Temperature and Humidity Control in Surgery Suites

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Topics We'll Cover …

- **Review design criteria, discuss actual requirements, impact on hospital**
- **Impact of temperature *and* humidity on HVAC system design**
- **System solution alternatives (and impact on *energy* cost)**

temperature and humidity control

Why Important?

Quality = Patient Outcomes

Efficiency = Costs & Utilization

temperature and humidity control

Why Important?

- **Patient Satisfaction** **(Quality)**
- **Occupant Comfort** **(Quality, Efficiency)**
- **Case / O.R. Turnover** **(Efficiency)**
- **Infection Control** **(Quality, Efficiency)**

temperature and humidity control

Code Requirements

	surgery room conditions				
	dry bulb °F	relative humidity %	room air changes	outdoor air changes	% outdoor air
IDPH	68-73	30-60	12	-	-
ASHRAE*	68-75	30-60	20	4	20
AIA	68-73	30-60	15	3	20
VA	62-80	45-55	15	15	100

**Based on ASHRAE Standard 170 for public review*

temperature and humidity control

Yeah, but…..

What Temperature??

Room Temperature

or

"Patient" Temperature

temperature and humidity control

"Patient" Temperature

- **Ideal body temperature?**
  - Depends on surgical case
  - Normothermia encourages blood/oxygen delivery to the wound
  - Normothermia is defined as maintaining a "normal" body temperature
    - $36°C \leq T_{body} \leq 37.5°C$
    - $96.8°F \leq T_{body} \leq 99.5°F$

temperature and humidity control

"Patient" Temp *(Cont…)*

- **Other issues contributing to control of body temp**
  - Administration of cool fluids (irrigation, IV's, etc.)
  - Internal redistribution of body heat; limited by anesthesia (vasoconstriction)
- **Infection Control makes this important**
  - Declining Reimbursements
  - Reporting of Patient Outcomes

temperature and humidity control

"Patient" Temp *(Cont…)*

- **Maintaining Normothermia**
  - Control room temperature (T-stat)
  - Control body temperature
    - Perioperative warming (most important)
    - Airflow blankets
    - Localized heat therapy
    - Blood warmers
- **Clinical issue that requires our input**

temperature and humidity control

Patient Preferences

- **Positive Outcome!**
- **Comfort**

temperature and humidity control

User Preferences

- **Users Defined = Surgeons, Nurses**
- **Cool, Dry Climate**
- **Why?**
  - Comfort
  - Avoid fatigue and loss of focus
  - Infection Control
  - Positive impact on surgery outcome
    - Bleed Rates (Heart), Drying of Adhesives (Ortho)

temperature and humidity control

Hospital Preferences

- **Surgery is typically #1 revenue generator**
- **Surgeons are hard to recruit/retain**
- **Dry climate increases the efficiency of O.R.'s**
- **Increased Focus on Infection Control**
  - Reporting HAI's
  - Declining Reimbursements
    - CMS-1533-P
    - http://www.cms.hhs.gov/AcuteInpatientPPS/downloads/CMS-1533-P.pdf

temperature and humidity control

Summary of Issues

- **Surgery suites are advanced microclimates that require attention to control properly**
- **Environment of surgery suite directly impacts your hospital's business results (CFaO!)**
- **Consider all stakeholders**
- **Typically, looking for cool and dry – and looking to do it with minimal increase in energy cost**

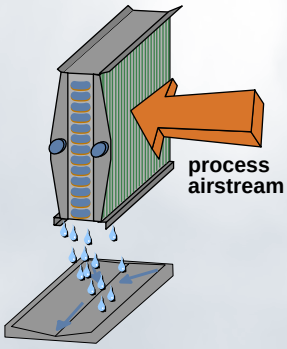
Topics We'll Cover…

- **Why temperature and humidity control is important**
- **"Cold coil" versus desiccant dehumidification processes**
- **System Options for Surgery Suite Control**
  - Cool-and-reheat ("cold coil")
  - Heat-activated desiccant wheel
  - Passive series desiccant wheel

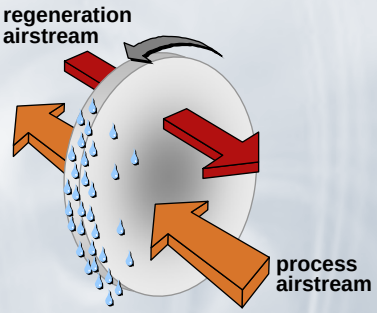
Why do we need to Dehumidification

- Infection Control
- Doctor Comfort
- Meet Codes
- Operating Room Efficiency

Dehumidification Processes



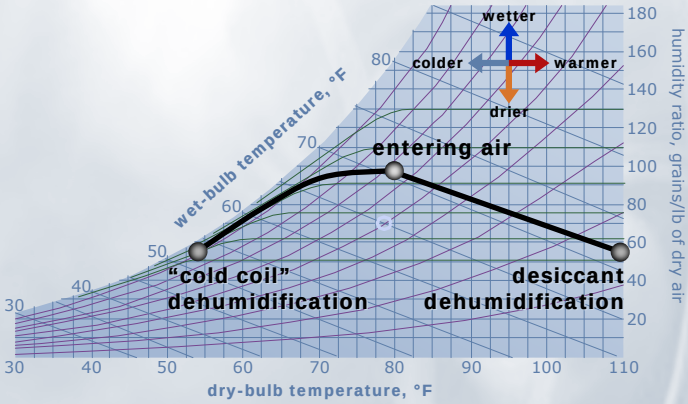
"cold coil" dehumidification (condensation)



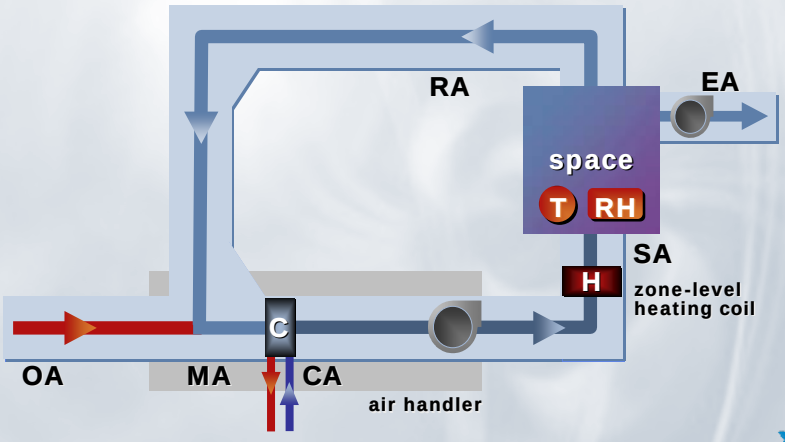
desiccant dehumidification (adsorption)

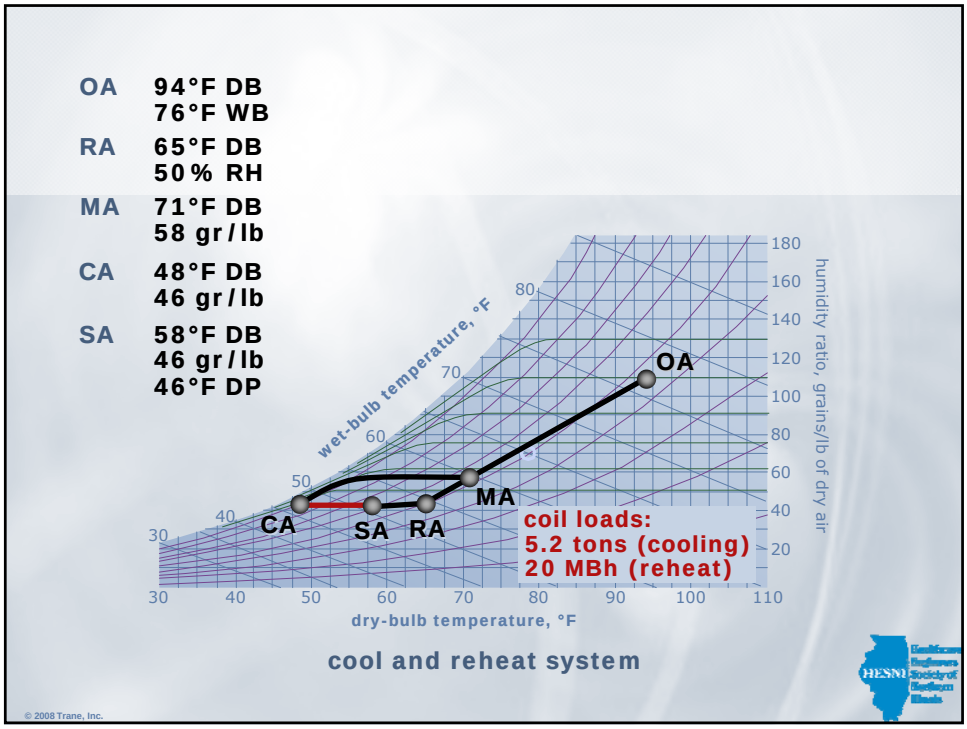
dehumidification processes

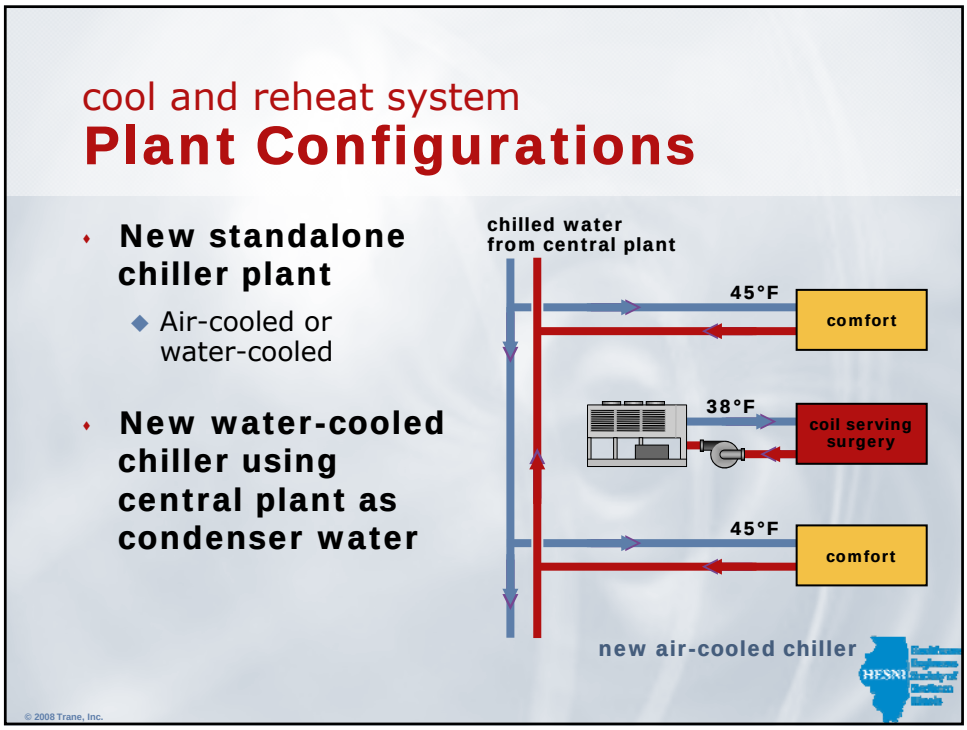
"Cold Coil" vs. Desiccant



Cool and Reheat System

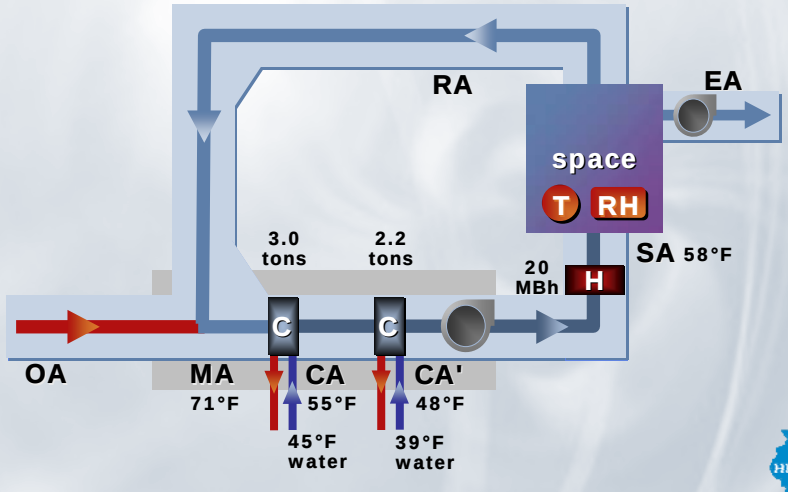






cool and reheat system

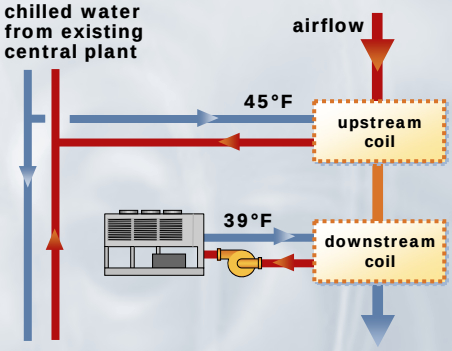
Two Coils in Series



two coils in series

Plant Configurations

- **New standalone chiller plant serving downstream coil**
  - Existing central plant serving upstream coil
- **New water-cooled chiller using central plant as condenser water**



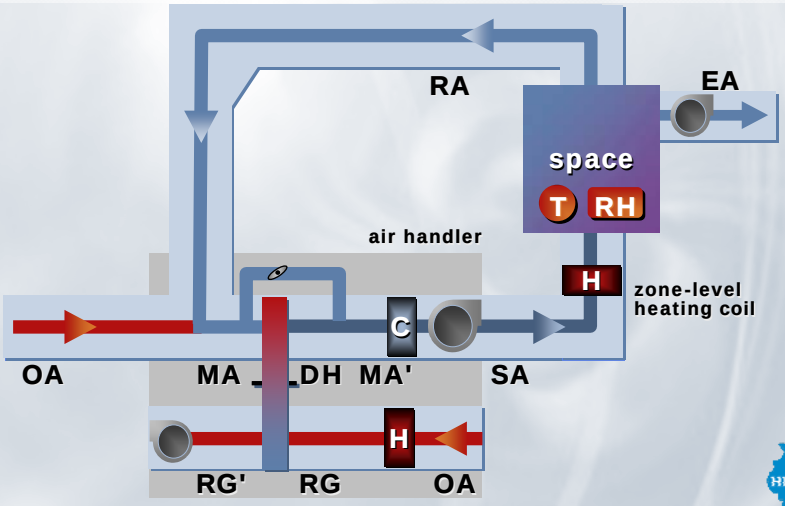
surgery room example

Cool and Reheat Systems

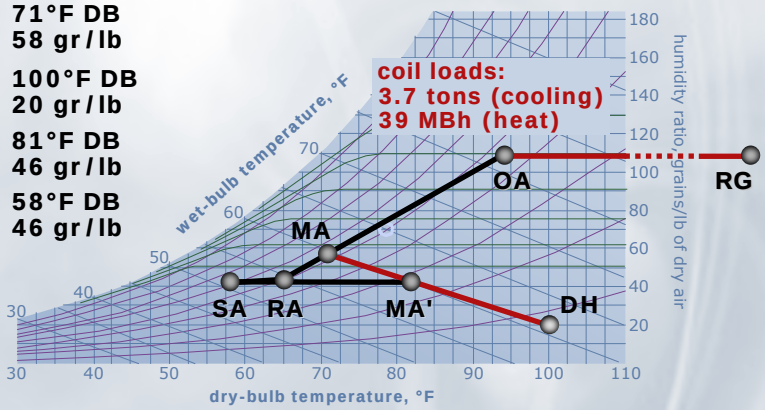
- **Requires new chiller to provide water cold enough for dehumidification**
  - Temperature leaving coil = 48°F
- **Alternative: Two coils in series**
  - Uses smaller new chiller to serve downstream coil (leaving-air temperature = 48°F)
  - Uses existing central plant to serve upstream coil (leaving-air temperature = 55°F)
- **Both require reheat at design conditions**
  - Consider options for heat recovery

conventional

Heat-Activated Desiccant



OA	94°F DB 76°F WB
RG	200°F DB
RA	65°F DB 50% RH
MA	71°F DB 58 gr/lb
DH	100°F DB 20 gr/lb
MA'	81°F DB 46 gr/lb
SA	58°F DB 46 gr/lb



heat-activated desiccant system

surgery suite example

Heat-Activated Desiccant

- **Existing central plant might be able to provide all cooling capacity**
  - Temperature leaving coil = 58°F
- **Requires high-temperature heat to regenerate desiccant**
  - High temperature often makes heat recovery unlikely
- **Requires a separate regeneration airstream**

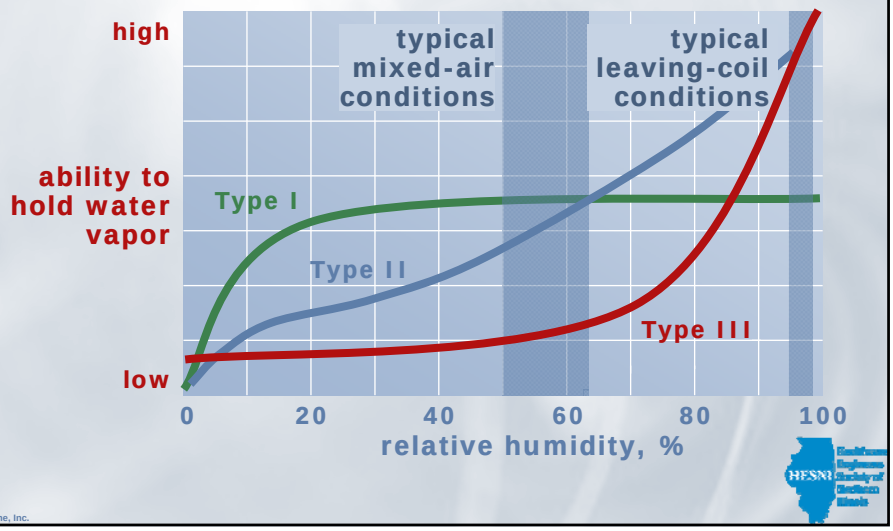
recent advances in desiccants

The Fundamentals

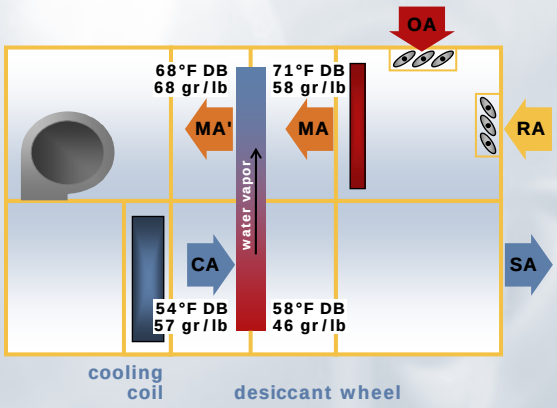
- **Desiccants adsorb more water vapor:**
  - When relative humidity of air is higher
  - When dry-bulb temperature of air is lower
- **Requirement for high-temperature regeneration heat has limited the use of desiccants to applications that require very low SA dew point**

how it works

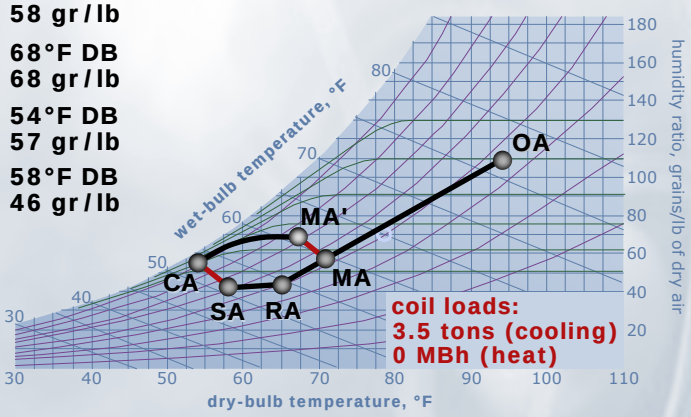
Passive Desiccant Wheel



Passive Series Desiccant Wheel



OA	94°F DB 76°F WB
RA	65°F DB 50% RH
MA	71°F DB 58 gr/lb
MA'	68°F DB 68 gr/lb
CA	54°F DB 57 gr/lb
SA	58°F DB 46 gr/lb



Passive Desiccant System

system alternatives

Comparison (Design Load)

	space RH	cooling tons	lvg coil °F	heating MBh
cool & reheat (1 coil)	50%	5.2	48	20
cool & reheat (2 coils)	50%	5.2		20
upstream coil		3.0	55	
downstream coil		2.2	48	
heat-activated desiccant	50%	3.7	58	39
Passive desiccant system	50%	3.5	54	0

Passive Desiccant
- less cooling tons
- no reheat
- warmer coil temp

... than cool & reheat

surgery suites

Passive Desiccant System

- **Existing central plant might be able to provide all cooling capacity**
  - No new chiller required
  - No glycol
  - No separate water distribution
- **...or may be able to use traditional direct-expansion (DX) equipment**
- **No heat required at design conditions**
  - May use reheat (or low-temperature preheat) at some part-load conditions

Farmington, Maine

Franklin Memorial Hospital

New hospital surgical wing

"It's refreshing and rewarding to get the testimonials from the doctors. I've talked to perhaps ten of the OR doctors who have stopped me in the halls to say they love the new system because it keeps them so comfortable."

Don Garrison,
chief of facility management

Passive Desiccant System

Requirements

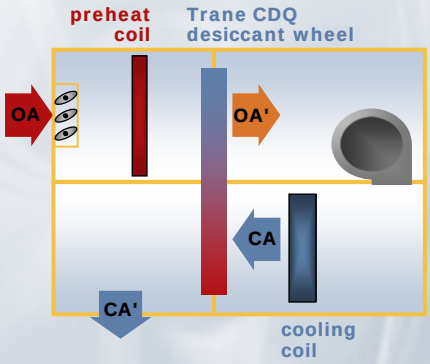
- 35°F to 45°F SA dew point
- Cold (not warm) SA dry bulb
- 35% to 55% space RH
- High air changes/hr

Ideal applications

- Laboratories
- Hospitals
  - Operating rooms
  - Pharmacies
  - Laboratories
- Dry storage
  - Rare books
  - Archives, warehouses
- Museums
- Humidity-sensitive comfort applications

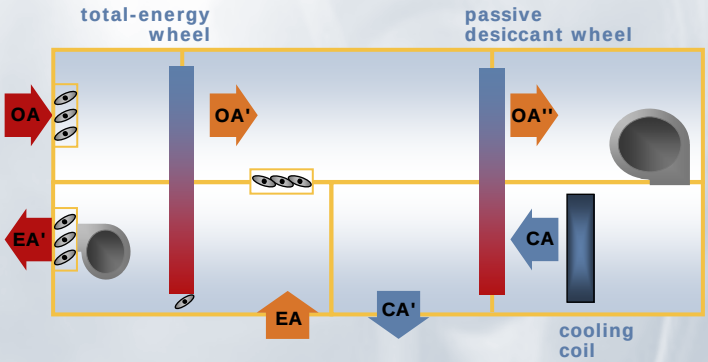
other applications

Dedicated OA Unit -PDS

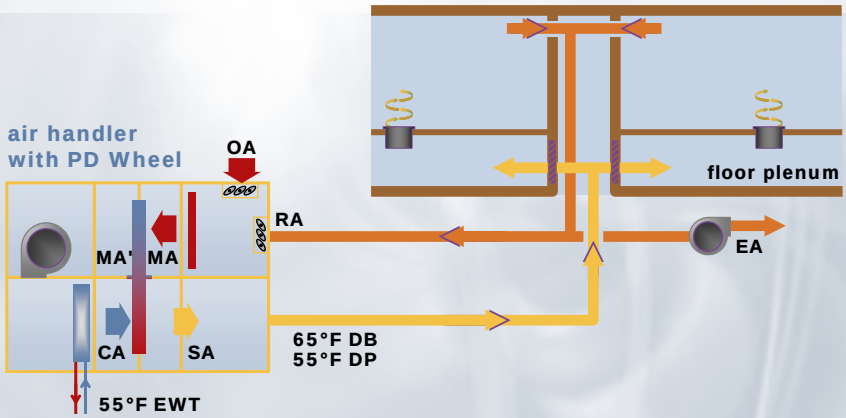


other applications

Dedicated OA Unit-PDS & ERW



Underfloor Air Distribution



Needs 65°F air … but dry

Summary

- **Passive Desiccant Systems have the following advantages over a Cool & Reheat System and over a Heat Reactivated Desiccant Systems:**
  - Uses less energy.
  - Eliminates the need for a separate low temperature glycol system or an outdoor air reactivation system with a high temperature heat source.
  - Does not require additional utilities except for a fractional horsepower motor to rotate the passive desiccant wheel.
- **PDS is <u>not</u> an energy recovery system - there is only one air stream – Cross contamination is not as issue.**

Questions?