Pressure Gain Combustion for Efficiency Improvements in Gas Turbine

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PhD program in Industrial Engineering

SCOPE OF THE STUDY

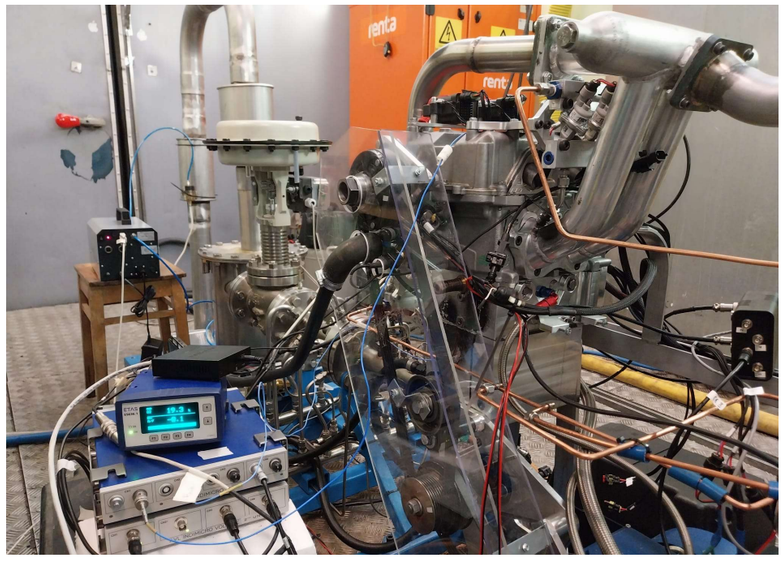
Gas turbines are approaching their maximum efficiency and performance improvements are becoming increasingly difficult to achieve. **Pressure Gain Combustion (PGC)** represents one of the most promising technology to break out the current limits.

This research focuses on the innovative deflagrative-based PGC developed by the Finnish company Finno Exergy Oy. A carefully designed geometry confines the flow creating the pressure rise during the combustion phase. The project envisages a **joint experimental and numerical approach** to fully characterize the combustor.

FIRST YEAR OBJECTIVES

I am currently at the sixth month of my PhD.
The main objectives of the first year consist in:

1. Development of a 1D model of the combustor;
2. Calibration of the model through experimental results;
3. Scaling up of the current system.



FIRST YEAR ACTIVITIES - NUMERICAL

- Predictive 1D model to obtain burn rate inside the combustor as function of the measured variables.
- Parametric analysis on model parameters to match the experimental data.

FIRST YEAR ACTIVITIES - EXPERIMENTAL

Experiments with 100% hydrogen acquiring:

Position	Parameter
Upstream the PGC	Air dynamic pressure
Inside the PGC	Cylinder dynamic pressure 1
	Cylinder dynamic pressure 2
	Round signal
Downstream the PGC	Exhaust dynamic pressire
	λ
	NOx (gas analyser)

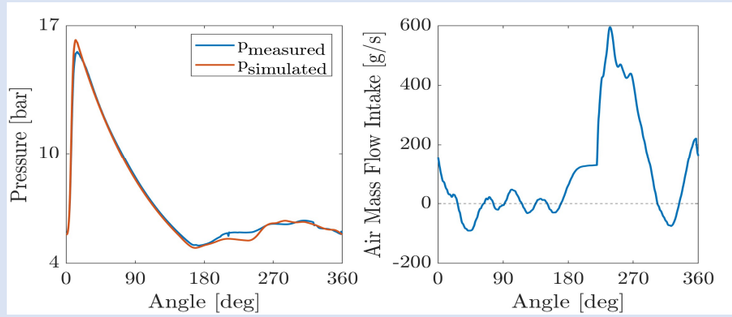
The geometric & operating parameters that could be varied during the campaign are shown in the Table below. For different geometric configuration the optimal timings were found and tested.

Type of parameter	Parameter
Geometry	Outlet Orifice Diameter
Supply pressure	Hydrogen Supply Pressure
Timings	Injection Duration
	Injection End Timing
	Spark Plug Timing
	Intake Valve Closing
	Rotational Velocity

The Pressure Gain obtained was 30.32 %

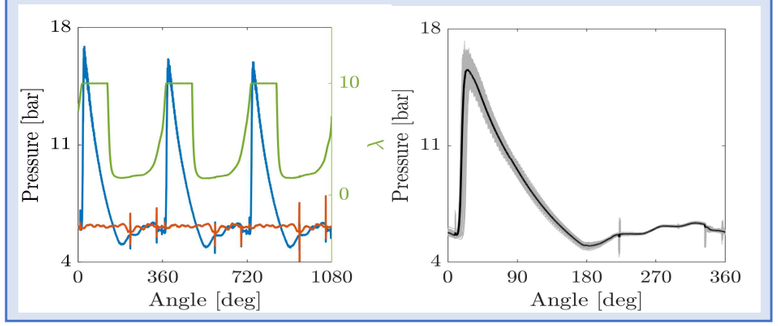
PRELIMINARY RESULTS – NUMERICAL

Matching Measured and Simulated Cylinder pressure (left and identifying backflow in the intake pipe (right):



PRELIMINARY RESULTS - EXPERIMENTAL

Cylinder pressure (blue), intake pressure (red), and λ (green) trend during 3 consecutive cycles (left);
Mean cylinder pressure over the whole test (black) with respect to all cycles (grey) (right).



FOLLOWING STEPS

- Scaling up of the system
- Additional experimental campaign with ionization sensors to capture the flame front

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