Optimization of CO2 injection, used as a cooling agent into a prototype high-pressure combustor for H2 oxy-combustion in sCO2

Halina Pawlak-Kruczek, **Jakub Mularski**, **Dariusz Pyka**, Krystian Krochmalny, Mateusz Kowal (Wrocław University of Science and Technology, Poland)

Introduction: Hermes – development of a closed-loop renewable Energy system based on SC-GT operating on methanol/H2/CH4. Net-zero greenhouse gas emissions.

The **flow conditions** for the simulation were as follows:

H_2 mass flow rate: 0.02 kg/minute

Cooling CO_2 mass flow rate: 1.7 kg/minute

Oxidant (O_2 with CO_2) mass flow rate: 1 kg/minute where O_2 mole fraction equals 0.3.

The operating pressure equals 8 MPa and inlet temperatures of all gases equal 330K

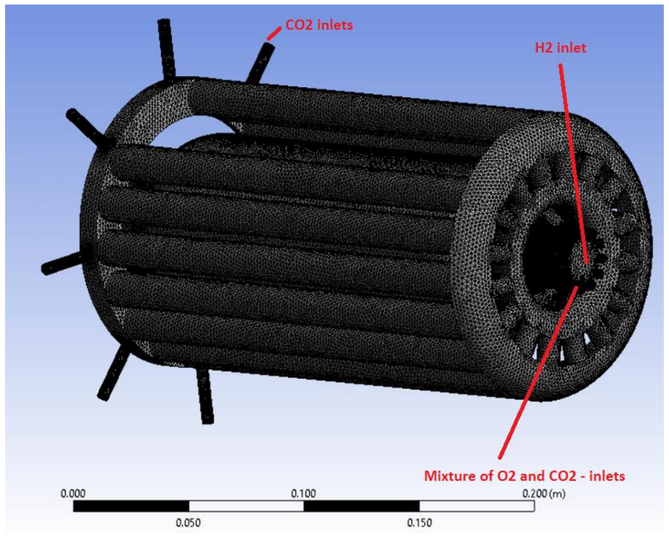

Fig. 1 Numerical mesh of the high-pressure reactor's fluid

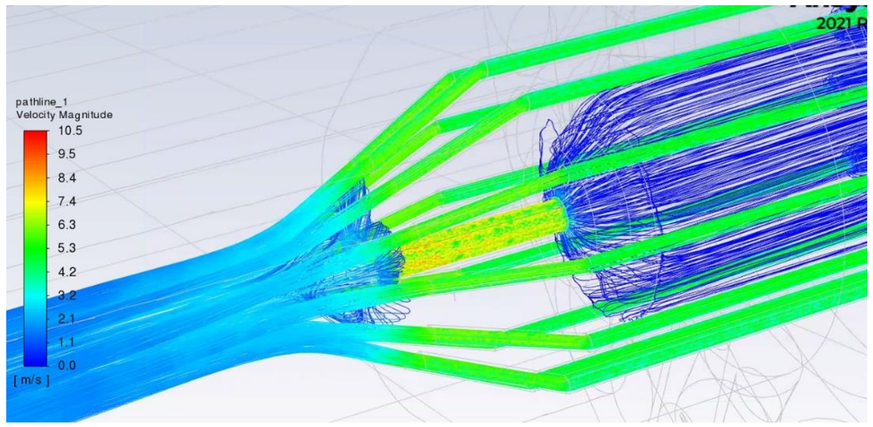

Fig. 2 Velocities of the streams of H2 and a mixture of O2 and CO2

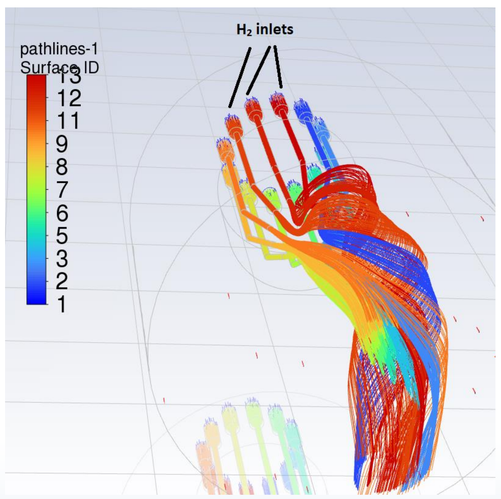

Fig. 3 Identification pathlines of H_2 and oxidant streams for 80 bars. Streams 11, 12, and 13 correspond to H_2. The rest of the streams correspond to oxidant.

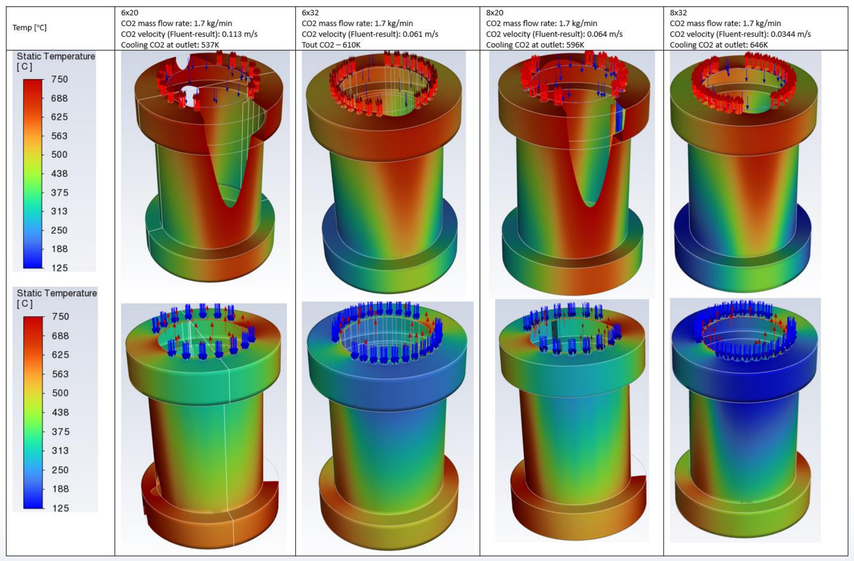

Fig. 4 Outer metal temperatures for different sCO2 system configurations (D6/20, D6/32, D8/20, D8/32)

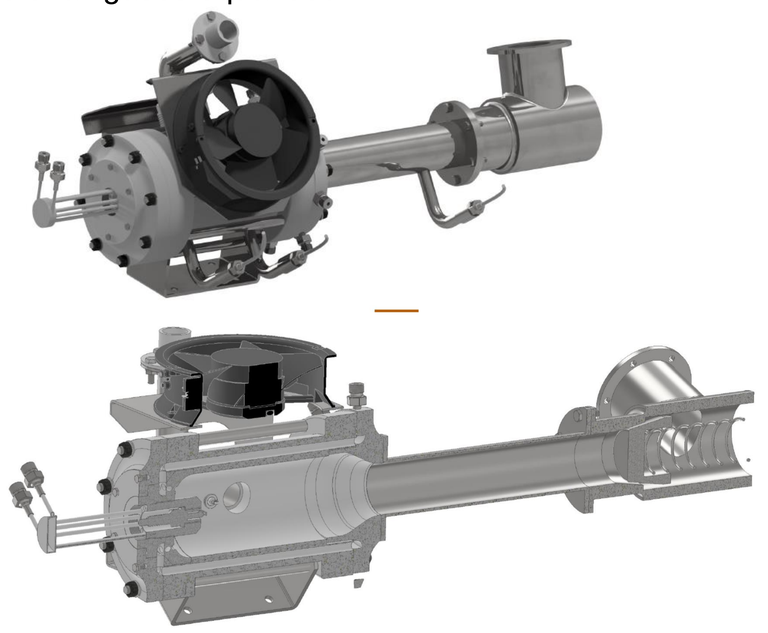

Fig. 5 Final design of high-pressure combustion chamber based on injection and sCO2 cooling analyses

Conclusions:

- Effect of central H2 inlet in Fig. 2 – poor mixing of fuel and oxidizer
- Circumferential injection of H2 along with the oxidizer substantially improved the degree of mixing – Fig.3
- Eight circumferential sCO2 pipes with a size of 32 mm allowed obtaining the lowest outer metal temperature – Fig. 4
- Final design of high-pressure combustor

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