High Temperature Heat Pump

Hybrid Energy

Summary of technology

High Temperature heat pumps are based on hybrid technology using ammonia and water as refrigerant. Figure 1 shows the system layout. Key info:

- Two types are available: GreenPAC is a one-stage heat pump and HyPAC is 2-stage.
- For heat pump with high temperature lift, 2 stages (2 compressors) may be required.
- Driving energy: Electrically.
- Refrigerant: NH₃ + H₂O (approx. 50/50).
- Industry segments: Food (dairy, meat, ...), process and waste treatment (biogas, ...)
- Effect:
  - 0.5 to 2 MW (reciprocation compressors)
  - 1 to 5 MW (screw compressors)
- Lubrication type and system: Compressor oil with oil filling and drainage.
- Performance see table 1.
- Sink (output) temperatures: 80 – 120 °C.
- Source temperatures: 30 – 100 °C.
- Maximum total temperature lift 90 °C.
- References: 20+ heat pump sold.
- Transport media on sink and source side: Liquid/liquid and rather clean.
- Heat exchanger type: Welded, plate type.
- Pressure: Up to max 40 bars.
- Control system: Siemens S7.
- Height: max. 5 m.
- Footprint: max. 3.6 x 6.5 m.

Table 1: Performance.

<table>
<thead>
<tr>
<th>T_source,in [°C]</th>
<th>T_source,out [°C]</th>
<th>T_sink,in [°C]</th>
<th>T_sink,out [°C]</th>
<th>COP heating [  ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>70</td>
<td>90</td>
<td>120</td>
<td>5.6 (calc.)</td>
</tr>
<tr>
<td>53</td>
<td>48</td>
<td>65</td>
<td>110</td>
<td>3.6 (calc.)</td>
</tr>
<tr>
<td>50</td>
<td>44</td>
<td>65</td>
<td>85</td>
<td>5.5 (meas.)</td>
</tr>
<tr>
<td>73</td>
<td>46</td>
<td>70</td>
<td>95</td>
<td>8.1 (meas.)</td>
</tr>
</tbody>
</table>
Project example: TINE Bergen (dairy)

TINE was awarded with the Heat Pump City of the year in 2019, category Decarbonization. Project info:

- Turn-key project with chiller, NH₃ heat pump and Hybrid Energy GreenPAC in cascade from -1.5 °C up to 95 °C.
- GreenPAC:
  - Effect 0.9 MW.
  - Source: 67 °C / 60 °C.
  - Sink: 73 °C / 95 °C.
  - COP: 5.5 (measured).
- Conclusions recently published by SINTEF at the high temperature heat pump symposium in Copenhagen March 2022:
  - Successful implementation.
  - System adjusts to varying demands in winter and summer.
  - In winter, TES bridges surplus and deficits.
  - High and almost constant COP’s → properly designed heat pump system.
  - Suitable for other climatic conditions.

FACTS ABOUT THE TECHNOLOGY

Heat supply capacity: 0.5 MW to 2 MW with reciprocating compressor, or 1 MW to 5 MW with screw compressor.

Temperature range: Sink out from 80 °C to 120 °C, with max. temperature lift of 90 °C.

Working fluid: Ammonia and water.

Compressor technology: Piston, screw compressors.

Specific investment cost for installed system without integration: From 200 €/kW up to 600 €/kW depending on the effect and the number of compressors.

TRL level: TRL9 (20+ heat pumps in operation)

Expected lifetime: 20+ years.

Size: Depending on power of the heat pump: max. footprint for 2 MW system is 3.6 m x 6.5 m.

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All information were provided by the supplier without third-party validation. The information was provided as an indicative basis and may be different in final installations depending on application specific parameters.