PROJECT 11 - DEVELOPMENT OF AN ADVANCED NATURAL GAS BURNER USING THE FLAMELESS OXIDATION

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Research Centre for Gas Innovation
cleaner energy for a sustainable future

V Workshop Interno RCGI
University of Sao Paulo, Brazil
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In conjunction with Project 2 – Laboratory of advanced diagnostic for combustion

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The Combustion Area

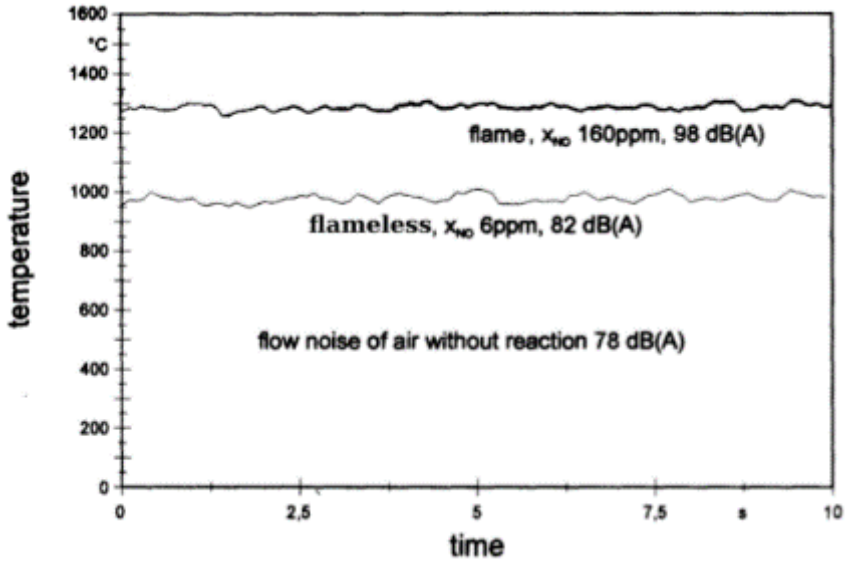
Combustion present in several applications

Targets:

- Lower pollutant emission

The Flameless Concept

Possible alternative: Flameless combustion
(Wunning and Wunning [1997])



- Furnace study case
  - NO emission reduction: 95%
  - Combustion noise reduction: 80%

The Flameless Concept

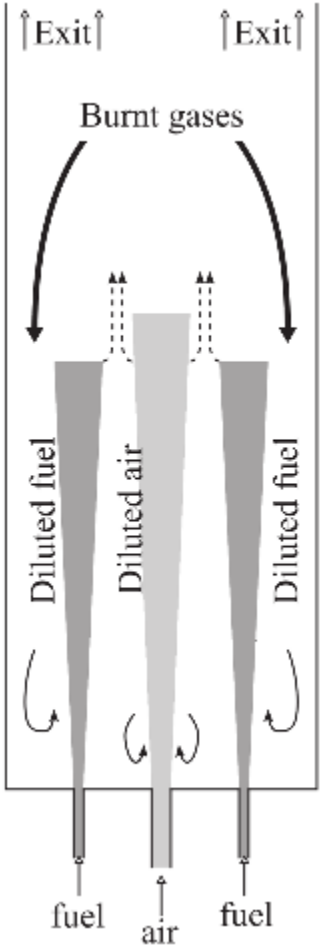
Characteristics

- Absence of visible flame
- Low pollutant emission
- Small temperature gradients inside the chamber
- Reduced Noise

Potential applications

- Industrial Furnaces
- Gas Turbines
  - Power Plants
  - Propulsion Engines

The Flameless Concept

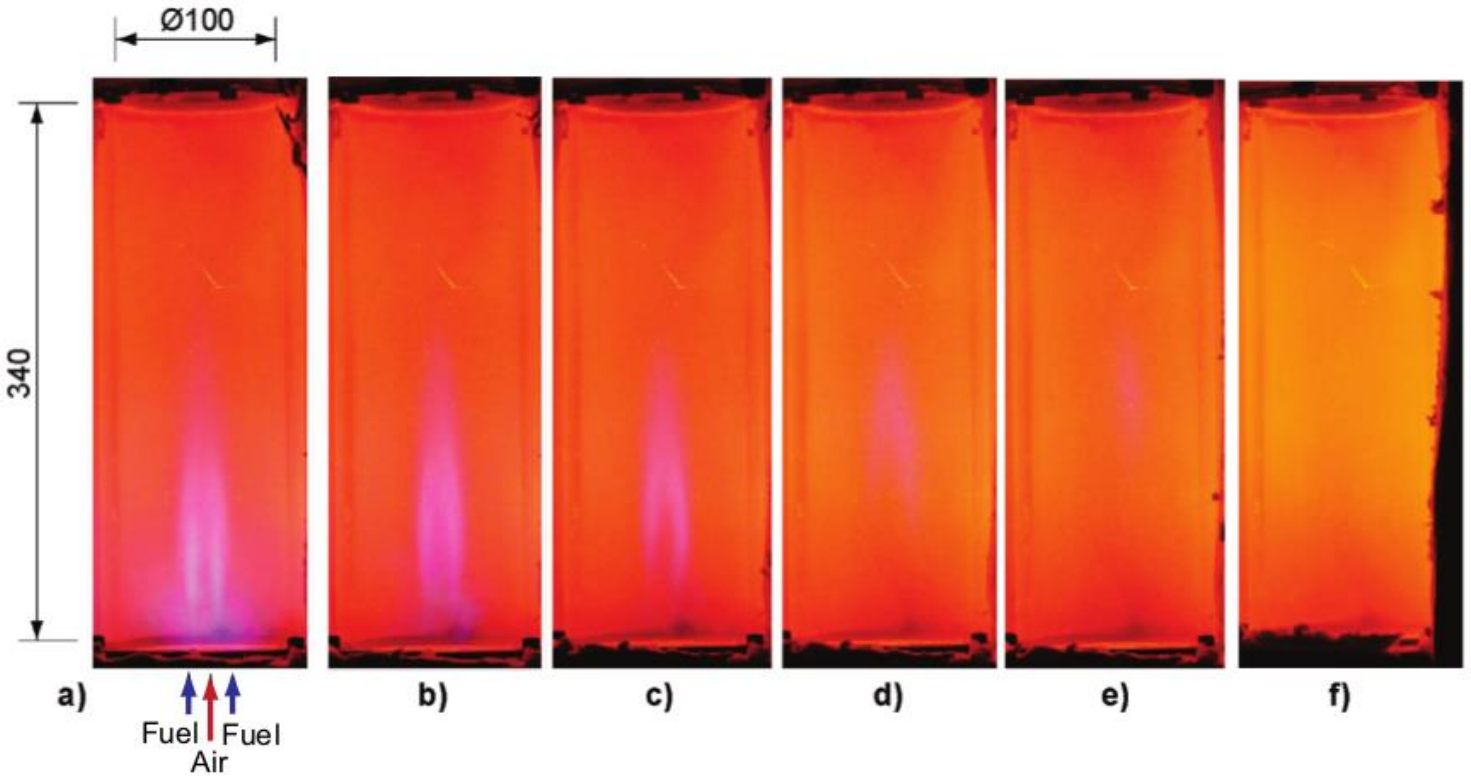


Lamouroux et al. [2014]

- High dilution of reactants with burnt gases
- **Turbulence-chemistry interaction**
- Simple chamber geometry
- Fuel: Methane

The Flameless Combustion

From conventional flame to flameless regime

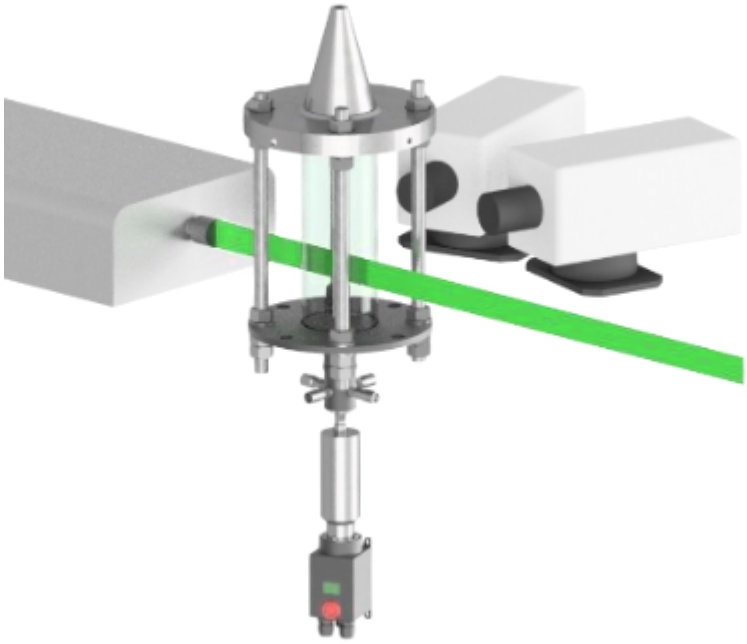


Veríssimo, et al. [2011]

Experimental – TR-PIV System (Project 2)

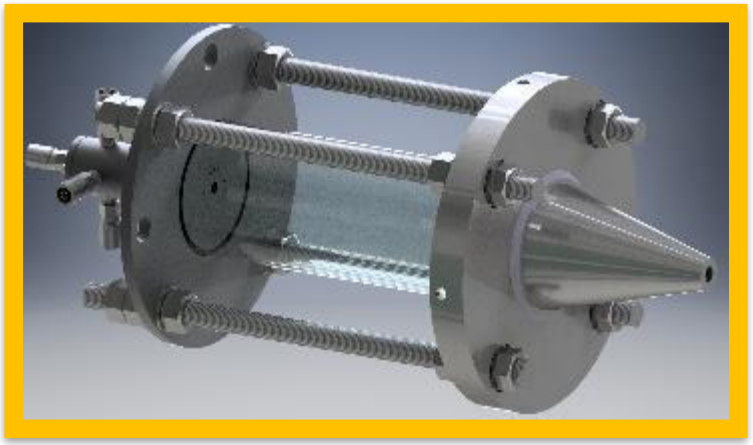
2D3C – Reactive/Non-Reactive

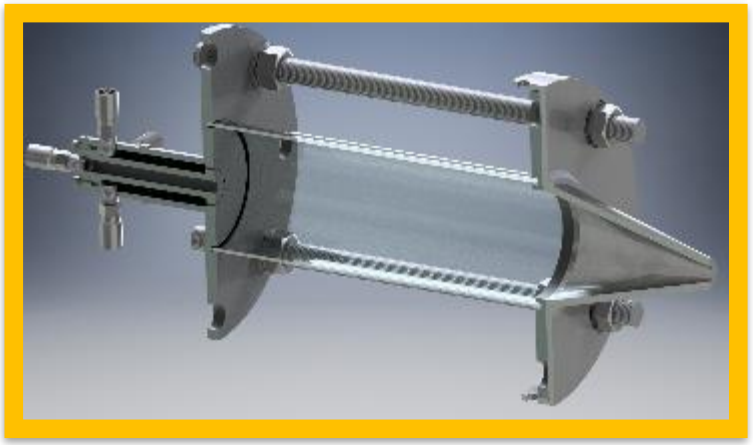
- High-repetition laser: Nd:YLF LDY302
  - λ: 527 nm; 4.5 mJ/pulse @ 5kHz.
- CMOS Camera
  - 12-bit camera, 1280x800 pixel, res: 0.5mm
- Solid seeding (non trivial)
  - SiO_2 : 0,26 g/cm3 – 0.3 µm
- Expected results
  - Instantaneous and Mean velocity components
  - Turbulence fields and statistics



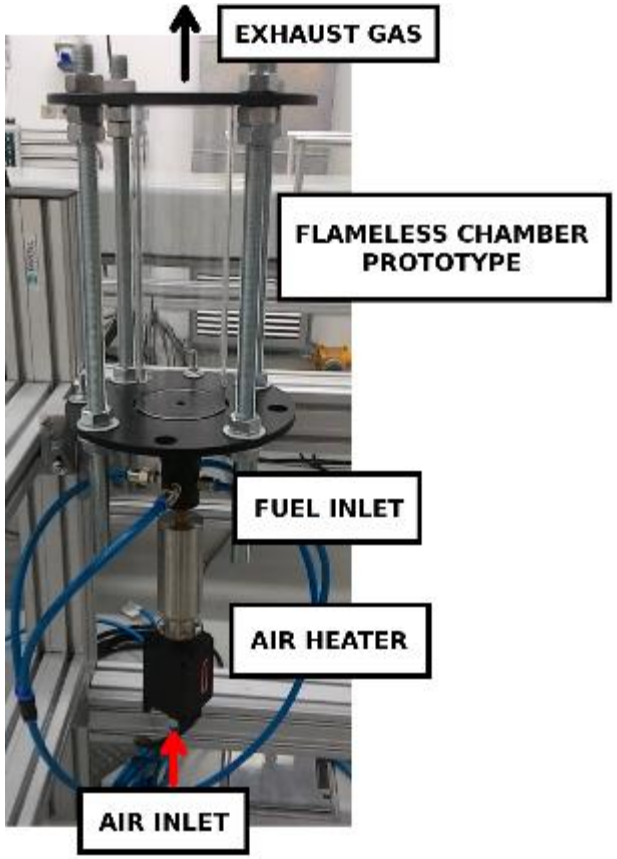
Experimental

CAD Model

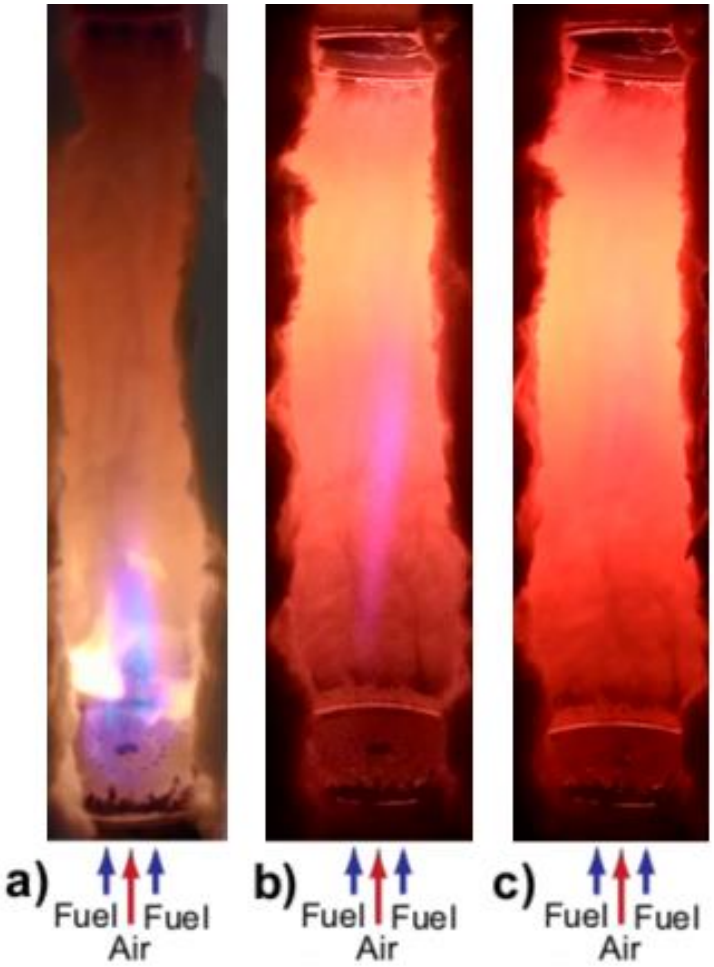




Test bench



Study cases



- a) Conventional
  - V_{Air} : 163 [m/s]
  - φ : 0.525
- b) Transition
  - V_{Air} : 127 [m/s]
  - φ : 0.674
- c) Flameless
  - V_{Air} : 96 [m/s]
  - φ : 0.891

Chamber operating

Conventional Transition Flameless

Next steps

2018

- Commissioning of the solid seeding system
- TR-PIV - Non-reacting cases
  - Validation against literature data
  - Development of image correction procedure
    - Cylindrical quartz wall

2019

- Enhance the algorithm for statistics and turbulence calculations developed in our laboratory
- TR-PIV – Reacting cases
- Data analysis for turbulence-chemistry interaction assessment

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