Enhanced Dehumidification or Passive Heat Recovery using Heat Pipes

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Conventional Dehumidification

1 = OUTSIDE AIR (28/20°C)
2A = SUPPLY AIR (17.5/14°C)
2B = SUPPLY AIR (14.5/14°C)

A = PROCESS LOAD (LOWER SHR)
B = ACTUAL PROCESS (HIGHER SHR) FOR CONVENTIONAL COOLING COIL

PROCESS A & B SAME TOTAL LOAD DIFFERENT SHR
Conventional Dehumidification

1 = OUTSIDE AIR (28/20°C)
2 = OVERCOOLED AIR (12.5/12°C)
3 = REHEATED SUPPLY AIR (17.5/14°C)
Heat Pipe Operation

WARM AIR

COOL AIR
Wraparound Heat Pipe

- **Precool (PRECOOL):** 28.0/20.0°C
- **Cooling Coil:** 23.0/18.4°C → 12.5/12.0°C
- **Reheat (REHEAT):** 17.5/14.0°C
Heat Pipe Enhanced Dehumidification

1-2 = HEAT PIPE PRECOOL
2-3 = COOLING COIL
3-4 = HEAT PIPE REHEAT
Running Cost Saving

- Reduced Cooling Load
- Free Precool
- Free Reheat

Diagram showing the relationship between reduced cooling load and other factors.
Capital Cost Saving

500 kW CHILLER CAPACITY
Conventional method

400 kW CHILLER CAPACITY
Enhanced method
Case Study: Ulster Hospital

- Chilled beams in critical areas
- 100% outside air
- Low dewpoint
- Existing chiller capacity too low
## Case Study - Annual Performance

<table>
<thead>
<tr>
<th>Bin no.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature range (°C)</td>
<td>26.7 to 23.9</td>
<td>23.9 to 21.1</td>
<td>21.1 to 18.3</td>
<td>18.3 to 15.5</td>
<td>15.5 to 12.7</td>
<td>12.7 to 9.9</td>
<td>9.9 to 7.1</td>
<td>7.1 to 4.3</td>
<td>4.3 to 1.5</td>
<td>1.5 to -1.3</td>
<td>-1.3 to -4.1</td>
<td>-4.1 to -6.9</td>
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<tr>
<td>Bin midpoint temperature (°C)</td>
<td>25.3</td>
<td>22.5</td>
<td>19.7</td>
<td>16.9</td>
<td>14.2</td>
<td>11.4</td>
<td>8.6</td>
<td>5.8</td>
<td>3.1</td>
<td>0.3</td>
<td>-2.5</td>
<td>-5.3</td>
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<tr>
<td>Mean coincident wet bulb (°C)</td>
<td>17.6</td>
<td>17.3</td>
<td>15.7</td>
<td>14.1</td>
<td>12.3</td>
<td>9.5</td>
<td>7.5</td>
<td>5.0</td>
<td>2.3</td>
<td>-0.1</td>
<td>-2.6</td>
<td>-5.3</td>
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<tr>
<td>Dewpoint temperature (°C)</td>
<td>13.1</td>
<td>14.4</td>
<td>13.3</td>
<td>12.3</td>
<td>10.9</td>
<td>7.9</td>
<td>6.5</td>
<td>4.1</td>
<td>1.3</td>
<td>-0.6</td>
<td>-2.7</td>
<td>-5.3</td>
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<td>Hours p.a.</td>
<td>10</td>
<td>62</td>
<td>177</td>
<td>675</td>
<td>1514</td>
<td>1514</td>
<td>1770</td>
<td>1514</td>
<td>1770</td>
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<td>1770</td>
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<td>Supply air volume (m³/s)</td>
<td>64.41</td>
<td>64.41</td>
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<tr>
<td>Air onto heat pipe precool side db (°C)</td>
<td>25.3</td>
<td>22.5</td>
<td>19.7</td>
<td>16.9</td>
<td>14.2</td>
<td></td>
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<tr>
<td>Air onto heat pipe precool side wb (°C)</td>
<td>17.6</td>
<td>17.3</td>
<td>15.7</td>
<td>14.1</td>
<td>12.3</td>
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<tr>
<td>Precool capacity saving (kW)</td>
<td>355.4</td>
<td>294.7</td>
<td>234.0</td>
<td>173.4</td>
<td>114.9</td>
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<td>Cooling input energy saving (kWh)</td>
<td>1185</td>
<td>6090</td>
<td>13806</td>
<td>39015</td>
<td>43815</td>
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<td>Reheat capacity saving (kW)</td>
<td>355.4</td>
<td>294.7</td>
<td>234.0</td>
<td>173.4</td>
<td>114.9</td>
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<td>Reheat energy saving (kWh)</td>
<td>3949</td>
<td>20302</td>
<td>46020</td>
<td>130050</td>
<td>146051</td>
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</table>
Case Study - ROI

![Graph showing ROI calculation with cost and time axes.]
Conclusions

- ‘Enhanced cooling coil’ is a combination of conventional cooling coil and wraparound heat pipe
- Reduced running costs
- Low initial cost
- Attractive ROI
Other Heat Pipe Applications

- Heat recovery – preheat outside air using ‘dirty’ extract air
- Indirect free cooling – used on high integrity data centres etc. where direct free cooling cannot be used
- Evaporative cooling can be effectively combined with heat pipe in many climates
Thank you

- Any questions

Heat Pipes for Enhanced Dehumidification

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