Oxy-fuel combustion with preheated Oxygen-Natural gas (HeatOx) for small and medium size glass furnaces

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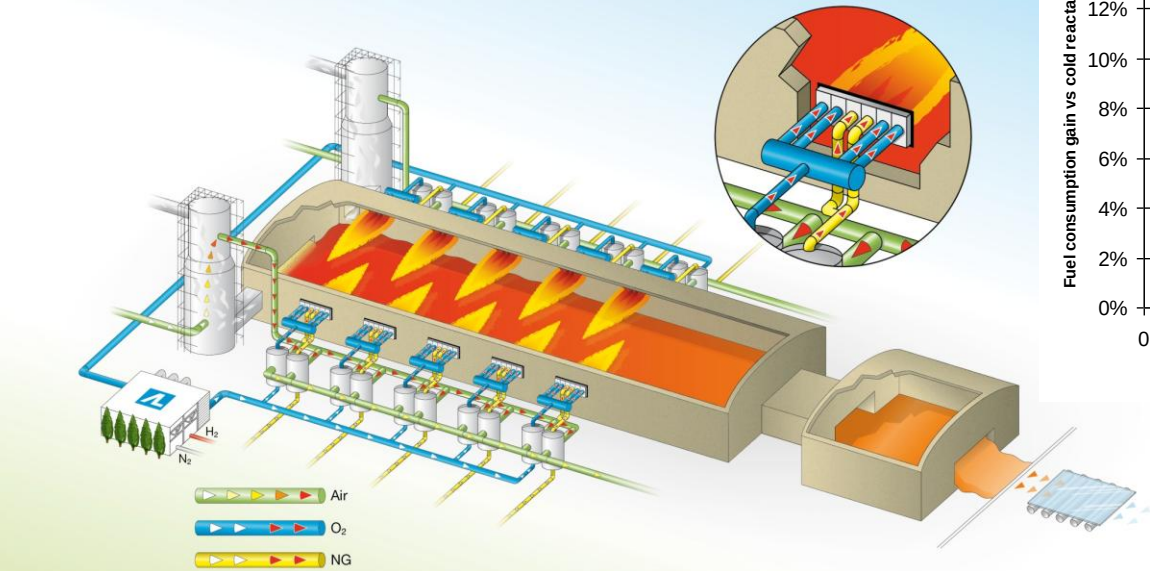
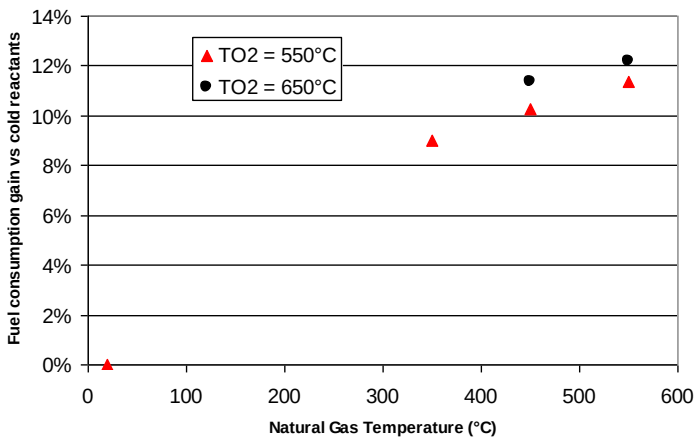
Agenda

- **Background**
- **HeatOx solution development for small/medium furnaces**
- **ALGLASS HeatOx technology components**
- **HeatOx burner tests results**
  - 2MW ALGLASS HeatOx NOx results
  - Flame length
  - Flame luminosity enhancement
  - Burner pressure drop curves
- **Summary**

Background

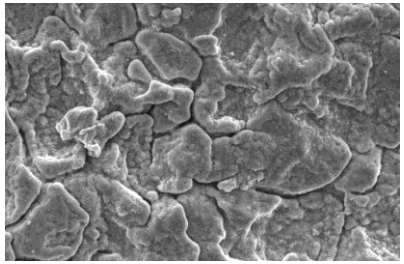




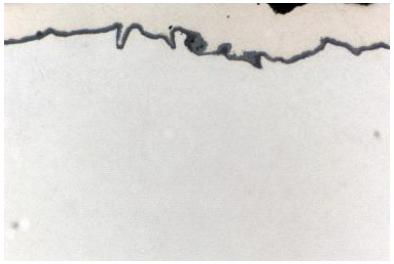
- ~10% NG and Oxygen saving thanks to NG (450°C) and O_2 (550°C) preheating.
- The saving was validated for a float glass tank as a first reference.
- More compact HeatOx solution has been developed for small/medium furnaces and will be implemented for a tableware glass tank under LIFE+ as a second reference.

Background (Cont.)

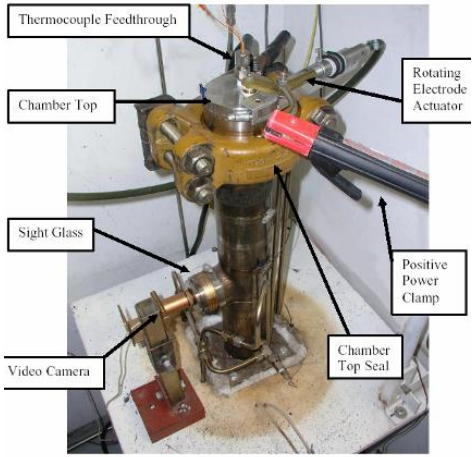
- Material study for preheated oxygen
  - Cyclic oxidation / Promoted combustion study
  - Long term exposure



Macroscopic analysis



Oxide scale



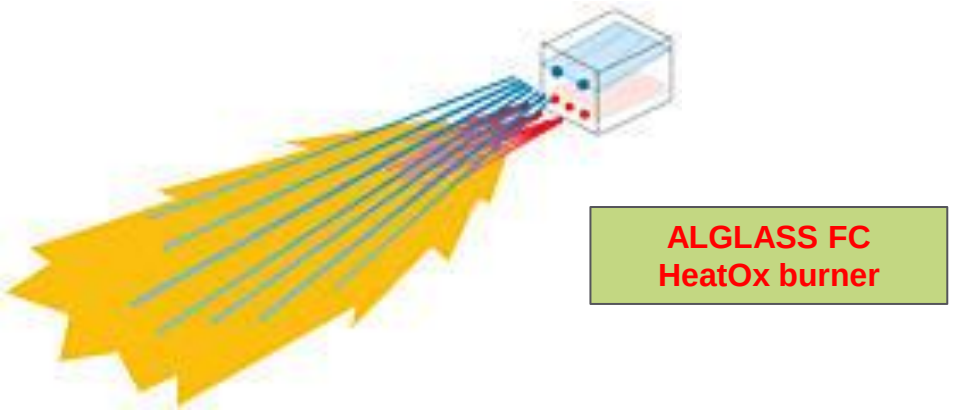
Promotion Ignition Chamber

- Special attention has been paid to oxygen preheating hazards:
  - Material selection
  - Flange design and choice

HeatOx solution development for small/medium furnaces

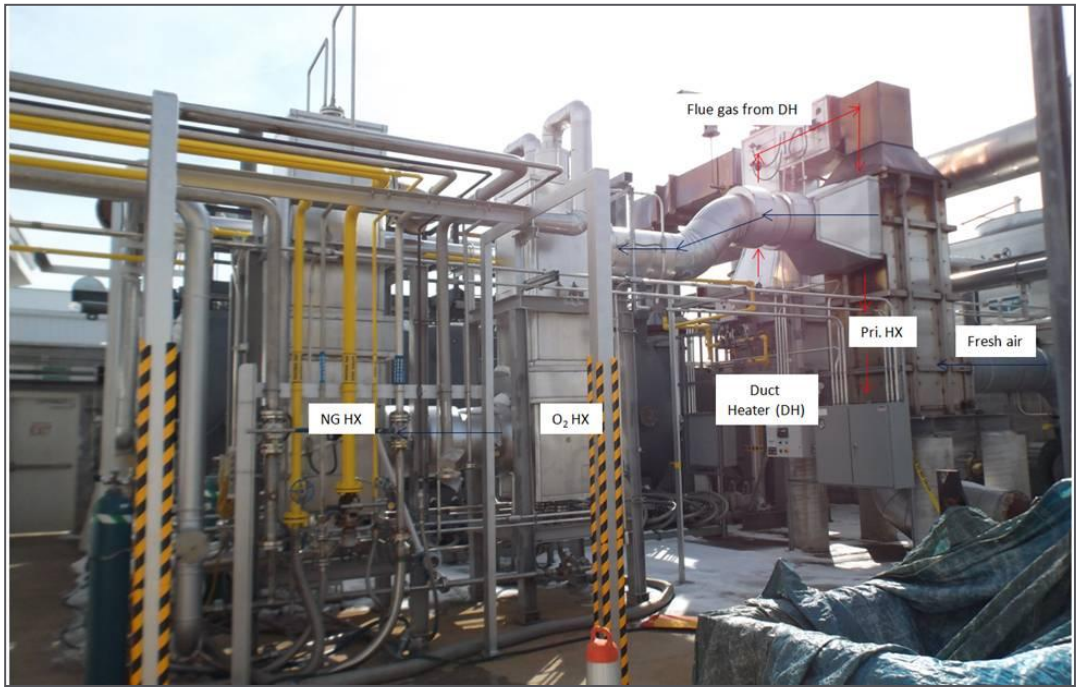
- **One heat exchanger for multiple burners**
  - CAPEX savings and smaller footprint
  - Independent control of flowrate and temperature

- **ALGLASS FC HeatOx burner**
  - Compact and operable with hot and cold reactants
  - Constant flame length (~3m) with hot and cold reactants



HeatOx solution development for small furnaces (Cont.)

- **Pilot scale tests at DRTC**
  - Tested O2/NG heat exchangers with multiple independent inlets/outlets.
  - 1MW and 2MW HeatOx burners were tested with cold and hot reactants.
  - Temperature control schemes were validated.



HeatOx solution development for small furnaces (Cont.)

- **Industrial demonstration under LIFE+ (start-up in 2015)**
  - One O2/NG heat exchanger for four burners (total 8 burners).
  - Heat recovery process optimized by Air Liquide

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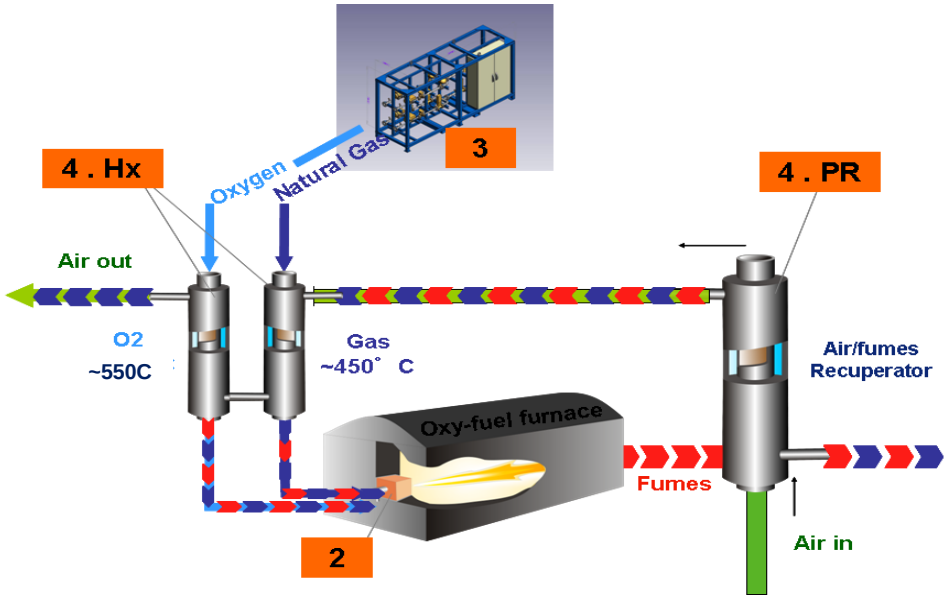
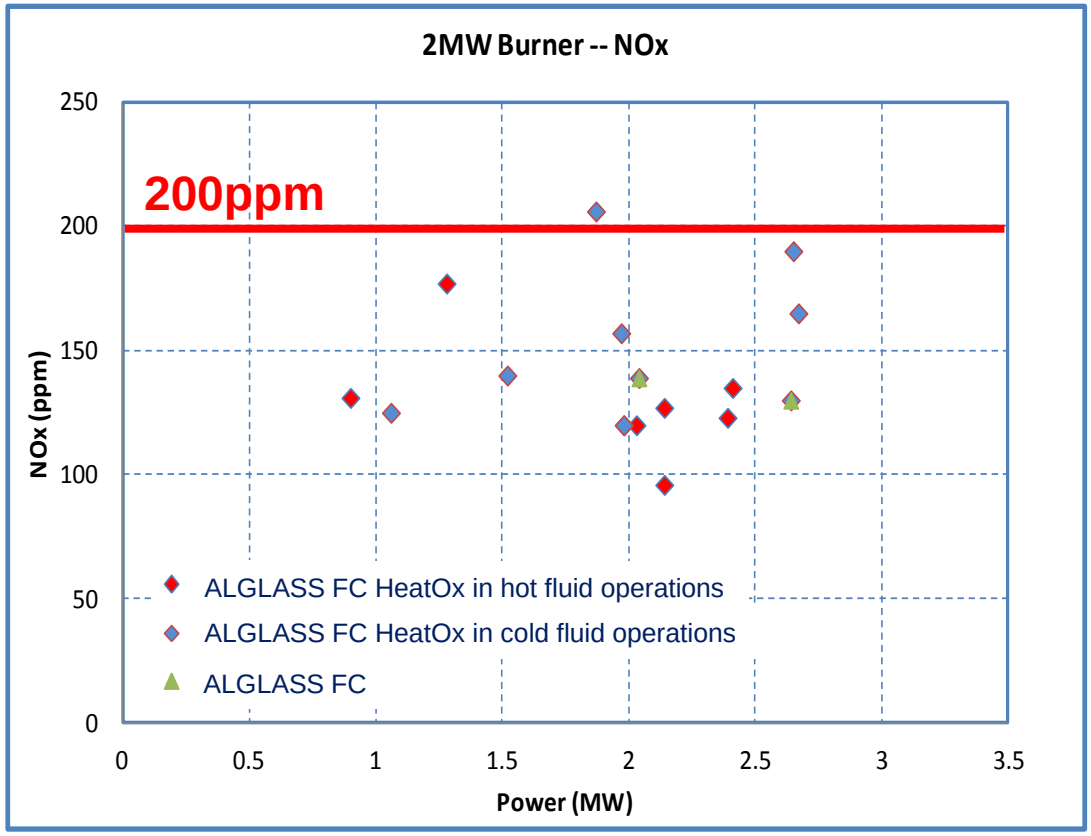
ALGLASS HeatOx Technology Components

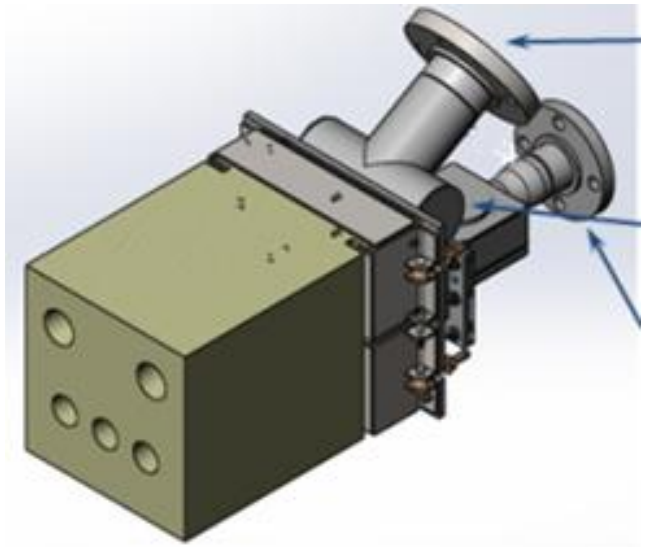


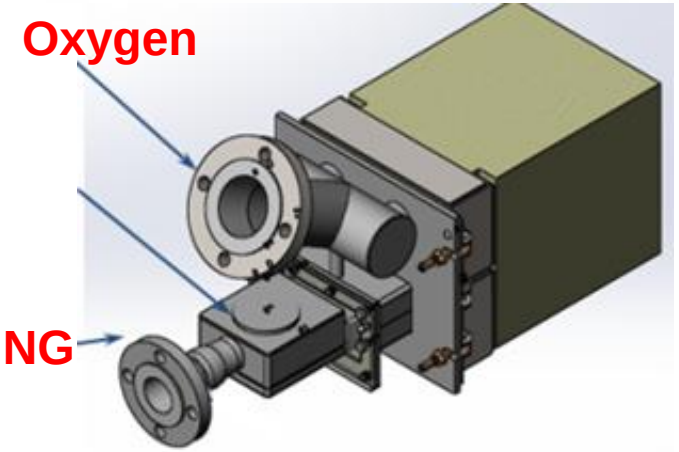
	Global Offer
Part 1	*Oxygen*
Part 2	*Burners*
Part 3	*Valve train*
Part 4	*Thermal heat exchangers*
Part 5	*Engineering, installation and integration*

- One heat exchanger (O_2/NG) can accommodate multiple burners (Patent pending, WO 2014/052627 and WO 2014/052635).
  - Flowrate and temperature can be controlled individually.
- ALGLASS FC HeatOx burner can be operable with cold and hot reactants without operator's manipulation (Patent pending).
- Built-in safety and control logic.

2MW ALGLASS HeatOx burner NOx results

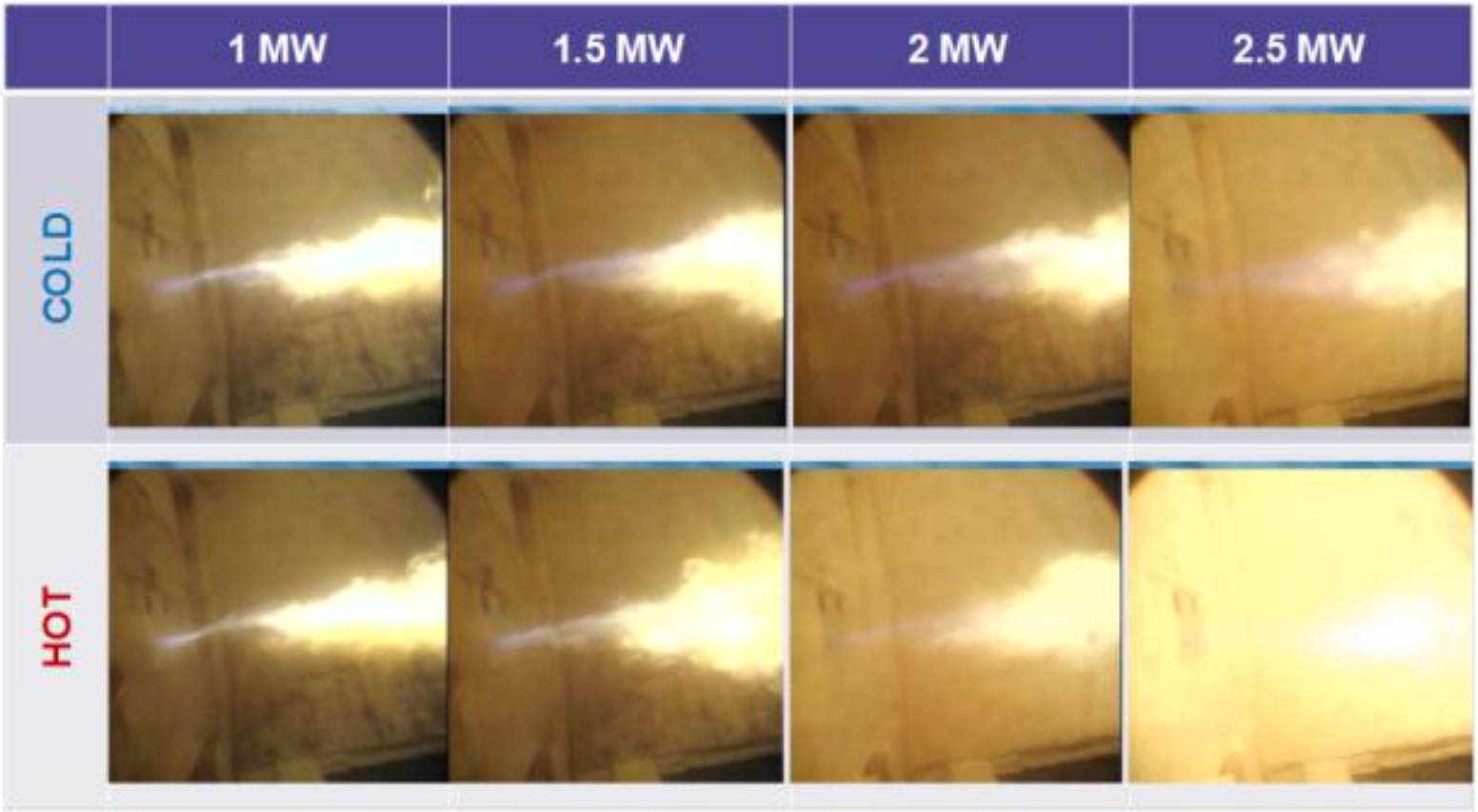






Flame length

- Flame length was about 2.7-3m irrespective of operating temperature of reactants.



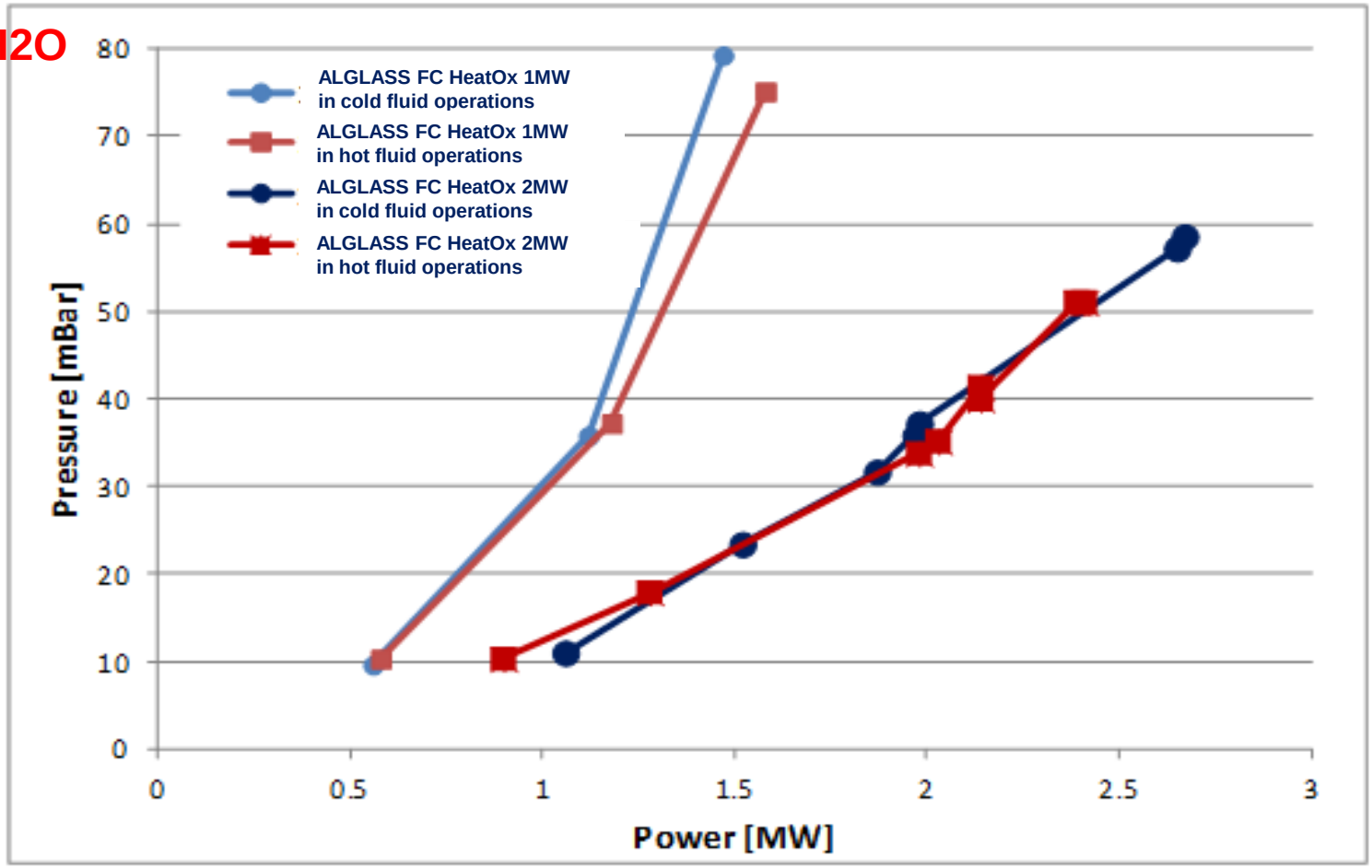
Flame luminosity enhancement

2.5MW cold O2 and NG

2.5MW hot O2 and NG

Burner Pressure Drop Curves

30inH2O



Summary

- **Pilot scale HeatOx system was demonstrated at DRTC.**
  - O2/NG temperature (400°C – 600°C)
  - Multiple burners can be simultaneously operated with independent power control.

- **ALGLASS FC HeatOx burner**
  - Compact and operable with hot and cold reactants
  - Constant flame length (~3m) with hot and cold reactants.
  - NOx level under 200ppm at any given power.
  - Flame luminosity enhancement.
  - Pressure drop and fluctuation is minimal during the transition from cold to hot operation.