Adsorption chiller

Presented by

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Background

- Environmental issue
  - Globe warming

Global Warming, IPCC
Background

Massive Waste Heat Disposal

![Graph showing energy disposal (TW) vs. Temperature [°C]]

Two-bed silica gel – water adsorption chiller

Material:
Carbon steel

Advantages:
- Low maintenance cost-no moving parts
- Benign environment – water/silica gel
- Energy recovery – conversion of waste heat to effective cooling

COP = 0.3 ~ 0.7

COP = \frac{\text{cooling capacity}}{\text{heat input}}

Coeficient of performance
Standard operational sequence of a two-bed adsorption chiller

Valve opens → Bed 1 - 31°C → Valve opens → Bed 2 - 85°C → Valve closes → Bed 1 - 31°C → Valve closes → Bed 2 - 31°C

Evaporator - 14°C → Valve opens → Condenser - 31°C

Operation time frame ~ 420 s

Standard operational sequence of a two-bed adsorption chiller

Valve closed → Bed 1 - 31°C → Valve closed → Bed 2 - 31°C → Valve closed → Bed 1 - 31°C → Valve closed → Bed 2 - 85°C

Evaporator - 14°C → Valve closed → Condenser - 31°C

Operation time frame ~ 30 s
Standard operational sequence of a two-bed adsorption chiller

![Diagram of a two-bed adsorption chiller showing the temperatures and valve states.]

Silica gel + water adsorption chiller

Operation time frame ~ 420 s

Cyclic steady state behavior of a two-bed adsorption chiller

![Graph showing the cyclic steady state behavior with various temperature curves.]

Tchill-in
Tchill-out
Tcooling-in
Tcooling-out
Tbed-in
Tbed-out
Hot water efficiency for chilling temperature 12°C – 7 °C

Cyclic steady state behavior of a two-bed adsorption chiller

COP comparison by mass & heat recovery scheme

![COP comparison graph]

Four-bed adsorption chiller (5Rtons)

![Four-bed adsorption chiller image]

Schematic of four-bed adsorption chillers

Performance comparison between 2- & 4-bed adsorption chillers

A new adsorption chiller process was developed recently and is going to be patented by UWA.
Comparison between Adsorption and Absorption chillers

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Adsorption chiller</th>
<th>Absorption chiller</th>
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</thead>
<tbody>
<tr>
<td>Initial Investment Cost</td>
<td>Slightly High due to less production</td>
<td>Low</td>
</tr>
<tr>
<td>Size</td>
<td>Bulky</td>
<td>Compact</td>
</tr>
<tr>
<td>Working medium</td>
<td>Silica gel – water</td>
<td>LiBr – water</td>
</tr>
<tr>
<td>Thermal Energy</td>
<td>Temperature as low as 55°C</td>
<td>Temperature as low as 75°C</td>
</tr>
<tr>
<td>Cooling temperature</td>
<td>Any low temperature, fluctuation is not a problem</td>
<td>&gt;22°C and must be stable</td>
</tr>
<tr>
<td>Corrosion</td>
<td>No</td>
<td>Yes (strong)</td>
</tr>
<tr>
<td>Crystallization</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Operation cost</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Maintenance cost</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Performance</td>
<td>For low temperature heat source, it is good</td>
<td>For high temperature heat source, it is good</td>
</tr>
<tr>
<td>Reliability</td>
<td>Robust</td>
<td>Not robust</td>
</tr>
</tbody>
</table>

Comparison between Adsorption and Absorption chillers

HIJC USA Inc
Q&A?