The Oxy-combustion Burner Development for the Lacq CO_2 Pilot

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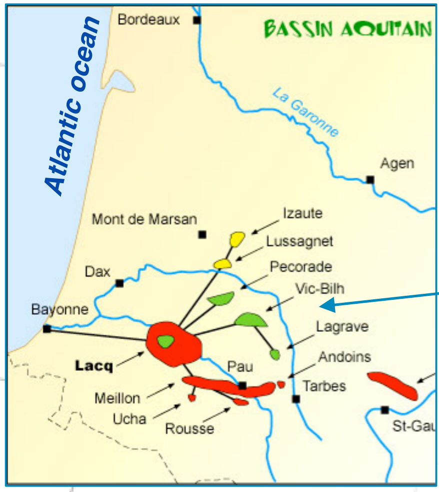
Lacq CO_2 Pilot

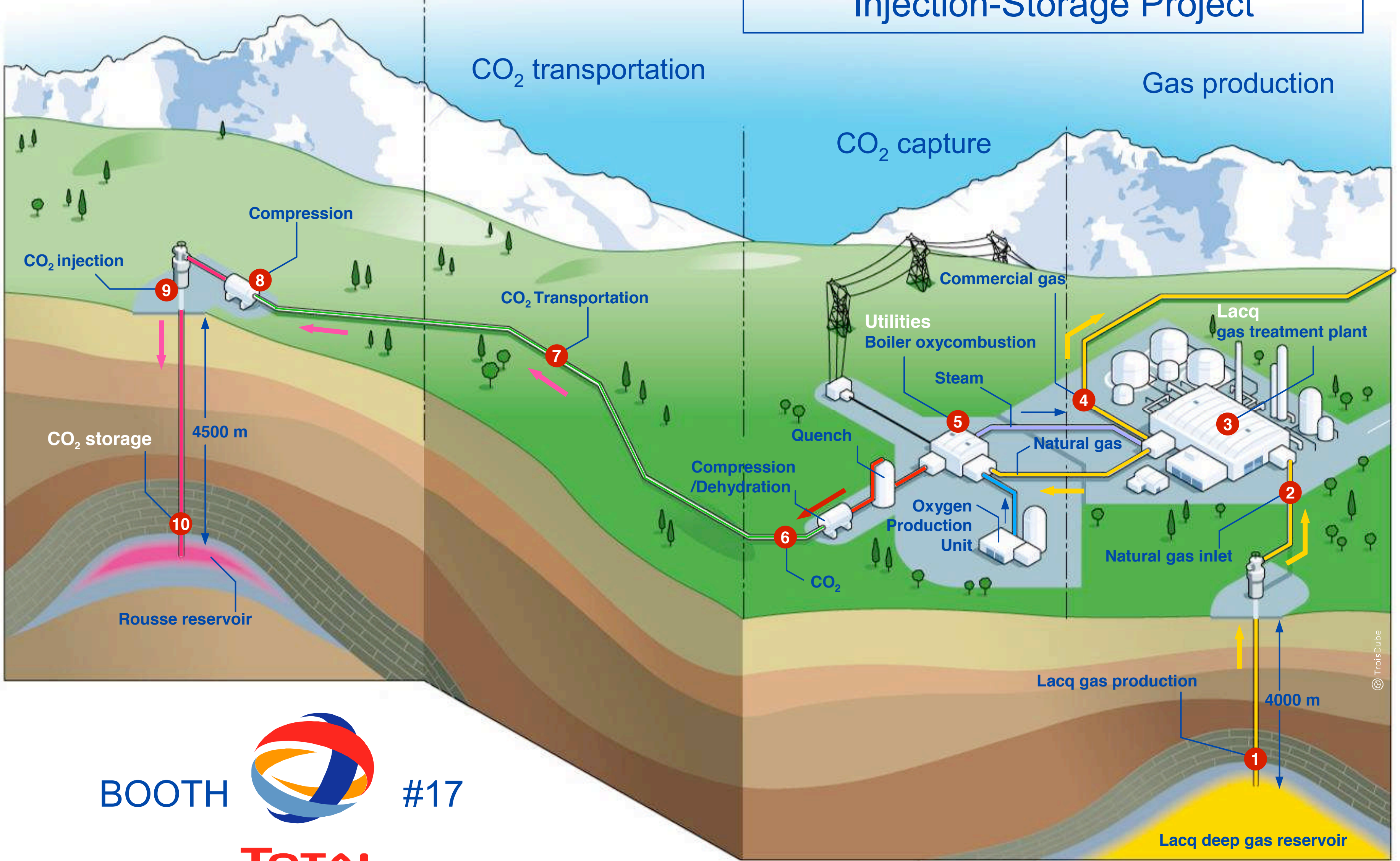
Pilot location - Total Exploration & Production France



Gas field
Oil field
NG Storage

Carbon capture & geological storage in Lacq region

Integrated Capture-Transportation-Injection-Storage Project



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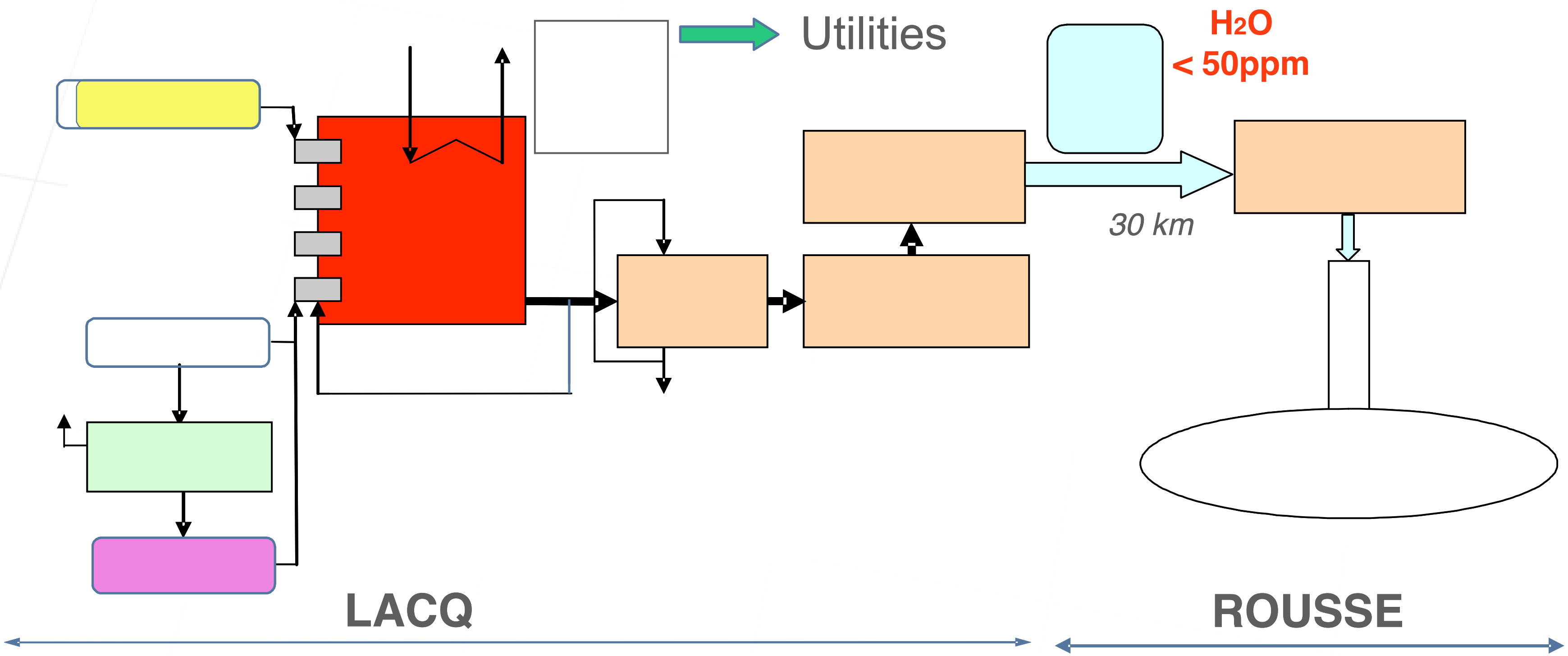
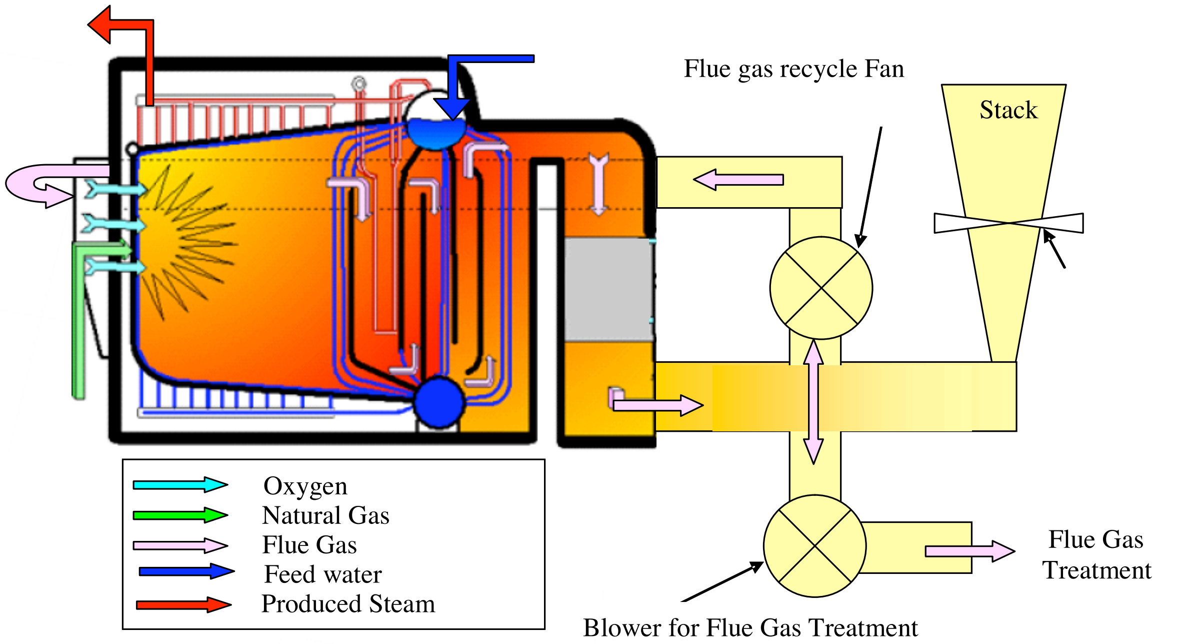
CCS Lacq pilot plant – Major challenges



- Industrial scale 30MWth oxycombustion unit with gas
- Revamping of a conventional boiler
- CO_2 transport and injection for 2 years
- 120 kt CO_2 storage in a depleted reservoir
- First CO_2 injection for storage in France
- Public acceptance with consultation and dialogue
- French and international legal framework not frozen

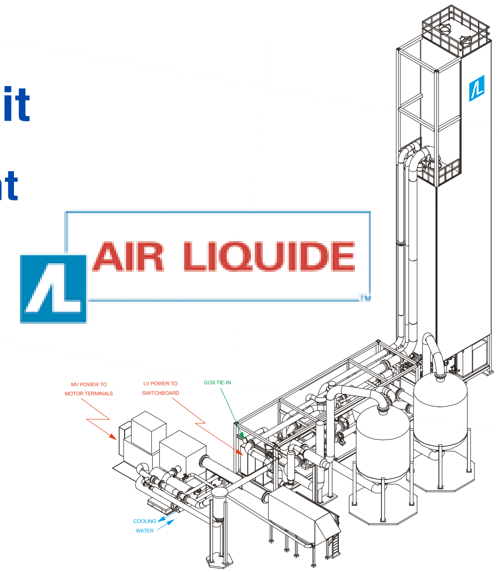
Boiler revamping

- Existing boiler revamping with CO_2 recycling.
- 40 t/h steam 60b/450°C ($30MW_{th}$) to HP network.
- Alstom in charge of boiler revamping works.

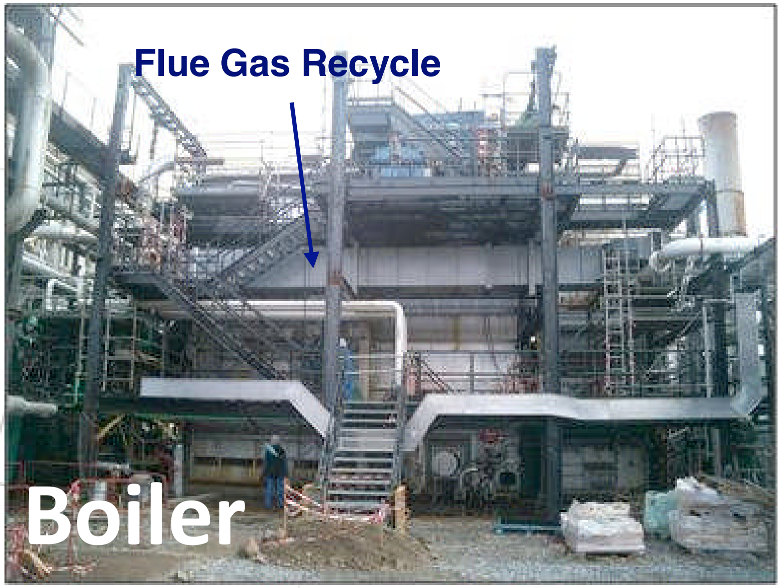


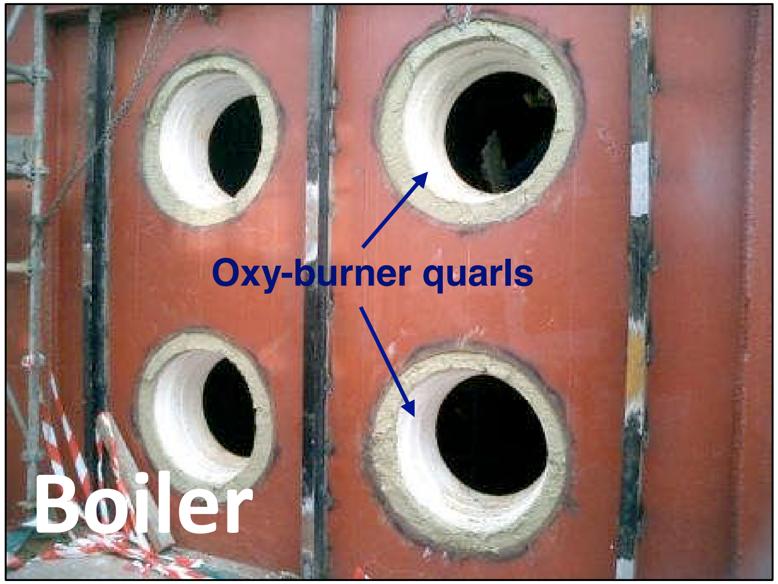
Cryogenic Air Separation Unit

- Standard ASU packaged plant
- 240 tpd O2
- LP: 1,8 bar abs
- Variable purity (95-99,5% O2)
- No oxygen storage



Construction





Oxy-burner development

Oxy-burner Concept for Oil & Gas Applications

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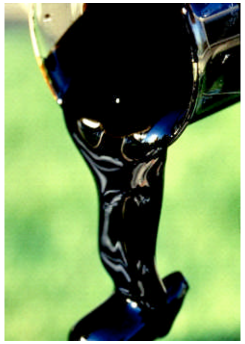
- Challenges for oxy-burner concept:
  - In-furnace heat flux management
  - Minimize flue gas recycle (FGR)
  - High viscosity / high density liquid fuels
  - High sulfur and high metals content
  - Use of usual materials

Oil Sands



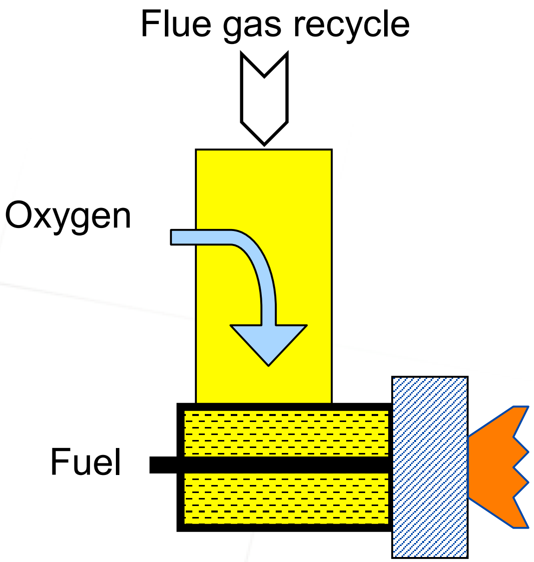
Bitumen
°API 11

- Air Liquide's oxyburner concept achieves:
  - Fuel flexibility for gas & liquid fuels
  - Variable flue gas recycle rate
  - Air mode for transient operation
  - Important turndown ratio
  - Oxy-flame stability with uneasy fuels
  - Optimum operating procedures (air-oxy mode)

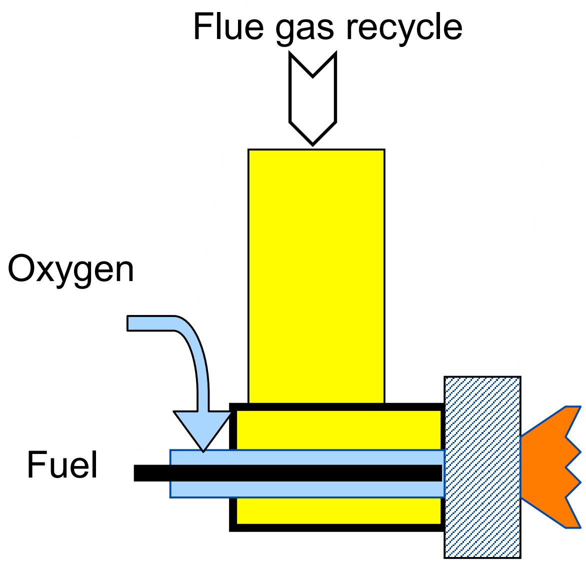
Air Liquide Oxy-burner Principle

No external oxygen mixing:

- Intrinsic oxygen flames advantages: flame stability, turndown ratio, uneasy fuels.
- Improved operating safety: dedicated pure oxygen circuit all along distribution system.
- Additional flexibility to adjust FGR rate.



Synthetic air approach



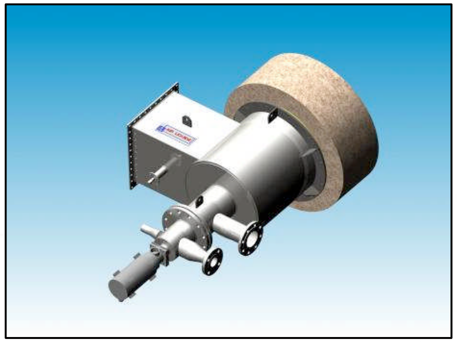
Air Liquide oxy-burner

Oxy-burner Development path

Size

8 MW

1 MW



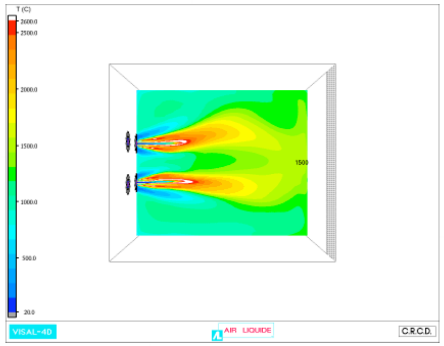
8 MW oxy-burner design for Lacq boiler

1 MW prototype AL-R&D center rig

4 x 8 MW burners being set up in Lacq boiler

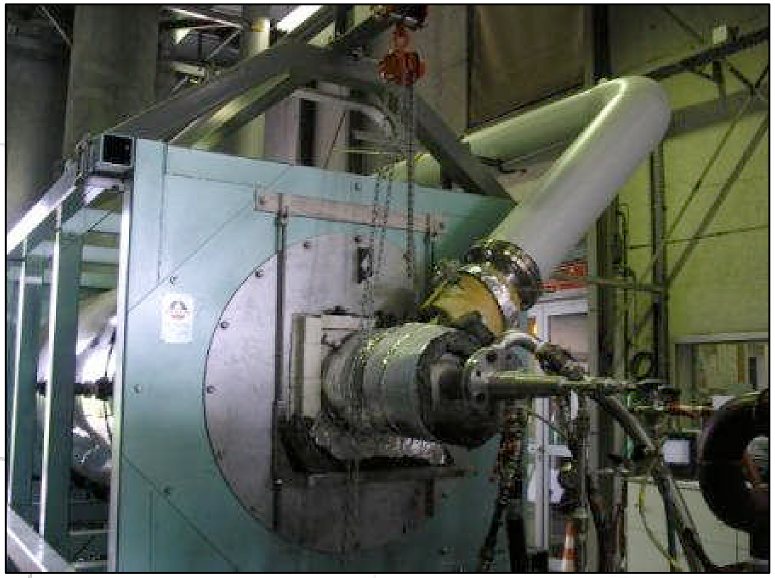
2006 | **2006-2007** | **2008**

- Upscaling know-how
- CFD modeling using proprietary code
  - Specific to oxy-combustion
  - Fine tuned with oxy-combustion experimental data



1 MWth Oxy-combustion Test Rig

- Versatile and functional test rig
  - Variable FGR rate and temperature
  - Liquid / gas fuel feed capability
  - Cold wall configuration
  - Combustion monitoring
  - Emission control

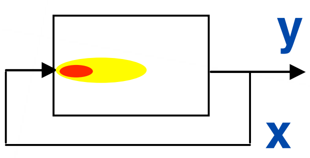


Experimental Results at 1 MWth Test Rig

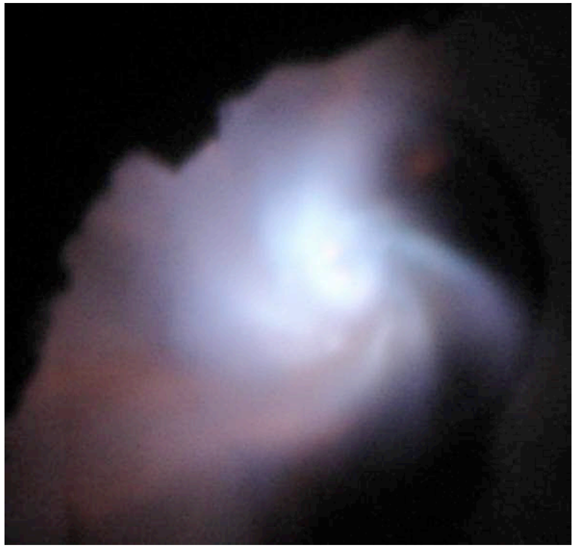
- High CO_2 concentration achieved:
  - 94% vol dry systematically.
  - Importance of pressure control along FGR circuit to avoid air in-leakages.
  - Slightly positive pressure in chamber.
- Views of 1 MW oxy-burner prototype with natural gas:

FGR = 1

FGR = 0



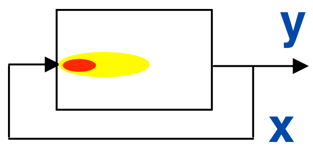
FGR rate = x / y



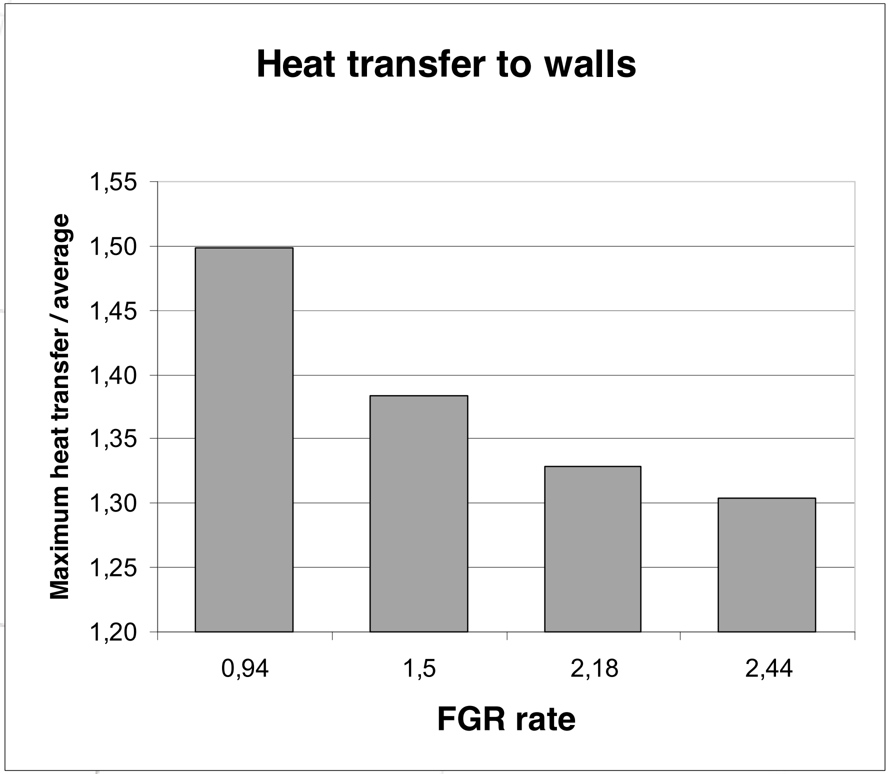
FGR = 1,5

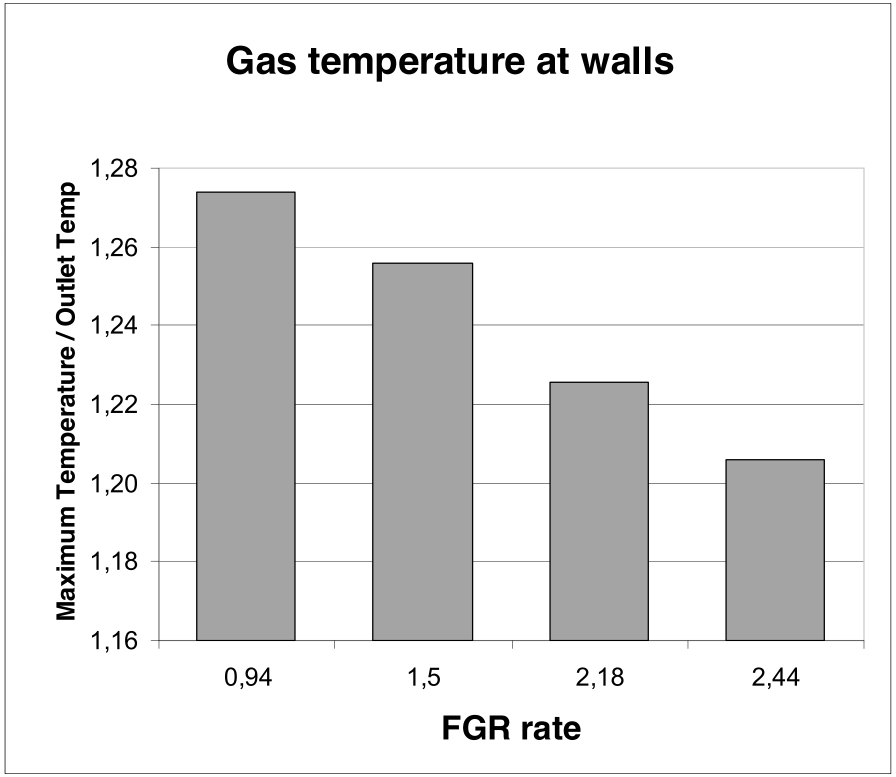
Experimental Results at 1 MWth Test Rig

- Controlled heat flux with reduced FGR
- Adjustable flame length
- Air mode for transient operation
- Large turndown ratio (10%)
- Oxyflame stability with uneasy fuels
- Rehearsal of burner operating mode



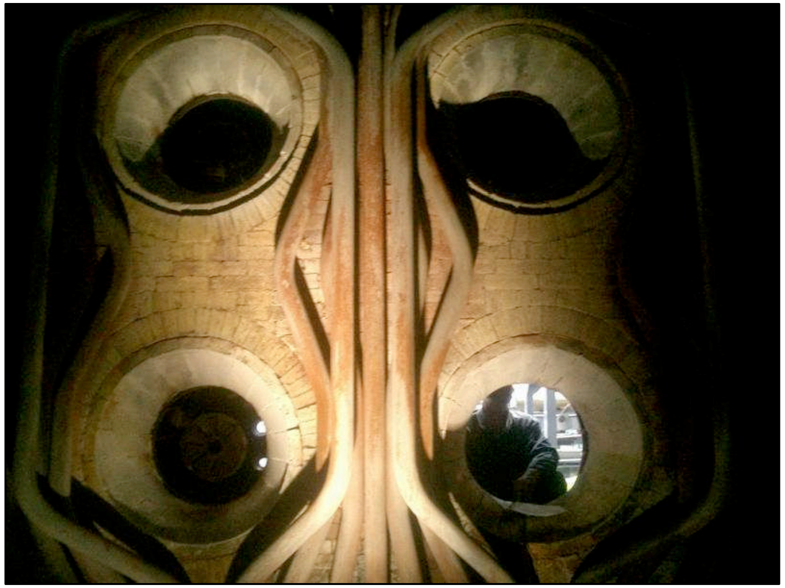
FGR rate = x / y



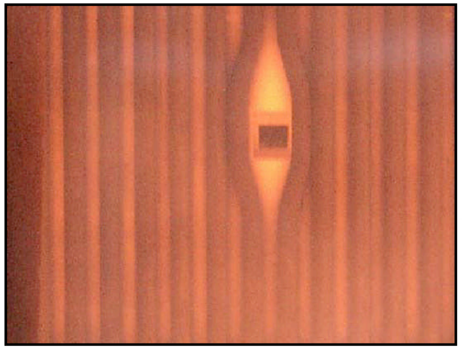


Oxy-burner Implementation into Lacq Boiler

- Retrofitting of an air-fired boiler
  - Oil & Gas boiler configuration
  - Fixed geometry:
    - 4 horizontal burners
    - Chamber: L 5 m; W 4,5m; H 6-7m
- Careful sealing at every interface to minimize air in-leakage
- Fluid distribution control and measurement
- Operating mode
- Safe operation Safety analysis
- Tests and measurement plans



Openings for the 4 existing air-fired natural gas burners



Existing measurement port

Conclusions

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- Total CO2 Lacq pilot will demonstrate integrated scheme (from capture to storage) feasibility at industrial scale
- ✓ Oxy-combustion is a proven technology that facilitates CO_2 capture.
- ✓ Air Liquide oxy-burner concept - with separate injection of oxygen and flue gas recycle - enables safe oxygen handling for oxy-combustion in boilers.
- ✓ Oxy-burner performances demontrated in a 1MW boiler
  - ✓ fuel flexibility
  - ✓ Turndown
  - ✓ FGR rate flexibility
  - ✓ air to oxy transition
- ✓ Scale-up of the oxy-burner to 8 MW
- Start-up of the retrofitted oxy-boiler is scheduled early 2009.

Thank you!

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