AIR LIQUIDE
Creative Oxygen

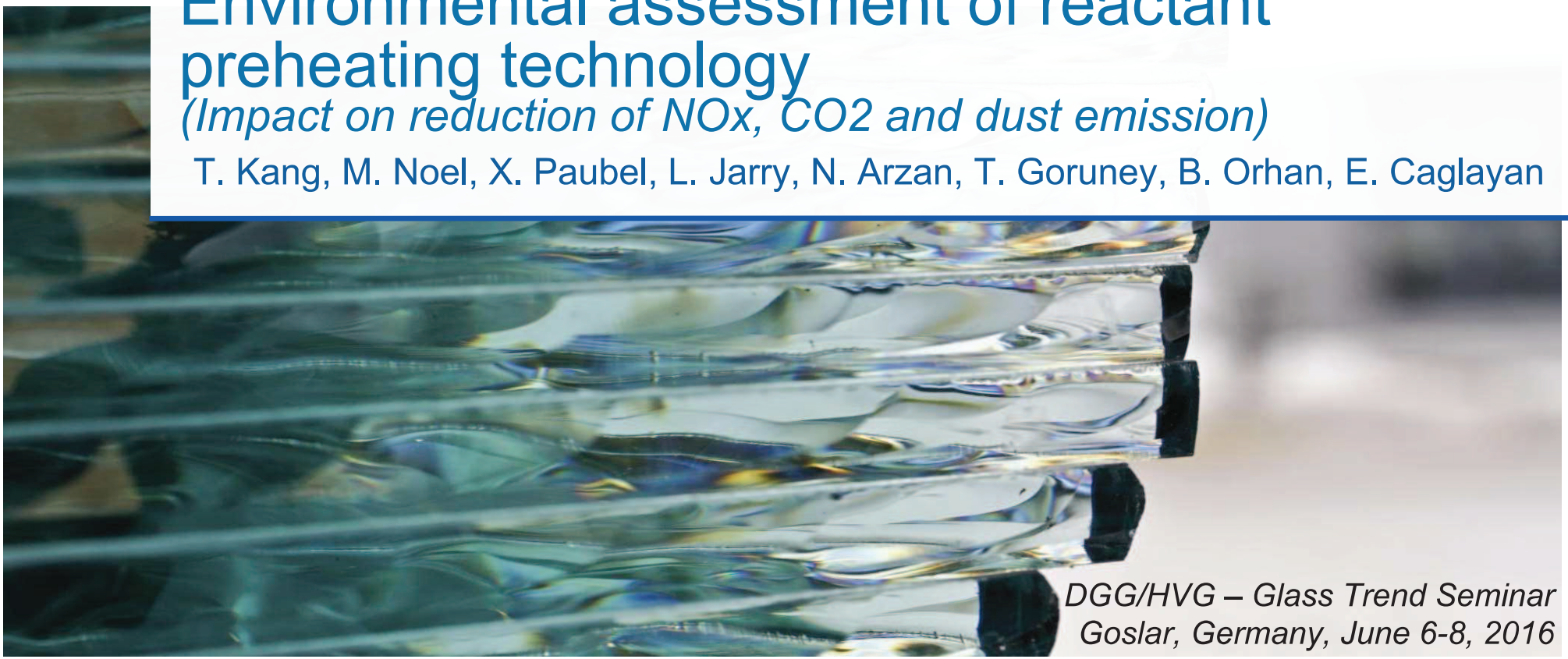
nexelia

nexelia Heat-OxyCOMBUSTION

Environmental assessment of reactant preheating technology

(Impact on reduction of NOx, CO2 and dust emission)

T. Kang, M. Noel, X. Paubel, L. Jarry, N. Arzan, T. Goruney, B. Orhan, E. Caglayan



DGG/HVG – Glass Trend Seminar
Goslar, Germany, June 6-8, 2016

Trends & Needs and AL Ambitions

Trend & Needs

- More stringent regulation on pollutant emissions and carbon footprint
- Melting representing 60-80% of total energy consumption
- Customer request for short payback time

AL Ambitions

- Energy reduction in electrical boosting, fuel, and oxygen
- NOx and CO2 reduction
- CAPEX < 3yrs

Oxygen and natural gas preheated at high temperature

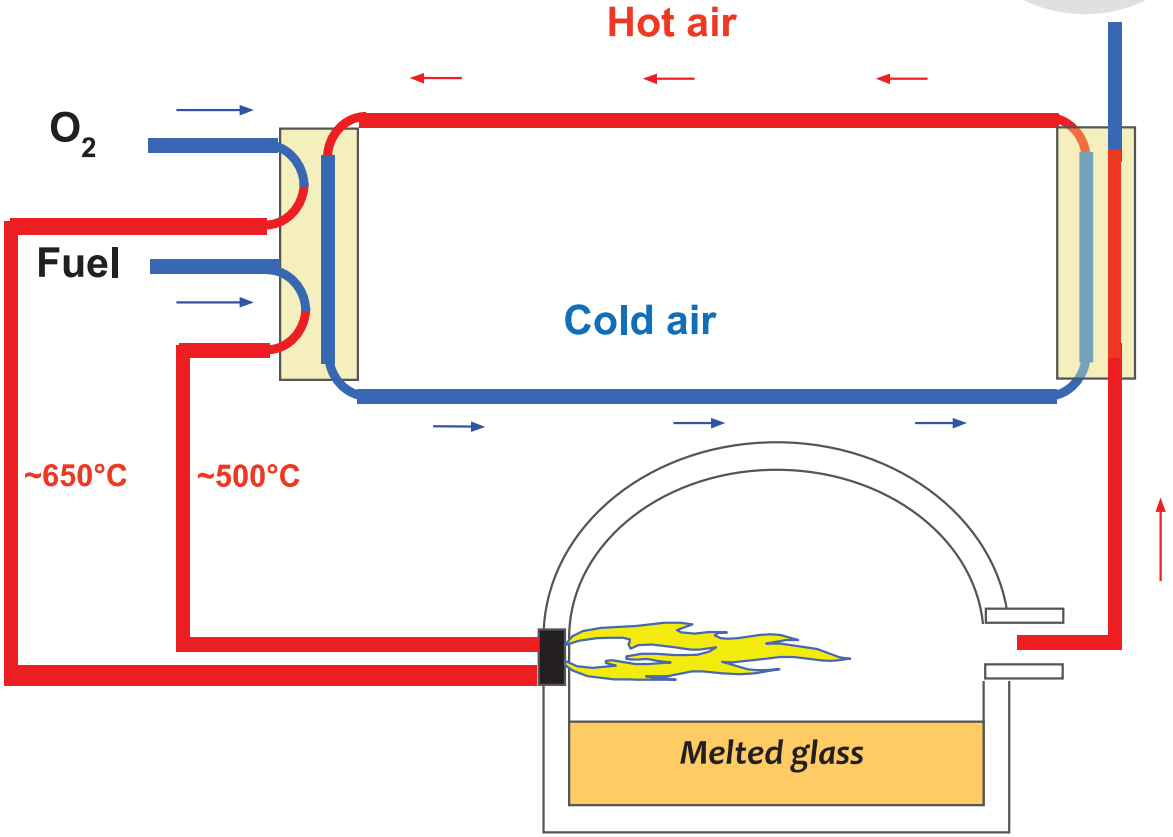
Air Liquide's Heat Oxy-combustion (HeatOx)

GREEN SOLUTION

NOx & CO2 reduction

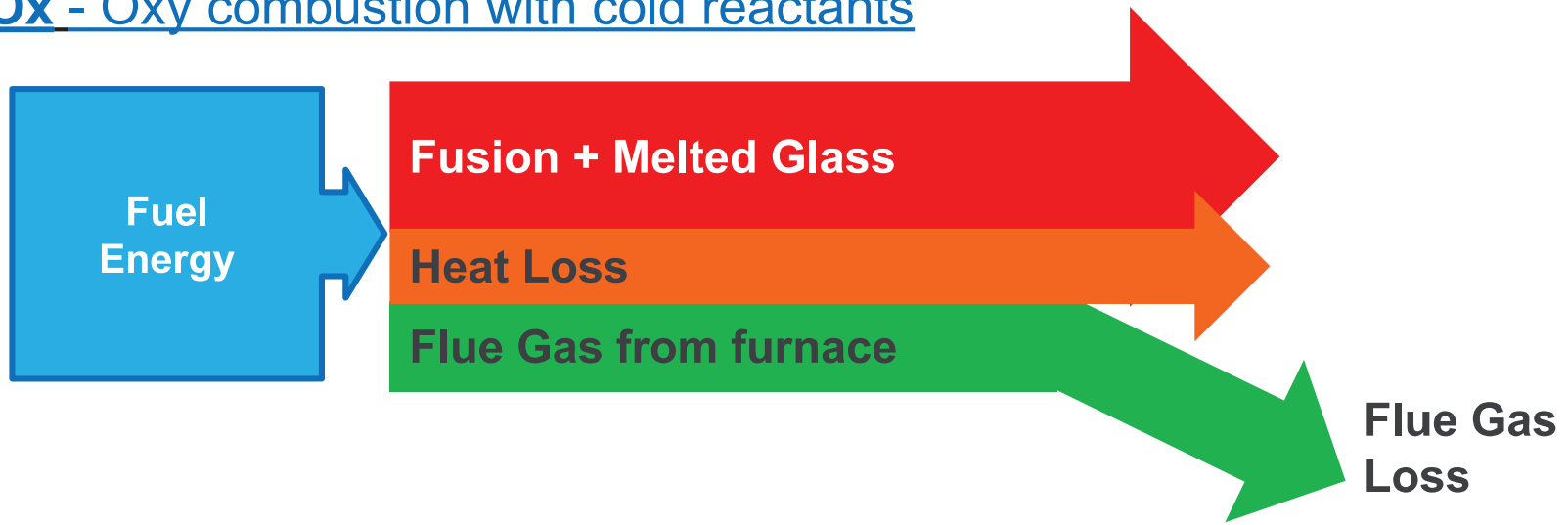
A COMPETITIVE/Robust/Safe SOLUTION…

Mixing advantage of oxy-fuel and heat recovery

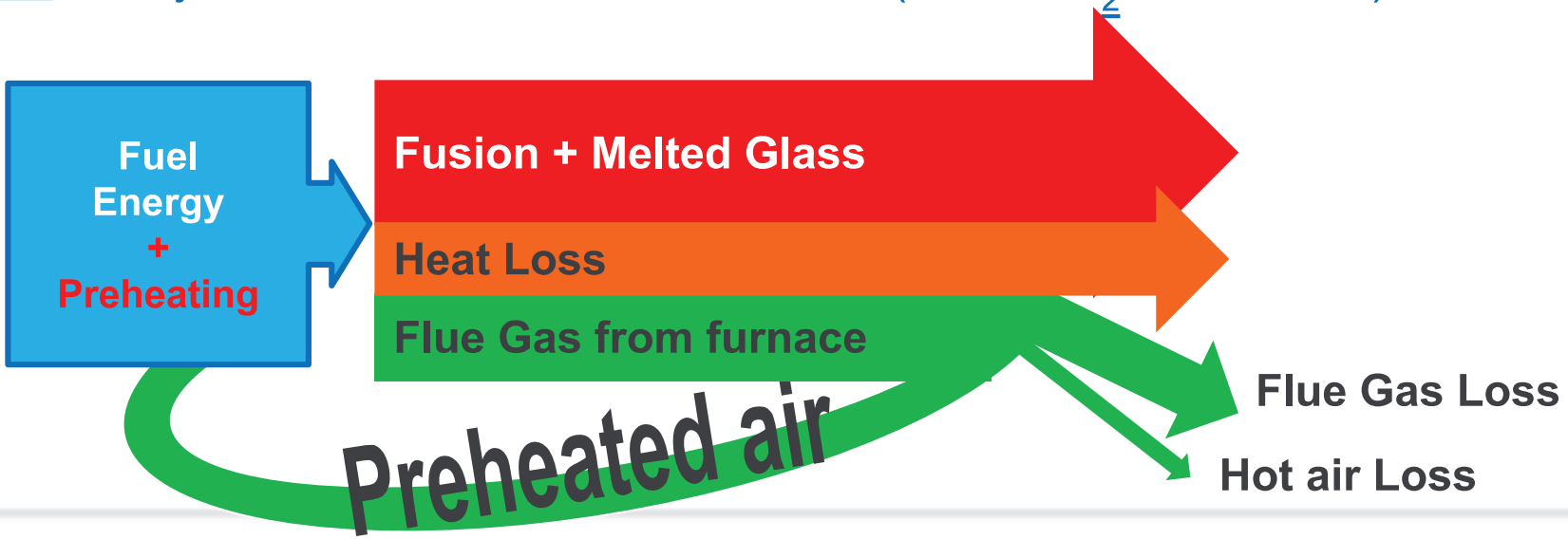


ColdOx vs. HeatOx efficiency comparison

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



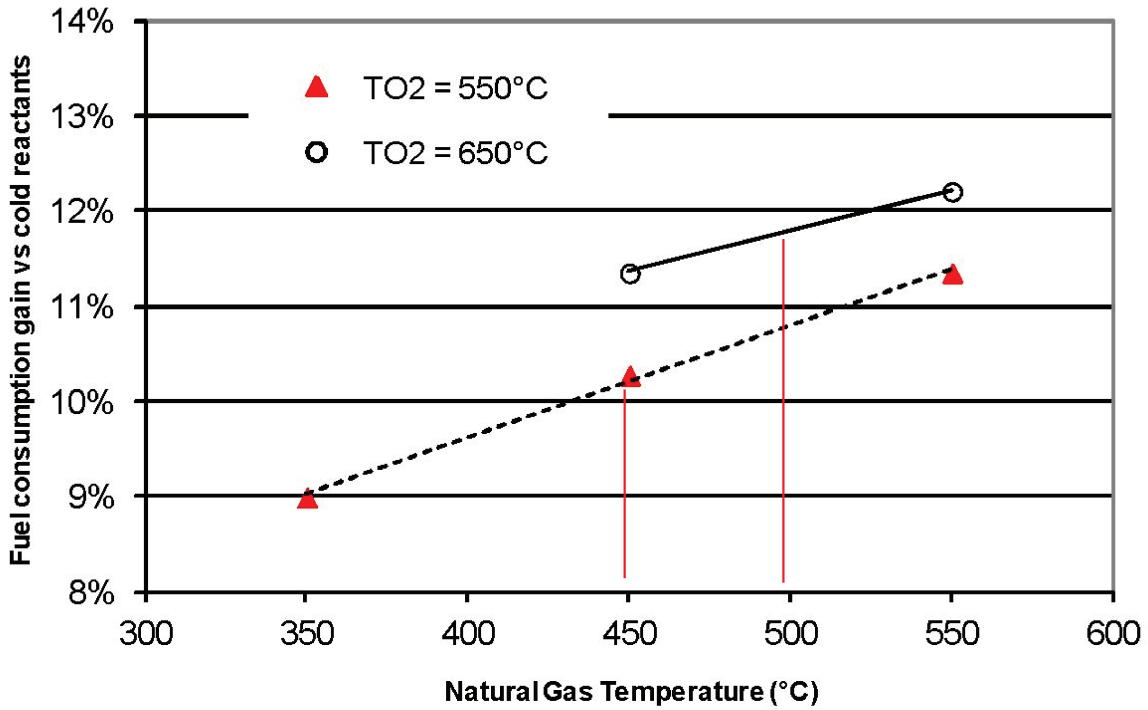
- **HeatOx** – Oxy combustion with hot reactants (650°C O_2, 500°C NG)



HeatOx efficiency breakdown

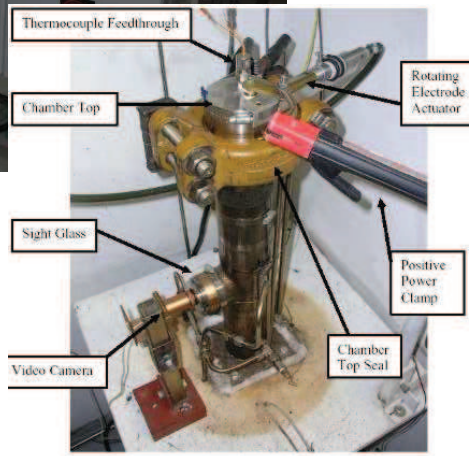
- Savings (550°C O2 and 450°C NG):
  - Sensible heat thanks to Preheating → 6-7%
  - Less flue gas flowrate (-7.5% mass flow) → 2-3 %

HeatOx ~10% additional savings vs. ColdOx



Background : 10 years of experience

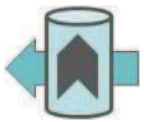
- Main challenge in the beginning was related to risks associated with preheated oxygen/natural gas.
- Material compatibility test
  - Ignition & Flame propagation:
    → Promoted combustion study
  - Oxidation
    → Cyclic oxidation tests
    → Long term exposure tests

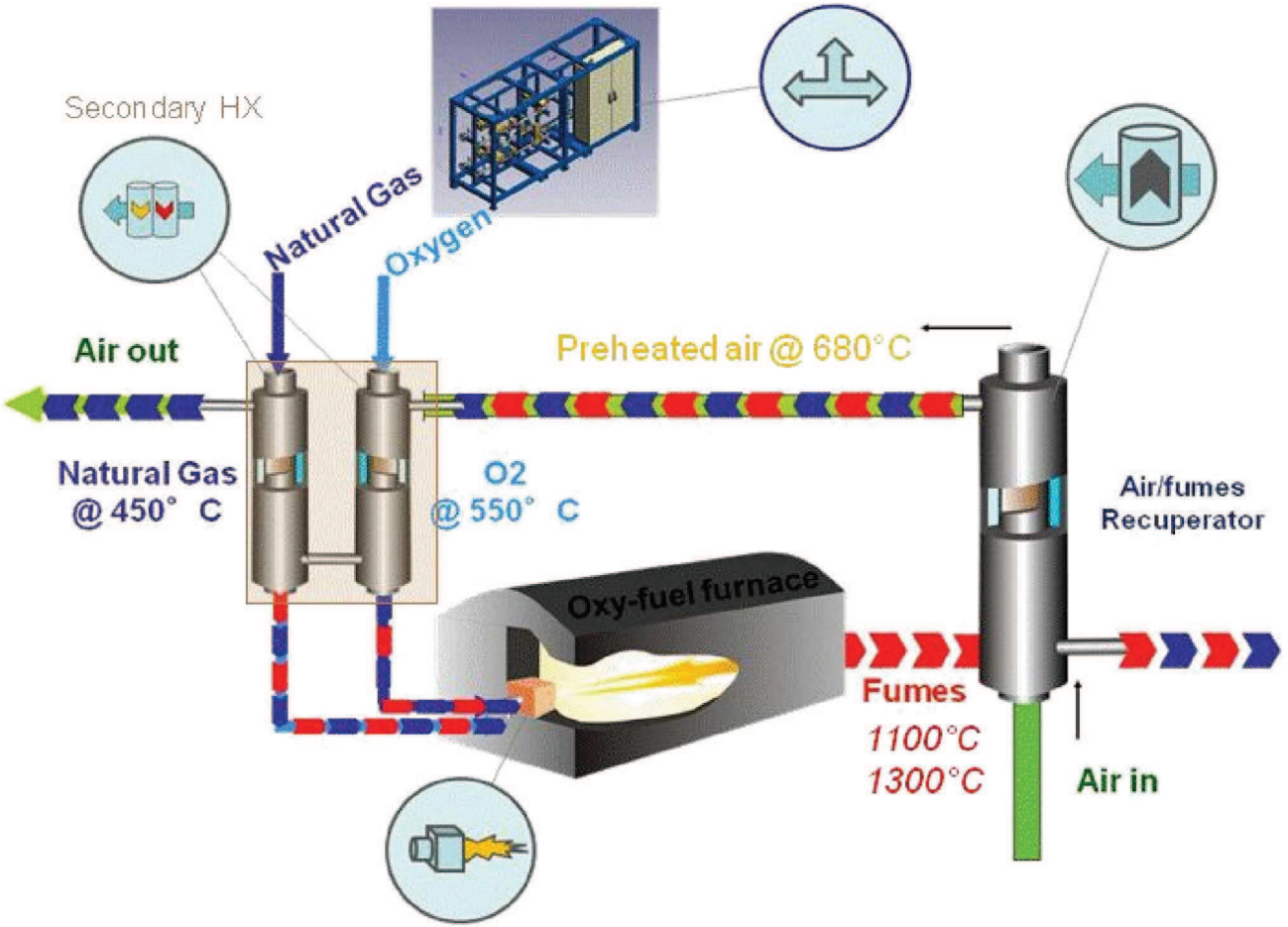


Specific Design Know-how:

- 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

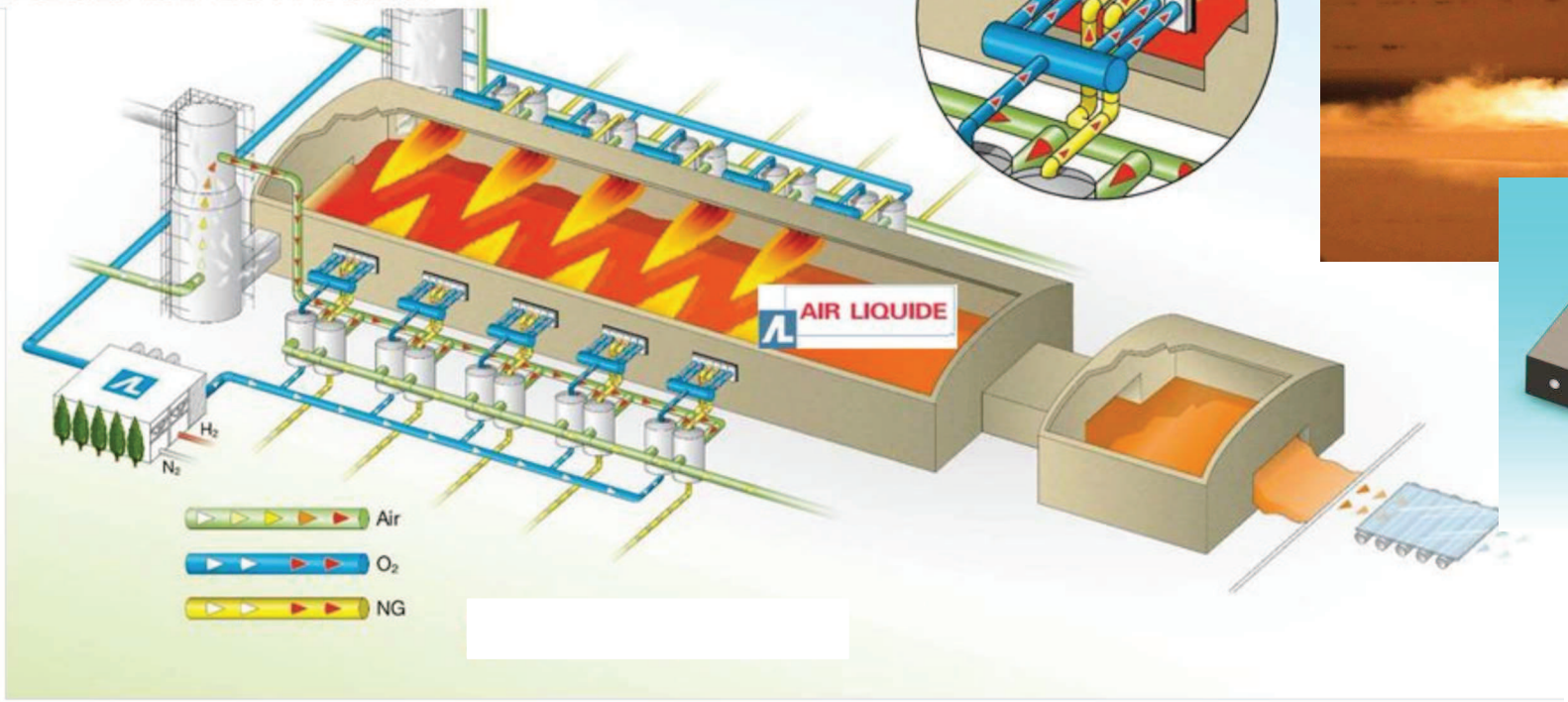
HeatOx Component Technologies

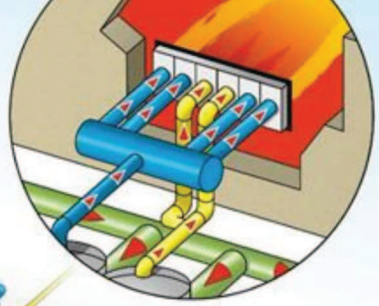
Components	Item
	Burners
	Valve train
	O2/NG Heaters
	Heat recuperator
	Engineering, Installation and Integration



HeatOx : Proven on float glass furnaces

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



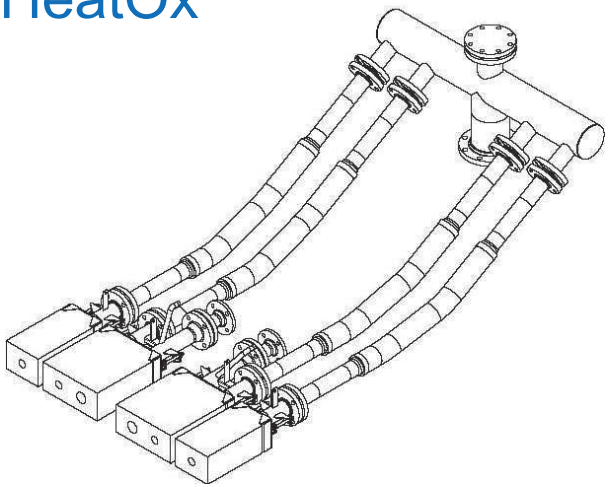


- **HeatOx,** 20-25% fuel saving* was validated with **two** float glass tanks.
  - ALGLASS SUN HeatOx burner
  - One O2 and one NG heat exchanger for each burner.

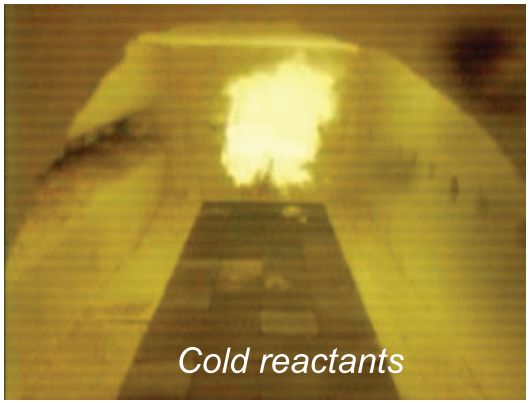
*compared to state of the art air-fired furnace

Proven on float glass

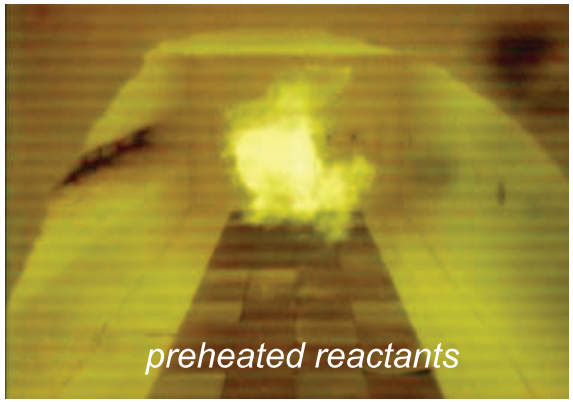
- Highly separated jet burner adapted to float with HeatOx
  - Long and wide flame
  - Manage hot & cold reactant
  - Highly flexible
    - Bi-fuel (oil & gas)
    - Easy to implement (multi-block design)
    - Compatible with air (back-up)
    - Variable flame length with dispatching of O2 flow
    - 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 VS. state of the art air-fired furnace on float furnace (AGC)

- Energy consumption - 25%
- CO2 emission - 15%

  [Taking into account CO_2 emission from oxygen production]
- NOx emission - 83%
- 0.3kg/t [BAT: 1.75-2kg/t, NO2 equivalent]

No effect on other furnace performance

- Batch and foam behavior
- Crown temperature
- Glass quality
- Furnace refractory
- Flue gas

New HeatOx

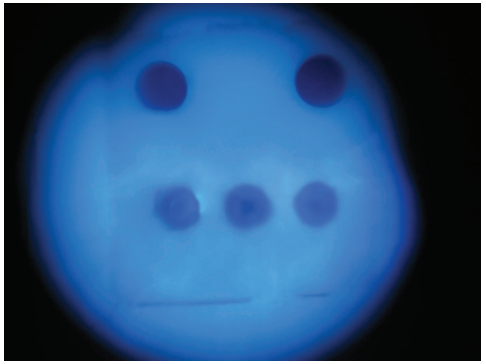
New Patented AL Technology Oxygen preheating in glass melting for small / medium furnaces

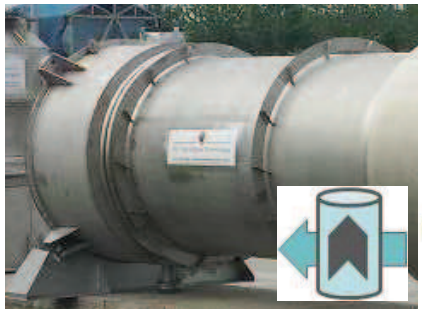
- **One compact heat exchanger (O_2/NG)**
  Can accommodate multiple burners (patent pending), lower CAPEX and smaller footprint.

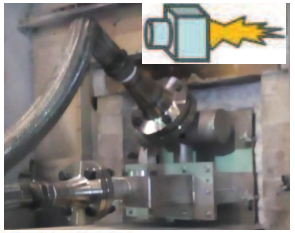
- **Flowrate and temperature** can be **controlled individually** (patent pending).

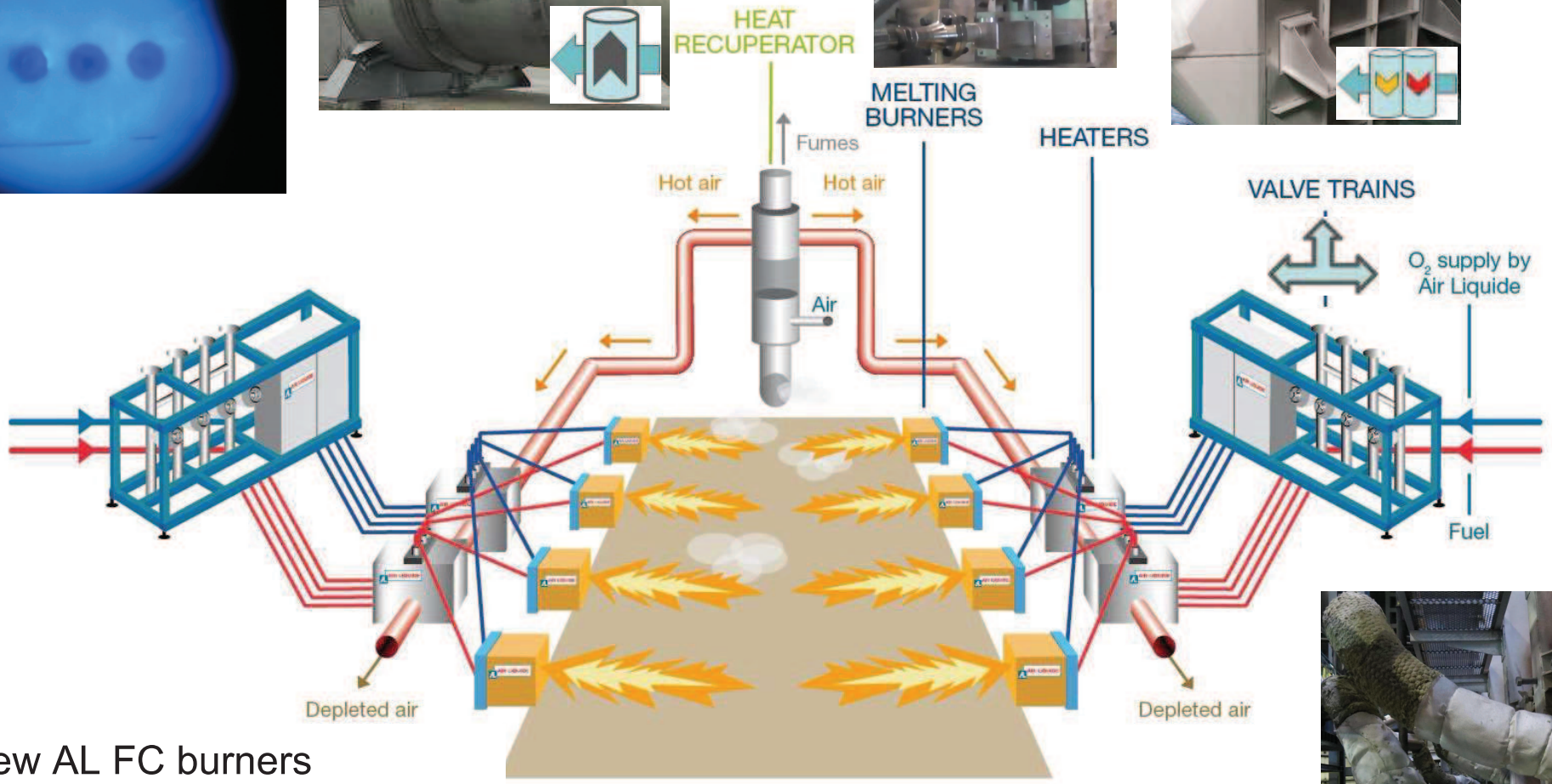
- **Compact burner** for preheated reactant (patent pending) with same coverage.

Heat Oxycombustion solution for small/medium furnaces



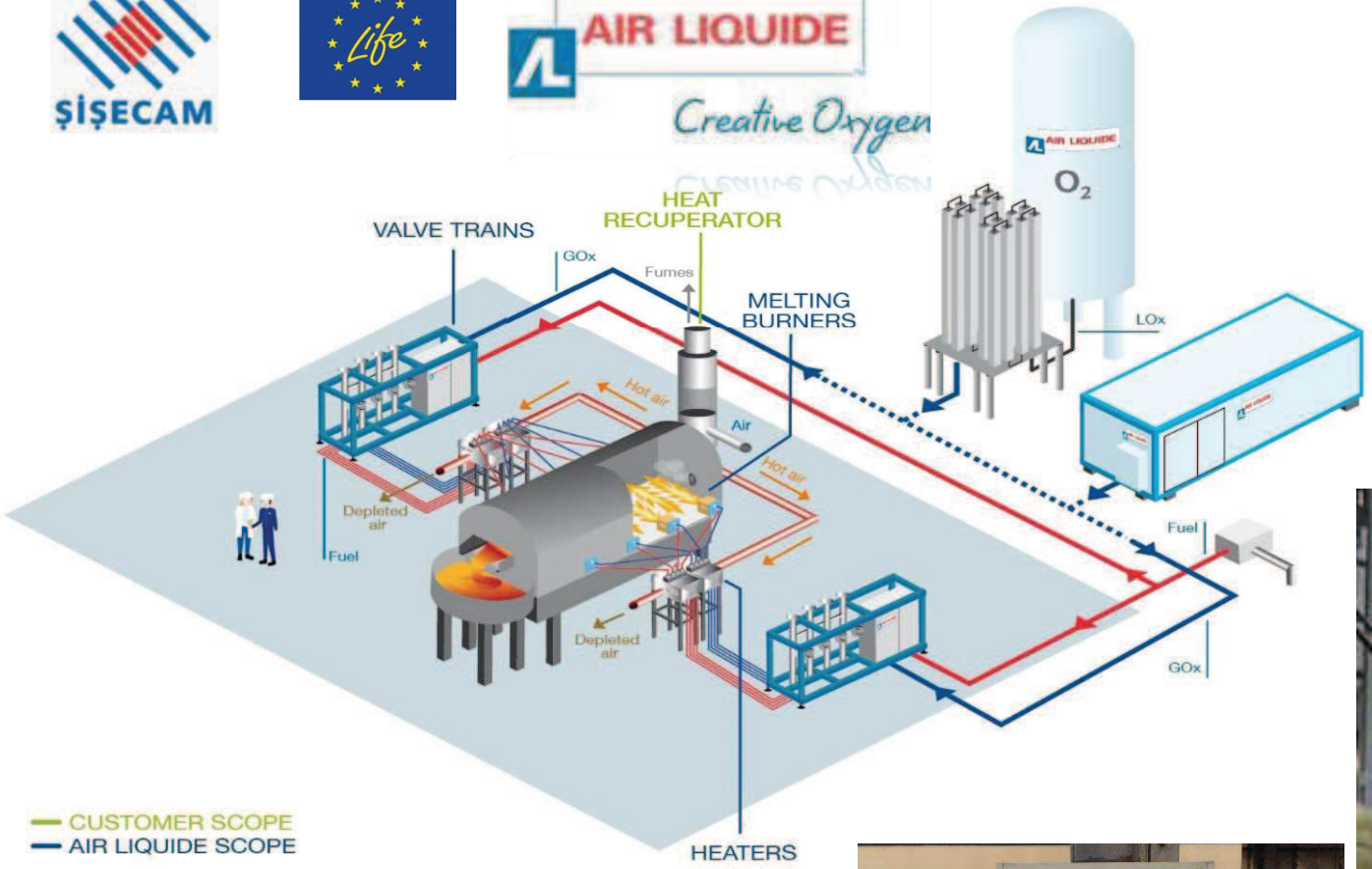


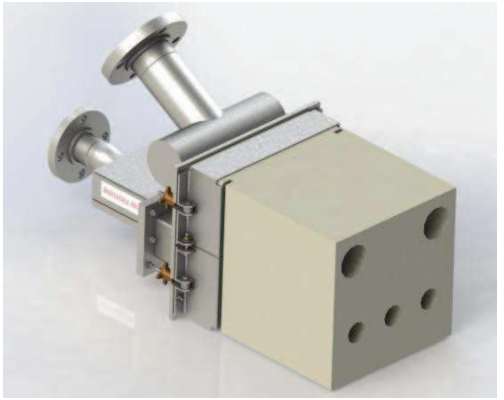




- ✓ New AL FC burners
- ✓ New AL O2 & NG Heaters

LIFE+ Eco-HeatOx ŞIŞECAM + Air Liquide



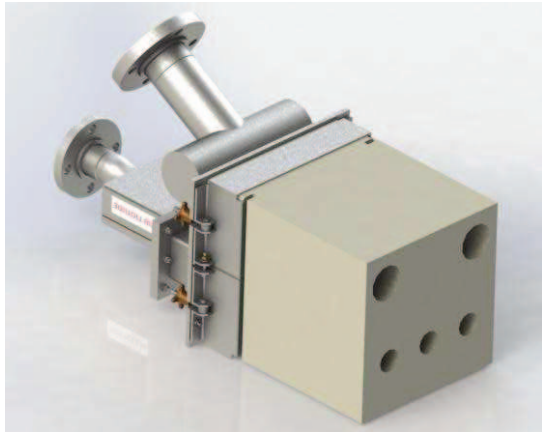


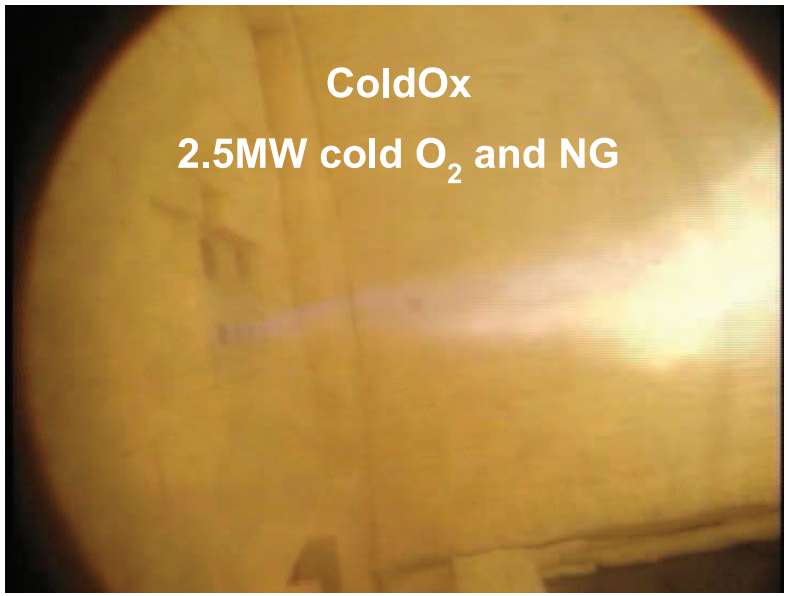
HeatOx installation at PB

/ Dated:

HeatOx Burner

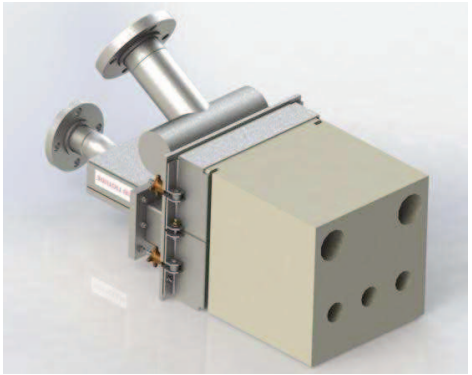
- Compact and operable with **Hot / Cold Oxygen** and **Hot Natural gas** (Patent Pending)
- Constant flame length (~3m)
- Could be operated with hot air as back up

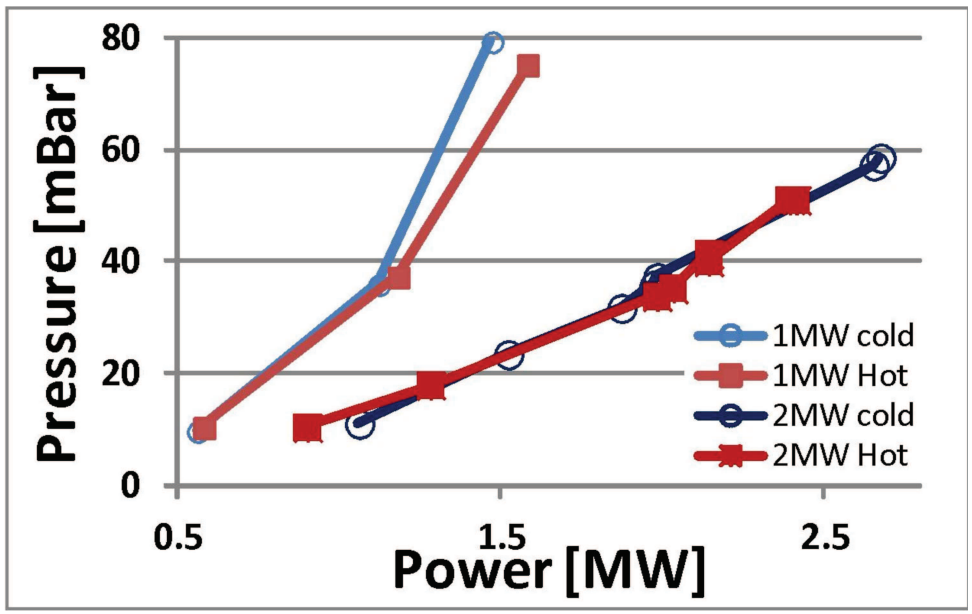


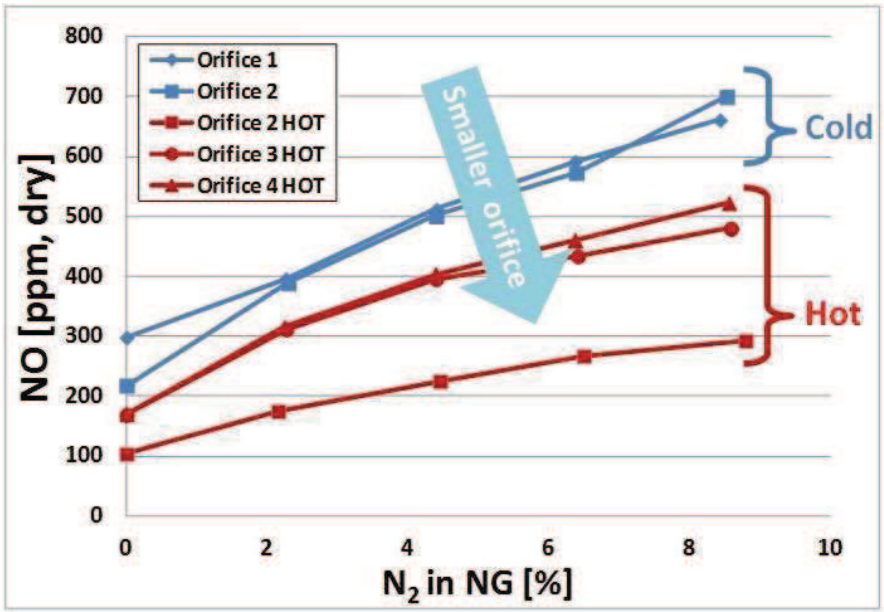


Emissions

- Compatible pressure drop between cold and hot operation
- Minimal pressure fluctuation during the transition
- ~15% CO2 reduction compared to state of art air combustion considering CO2 emission from O2 production
- Low NOx: 0.417kg/t for ColdOx and 0.308kg/t for HeatOx at 6% O2 [Eco-HeatOx Project, NO2 equivalent]
  [BAT: 0.5-0.8kg/t for oxy-fuel container glass furnaces]
- Particulate emission assessment on going.







Customer and Environmental benefits

1. Reduction in energy costs:
   - Electric boosting for glass melting, Fuel and Oxygen
2. Affordable with less than 3 year payback
3. Compliance with new environmental regulations
   - CO2, NOx, Particulate reduction
4. Energy performance commitment (>10%) compared to traditional oxy-combustion
5. Easy integration into standard furnace processes
6. Dedicated central team

Thank you

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