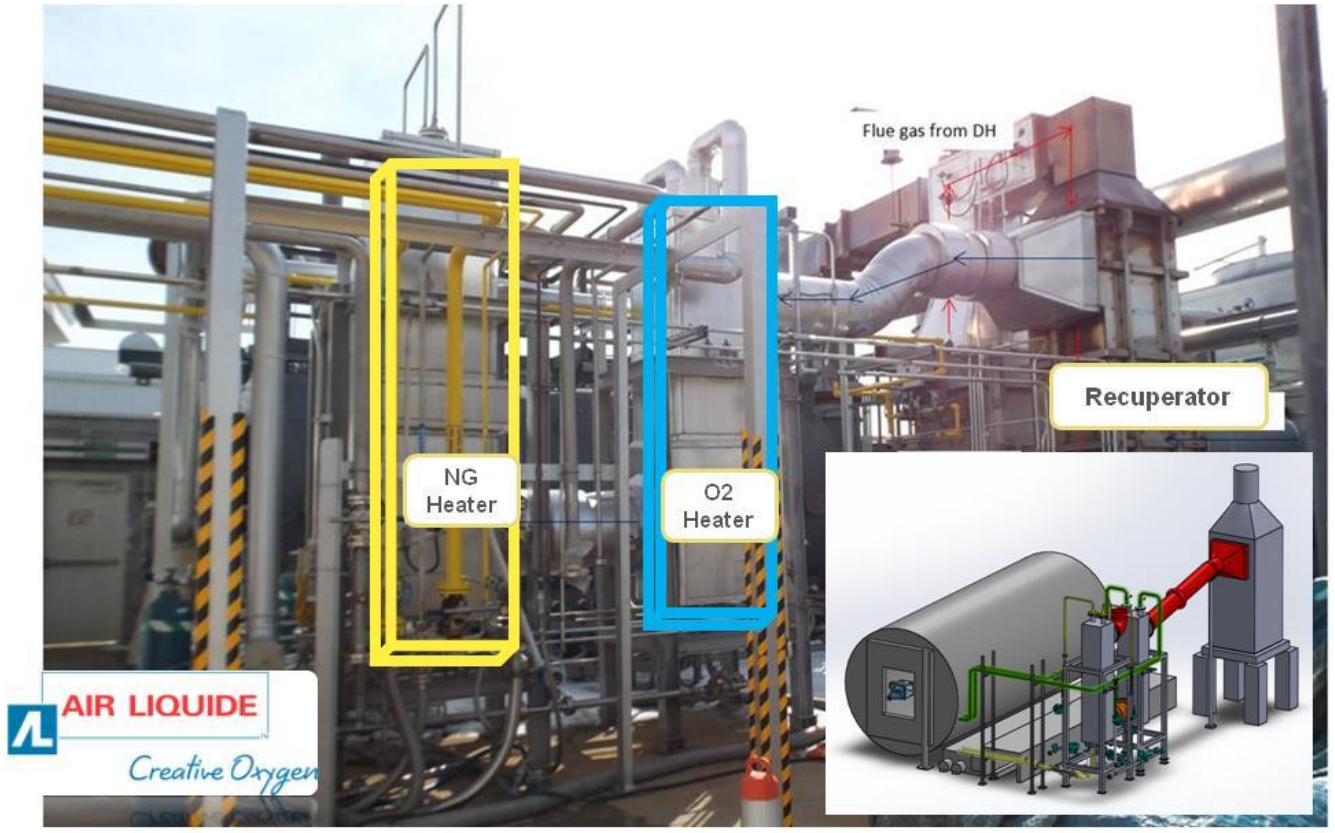


Fig. 1. Spectral emissivity of flame



Background (Cont.) : 10 years of experience

- **HeatOX Platform - USA**
- **with 1-2MW burners with Hot reactants in a furnace with temperature control schemes**



/ Owner: JARRY Luc / Reducing Energy Consumption 17/04/2015

Background

- Evaluation of the preheated oxygen/natural gas hazards.
- Main risks :
  - Ignition & Flame propagation:

    → Promoted combustion study
  - Corrosion:

    Long term exposure tests

    Cyclic oxidation state

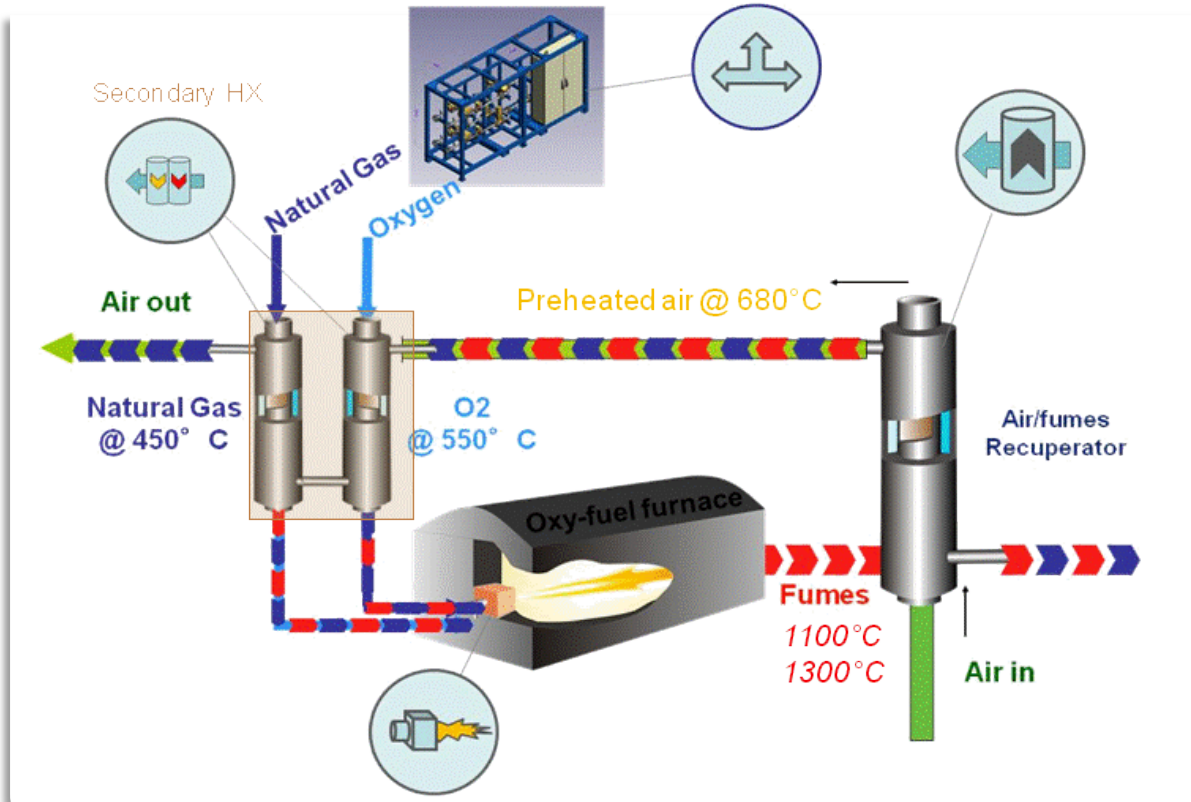
Promotion Ignition Test

Material :

- ❖ Specific design / Material selection / Flange design / Dedicated gaskets and leaks control / Design of oxygen equipments / Procedure
- ❖ Automatic control and regulation of reactants temperature
- ❖ Manufacturing process for the heat exchangers

HeatOx: Features

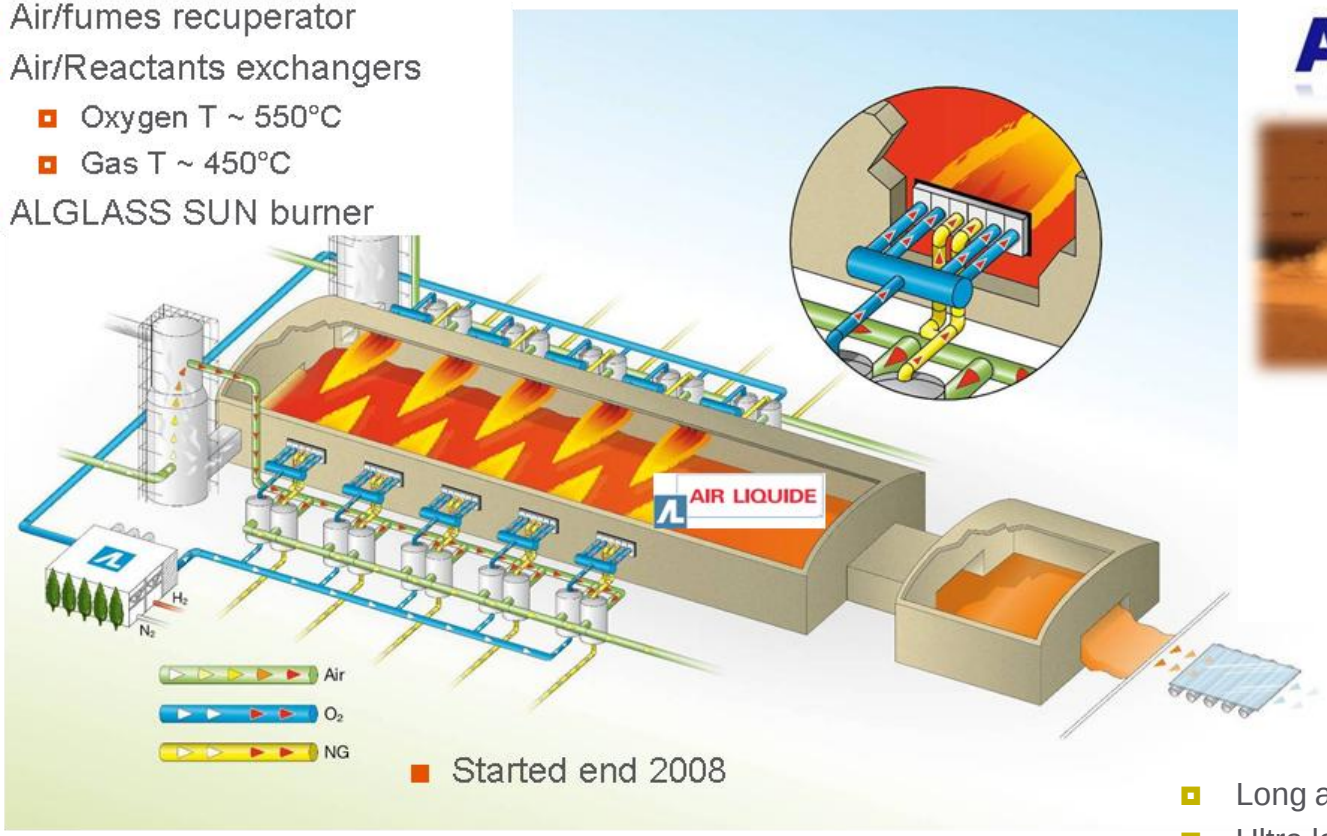
Components	Item
	Burners
	Valve train
	O2/NG Heaters
	Heat recuperator
	Engineering, installation and integration



- ✓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

- Long and wide flame
- Ultra low Nox (~ 0,1 kg Nox / t SLS glass)

- **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

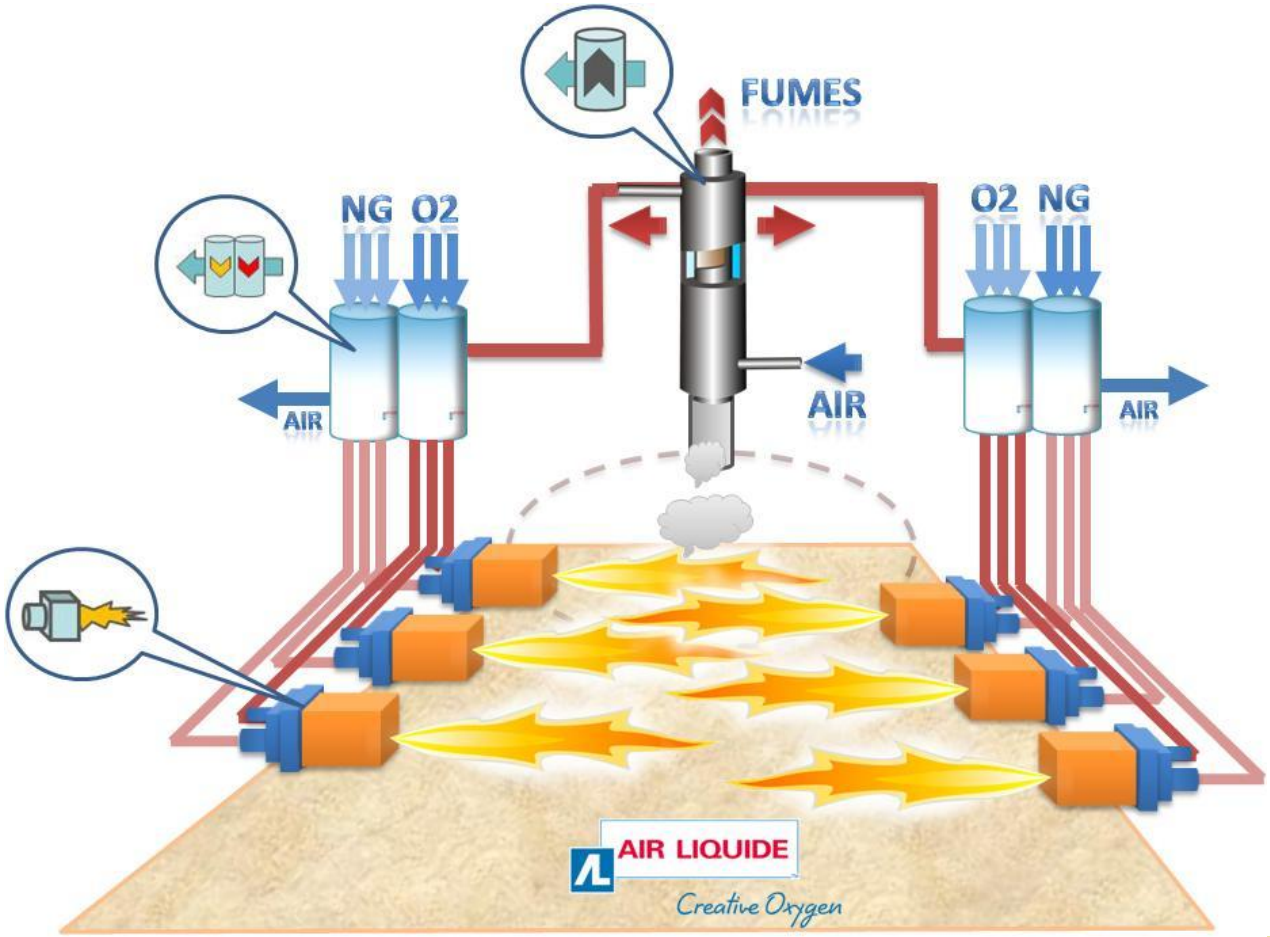
New HeatOx

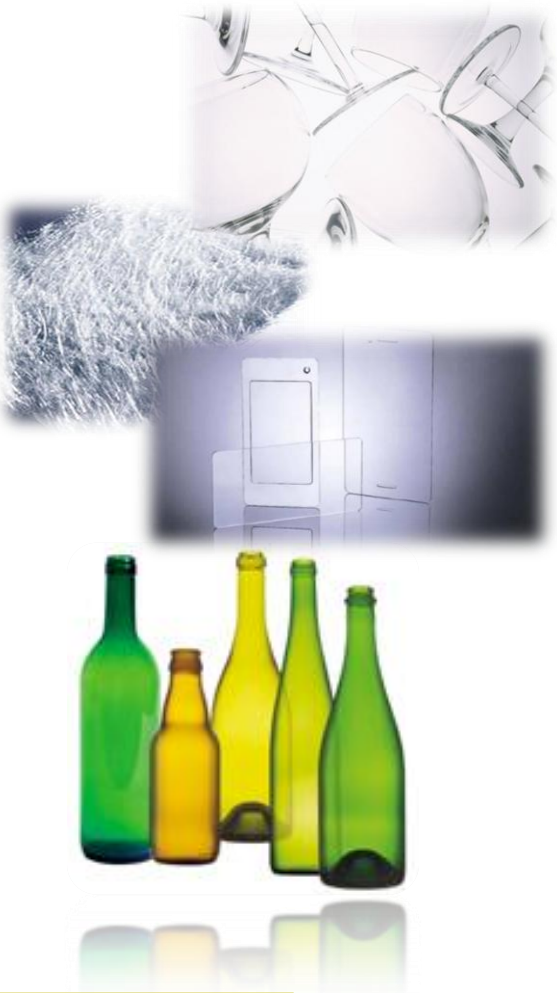
- **New Patented AL Technology**: Oxygen preheating in glass melting for small/medium furnaces
  - One heat exchanger (O2/NG) can accommodate multiple burners (patent pending)
  - Flowrate and temperature can be controlled individually (patent pending).
  - CAPEX savings and smaller footprint

HeatOx for small-medium size furnaces

HeatOx tailored for **mid-size furnaces (50-300tpd)** as glass packaging or fiber furnace**.**

Heat exchangers which could **feed multiple burners independently**

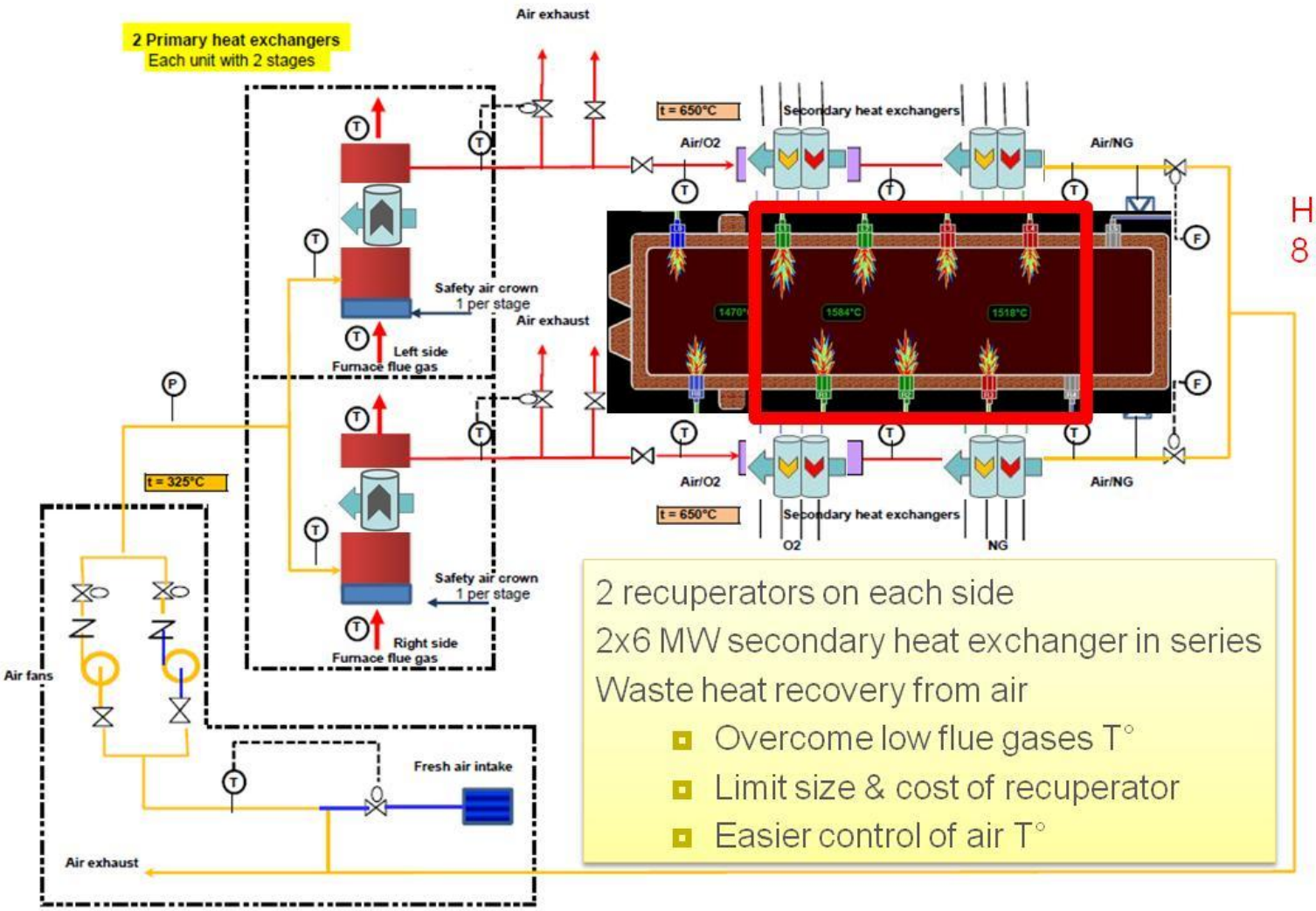




LIFE+ Eco-HeatOx ŞIŞECAM

- 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: **20% less CO2 and 90% less NOX**
  - Increase of thermal efficiency in tableware glass plants**: 20%**
- Status of project
  - Start-up of furnace (ColdOx) in 2014
  - Detailed design of HeatOx process & heat exchangers done
  - Manufacturing of equipment on-going
  - One HeatOx FC burner already in operation with cold reactant
  - Installation on-fly and start-up in Sept 2015

LIFE+ HeatOx ŞIŞECAM : Process scheme



HeatOx on
8 burners

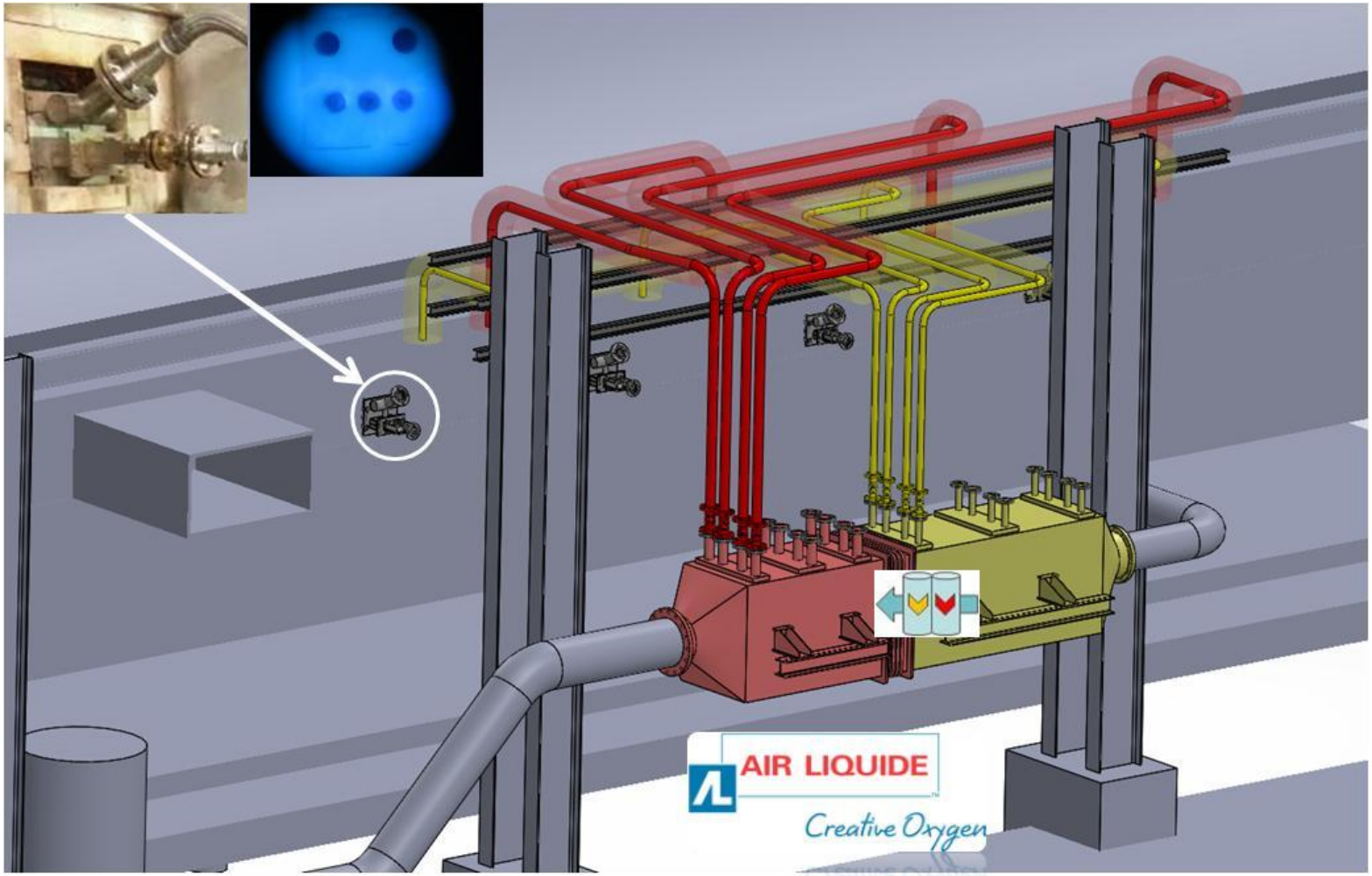
2 recuperators on each side

2x6 MW secondary heat exchanger in series

Waste heat recovery from air

- Overcome low flue gases T°
- Limit size & cost of recuperator
- Easier control of air T°

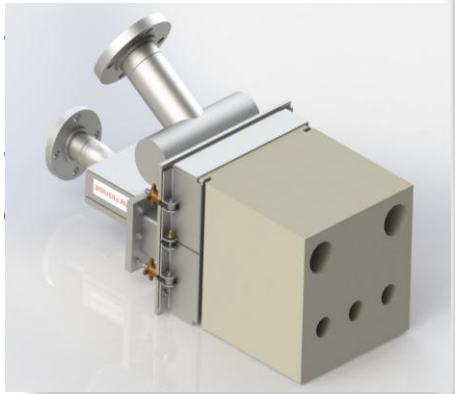
LIFE+ HeatOx ŞIŞECAM : Implantation

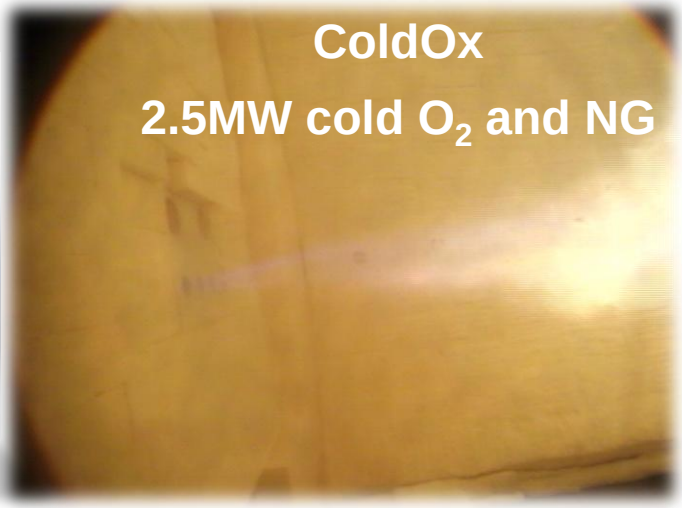


HeatOx solution for small/medium furnaces

HeatOx burner

- Compact and operable with **hot Oxygen** and **hot Natural gas**
- Enable to operate cold reactants too (automatic setting) for safety concern *patent pending*
- Constant flame length (~3m)
- could be operated with Hot Air back up
- NOx level under 200ppm at any given power.





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

Customer benefits

1. Reduction in energy costs:
   - Electric boosting for glass melting, Fuel and Oxygen
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*