Integrated Thermal Energy Storage Heat Exchanger

Unit-Cell Plate Fin HX/Graphite Foam-PCM Composite

Jim Nash, Engineering Director
Brayton Energy
Project Goal and Objectives

Demonstrate an Integrated PCM Heat Exchanger capable of full-life operation at 760°C and 24 MPa in a commercial supercritical CO₂ CSP powerplant.

Objectives:
1. Full-scale integrated PCM heat exchanger design concept.
2. Adaptable to other TES media; e.g. thermo-chemical.
3. Structural validation of heat exchanger at pressure and pressure with accelerated testing.
5. Fabrication of a full-scale sub-core.
6. Performance validation in sCO₂ test facility.
# Key Design Specifications & PCM Characteristics

## Key Design Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T$, CO$_2$ Charge</td>
<td>760°C</td>
</tr>
<tr>
<td>$P$, CO$_2$</td>
<td>24 MPa</td>
</tr>
<tr>
<td>Lifetime</td>
<td>30 years</td>
</tr>
<tr>
<td>Charge Duration</td>
<td>6 h</td>
</tr>
<tr>
<td>$T$, Discharge, IN</td>
<td>556°C</td>
</tr>
<tr>
<td>$T$, Discharge, OUT, min</td>
<td>670°C</td>
</tr>
</tbody>
</table>

## Key PCM Characteristics

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T$, Solidus</td>
<td>706°C</td>
</tr>
<tr>
<td>$T$, Liquidus</td>
<td>718°C</td>
</tr>
<tr>
<td>Latent Heat of Fusion</td>
<td>377 kJ/kg</td>
</tr>
<tr>
<td>Thermal Conductivity, x-y</td>
<td>23.6 W/m·K</td>
</tr>
<tr>
<td>Thermal Conductivity, z</td>
<td>14 W/m·K</td>
</tr>
</tbody>
</table>
Concept

MgCl$_2$ Infused Graphite Foam

Unit-Cell Plate Fin Heat Exchanger Cell
Design Simulations - Charging

Analysis Objective: Optimize thermal-fluid design for minimum $/kWh

- PCM dimensions: 50 mm x 1 m
- Scales vary by plot
Design Simulations - Discharging

Temperature

Liquid Fraction

30 min

60 min

100 min
Status

• Thermal-fluid design optimization in process.
  • Collaboration with ANL.
  • Coordination with Gas-Phase System effort.
• Test article design for ANL in process.
• Next:
  • Integrated Heat Exchanger mechanical design
  • Specifications and envelope to Echogen
  • Structural validation test article design and preparation.
Questions?