Desiccant Enhanced Air Conditioning

Membrane Energy Exchangers

Raising the Bar of Efficiency
Introduction

• The Potential of Liquid Desiccant Technology
• Membrane Energy Exchanger Development
• Active Enthalpy Pump System
• Comparison of System Level Efficiencies
• Conclusions
Liquid Desiccant Technology

• Advantages:
  – Humidity control
  – Conditioning unit design flexibility
  – Energy efficient dehumidification

• Challenges:
  – Desiccant corrosiveness
  – Exchanger design

Equilibrium air conditions over Lithium Chloride (LiCl) solution
Membrane Energy Exchanger

- Vapor permeable membrane technology is enabling an exchanger breakthrough
  - Membrane provides complete separation of air from desiccant
  - Low vapor transfer resistance
  - Zero liquid penetration

![SEM of filtration membrane](image-url)
• Viable exchanger design requires:
  – Complete separation of liquid desiccant from the air stream
  – Corrosion resistant (polymer) construction
  – High sensible and latent effectiveness (compact)
  – Cost competitiveness
  – Proven durability
  – Flexibility of application

Membrane Energy Exchanger

Counter flow, flat plate Liquid to Air Membrane Energy Exchanger (LAMEE)
Active Enthalpy Pump
DOAS with liquid desiccant system and heat pump

Exhaust LAMEE provides desiccant regeneration using waste compressor heat.

Enthalpy wheel (or other recovery device) provides energy recovery from exhaust air. Supply LAMEE efficiently conditions the supply air. Heat pump provides heating/cooling of the liquid desiccant. Transfer loop is used to maintain moisture mass balance.
Active Enthalpy Pump
Packaged unit configuration

• Full packaged unit will help with industry acceptance
• Standard power and ducting connections
• Cost competitive with substantial energy savings!
Efficiency Comparisons
Basic DX Air Conditioning Unit

177 kW net cooling @ 8000 cfm
Cooling coil: 233 kW
Power inputs:
Compressor: 79.6 kW
Fans: 4.8 kW
Misc: 6.0 kW
TOTAL: 90.4 kW

177 kW/90.4 kW = 1.96
Efficiency Comparisons
Solid Desiccant System with Active Regeneration (DX)

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
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<tr>
<td>DB (°C)</td>
<td>35.0</td>
<td>27.2</td>
<td>21.1</td>
<td>23.9</td>
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<td>W (g/kg)</td>
<td>16.8</td>
<td>11.7</td>
<td>7.1</td>
<td>9.58</td>
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177 kW net cooling @ 8000 cfm
Cooling coil: 89.1 kW
Power inputs:
Compressor: 26.0 kW
Fans: 16.0 kW
Misc: 1.2 kW
TOTAL: 43.2 kW

177 kW/43.2 kW = 4.10
Electricity input is 48% of that required for a basic DX unit
Efficiency Comparisons
Wheel – Alpha Plate System (DX)

177 kW net cooling @ 8000 cfm
Cooling coil: 83.5 kW
Power inputs:
Compressor: 24.4 kW
Fans: 13.7 kW
Misc: 2.8 kW
TOTAL: 40.9 kW

177 kW/40.9 kW = 4.33
Electricity input is 45% of that required for a basic DX unit
Efficiency Comparisons
Enthalpy Pump System (DX)

DB (°C): T1
W (g/kg): RA

T1: 35.0, 9.58
T2: 25.9, 11.1
T3: 21.1, 7.1

177 kW net cooling @ 8000 cfm
Cooling coil: 76.9 kW
Power inputs:
Compressor: 14.8 kW
Fans: 13.3 kW
Misc: 1.2 kW
TOTAL: 29.3 kW

177 kW / 29.3 kW = 6.04
Electricity input is 32% of that required for a basic DX unit
Conclusions

• Liquid to air membrane energy exchangers are a revolutionary technology that will change how we condition air in buildings.

• The combination of energy recovery and liquid desiccant conditioning offers significant energy savings even when compared to state-of-the-art HVAC systems.

• Desiccant systems offer expanded capability, especially enhanced humidity control and drying for specialized applications (low dew point).