Experimental investigation of CH_4/H_2 blends on the emissions of a mGT setup with enhanced EGR

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Context

- Amine-based carbon capture is a key solution to mitigate CO_2 emissions in gas turbines
- Exhaust Gas Recirculation (EGR) allows to increase the CO_2 concentration and decrease the mass flow rate → good integration with amine-based capture
- Higher EGR rates are limited by the stability of the combustion (flame-out) and by CO levels emitted
- H_2 is investigated as an EGR facilitator for achieving higher EGR rate

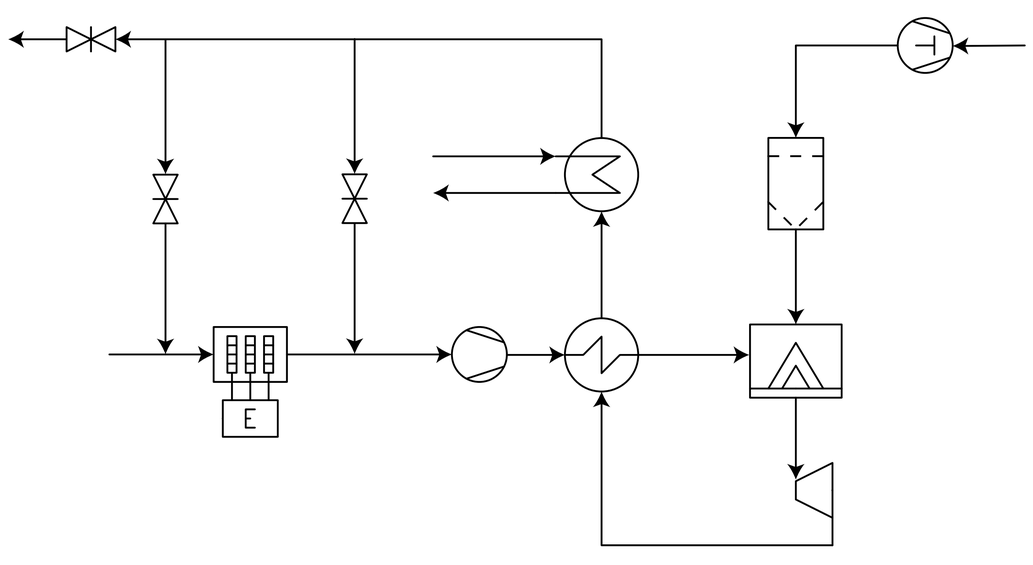
Objectives:

- Determine the impact of H_2 injection on CO and NO_x
- Determine the impact of H_2 injection on combustion stability (flame-out limit)

Methodology

The 3kWe micro gas turbine (MTT EnerTwin) has been modified:

- Electrical preheating of the air for a constant compressor inlet temperature
- Mixing station to change fuel composition
- External EGR loop with valve controlling the back-pressure



Operation conditions:

- Fuel: 100% CH_4 or 80% CH_4/20% H_2
- Dry composition of CO_2, O_2, NO_x and CO in the exhaust gases
- 25°C compressor inlet temperature and 70% of nominal load
- EGR rates applied up to 84%

Results and discussion

H_2 addition allows to extend the:

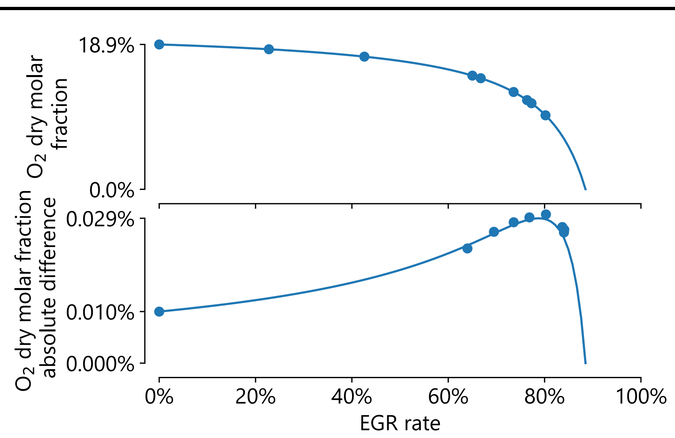
- Maximal EGR rate appliable: 80% → 84%
- Maximal CO_2 concentration: 6.5% → 7.8%

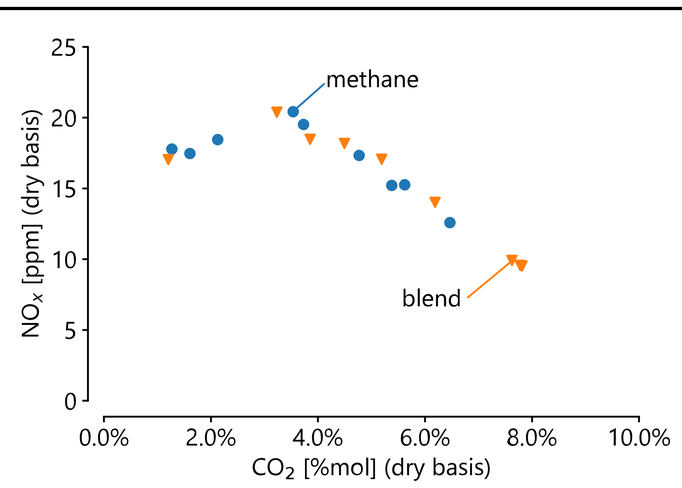
Impact on NO_x:

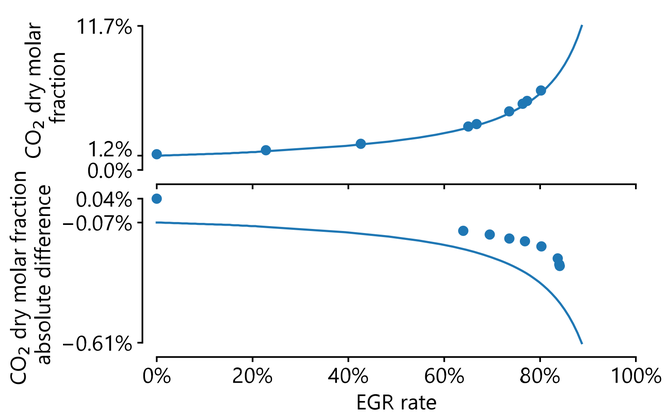
- Unchanged
- Highly diluted conditions → flame temperature not affected by H_2

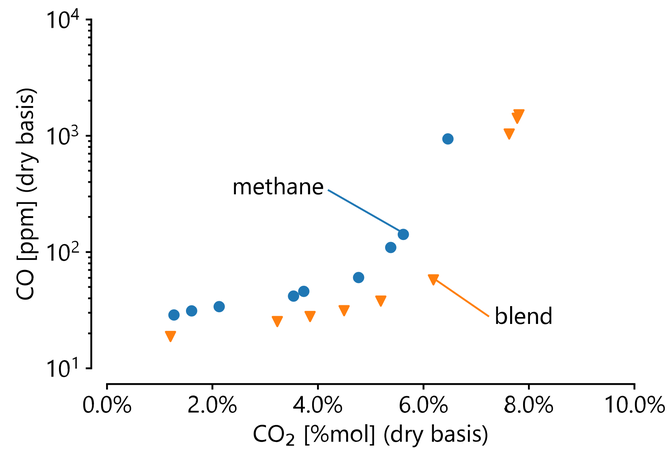
Impact on CO:

- Drastically reduced
- More oxygen present in the combustion chamber
- High reactivity of H_2
- Less carbon in the fuel









Conclusion

- Hydrogen injection decreases the CO formation by up to 15
- Hydrogen injection leaves NO_x emission constant
- Hydrogen injection allows for higher EGR rate

Hydrogen is an EGR facilitator that can be used to achieve higher CO_2 concentration by stabilizing the combustion and reducing the emission of pollutants.

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