

DEHUMIDIFICATION

Using refrigeration and desiccant technology

The how when and where...

The advantages in cold storage applications...

presenter

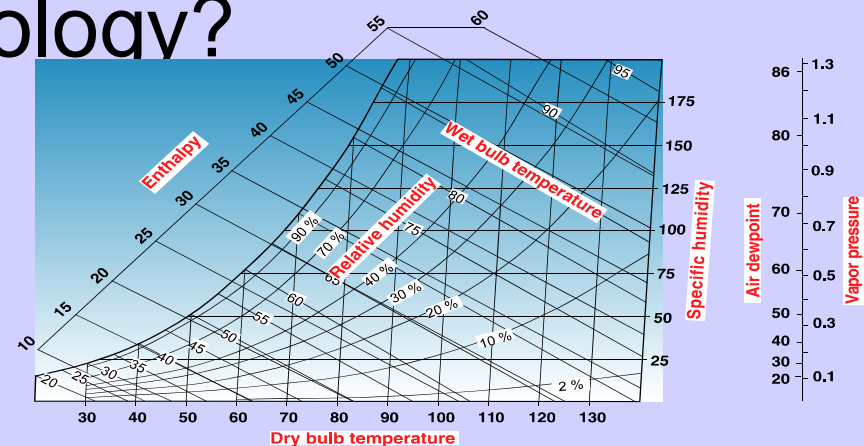
Lennart Bosman

Regional Manager - Munters Corporation





- ❑ Dehumidification – a Brief psychrometric review...
- ❑ How does it work...?
- ❑ When should we consider desiccant technology?
- ❑ Applications...

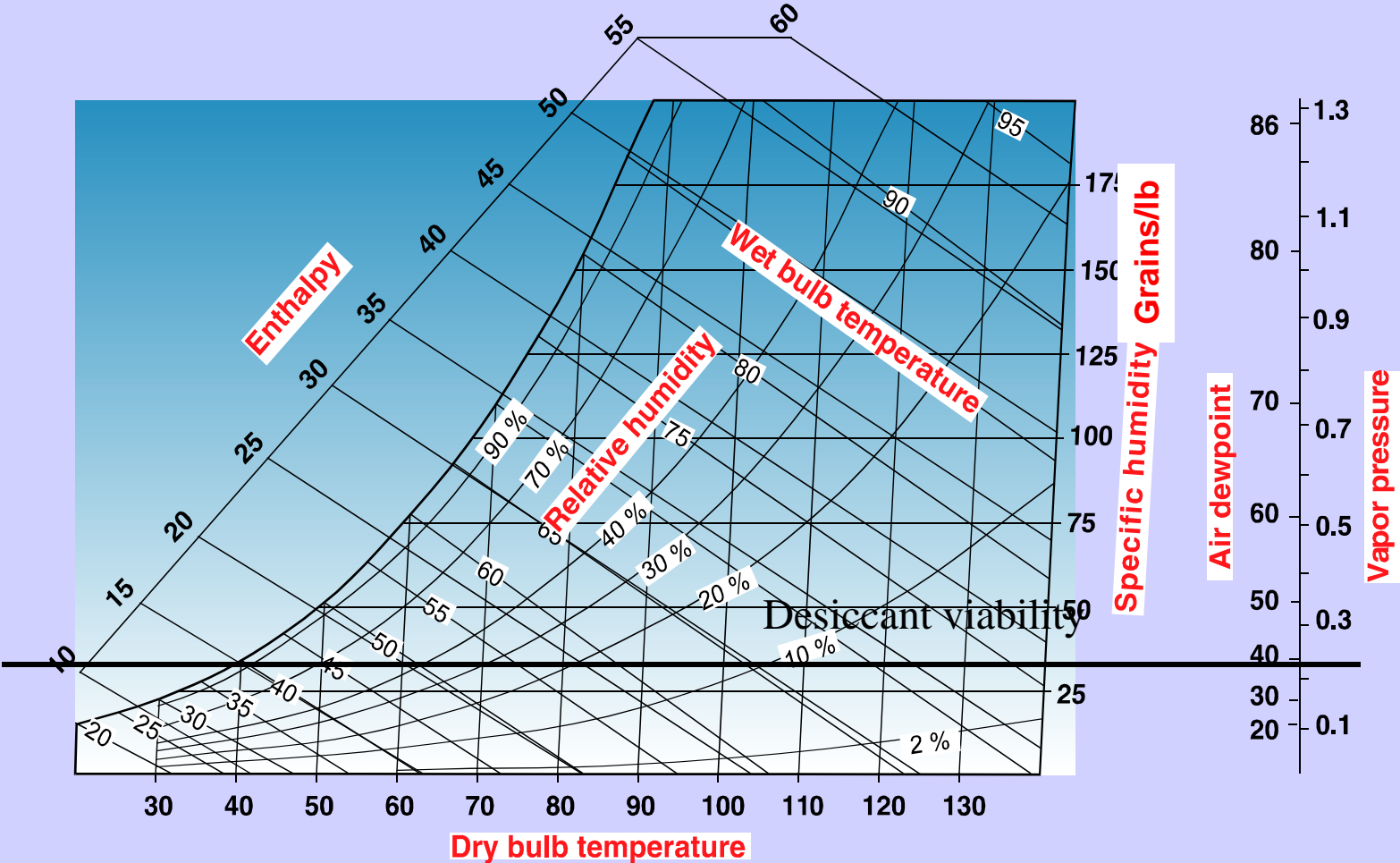


Chapter 1

Using refrigeration and desiccant
for make up air or comfort
cooling



Psychrometric-terms...

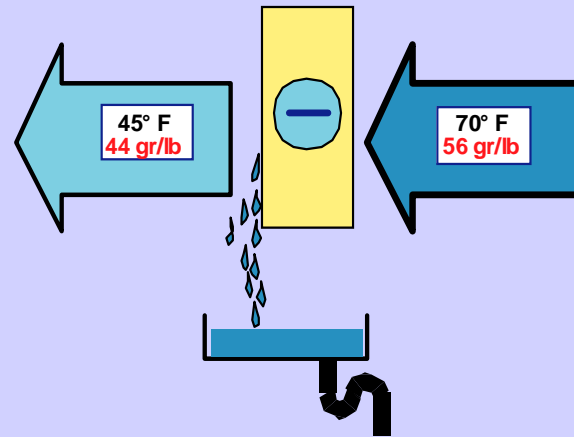


Methods of dehumidification...

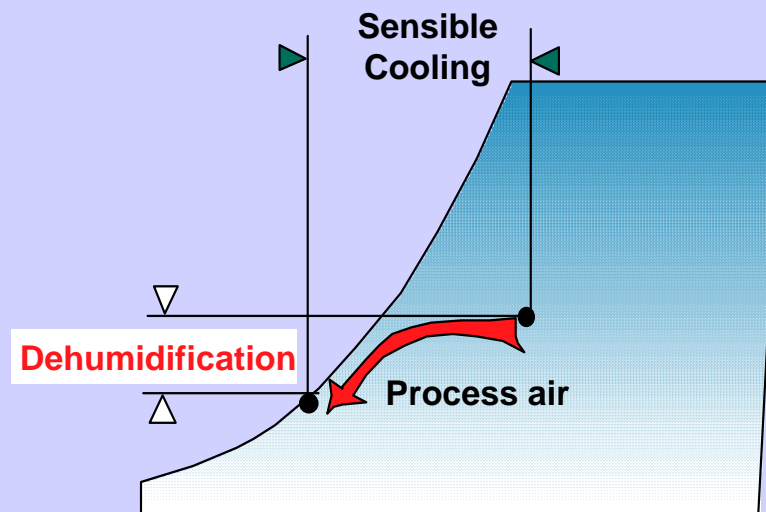
- Cooling based (condensing)
 - DX refrigeration, sub-cool and reheat
 - Chilled brine
- Desiccant based (adsorbtion)
 - Stacked tower – primarily used for compressed air
 - Liquid spray systems – controlling humidity by controlling concentration of chemicals
 - Honeycomb desiccant wheel systems



Cooling-Based Dehumidification



- Maximum moisture content is proportional to air temperature
- Cooling the air removes moisture by condensation



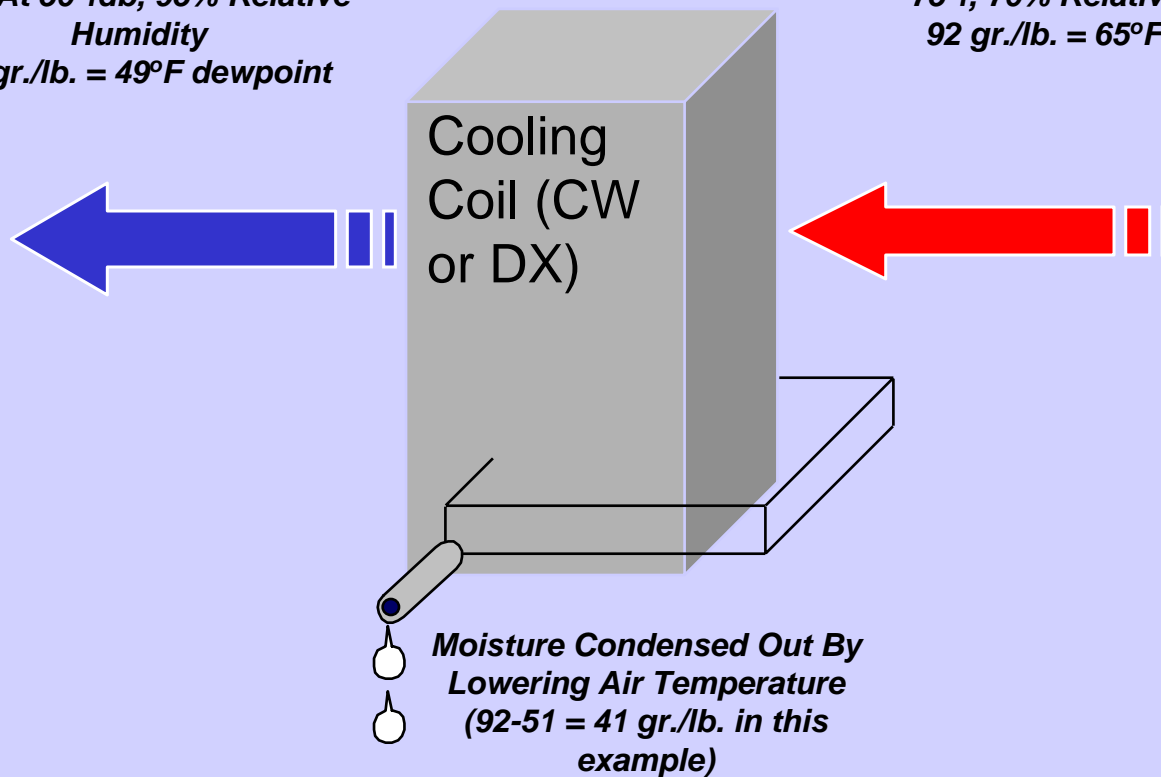
DH Handbook 3—2/3



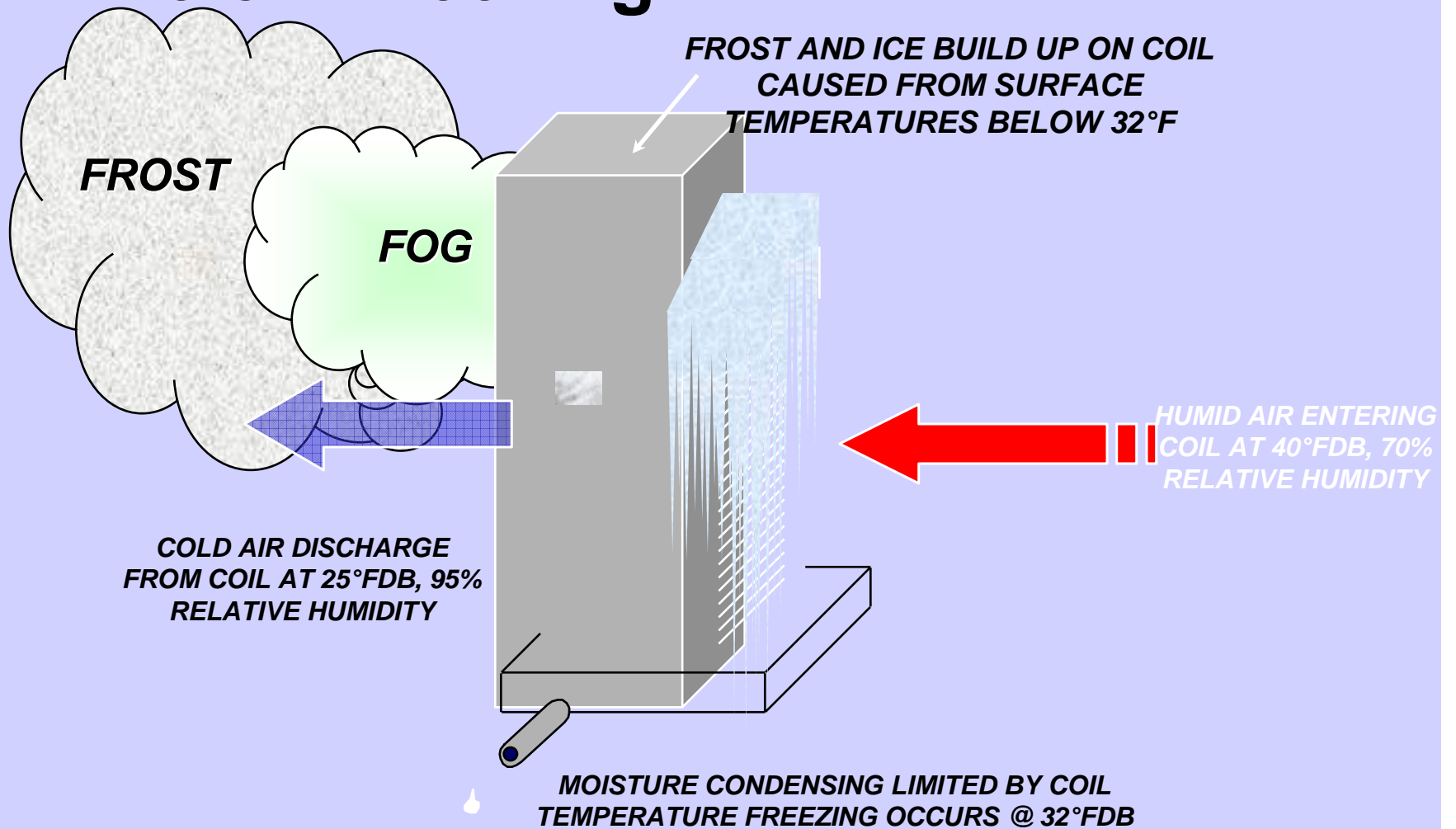
Typical Cooling Coil Performance

*Cold Air Discharge From
Coil At 50°fdb, 95% Relative
Humidity
51 gr./lb. = 49°F dewpoint*

*Humid Air Entering Coil At
75°f, 70% Relative Humidity
92 gr./lb. = 65°F dewpoint*



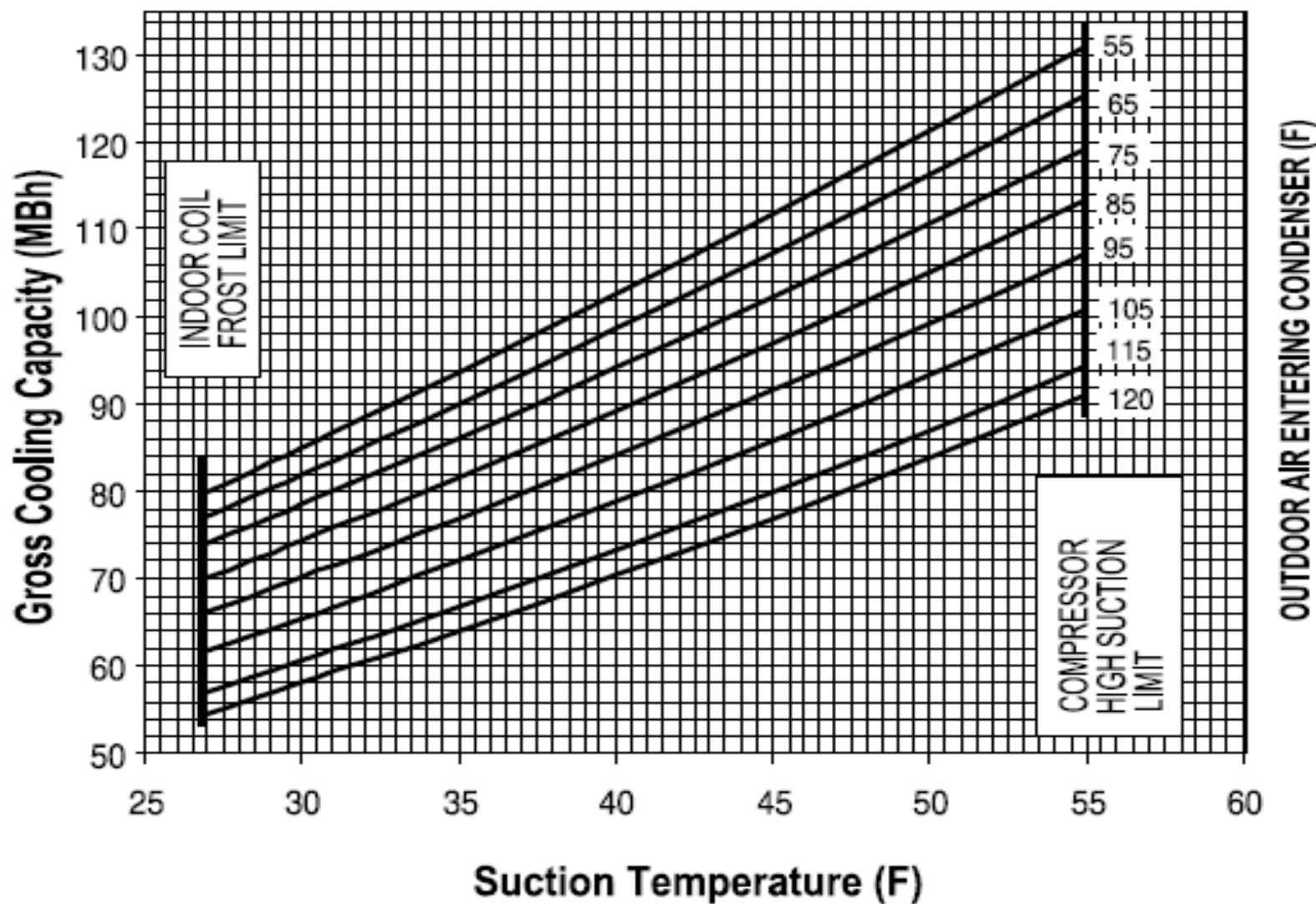
Typical Coil Performance Below Freezing





Compressor curves

Table 6 Capacity Curves Condensing Unit Only



The data ...

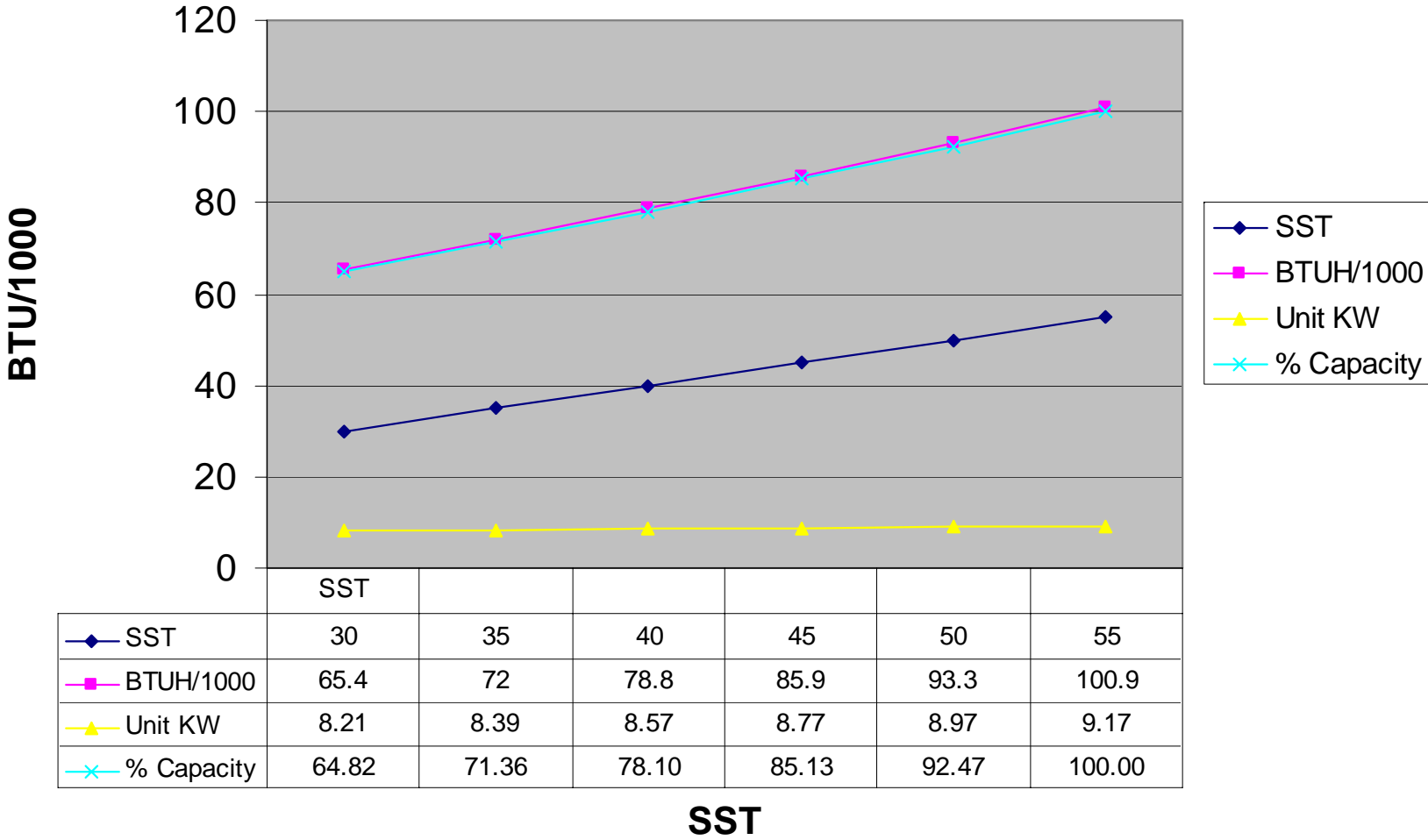
Table 5 Gross Cooling Capacities (MBh) — 7½ Ton Condensing Unit Only

Outdoor Temperature in Degrees (F)		Suction Reference Temperature (F)					
		30	35	40	45	50	55
65	Head press PSIG	166	171	177	182	189	195
	Cap. Btuh/1000	82.0	90.1	98.6	107.3	116.3	125.4
	Unit KW	5.45	5.59	5.74	5.91	6.09	6.29
75	Head press PSIG	190	196	202	208	214	221
	Cap. Btuh/1000	78.4	86.1	94.1	102.3	110.8	119.5
	Unit KW	5.97	6.12	6.29	6.47	6.66	6.86
85	Head press PSIG	217	223	229	236	242	250
	Cap. Btuh/1000	74.4	81.7	89.2	97.1	105.2	113.5
	Unit KW	6.60	6.76	6.94	7.13	7.33	7.54
95	Head press PSIG	247	253	259	266	273	281
	Cap. Btuh/1000	70.1	77.0	84.2	91.6	99.3	107.3
	Unit KW	7.35	7.52	7.71	7.90	8.10	8.31
105	Head press PSIG	279	285	292	299	307	315
	Cap. Btuh/1000	65.4	72.0	78.8	85.9	93.3	100.9
	Unit KW	8.21	8.39	8.57	8.77	8.97	9.17
115	Head press PSIG	313	320	327	335	343	351
	Cap. Btuh/1000	60.5	66.7	73.2	80.0	87.0	94.3
	Unit KW	9.17	9.35	9.54	9.73	9.92	10.12

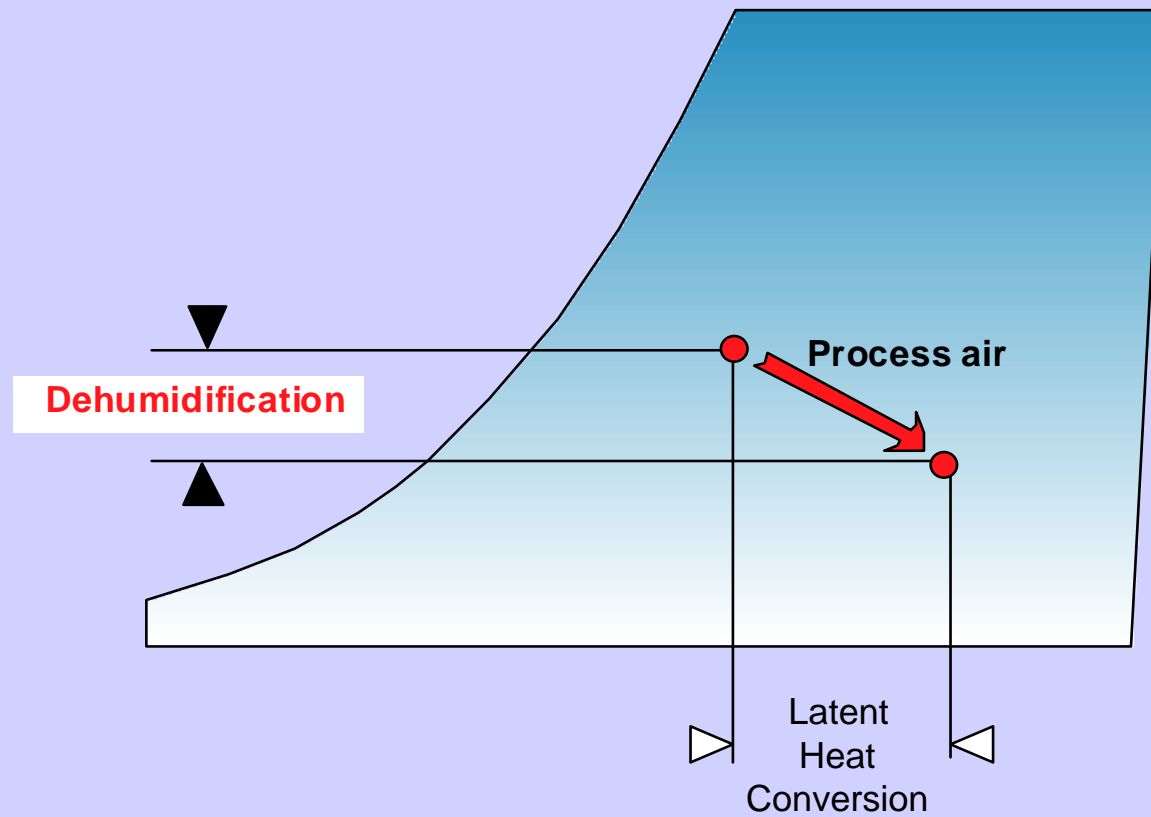
Performance data calculated at 15° F subcooling and 15° F superheat and does not include capacity loss due to refrigerant lines.

The Curve

Compressor Capacity Curve

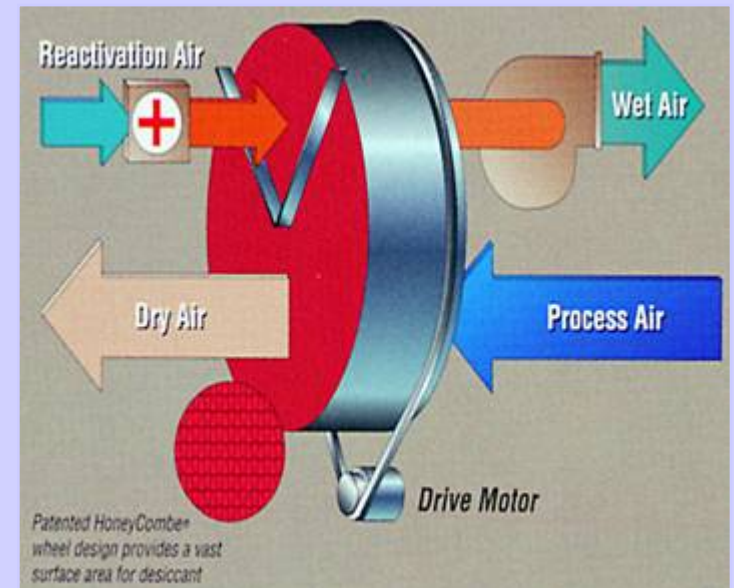


Desiccant-Based Dehumidification



Desiccant Dehumidification: HoneyCombe® Technology

- HoneyCombe® Wheel carries desiccant
- Desiccant wheel removes moisture from process air
- Wheel rotates to reactivation section. Heated air drives moisture away
- Dry air acts as a sponge, preventing moisture from condensing on surfaces.
- Defrost cycles extended considerably, evaporators operate efficiently.



NOTE: Primary objective is dehumidification

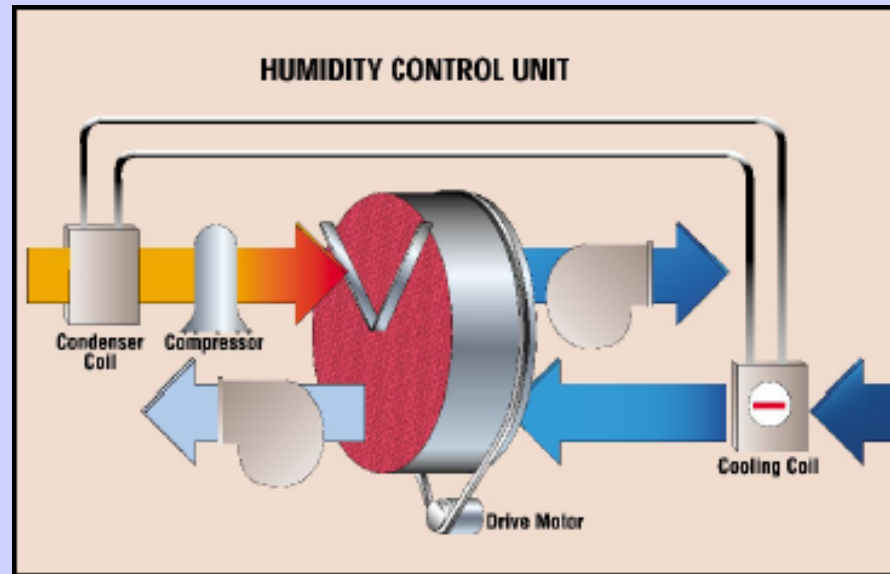


Cooling based dehumidifiers vs. Desiccant Dehumidifiers

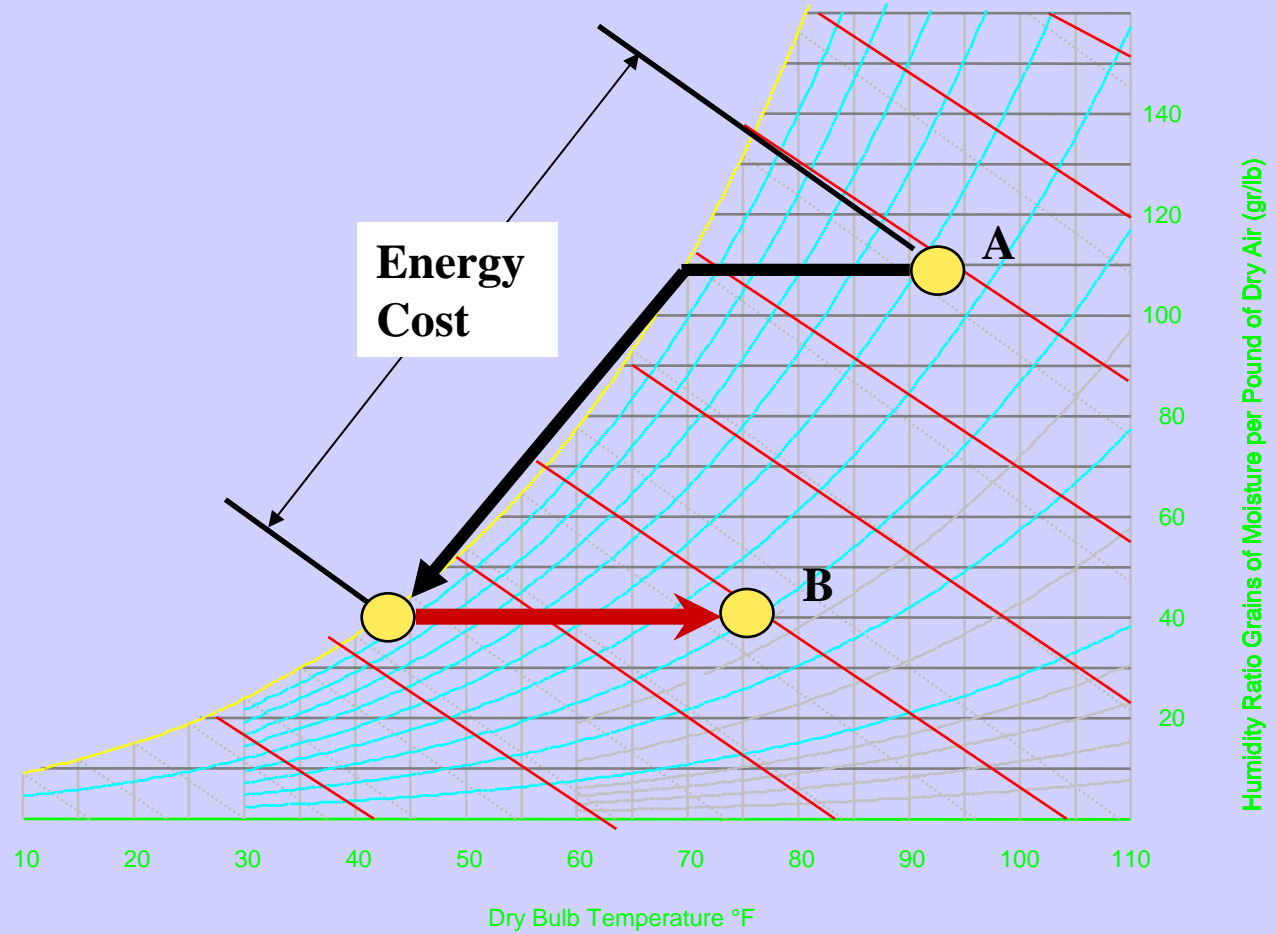
Most economical when used in COMBINATION!



Humidity Control Unit HCU

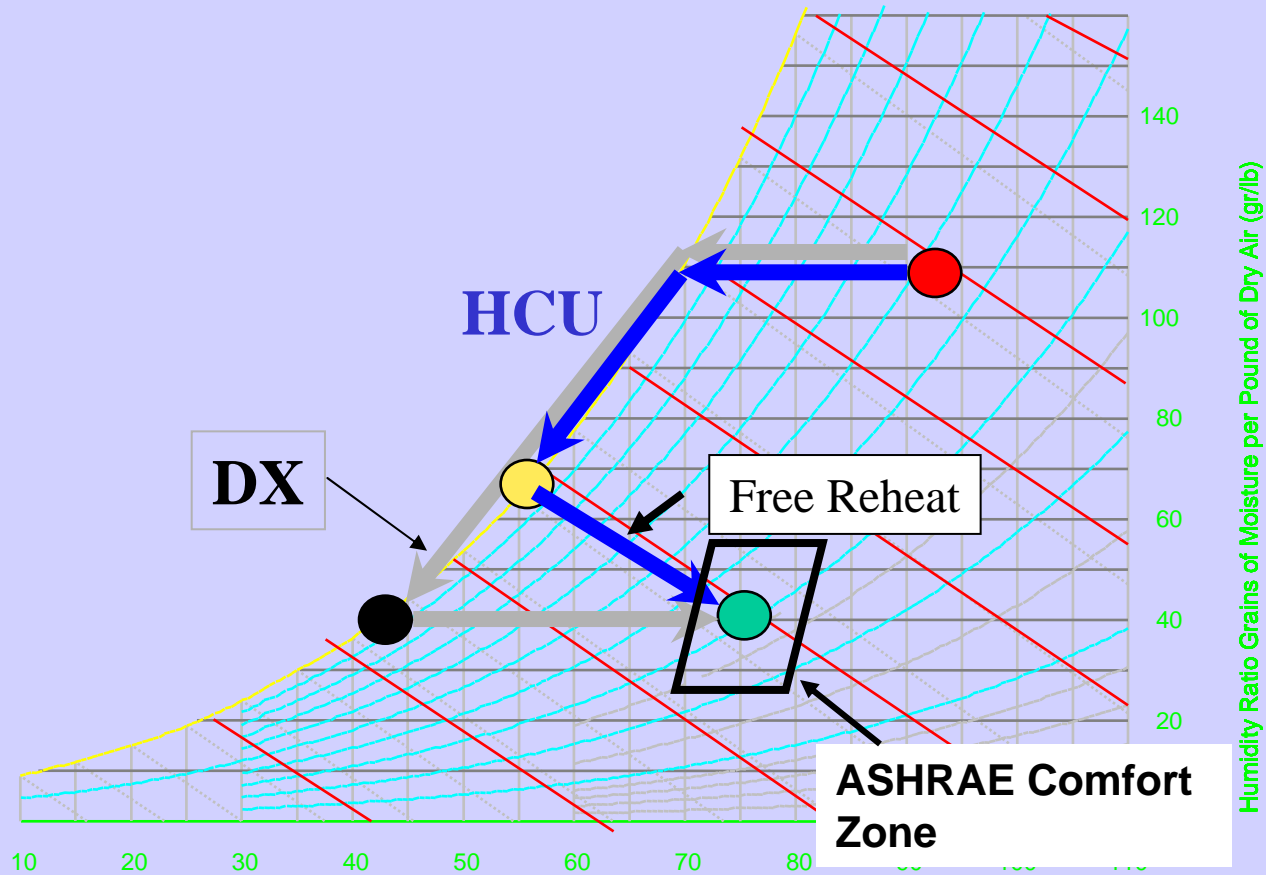


Energy cost of a traditional DX cycle used to cool & dehumidify make up air

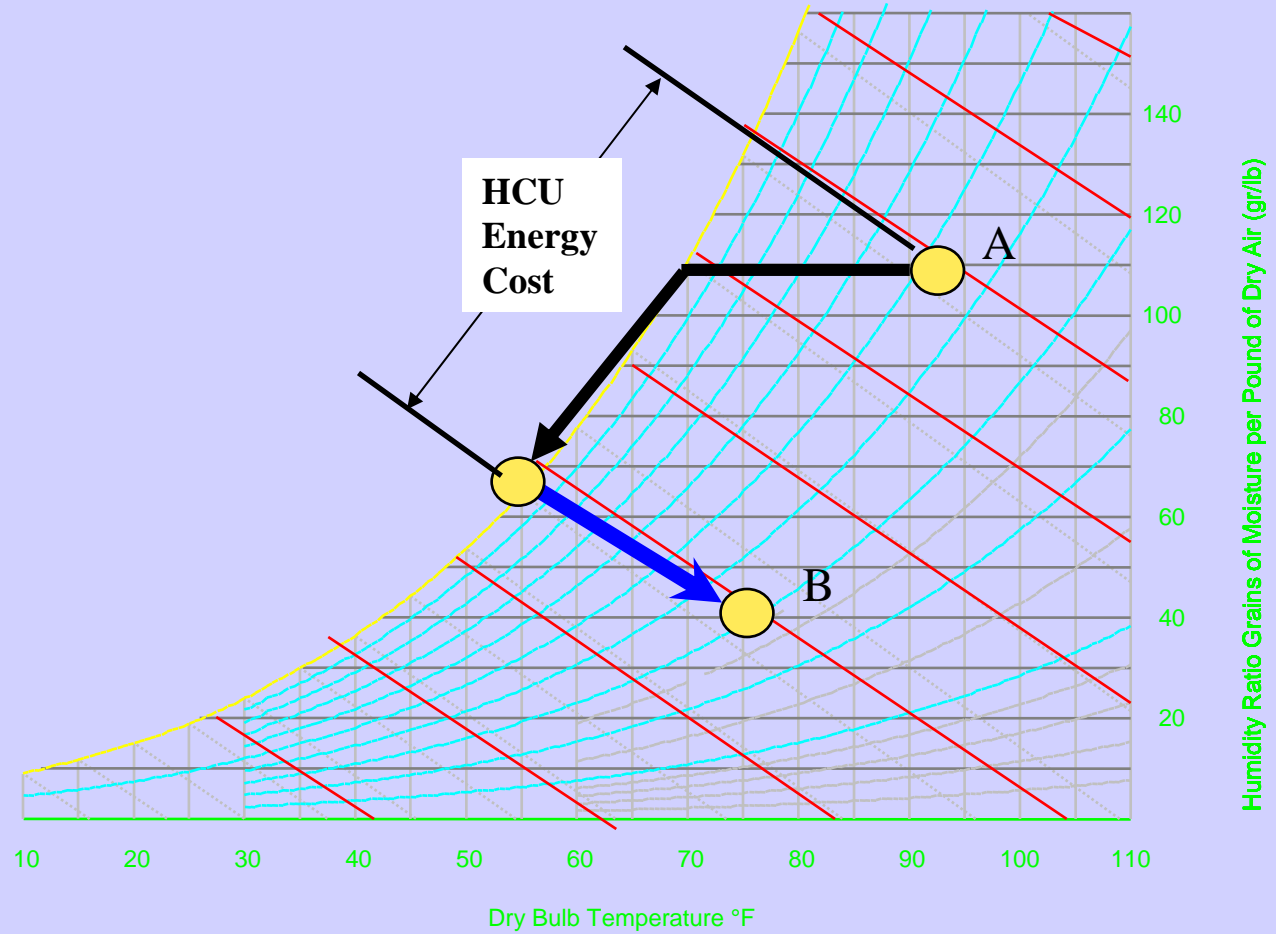




HCU: The best of both worlds

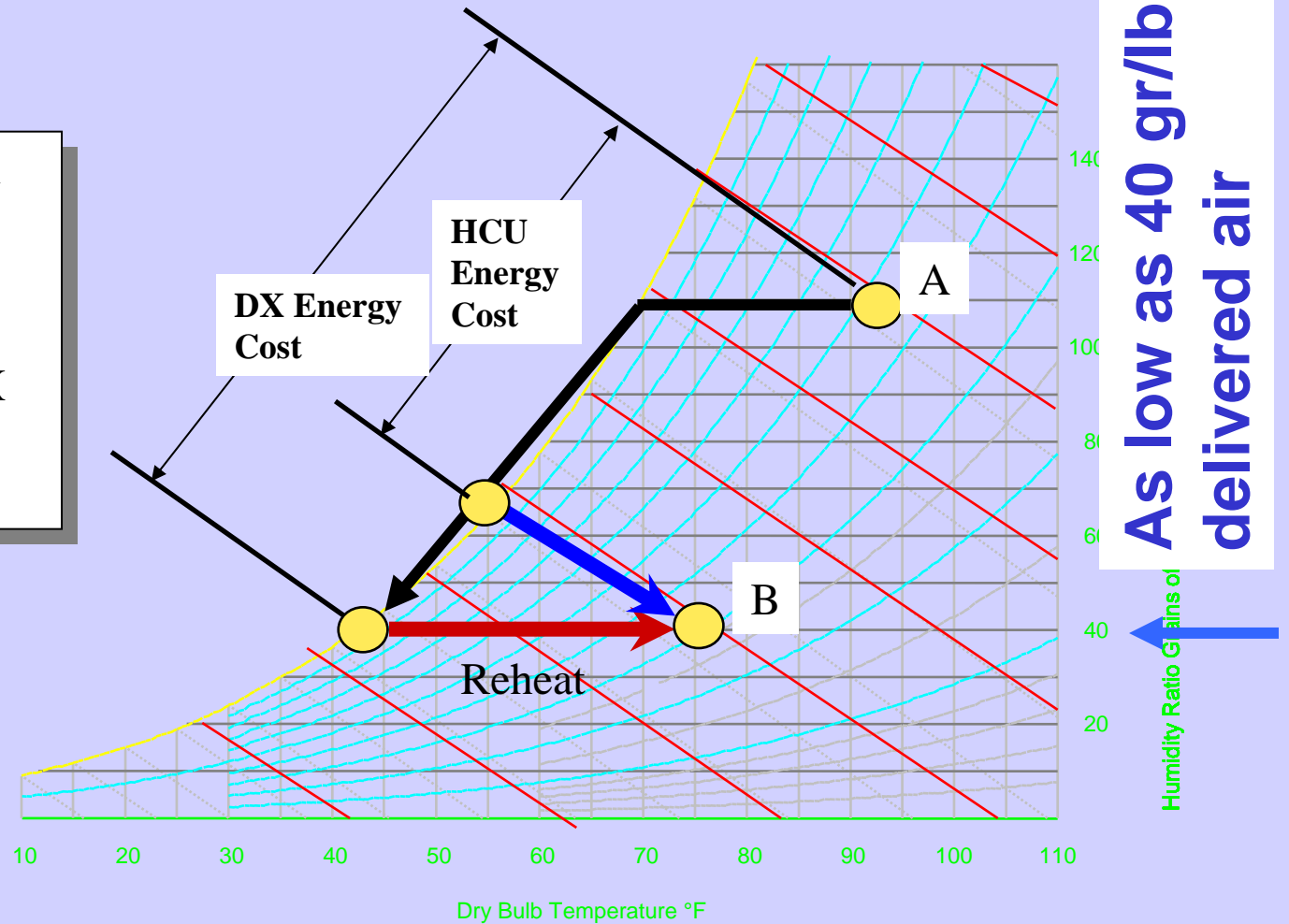


Comparison of HCU and DX cycles to cool & dehumidify make up air



Comparing Energy Costs of HCU and DX cycles At Peak Conditions

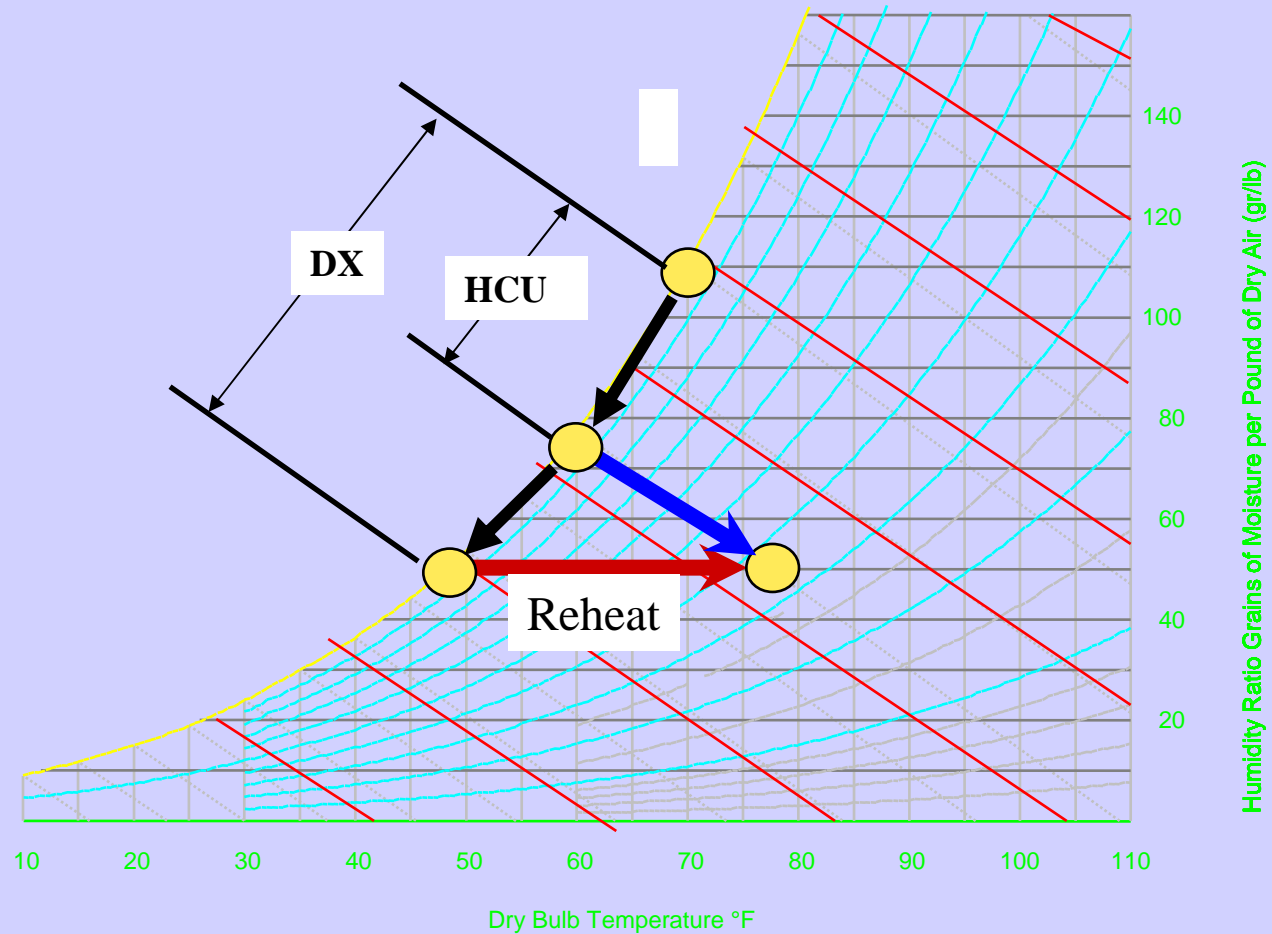
HCU doesn't need to cool to as low a temperature, so it saves 30 to 40% energy cost vs. DX systems.



HCU saves money at peak design conditions



HCU saves even more money at off-design conditions



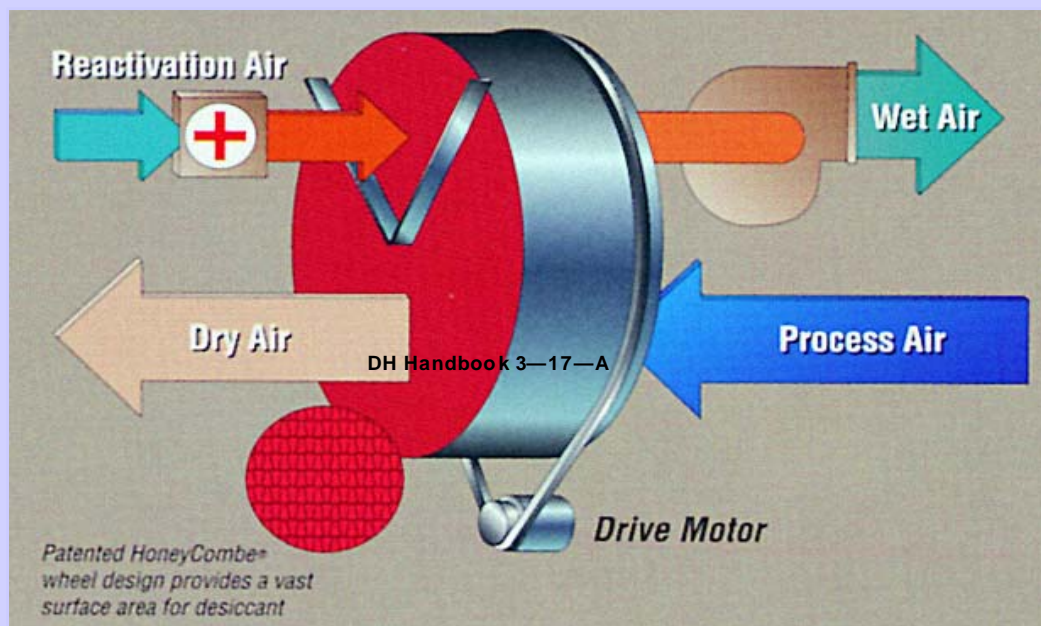
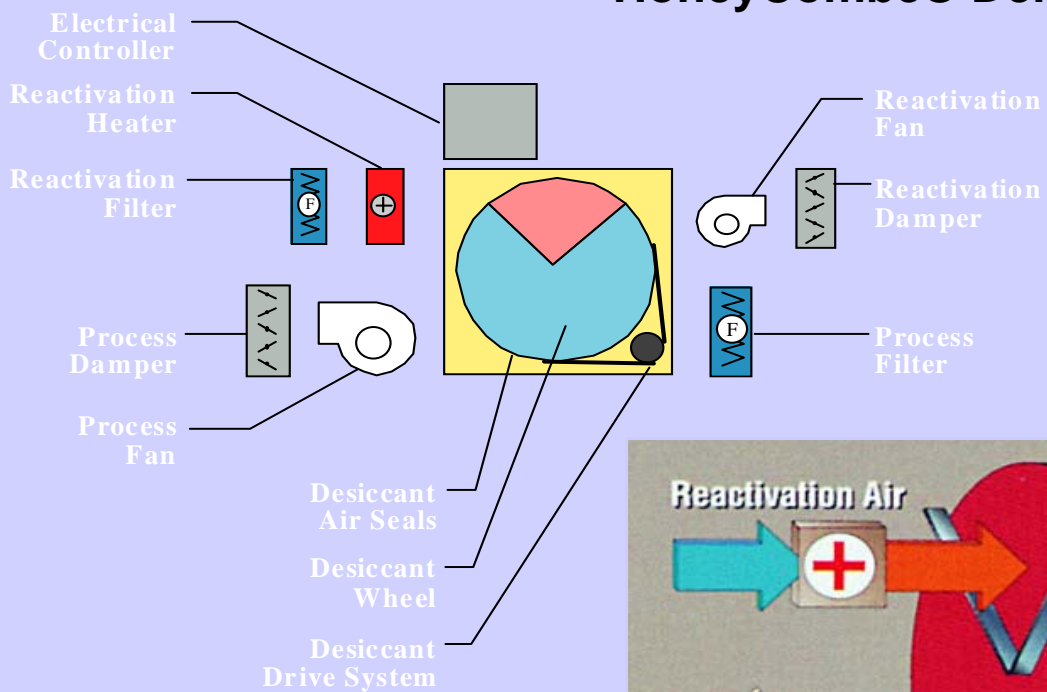
Chapter 2

Using desiccant when
refrigeration will not do the job



How it works...

HoneyCombe® Dehumidifier Components





Room Air @ 70°F, 50% rh

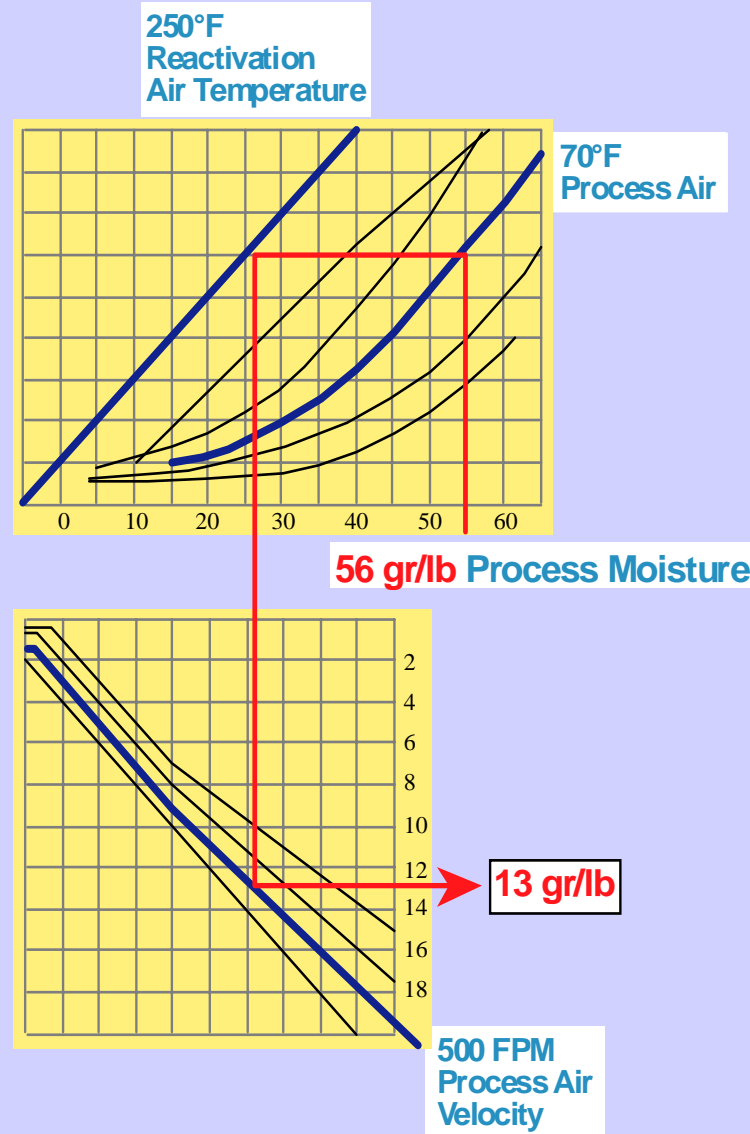
Basic Parameters:

Process Air

- 70°F
- 56 gr/lb
- 500 fpm face velocity

Reactivation Air

- 250°F after the heater



Change in Process Temperature

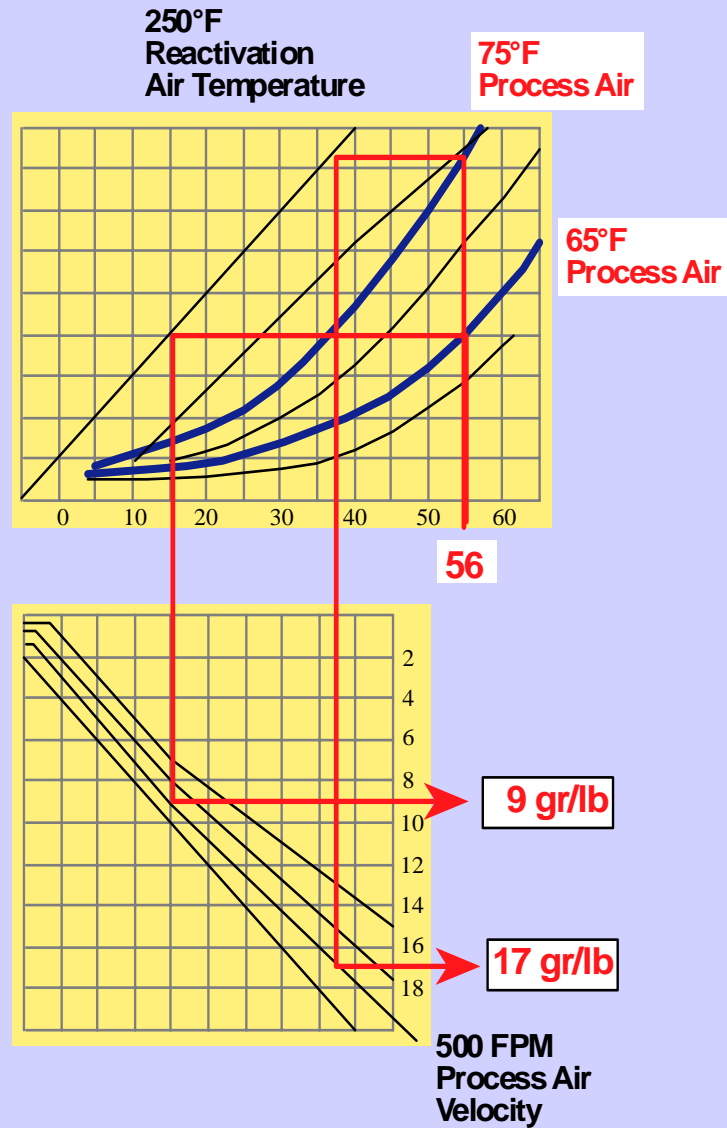
Basic Parameters:

Process Air

- 65 and 75°F
- 56 gr/lb
- 500 fpm face velocity

Reactivation Air

- 250°F after the heater



Change In Process Moisture

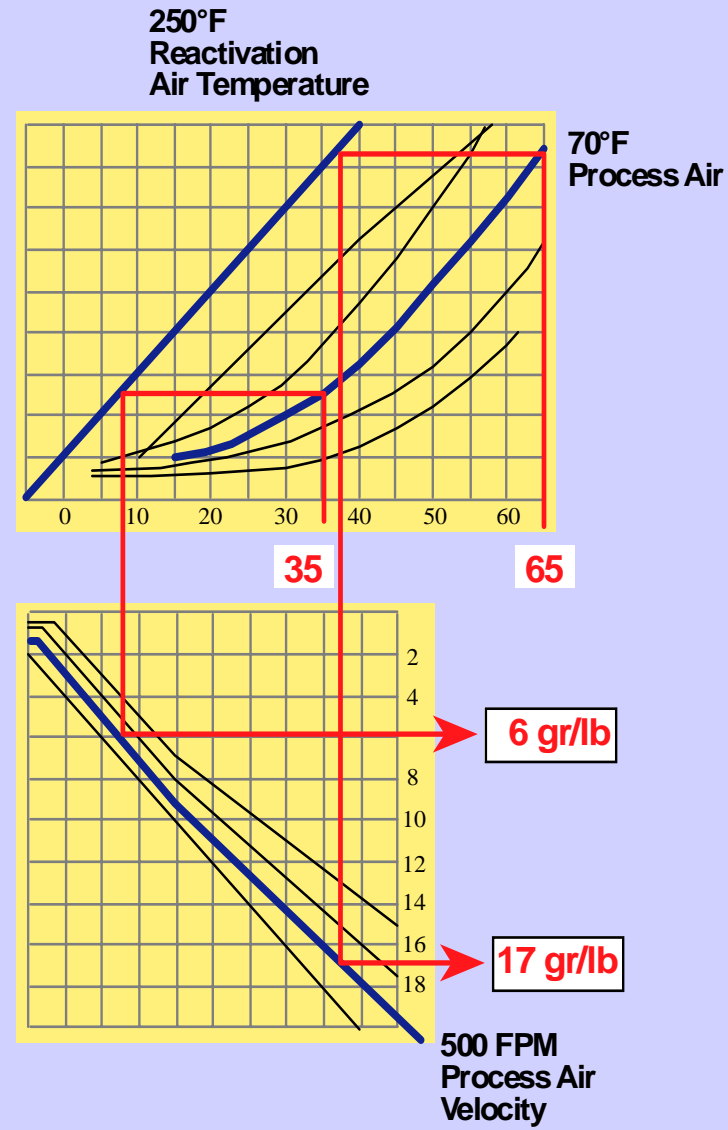
Basic Parameters:

Process Air

- 70°F
- 35 and 65 gr/lb
- 500 fpm face velocity

Reactivation Air

- 250°F after the heater





Change in Unit Size (Process Air Velocity)

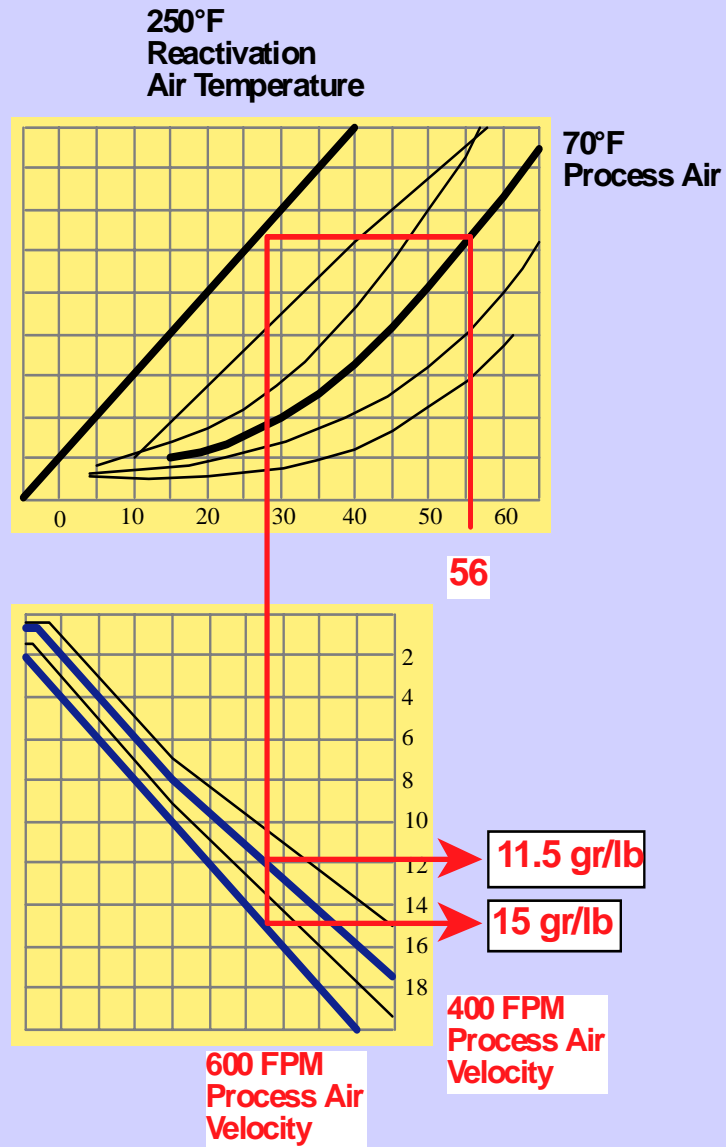
Basic Parameters:

Process Air

- 70°F
- 56 gr/lb
- 400 and 600 fpm

Reactivation Air

- 250°F after the heater





Change Reactivation Temperature

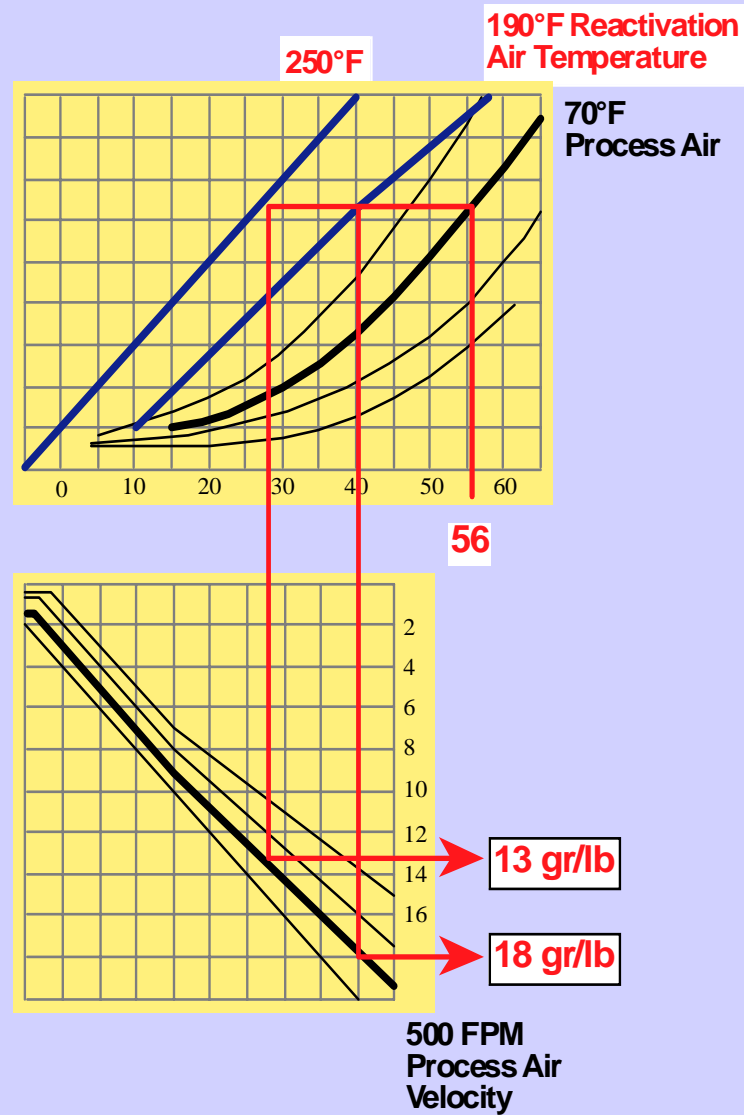
Basic Parameters:

Process Air

- 70°F
- 56 gr/lb
- 500 fpm

Reactivation Air

- 190 and 250°F



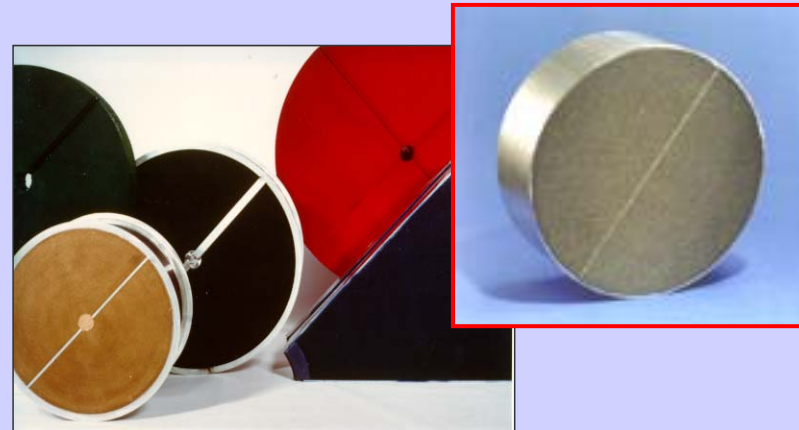
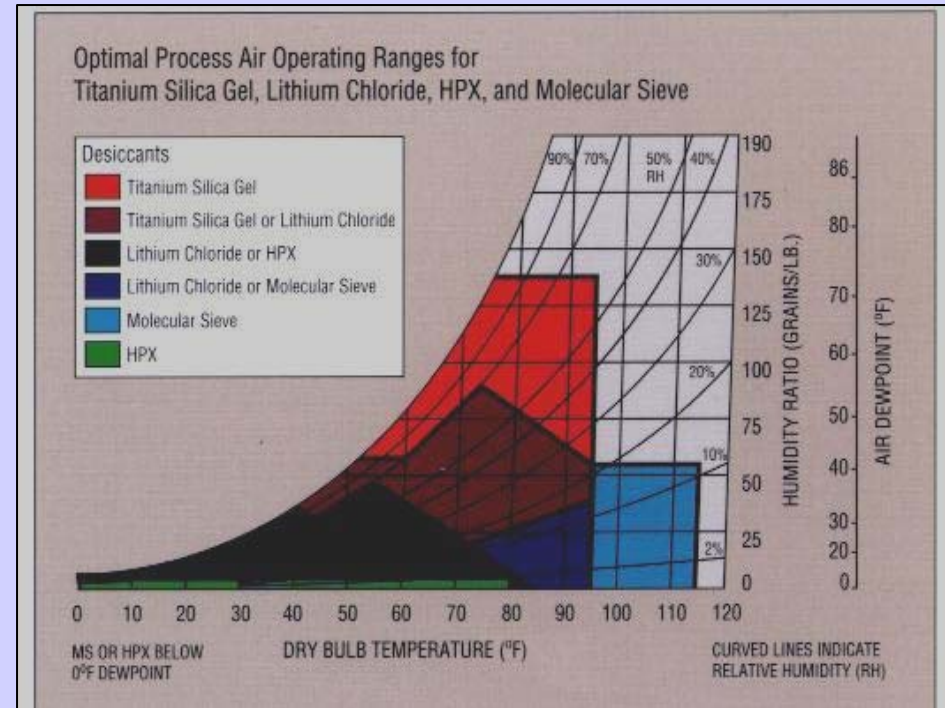
HoneyCombe® Technology Benefits...

- ◆ HoneyCombe® Wheel carries desiccant
- ◆ Very large surface area for desiccant material (1 cu. ft. = 500 football fields)
- ◆ Wheel rotates to reactivation section - Rotates only 8-12 times per HOUR!
- ◆ Simple, mechanical design
- ◆ Desiccant removes moisture from process air in vapor form, no condensing water or drainage required.
- ◆ No standing water
- ◆ Heated reactivation air carries moisture away in vapor form
- ◆ A complete separation of Humidity and Temperature control
- ◆ Shift in latent energy requirements to another utility, natural gas, steam, propane
- ◆ Ultra low dewpoint's achievable - as low as -70°F



Desiccant Wheel Choices

- ◆ Titanium Silica Gel - Durable & insoluble
- ◆ Lithium Chloride - Broad application range
- ◆ Molecular Sieve - Low dew points over wide temperature ranges
- ◆ HPX - High performance
 - ◆ GTR
 - ◆ Power Purge



Chapter 3

The advantage's of using
desiccant systems in cold
storage applications



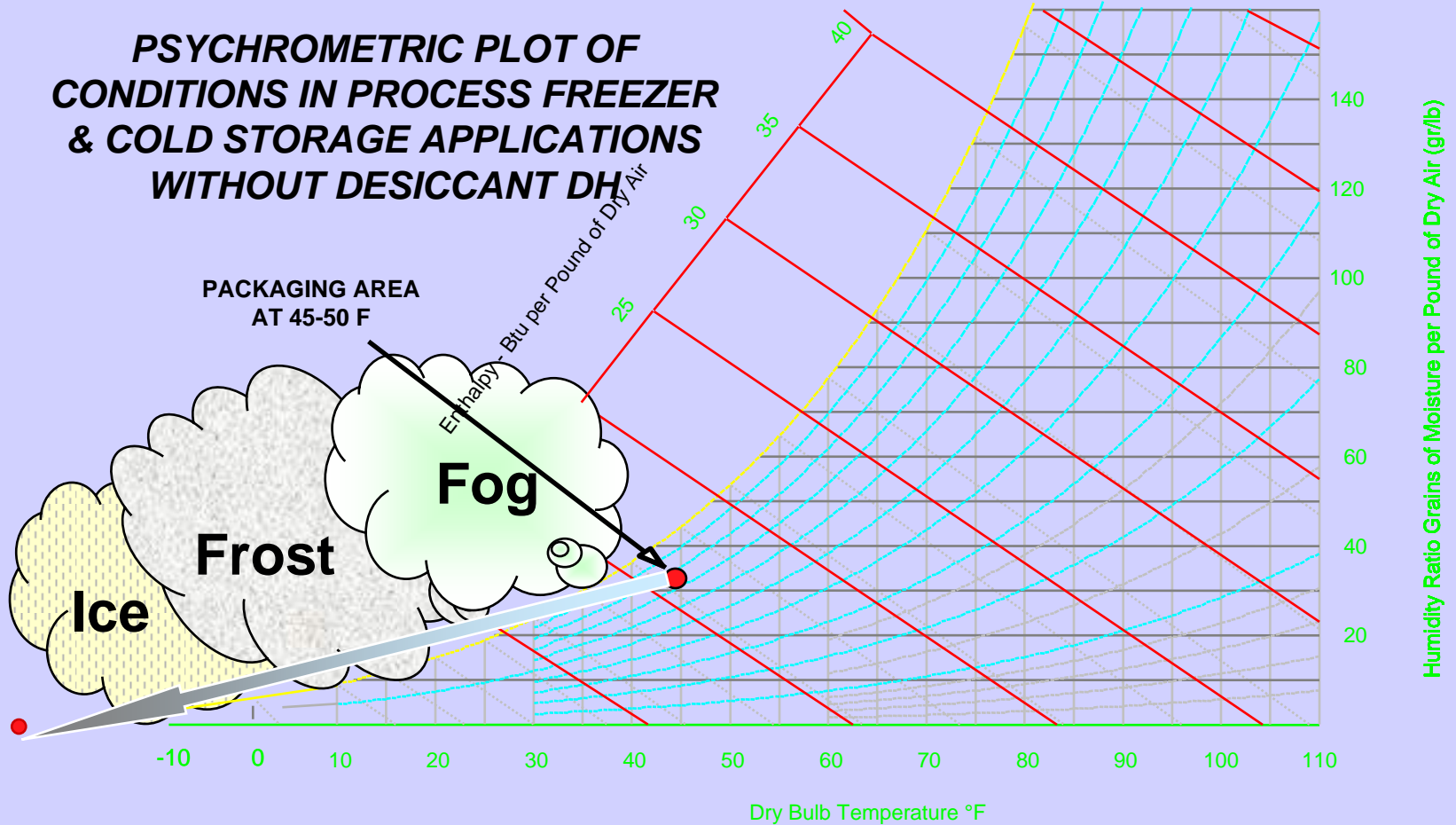
Working in cold Storage... is not always easy





Psychrometric Plot Typical Cold Storage

**PSYCHROMETRIC PLOT OF
CONDITIONS IN PROCESS FREEZER
& COLD STORAGE APPLICATIONS
WITHOUT DESICCANT DH**





Problem: SAFETY

Unsafe environment -
risk of accidents caused by slippery floors can result in
costly expenses





Reducing or Eliminating Ice

- To reduce or eliminate ice accumulation the moisture level (dew point) must be low enough to prevent condensation on cold surfaces. Dehumidification is required.
- To understand the limitations of condensation control in low temperature spaces one must first recognize the differences between the two methods of dehumidification – cooling versus desiccant.
- Both technologies remove moisture from air. The primary difference is the dew point of the air that each can effectively deliver.

Psychrometrics of Cooling-Based Dehumidification

- Air is circulated over a cold coil and cooled to saturation
- Further cooling condenses moisture on coil fins
- Dew point reduction is limited by minimum practical coil temperatures (freezing)
- Subfreezing areas that utilize this method must deal with ice build-up on evaporators, walls, floors, ceilings, door frames, etc.
- Regularly scheduled defrosts are needed and have become the standard operating procedure.

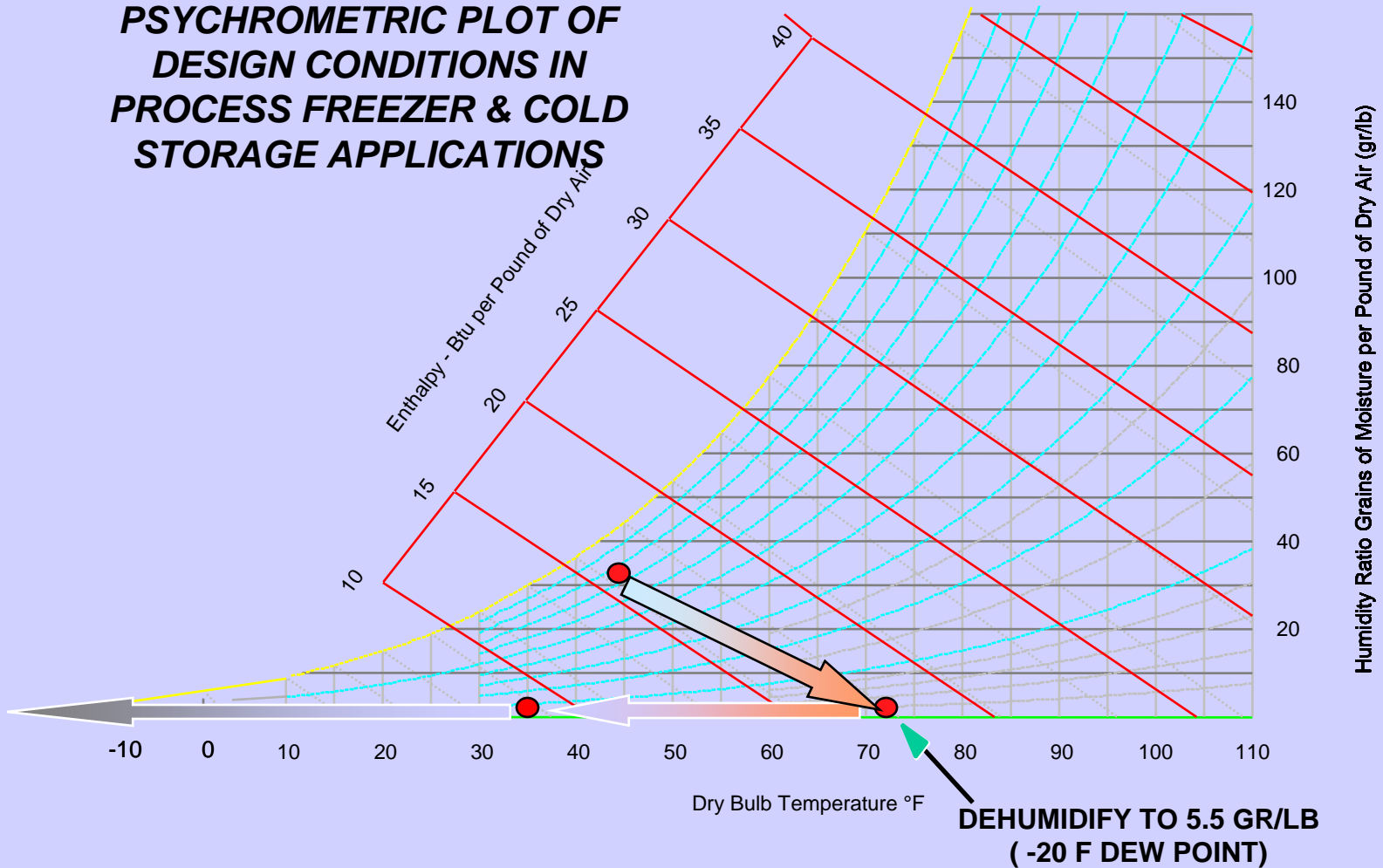
NOTE: Primary objective is temperature control, dehumidification is a byproduct.



Psychrometric Plot

Cold Storage with Desiccant

**PSYCHROMETRIC PLOT OF
DESIGN CONDITIONS IN
PROCESS FREEZER & COLD
STORAGE APPLICATIONS**



Applications in cold environments...

- **Loading docks** - large infiltration loads from truck doors
- **Cold storage freezers** - moisture from loading dock and process area
- **Spiral freezers** – moisture from product environment
- **Plate freezers** – moisture from environment
- **Process freezers** – moisture from product and environment
- **Meat processing** - moisture from various sources causing overhead condensation



Effects of Humidity on Freezer's

- Fog and condensation
- Ice on Floors, Walls, Doors & Evaporators
- Extensive cleaning time
- Food warms (food quality / safety)
- Refrigeration plant over worked
- Increased energy consumption
- Increased defrosts (inefficient, increased downtime)
- Ice in room (worker safety, reduced operator speed)
- Contamination through door
- Iced evaporator (reduced air flow, increased maintenance)





The warehouse culprit..

- Many cold stores are not equipped with an airlock, often using plastic strip curtains to reduce the amount of moisture introduced when the door is opened.
- This approach does not provide a complete vapor barrier. Moisture still infiltrates into the cold store, ice builds up on evaporators, overhead structures, door mechanisms, floor, etc.



Freezer Air Lock / Loading Dock

In addition to Ice, fog & frost this causes:

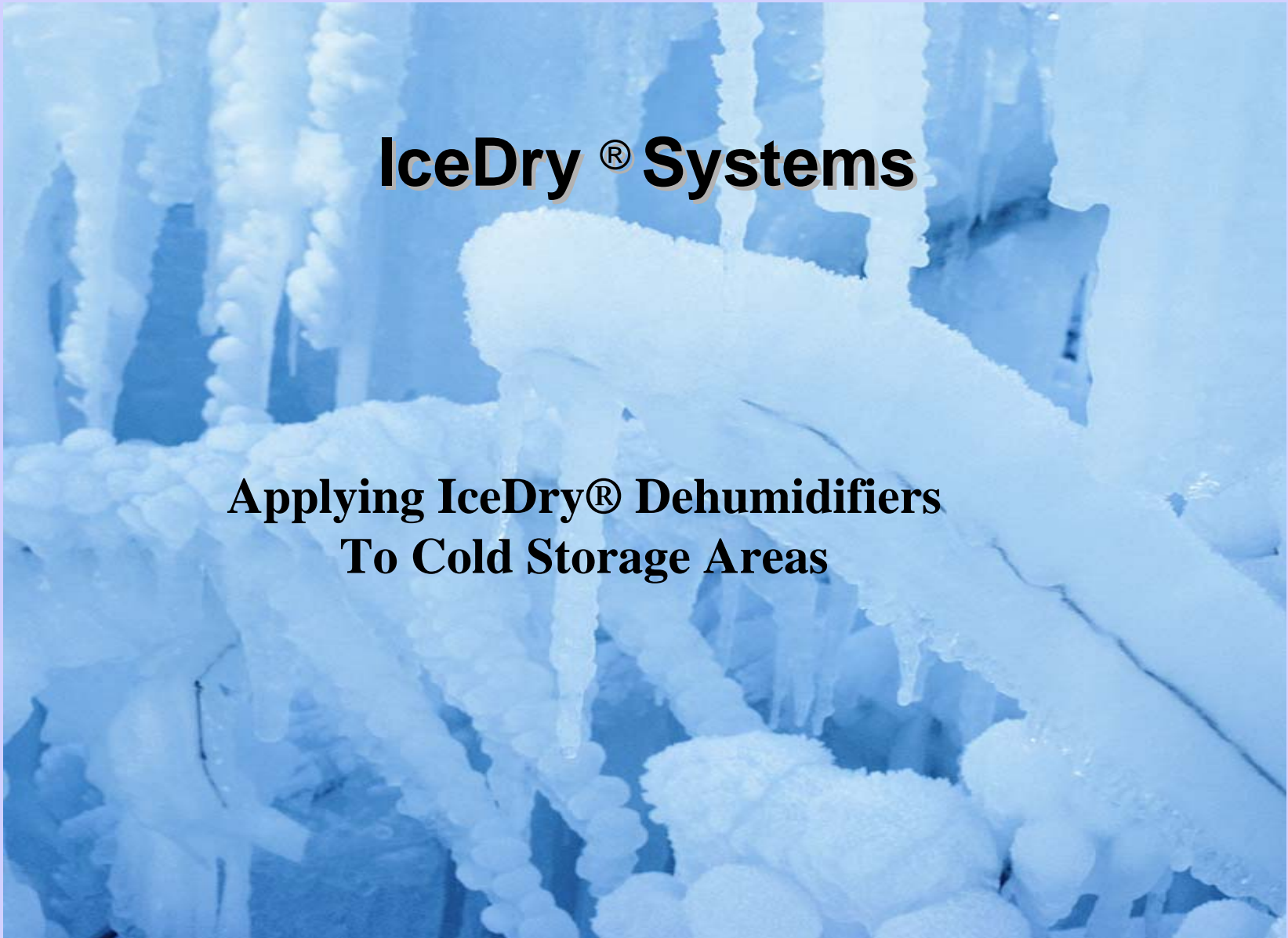
- Blinding strip curtains
- Poor visibility
- Lost cooling capacity
- Extended loading times
- Fork truck and structural damage
- High maintenance cost of doors etc.
- Need for mechanical de-icing





IceDry[®] Systems

**Applying IceDry[®] Dehumidifiers
To Cold Storage Areas**



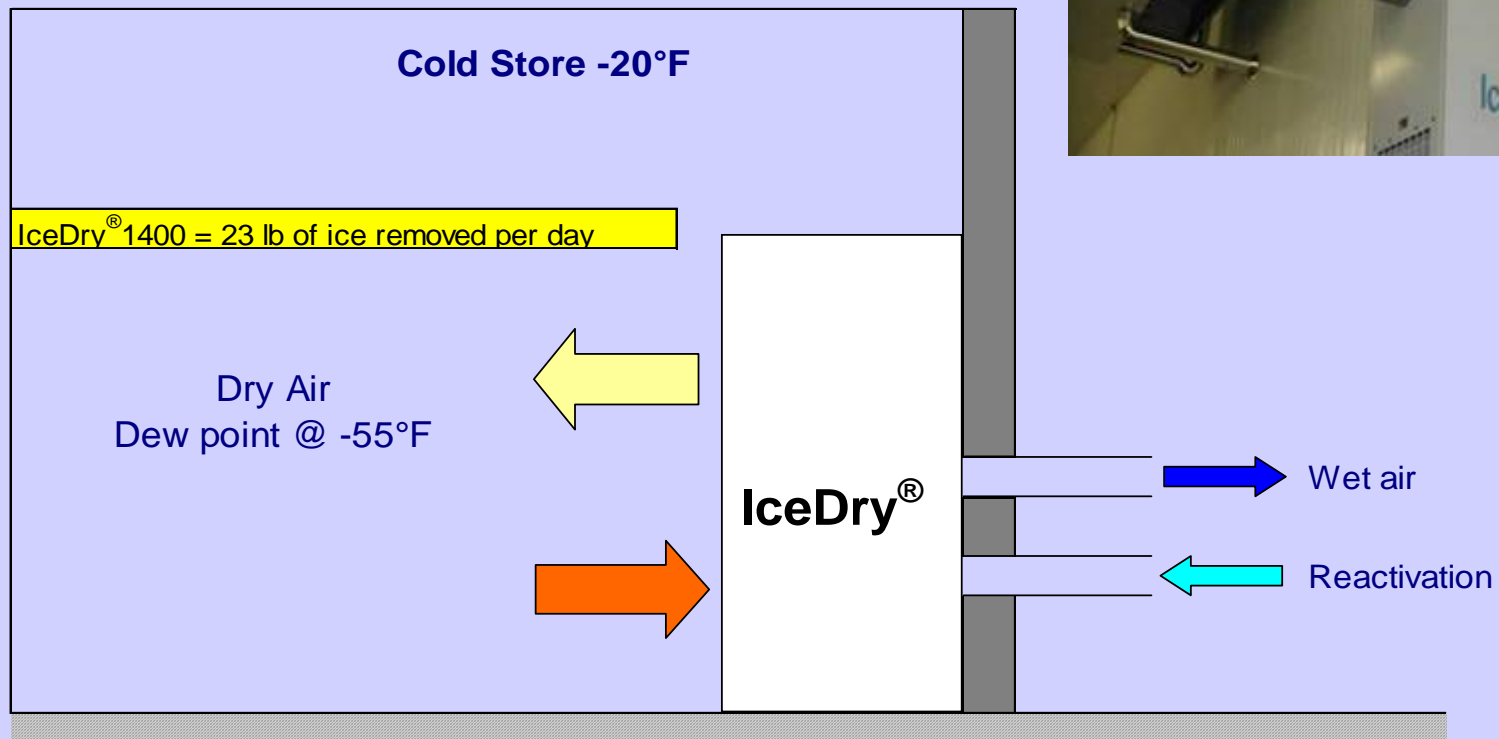


Limited Access Cold Storage

- Stand alone IceDry[®] unit designed to run continuously, providing ice removal 24 hours per day.
- Cost effective solution for limited access areas:
 - cold storage doors open < 10 minute per hour
 - facility doesn't operate 24 hours per day. Gives IceDry[®] chance to remove moisture that infiltrated during the day.
- If door activity varies or is expected to increase in future then include an air curtain in design to improve dry air distribution over the cold door.

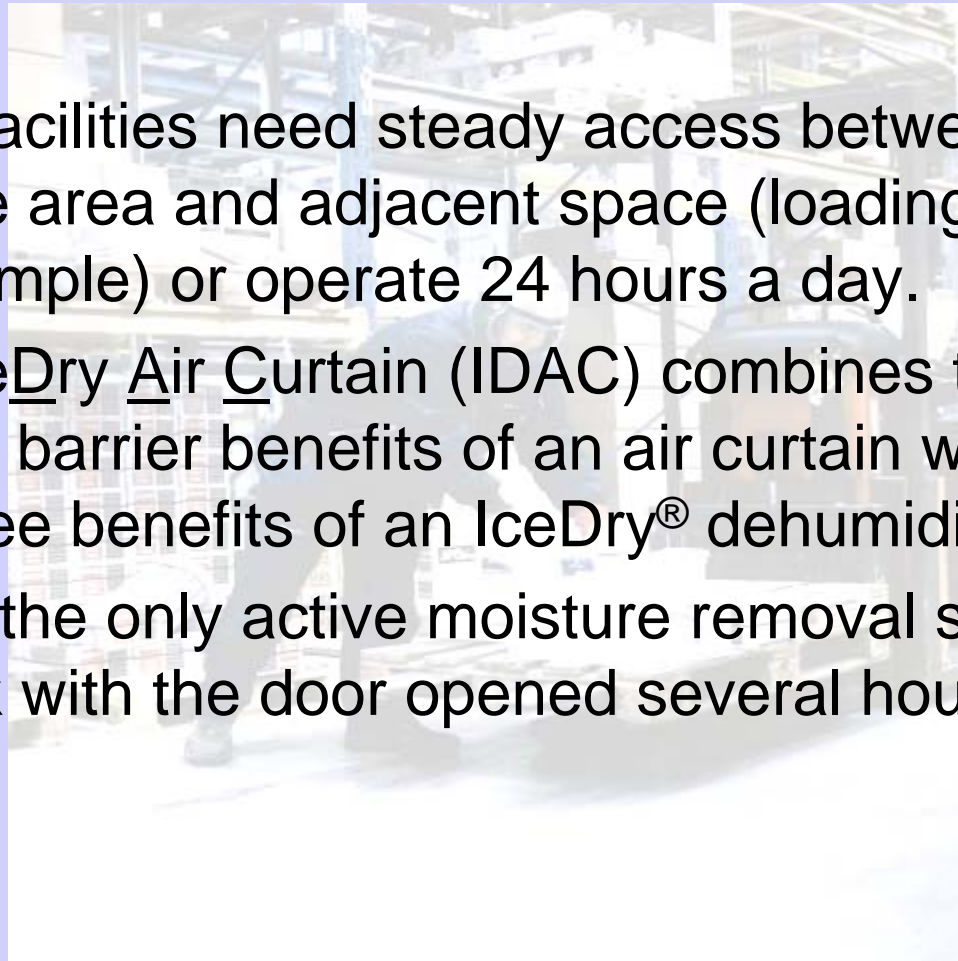


Stand-Alone IceDry[®] Solution

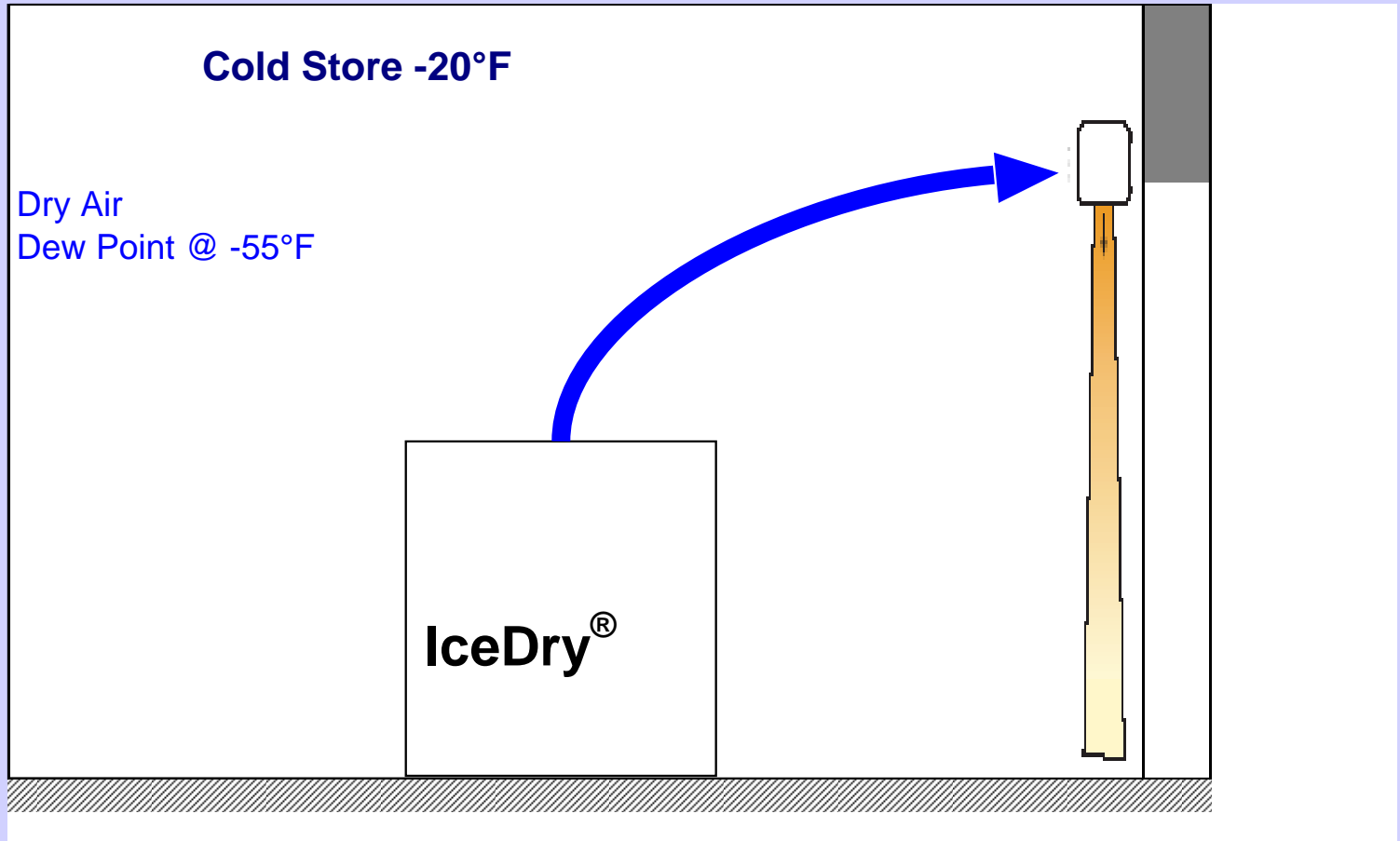


Active Cold Storage

- Many facilities need steady access between cold storage area and adjacent space (loading dock for example) or operate 24 hours a day.
- The IceDry Air Curtain (IDAC) combines the climate barrier benefits of an air curtain with the frost-free benefits of an IceDry® dehumidifier.
- This is the only active moisture removal solution to work with the door opened several hours per day.

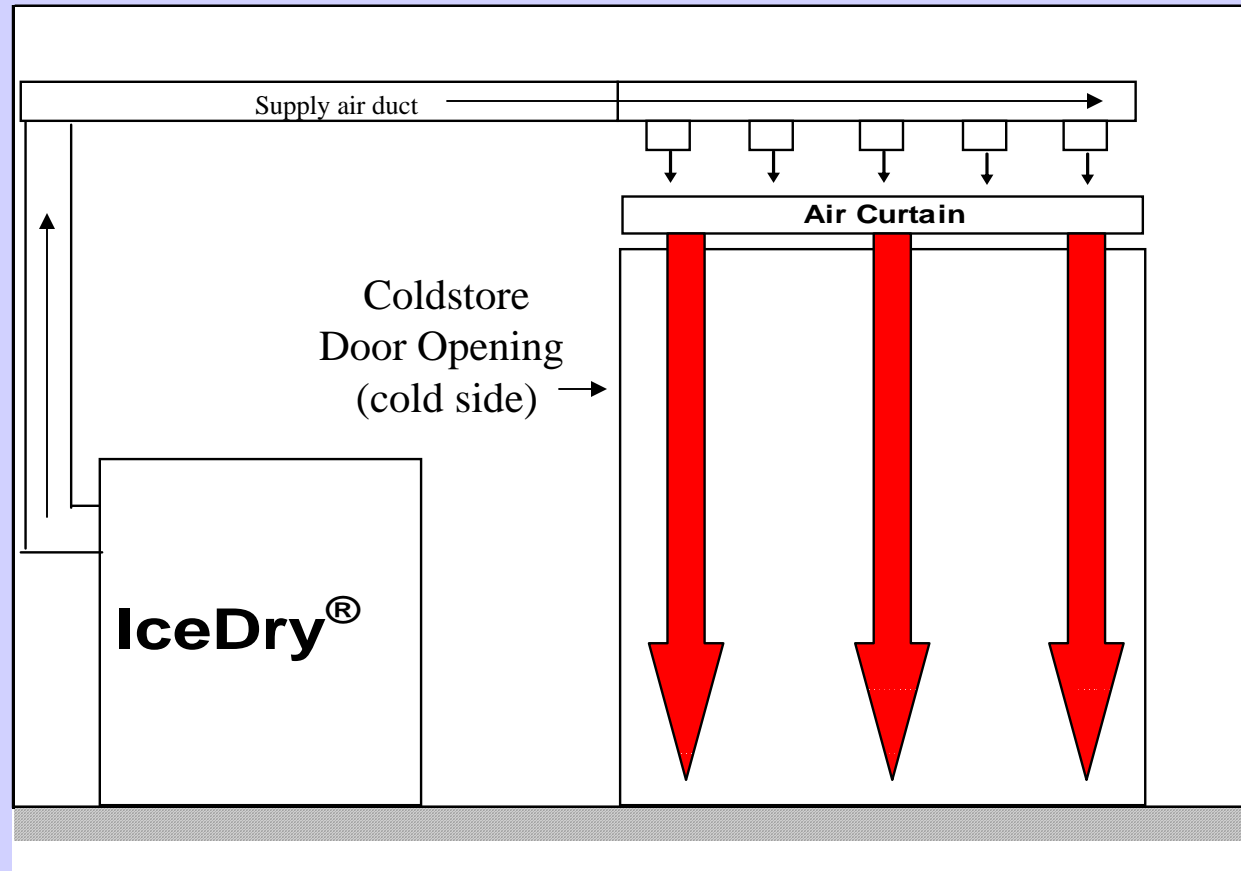


IceDry[®] Air Curtain





IceDry[®] Air Curtain





KLM Catering Services

Before IceDry®



After IceDry®



Evaporators Before & After IceDry®







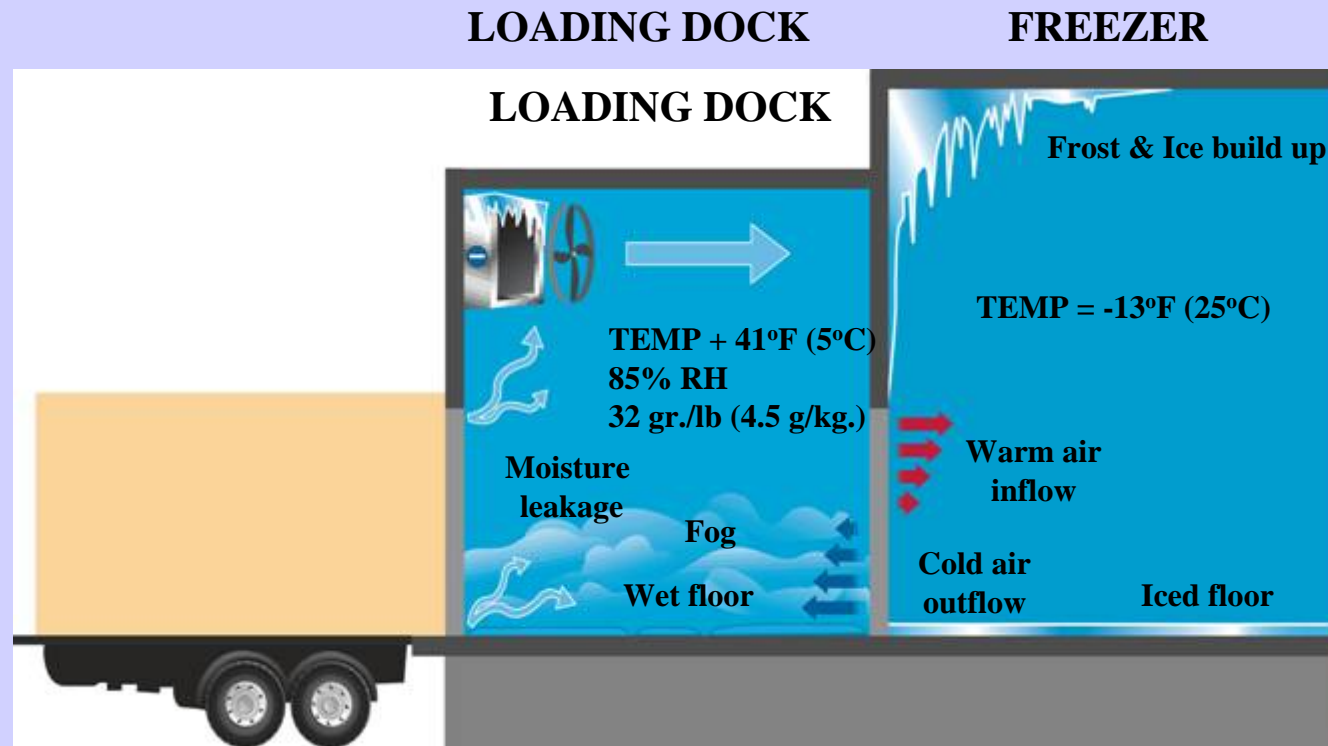
15 days later

K



Freezer / Loading Dock

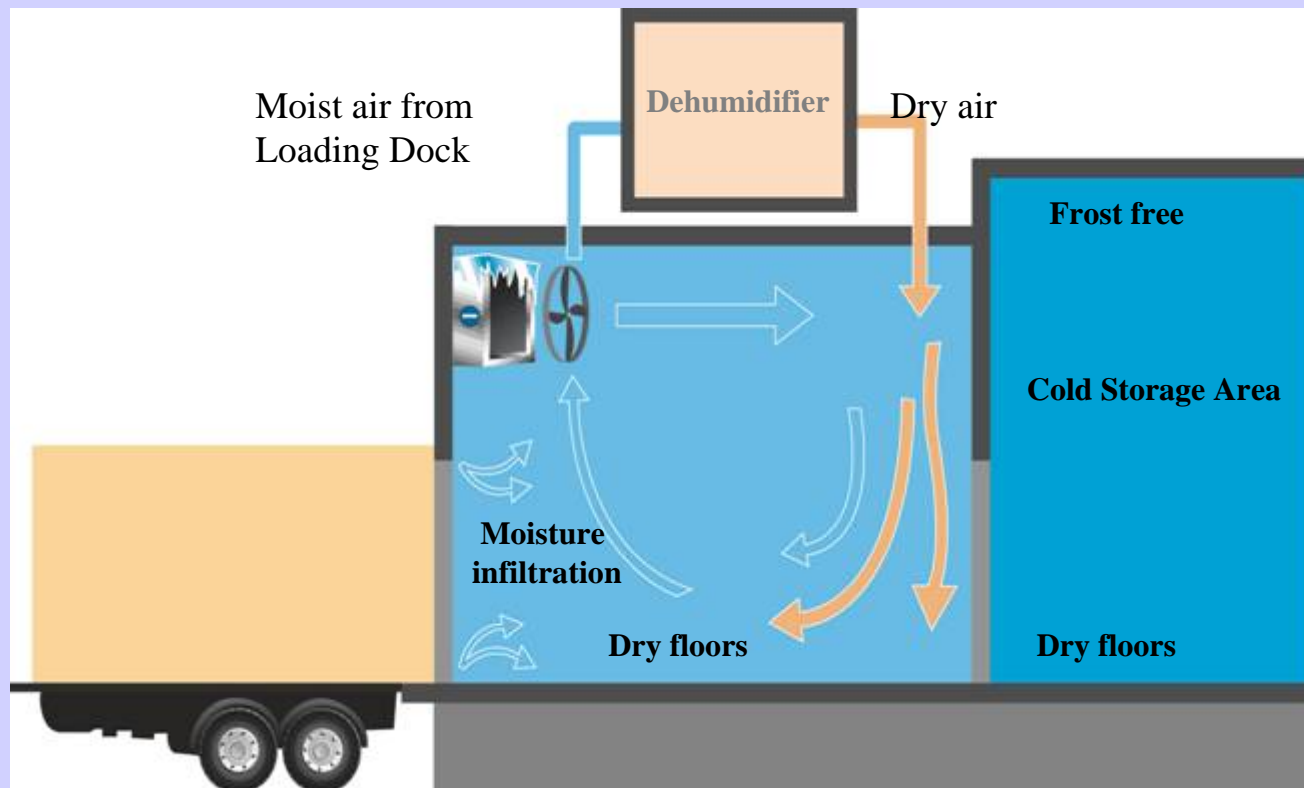
One example





With Dehumidifier Installed

Desiccant dehumidifier keeps the Loading Dock dry, reducing the moisture load to the Freezer





Before

After



Benefits of Dehumidification

- Floors/doors kept dry and ice-free
- Speed up loading and unloading
- Fork trucks operate at normal speed
- Reduced occupational injuries from slips, falls and pallet mover accidents
- No ice on strip curtains or fog around door, visibility is improved
- Trouble-free pulldown after washdown
- Coils run more efficiently and run longer between defrosts





Dehumidification & Defrosts

- Defrosting is an expensive business
- One open door (8' x 10') can allow 1 gallon of water to enter a cold Freezer every minute
- When ice settles on a cooler, the refrigeration system has to cool through a layer of insulating ice
- Defrosts can represent 15% of energy consumption in Freezers

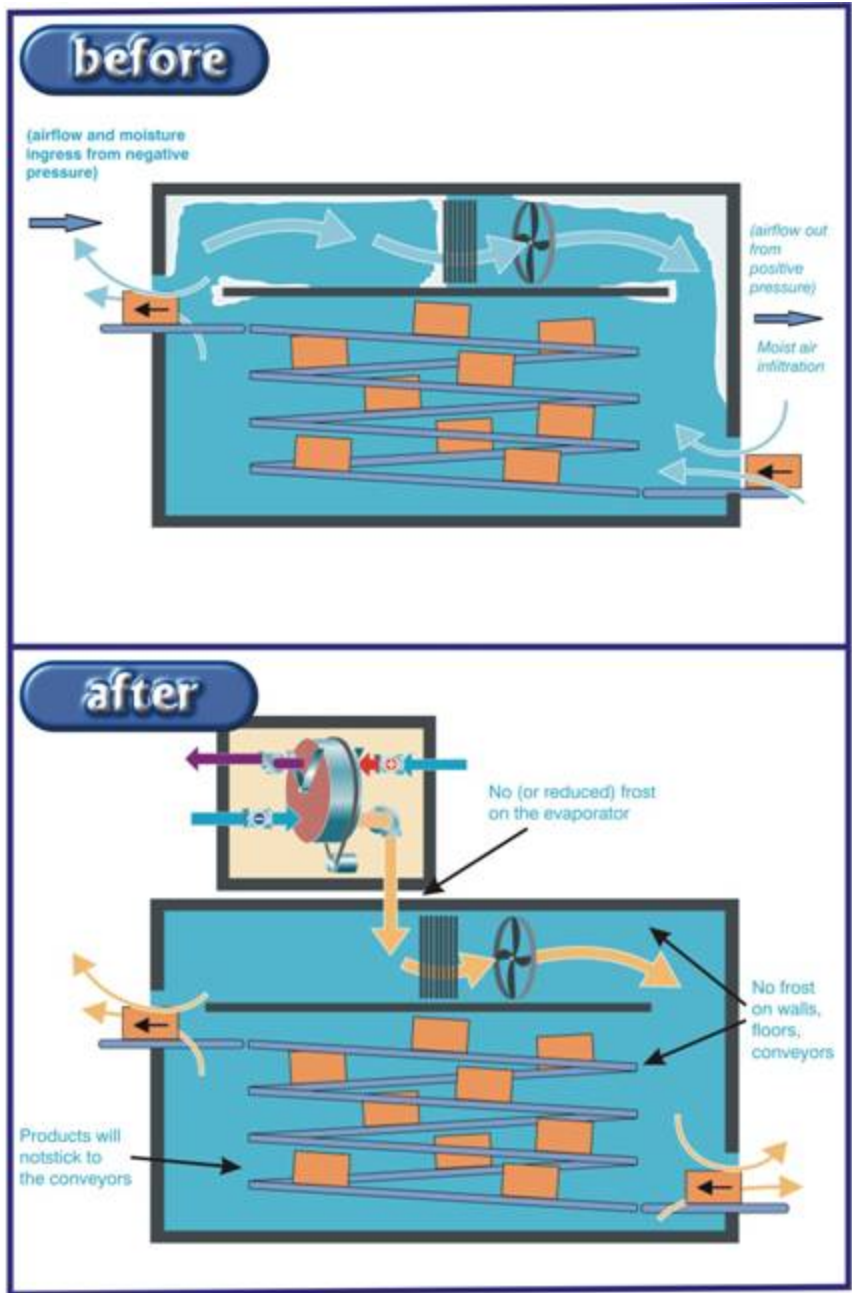
Roof Void Condensation

- Fire detection impeded
- Moisture leaching through into insulation - freezes
- Smallest perforations can penetrate and increase weight
- Lose insulation value
- Reduced safe working load for panels
- Panels bowing and collapsing



Dehumidification for Process Freezing





Frozen Baguettes

Moisture Sources:

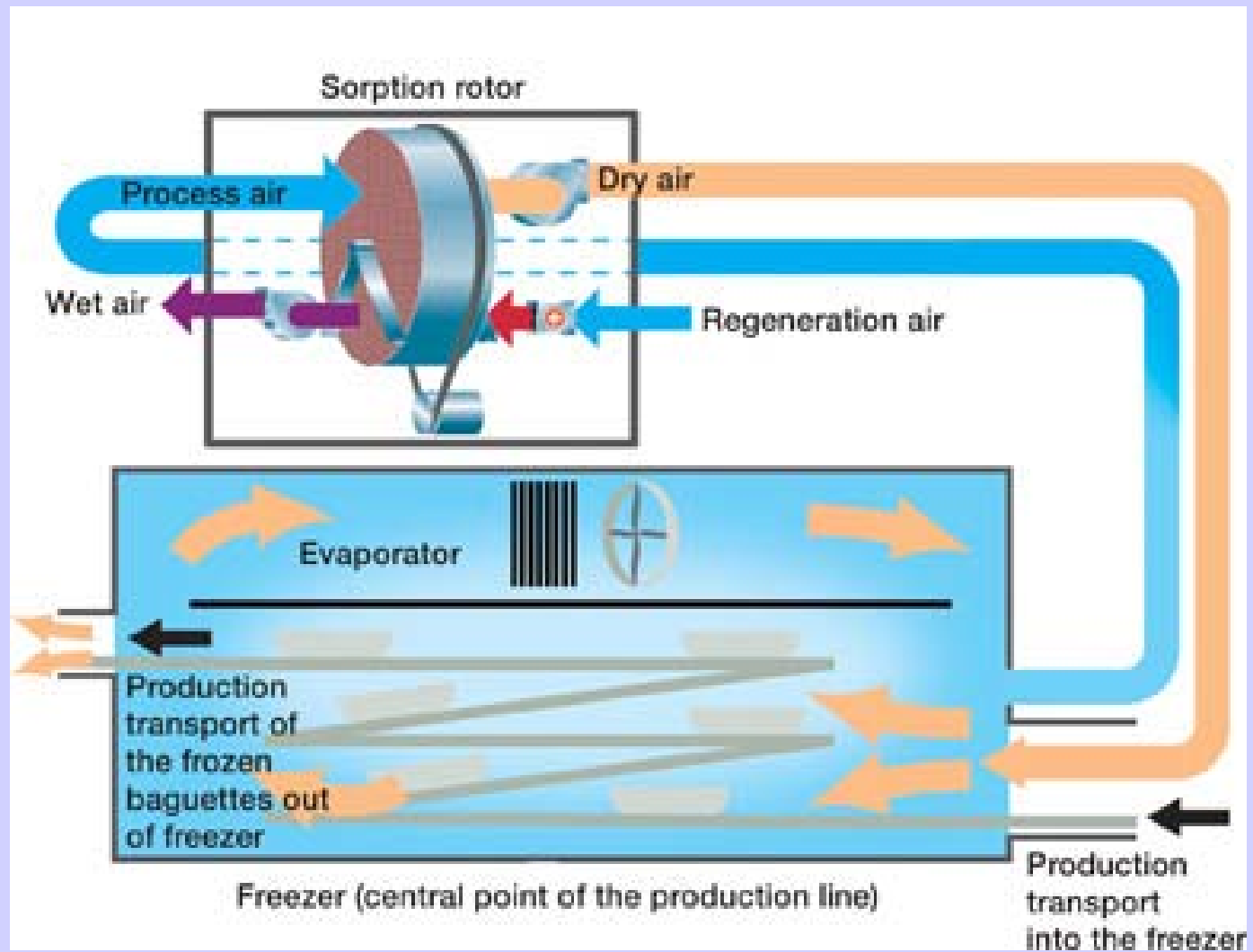
- Product releases moisture
- Infiltration of moist production air
- Washdown water

Benefits of Dehumidification:

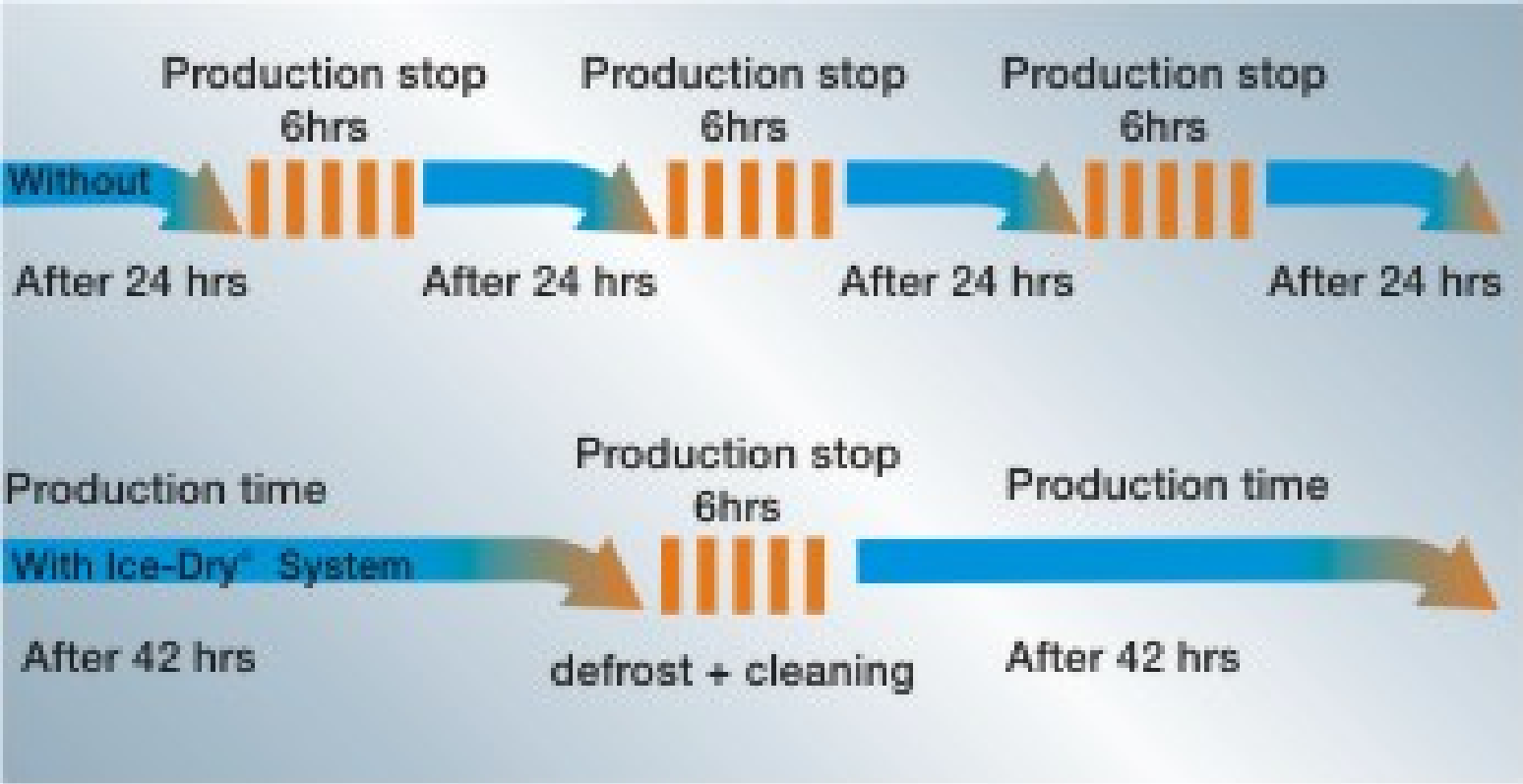
- Increase production capacity
- Less stoppages due to defrosts and cleaning
- Constant product quality
- Reduced cleaning labor
- Reduced high investments to increase freezer capacity
- Fast payback
- Energy savings through quicker cooling after washdown



Proposed Desiccant Solution



Langanese-Iglo





Winn-Dixie Super Brands Ice Cream Plant

Problem: Electronic Sensors In Carousel Freezer
Coating With Ice Requires Manual
Cleaning Every Two Hours
Freezer Maintained at -35°F

Solution: Dehumidify Ante-Room Surrounding The
Carousel Freezer With Dry Air

Force All Air Being Drawn Into The
Freezer To Be Dehumidified.

Winn-Dixie Super Brands Ice Cream Plant

Before Installation of Dehumidifier



Winn-Dixie Super Brands Ice Cream Plant

After Installation of Dehumidifier



Summary

- Desiccant dehumidification reduces or eliminates moisture problem in PRW's and food processing areas
- Evaluate benefits of controlling 3 phases of moisture:
 - Vapor – fog, mist. Eliminating fog will improve visibility, increase worker safety, and raise productivity.
 - Liquid – water, condensation. Eliminating condensation will maintain dry floors (improve worker safety and productivity), dry packaging materials (enhance product quality and shelf life), and prevent product adulteration (improve food safety and reduce scrap). Dry coils will also pay efficiency dividends.
 - Solid – ice. Reducing / eliminating ice will extend time between defrost cycles (saving energy and increasing productivity), reduce maintenance costs, and improve worker safety.
- Very quick pay back
- Easy to install without added cost
- Power consumption typically less than other solutions





THANKS

questions?

- Questions?

What's your application?

Would you like more information?

Thank you!

Did you learn anything?

Any questions?

Thank you for your attention

Can you spell desiccant?