Dehumidification & Indirect Evaporative Cooling
What is Moisture?

It is the water-vapour present in air around us. To understand or relate to moisture, we use the term RELATIVE HUMIDITY. As the name suggests, RH gives us a primary understanding of the moisture content in the air and is a relative term.
How do we control the RH in the surrounding air?

DESSICANT DEHUMIDIFICATION
How does a Desiccant Dehumidifier work?
Moisture-laden air enters the unit through the process inlet and passes through the EcoDry metal silicate fluted desiccant synthesized rotor, where the moisture is adsorbed.

The dry, dehumidified air is then delivered to conditioned area through the process outlet.
Some typical applications of DEHUMIDIFIERS
Production & Processing Area

- Food (Snack & Health Food)
- Biscuits
- Chocolates/Candy
- Pharmaceuticals
- Breweries
- Safety Glass
- Sand Blasting
- Electronics
- Photographic Films
  etc.
Storage

- Turbine Storage
- Electrode Storage
- Bearing
- Precision components
- Electronics
- Food items
- Leather
- Seeds
- Sugar
- etc.
Packaging

- Hygroscopic Powders
- Dairy products
- Tea/Coffee
- Chemicals
- Fertilizer

and many more...
Product Drying

- Foods
- Tea
- Coffee
- Cocoa
- Gelatine
- Soft Gelatin
- Capsules
- Yeast
- Seeds
- Silk
- Craft Paper Shells
Indoor Swimming Pool

- No mold & mildew on the wall/duct surfaces
- No fogging, condensation, rusting and rotting
- Reduction in annual maintenance costs
- Year-round comfort conditions for human beings
- Reduced injuries due to avoidance of slipping and falling accidents due to wet floor
- Improved sanitation in indoor pool area through elimination of overhead grill condensation
- Independent temperature and humidity control

Solution

Desiccant dehumidifiers offer simple and most economical solutions to humidity control. Dehumidifiers remove excess moisture from the air inside the pool area by continuously circulating dry air and thus controlling relative humidity between 50 to 60%. This prevents discomfort of swimmers and hampers growth of microorganisms in the pool interior.
Cold Storage

• Wet floors and ice build up on walls, floors, and conveyors
• Ice build up on evaporator coils
• Frost build up near the loading docks
• Fog in the loading dock
• Moisture absorption by cardboard cartons etc. which causes cartons to soften and sag, making them unstable and hazardous to workers as well as unmarketable

Source – Direct Floral Source International, Schaumburg, Illinois
Moisture ingress in the docking area due to:

- Frequent opening of the doors
- Fresh air
- Permeation due to walls
- People load

A more effective and practical solution is to have a “Dehumidified Air Curtain”
Solution

*Major benefits realized thru humidity control in Cold Stores using sorption technologies are:*

- Reduced occupational injuries due to avoidance of slipping and falling and pallet mover accidents due to wet/icy floor
- Reduction in annual operational costs
- Reduction in dock evaporator defrosts
- - Summer defrost schedules can be set back to winter schedules
- Independent temperature control
- Attractive Payback Period
- Improved sanitation in warehouse thru elimination of overhead condensation, snow, and ice
- Labor cost reduction due to avoidance of chipping ice off floors, racks or products
- Increased productivity as well as worker’s safety
- Increased shelf life
- Lower power consumption
- Easy to install and use
- Increased life of infrastructure
Humidity Control prevents:

• Warping
• Mildew Growth
• Fungus Growth
• Decay of Paper/Documents/Books
• Decay of Films/Photographic material
• Decay of Paintings
• Corrosion on metals
• Decay of Leather goods, Wooden items etc...
PROBLEM IDENTIFIED

• Preserving books, historic documents, paintings, photographs from the ravages of time.

• Books, historic documents, photographs and art works are all hygroscopic because they have paper as the organic base material.

• When they absorb moisture, they provide a base for microorganisms to multiply and breed, causing irreparable damage.

SOLUTION

• Dehumidifiers provide a low humidity environment which prevents microbial attack. The dry air is often enough for preservation without necessarily involving temperature control.
Critical areas in Hospitals that require temperature & humidity control

- Operation Theatre Rooms (18°C~22°C @ 50% RH)
- Imaging Department: X-Ray room, MRI, CT Scanner, Mammography, Ultrasound, Fluoroscopy, Angiology, Tomography (22°C~24°C @ 50% RH)
- Pathology Department: Dark Room, Biology lab, Chemical lab, Immunology, Hematology (22°C~24°C @ 50% RH)
What is Evaporative Cooling?

Not a new concept, it's the oldest known method of cooling hot & dry air to make living or working spaces more comfortable. In ancient times, people hung wet materials so that wind could blow through it to create a cooling effect. Cooling of water in clay pots is a perfect example of evaporative cooling. Max Cool Pads are uniform for even air flow; switching helps bonding of engineered fibers to netting, reducing sagging and adding lots of strength.
Why do swimmer feels cold after emerging from pool?
Evaporative Cooling using 2 Natural Elements
Adaptive Comfort

ASHRAE limits valid for:
- Operable windows
- No mechanical cooling
- Metabolic rate 1.1-1.3 met
- Clothing Level 0.5-0.7 clo

Air speeds raise upper limit of comfort band by 1-2°C

90% Acceptance (~5°C band)

80% Acceptance = 90% Acceptance ± 1°C

Prevailing Mean Outdoor Temperature
(Moving average of mean daily temperature, 7-30 days, single value for each day of year)
Adaptive Approach - The fundamental concept is to stretch the range of comfort temperature. Adaptive Approach also shows that the ambient outside air temperature is the most important parameter that affects the Comfort Temperature. It has been widely accepted that by applying a suitable combination of temperature, humidity, air movement, air cleanliness and dress protocol, it is possible to find human comfort over a wide range of temperatures. By accepting comfort temperatures around 26-30 deg C with higher air changes and allied with enhanced air movement, most of the occupants can be kept within the comfort zone, while achieving substantial energy savings.
What is Evaporative Cooling?
Direct Evaporative Cooling

Water evaporates directly into the air stream, thus reducing the air temperature while humidifying the air.

Outdoor Air
Hot & Dry

Supply Air
Cool & Fresh
Direct Evaporative Cooling
Indirect Evaporative Cooling (IDEC) Single Stage

- **Exhaust**
- **Water**
- **Outdoor Air Hot & Dry**
- **Supply Air Cool & Fresh**
- **Secondary Air Stream**
- **Cool Module**
Indirect Evaporative Cooling

Psychrometric Representation

DBT

Moisture Content

Constant Wet Bulb Enthalpy

RH %
Indirect Evaporative Cooling (IDEC) Two Stage

Two-stage evaporative air cooling (DCM + ECM)
Psychometric Representation

Two-stage evaporative air cooling (DCM + ECM)

DBT

Moisture Content

Constant Wet Bulb Enthalpy

RH %
Indirect Evaporative Cooling (IDEC) Three Stage

Warm Air → DRI Cool Module → Cool Air → Cooler Air → Conditioned Air

Three-stage evaporative air cooling for RH Control Application
1. Outdoor Air Conditioner

2. Supply Air Condition at outlet of Direct Cooler

3. Room Temperature achieved with Direct Cooler

4. First stage of Indirect Cooler

5. Second stage of Indirect Cooler

6. Room Temperature achieved with IDEC
# Temperature Analysis - Doha, Qatar

<table>
<thead>
<tr>
<th>City : Doha</th>
<th>Level-2 (Direct)</th>
<th>Level-3 (Indirect)</th>
<th>Level-3 (IDEC+DEC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outdoor Air</td>
<td>Typical Design</td>
<td>DBT (° C)</td>
<td>WB (° C)</td>
</tr>
<tr>
<td>Month</td>
<td>DBT (° C)</td>
<td>WB (° C)</td>
<td>DBT (° C)</td>
</tr>
<tr>
<td>Jan</td>
<td>28.20</td>
<td>17.40</td>
<td>19.02</td>
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<tr>
<td>Feb</td>
<td>32.10</td>
<td>17.80</td>
<td>19.95</td>
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<tr>
<td>March</td>
<td>35.8</td>
<td>18.2</td>
<td>20.84</td>
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<tr>
<td>May</td>
<td>42.3</td>
<td>21.9</td>
<td>24.96</td>
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<tr>
<td>June</td>
<td>43.7</td>
<td>22.1</td>
<td>25.34</td>
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<td>July</td>
<td>44.9</td>
<td>23.4</td>
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<tr>
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<td>Sept.</td>
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<td>23</td>
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<tr>
<td>Oct.</td>
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<tr>
<td>Nov.</td>
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<tr>
<td>Dec.</td>
<td>30</td>
<td>18.8</td>
<td>20.48</td>
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</table>
Possible Application

Sports / Stadium Seating arena / Indoor stadiums / Training Areas.
Possible Application

Religious Places
Possible Application
Possible Application

Warehouses & Godowns
Treated Fresh Air Systems....(Once thru Systems)
(For commercial buildings having a conventional air conditioning system & involving Treated fresh air AHU's.)

- First Stage Indirect Cooling + Chilled Water or DX cooling coil for 100% Fresh Air Applications.
- For DX application, the Unit can be offered to work with any commercially available Condensing unit. Humid working air being discharged from IDEC can be allowed to pass over DX Air cooled condenser coil thereby achieving reduction in discharge temperature & power consumption.

IDECCan also be integrated into Conventional Air Conditioning Applications.
IDEC for Pre-Cooling of Fresh Air (Conventional Air Conditioning)
Advantages of IDEC

- Low Capital Cost
- Power Saving
- Low Running Cost
- RH Regulation
- Door & Window can be left open
- Good IAQ & 100% Fresh Air
## Advantage of IDEC as Pre-Cooler for Fresh Air

### Summer Conditions /Air quantity - 17000 CMH

<table>
<thead>
<tr>
<th>Location</th>
<th>Outdoor Air Conditions (**)</th>
<th>Desired Condition</th>
<th>Cooling Coil Load (tons)</th>
<th>Power Consumption (kw)</th>
<th>Supply Air Conditions after IDEC</th>
<th>Cooling Coil Load (tons)</th>
<th>Power (kw)</th>
<th>Power (kw)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dubai</td>
<td>46/30, 15/95</td>
<td>93.3</td>
<td>83.97</td>
<td>33.2/27.17</td>
<td>71.87</td>
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<td>19.29</td>
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<tr>
<td>Riyadh</td>
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<td>70.31</td>
<td>27.9/15.34</td>
<td>29.32</td>
<td>20.9</td>
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<td>29.26</td>
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<tr>
<td>Kuwait</td>
<td>49/30, 15/95</td>
<td>93</td>
<td>83.70</td>
<td>33.8/26.62</td>
<td>67.8</td>
<td>70</td>
<td>61.02</td>
<td>22.68</td>
</tr>
</tbody>
</table>
IDEC offers many advantages for Cooling Applications.

- It offers a very viable alternative to Cool Large Spaces in Middle East Conditions without Mechanical Cooling.
- Significantly lower resultant room temperature & Moisture addition as compared to Single Stage Direct Coolers.
- IDEC also can be applied to Conventional Air Conditioning Equipment as pre-cooling device for fresh air cooling purpose wherever Energy recovery from Exhaust Air is not possible.
Indirect Direct Evaporative Cooling Systems
Indirect Direct Evaporative Cooling Systems