Baker Hughes: sCO2 Compressor

SPEAKER NAME:

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No.952953

Summary

- SOLARsCO2 and Baker Hughes
- Role in the SOLARsCO2 & Project status
- Project Main Drivers
- Compressor Architecture
- Conclusions and remarks

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Baker Hughes

We take energy forward

making it safer, cleaner and more efficient

for people and the planet.

Leading the energy transition

We have committed to achieve net-zero carbon eq. emissions from operations by 2050 and are investing in new technologies to help customers reduce their emissions.

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SOLARsCO2 and Baker Hughes

Baker Hughes

- *TPS* is the Product Company of Baker Hughes (BH) focused on Turbomachinery and Process
- sCO2 as part of the Energy Transition strategy in BH

SOLAR sCO2OL for BH

Commercially: expansion of the portfolio of turbomachinery and applications in the CSP market

Technically: define a new strategic R&D line dedicated to supercritical fluids turbomachinery analysis and definition of innovative products for additional applications.

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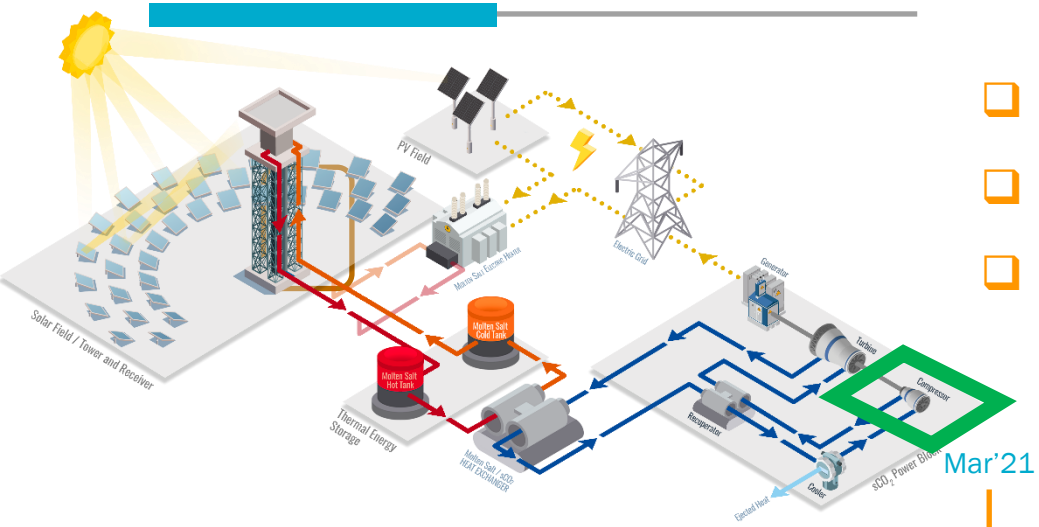
Role in the SOLARsCO2OL & Project Status



- Compressor design, production and testing (mechanical running test)
- CFD/FEM analyses from conceptual to detailed design phases
- Design assessment for both SOLARSCO2OL demonstration size and potential upscale.

Tasks for Compressor design & Production

Mar'21 | Jun'22 | Mar'23

- Definition of inlet thermodynamic conditions — DONE
- Conceptual Design — DONE
- Detail Design — ON-GOING
- Compressor & Auxiliaries Production and Testing

Tasks for future development and upscale

- Shaftline integration of sCO2 compressor and turbine
- Guidelines for sCO2 Compressor Upscale

(*) Image for reference only

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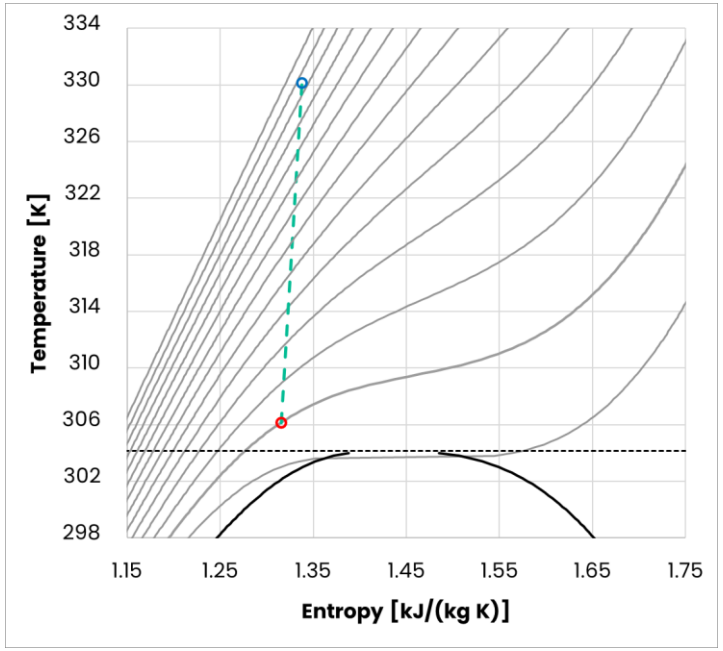
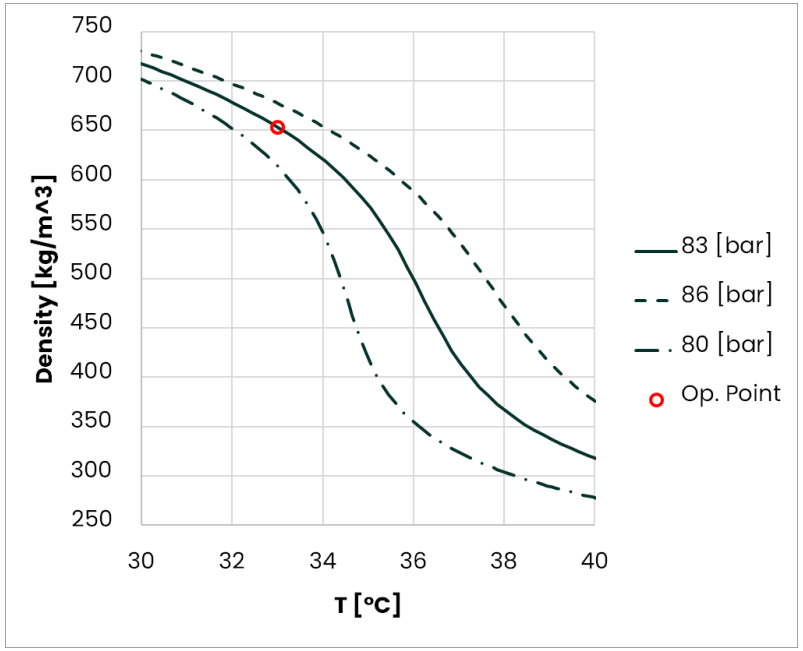
Project Main Drivers

- High density fluid vs Power reduction & CC dimensions
- Inlet conditions vs compressor Stability & Operability

Thermodinamic conditions at compressor boundaries



Effect of inlet temperature and pressure on CO_2 density



@ INLET FLANGE	
TT	33 °C
TP	83 bar
Density	653.3 kg/m^3
Comp. factor	0.220
EXPECTED @ EXIT	
TT	57 °C
TP	188 bar
Density	723.4 kg/m^3
Comp. factor	0.417
EXPECTED PERFORMANCE	
Pressure ratio	2.26
Gas Power	487 kW

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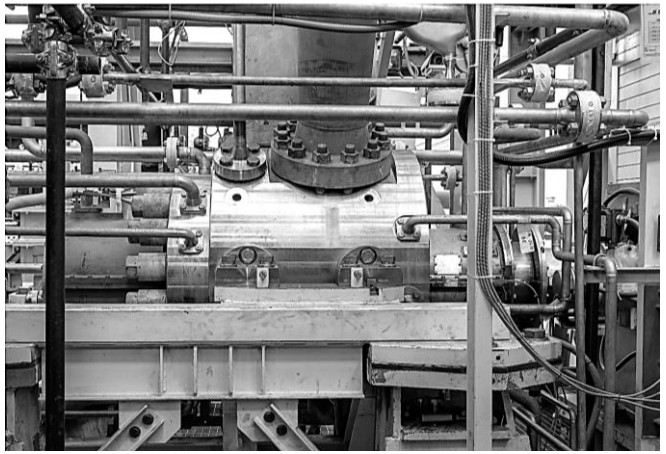
Project Main Drivers

- Experiences from STEP & sCO2-FLEX(*) programs
  - ✓ sCO2-FLEX compressor designed, produced and tested in supercritical conditions (Design point: T_{IN}=33°C; P_{IN}=79bar)

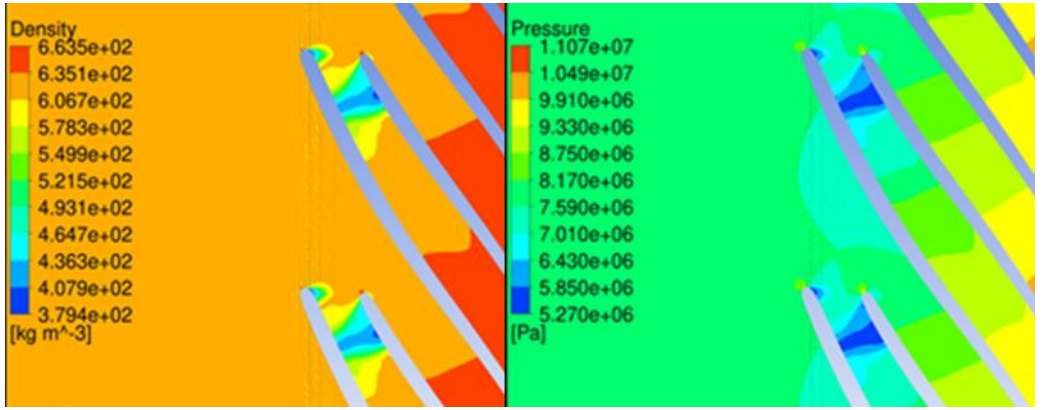
(*) HORIZON2020 project, GA No.764690

- High efficiency and large operability range
  - ✓ Dedicated high fidelity CFD, able to consider real gas effect in proximity of critical point and saturation lines

sCO2-FLEX Main CC – Prototype on the test rig



Density and pressure field inside rotor channel, close to chocking conditions



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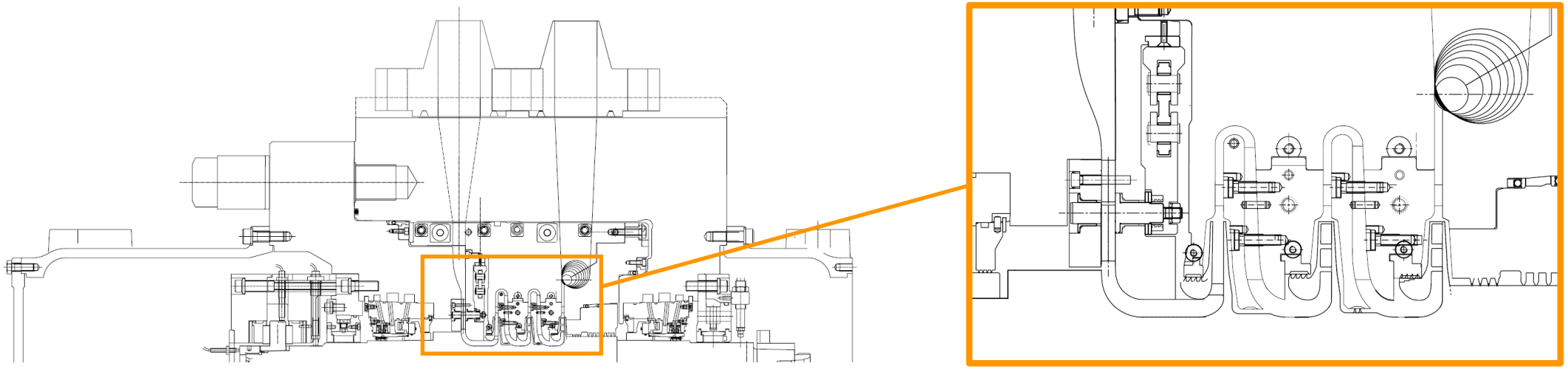
Compressor Architecture

- Design
  - ✓ Leveraging of previous experiences and dedicated design tools
- Manufacturing
  - ✓ Demonstration size is challenging for both rotor and machine

MAIN CHARACTERISTICS	
Compressor type	Multistage; barrel
Stages #	3
Impeller diameter [mm]	~150
Operating speed range [rpm]	6500 – 13500
Rotor length [mm]	~1000



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Conclusions & Remarks

- sCO_2 is part of energy transition strategy in Baker Hughes
- CO_2 characteristics close to critical point (high density, low compressibility and low viscosity) allow significant reduction in turbomachinery size and power consumption
- Compressor design is challenging due to:
  - ✓ sCO_2 thermodynamic properties
  - ✓ Inlet temperature control
  - ✓ High power density
  - ✓ Small dimensions in demonstration size
- Baker Hughes leveraged previous experiences as the sCO2-FLEX program successfully tested in supercritical conditions

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Thank you for your time!

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