Development of a New Dual-Cylinder Rotary Compressor for VI System

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INTRODUCTION

- Vapor injection compression cycle’s superiority over non-injection cycle has been well known.
- VI system produces the high heating/cooling capacity, and its power consumption is less than the non-injection system.
INTRODUCTION

- Unfortunately, other problems arise, such as mixture loss on refrigerant injection into the compression chamber (Sekiya et al., 2005, Tetsuhide et al., 2008)
Another solution for the two-stage compression cycle is the use of a two-stage compressor, because most of the gas is compressed two times, the indicated power increases because of its two times exhaust process.
The gas from the flash-tank will be compressed independently.
The refrigerating capacity in evaporator is

\[ q_o = h_1 - h_7 \]

The cooling COP of the new VI system is

\[ \text{COP}_L = \frac{q_o}{w_{1-9} + w_{5-8}} \]
The variation of COP\(_L\) with \(T_m\) (temperature of flash tank)

(Condensing temperature, \(T_k\), of 45°C, evaporating temperature, \(T_o\), of 3°C, 5°C, 7°C under cooling condition)
The variation of the optimal $T_m$ with $T_o$

- The optimal $T_m$ increases linearly with $T_o$.

(Condensing temperature, $T_k$, of 45°C, the superheat = 5°C and the sub cooling = 5°C)
The variation of $\frac{COP_L}{COP_{\text{BASE}}}$ with $T_0$ (under the optimum intermediate temperature $T_m$)

(condensing temperature, $T_k$, of 45°C, the superheat = 5°C and the sub cooling = 5°C)
Based on the above analysis, a new dual-cylinder compressor is designed and evaluated.

The compressor is designed based on 5 conditions:

<table>
<thead>
<tr>
<th>Operating condition</th>
<th>The first</th>
<th>The second</th>
<th>The third</th>
<th>The fourth</th>
<th>The fifth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensing temperature (℃)</td>
<td>45.6</td>
<td>39.6</td>
<td>43.6</td>
<td>31.5</td>
<td>46.5</td>
</tr>
<tr>
<td>Evaporating temperature (℃)</td>
<td>10.7</td>
<td>17.8</td>
<td>0.8</td>
<td>2.9</td>
<td>-4.7</td>
</tr>
<tr>
<td>Superheat (℃)</td>
<td>9.3</td>
<td>7.2</td>
<td>5.3</td>
<td>5.1</td>
<td>6.7</td>
</tr>
<tr>
<td>Sub cooling (℃)</td>
<td>6.1</td>
<td>1.0</td>
<td>7.0</td>
<td>4.0</td>
<td>9.9</td>
</tr>
<tr>
<td>Ambient temperature (℃)</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Contribution ratio</td>
<td>25%</td>
<td>33%</td>
<td>13%</td>
<td>10%</td>
<td>19%</td>
</tr>
</tbody>
</table>
The Comparison between theory and experiment of $\frac{COP_L}{COP_{\text{BASE}}}$
The variation of COP_L with the intermediate pressure $p_m$ about the first condition.
A new dual-cylinder rotary compressor for VI systems is developed and evaluated.

The cooling COP increase 4.6%-9.1% under the test conditions.

The variations of the COP\textsubscript{L} with the intermediate pressure \(p_m\) (pressure of flash tank) indicates that when the intermediate pressure exceeds the optimum value, the COP\textsubscript{L} is decreased dramatically because of the suction of liquid and this should be avoided in the application.
Thank you!