Towards the design of a supercritical combustion chamber for combusting H_2 in sCO_2 and sXe

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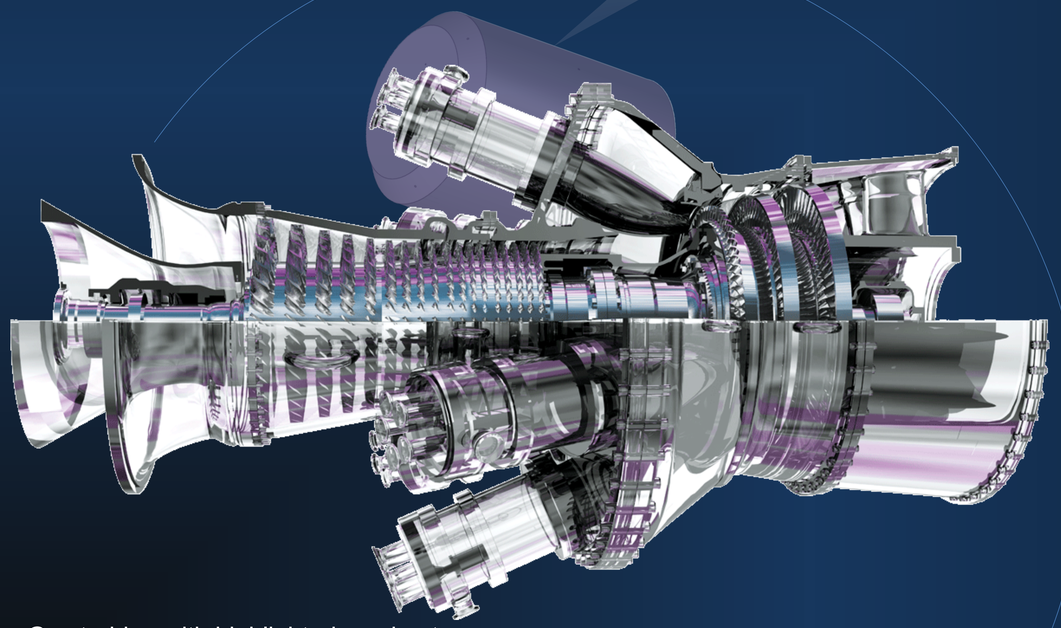
Introduction

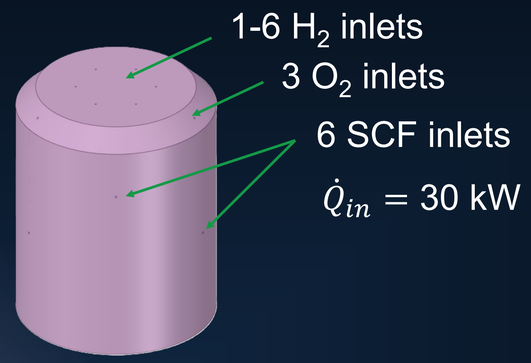
Background:
The HERMES project focuses on the development of a zero-emission energy system based on highly efficient supercritical gas turbine operating on sCO_2 and sXe using renewable fuels. All the combustion products are captured and reused for fuel production.

Objective:
The primary objective of this work is to analyze the mixing and supercritical combustion process. The influence of the following parameters was tested:
- number of fuel inlets
- angle of oxidant entry
- type of supercritical fluid in operation



Gas turbine with highlighted combustor
(https://www.cleanpng.com/png-gas-turbine-general-electric-cogeneration-1872266)

Methodology

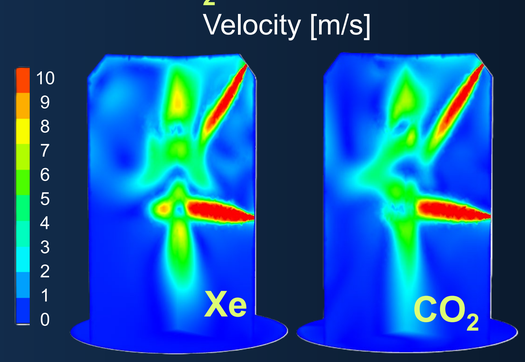


Investigated cases:
- Cold Mixing of H_2 in Xe at 10 bar
- Cold Mixing of H_2 in CO_2 at 10 bar
- Combustion of H_2 in sXe at 100 bar

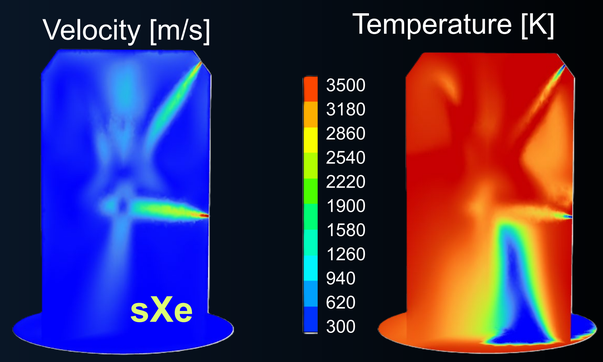
Models:
- Turbulence: k-omega SST
- State: Soave-Redlich-Kwong real gas
- Steady state

Results

Cold Mixing of H_2 and O_2 with Xe and CO_2 at 10 bar



Combustion of H_2 in sXe at 100 bar



Conclusions

- **Cold Mixing**: 3 H_2 inlets combined with axial O_2 injection gave the best mixing results
- **Combustion**: High temperature on the walls require other cooling system
- **Future work**: Implementation of the cooling flow section, enhancement the flow mixing at the outlet and validation of the data experimentally

Acknowledgment:
This work is carried out within HERMES project, number: 101083748, founded by European Union.

Funded by the European Union