Experimental Campaign Results (D5.5)

During the first period of Task 5.3, significant progress was achieved with the successful construction, commissioning, and initial operation of the CEEGS facility at the Helmholtz-Zentrum Dresden-Rossendorf. The first experimental campaign was carried out as planned, without any delays or deviations from the scheduled activities, marking a major step toward demonstrating the CEEGS cycle and increasing its Technology Readiness Level (TRL). The CEEGS facility is shown in figure 1.

Figure 1: CEEGS facility after commissioning.

The experimental campaigns achieved simultaneous operation at pressures up to 235 bar and temperatures up to 250 °C—values exceeding the initial design requirements and providing unique data for analysis. A dedicated data reduction concept was developed to process experimental measurements, enabling the extraction of key thermodynamic and fluid dynamic parameters, including heat transfer coefficients and thermal cycle efficiency.

Following the commissioning, outstanding issues such as process control optimization, instrumentation calibration, flow control, and plant insulation were completed. Technical challenges encountered during installation—such as damaged ball valves and welding spatter—were successfully resolved, ensuring reliable operation of the system's main components and subsystems, including the heat exchanger, pump, tanks, and expansion devices.

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Experimental Campaign Results (D5.5)

Analysis of the experimental results revealed several important findings:

- **Heat Transfer Performance:** The maximum cycle pressure was achieved by controlling the CO_2 pump outlet pressure, with results showing that higher pressures increase the heat transfer coefficient despite decreasing mass flow rates. Comparisons with literature correlations confirmed the accuracy of the experimental data, with only acceptable deviations observed.
- **Cycle Performance:** Thermal efficiency increased significantly with maximum cycle pressure, reaching its highest values at 235 bar. However, the influence of temperature on efficiency remained unclear, requiring further investigation. In the figure 2 the thermal cycle efficiency is shown.

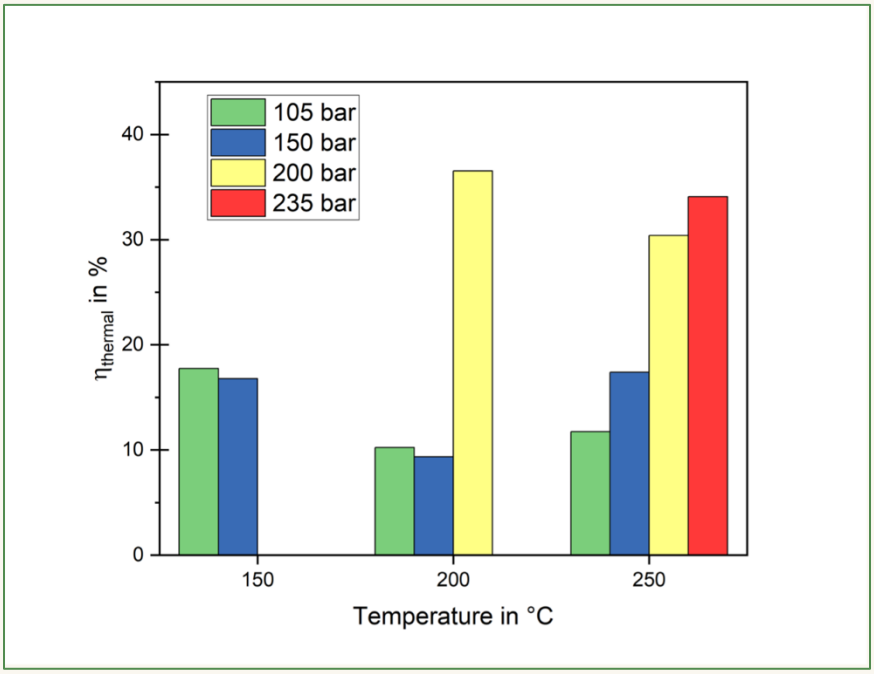

Figure 2. Thermal cycle efficiency for different maximum cycle temperatures and pressures.

- **Dynamic Operation:** Tests with dynamic increases in pressure and temperature demonstrated physically consistent behavior, providing the foundation for upcoming campaigns focused on dynamic operation.

Overall, the first experimental campaign provided a basic proof of concept for the CEEGS cycle under steady-state conditions. Future project phases will emphasize dynamic operation experiments and use the results to validate component models developed in other work packages.

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