ROTATION HEAT PUMP

ecop
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Introduction

Heat < 150°C (Cold > -20°C)

- Expensive / inefficient
- „off-the-shelf“
- Favorable (COP) efficient
- Techn. limits (temperature, ...)
- Difficult to implement

+ Simple

Energy Efficiency Directive 2012/27eu
Electricity Market
F gas Regulation 517/2014
1. Process Comparison

Schematic comparison of a 1- and 2-phase process

\[ \text{COP} = \frac{h_2 - h_3}{(h_2 - h_1) - (h_3 - h_4)} = 10.3 \]

Example:
- Sink: 70/95
- Source: 65/43

\[ \text{COP} = \frac{h_2 - h_5}{(h_2 - h_1)} = 6.05 \]
## 1. Process Comparison

COP potential of a Joule process compared with a 2 phase process with NH3

### Compression with 100% efficiency @1MW heat emission

<table>
<thead>
<tr>
<th></th>
<th>Joule process – Ar</th>
<th>2-phase process NH3</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.Compression in kW</td>
<td>1319</td>
<td>165</td>
</tr>
<tr>
<td>P.Expansion in kW</td>
<td>1222</td>
<td>-</td>
</tr>
<tr>
<td>Power Deviation</td>
<td>97</td>
<td>165</td>
</tr>
<tr>
<td>COP</td>
<td>10.3</td>
<td>6.1</td>
</tr>
</tbody>
</table>

### Compression with 80% efficiency @1MW heat emission

<table>
<thead>
<tr>
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<th>2-phase process NH3</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.Compression in kW</td>
<td>1649</td>
<td>207</td>
</tr>
<tr>
<td>P.Expansion in kW</td>
<td>1222</td>
<td>-</td>
</tr>
<tr>
<td>Power Deviation</td>
<td>427</td>
<td>207</td>
</tr>
<tr>
<td>COP</td>
<td>2.3</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Influence of lower compressor and expansion efficiency to the COP
2. Technology
2. Technology

- 1 – 2 isentropic compression
- 2 – 3 isobaric heat dissipation (WT-HD)
- 3 – 4 isentropic relaxation
- 4 – 5 isobaric heat supply (WT-ND)
- 5 – 1 isentropic compression (fan)

Key factor: heat transfer by non continuous temperature

Joule process within the rotation heat pump
3. Product

**COP ~ 5.5**

- Nominal thermal output 700kW (400-800 kW)
- Max. DT source in to sink out 40°C
- Temperature range -20°C bis 150°C
- Temperature spread up to 70°C
- Nominal heating water flow rate 21 m³/h / 0.5 bar pressure drop
## Technical Data

<table>
<thead>
<tr>
<th>Technical data¹</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight:</td>
<td>15t</td>
</tr>
<tr>
<td>Dimensions¹² (W x H x L):</td>
<td>2400 x 2500 x 7000mm</td>
</tr>
<tr>
<td>Connection heat source:</td>
<td>DN80 (3'')</td>
</tr>
<tr>
<td>Connection heat sink:</td>
<td>DN80 (3'')</td>
</tr>
<tr>
<td>Maximum flow temperature on heat sink:</td>
<td>150°C⁶</td>
</tr>
<tr>
<td>Maximum flow temperature on heat source:</td>
<td>110°C⁶</td>
</tr>
<tr>
<td>Maximum temperature spread between sink out and source in:</td>
<td>40 °C</td>
</tr>
<tr>
<td>Minimum flow temperature:</td>
<td>-20°C</td>
</tr>
<tr>
<td>Designed heat transfer medium:</td>
<td>H₂O</td>
</tr>
<tr>
<td>Heat output:</td>
<td>400-700 kW</td>
</tr>
<tr>
<td>Refrigerant</td>
<td>ECOP Fluid 1 (inert)</td>
</tr>
<tr>
<td>Nominal heating water flow rate³ / pressure drop⁴:</td>
<td>21m³/h / 0,5bar</td>
</tr>
<tr>
<td>Fuse protection:</td>
<td>500A gL/gG</td>
</tr>
<tr>
<td>Main supply:</td>
<td>400V-3-N ~50Hz</td>
</tr>
<tr>
<td>Nominal power consumption:</td>
<td>70 - 280kW</td>
</tr>
</tbody>
</table>
5. USP

- High Temperatures (up to +150°C)
- Flexible temperature range with one machine (-20°C bis+150°C ) only through control unit
- Summer- und Winter operation with one machine possible
- High efficiency by high temperature spreads (20 to 70°C)
- non-polluting (GWP = 0), not flammable and non toxic working gas (refrigerant)
- Low maintenance cost through rotation principle (no piston)
- High efficiency
- Higher COP
- High profitability (less additional expenses)
6. Outlook

- ECOP RHP M2 in development (2 MW thermal output)
- Ramp up of production plant in progress (capacity of 50 units per anno)
7. Pilot Installation
7. Pilot Installation

Different operations in Summer and Winter

Thermal output ~ **640 kW** by **COP > 4.11**

Sommer

Winter

**COP ~ 4.32**

640 kW

14 m³/h

**COP ~ 4.11**

640 kW

27 m³/h

**Source:**

60°/46°C

60°C

**Sink:**

95°/60°C

District heating

55°C

Preheating Boiler

42°/32°C

32°C

46°C
8. Summary

drop cap ecop rotation heat pump provides solution for industrial application:

• High Temperatures (up to +150°C)
• Sensible heat transfers at source and sink
• High efficiency by high temperature spreads (20 to 70°C)
• non-polluting (GWP = 0), not flammable and non toxic working gas (refrigerant)
• Low maintenance cost through rotation principle (no piston)
• Higher COP
• High profitability (less additional expenses)

Thank you for your attention!
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