Operating Room Relative Humidity Control using Liquid Desiccant Dehumidification

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Albany Medical Center Case Study
Operating room conditions

Design criteria

68°F – 75°F, 20 - 60% RH (ASHRAE 170)

Latent load = 12,143 Btu/Hr
3,559 Watts
ASHRAE 170
Design criteria
68°F – 75°F (20°C – 23.9°C)
20 - 60% RH
Latent load = 2,720 Btu/Hr per OR
20 Operating rooms
20 x 2,720 Btu/Hr = 54,400 Btu/Hr

20 x 3,570 CFM/Room = ~71,400 CFM
54,400 Btu/Hr / 80,000 CFM / 0.68
Δ Gr/lb = 1
Methods of Dehumidification

AIR TEMPERATURE, °F

AIR HUMIDITY, GRAINS / LB.

REFRIGERATION

LIQUID DESICCANT

DRY DESICCANT

PROCESS

PLANT AIR

CHES National Conference
St. John’s NL
September 16-18, 2018
Subcool & reheat dehumidifier
Conventional AHU

Outside air
33,600 CFM
(S) 90°F, 118 gr/lb

80,000 CFM
(S) 74°F, 81 gr/lb

Two (2) Existing AHUs

44°F Chilled water
323 Tons

180°F HW
438 Kbtu/Hr

80,000 CFM
55°F, 52.5 gr/lb

20 Operating Rooms
63°F, 63% RH
54 gr/lb
Conventional AHU

Outside air
33,600 CFM
(S) 90°F, 118 gr/lb

80,000 CFM
(S) 74°F, 70 gr/lb

Two (2) Existing AHUs

426 Tons
180°F HW
1,395 Kbtu/Hr

35°F Glycol

Cooling to:
39°F (3.9°C)
34 gr/lb

80,000 CFM
55°F, 34 gr/lb

46,400 CFM
63°F, 35 gr/lb

20 Operating Rooms

63°F, 40% RH
35 gr/lb
Conventional AHU

Advantages

• Usually lowest first cost
• Practical down to \( \approx 45^\circ F \) dew point
• Operating costs most beneficial with minimal reheat

Disadvantages

• Least efficient way to dehumidify when below 45°F dew point
• High operating cost
• Limited ability to extend performance
• Breeding ground for microorganisms
Liquid desiccant system schematic
Liquid desiccant system schematic

Conditioner

Regenerator

Desiccant solution transfer
Integrating a Liquid desiccant system
Energy Savings

• Electric savings
  o 1,151,906 Kw-Hr

• Eliminates reheat energy

• Natural gas savings
  o 19,306 Therms / year

• Energy incentive
  o $241,866 USD
  o Payback less than 2 years
Mechanical Room Installation
Outside air connection point
Mechanical Room Installation
CHES National Conference
St. John’s NL
September 16-18, 2018

Mechanical Room Installation
Mechanical Room Installation
Albany Medical Center

2nd Surgical Suite Retrofit
AHU Installation

- Outside air inlet
- Regenerator located in mechanical room
- Piping vestibule

CHES National Conference
St. John’s NL
September 16-18, 2018
Inside the AHU

Conditioner
Conditioner Heat exchanger
Pump tank
Conditioner
Theoretical Full Airflow Design Approach
Full Airflow Installation

Outside air
10,200 m³/hr
6,000 CFM
81°F, 122 grains/lb
27°C, 17 grams/kg

42,500 m³/hr
25,000 CFM

48°F (8.9°C) Chilled water
(S) 62 Tons
218 KW

52°F, 56 grains/lb
11°C, 8 grams/kg

42,500 m³/hr
25,000 CFM

Liquid Desiccant Conditioner

63°F, 40.9 grains/lb
17°C, 5.8 grams/kg

160°F (71°C) Hot water
(S) 441 KByte/hr
129 KW

Heater

Exhaust

Final Filter

32,300 m³/hr
19,000 CFM

68°F, 45.9 grains/lb
20°C, 6.6 grams/kg

(Summer)
Seven (7) OR’s
68°F (20°C), 45% RH
45.9 grains/lb
(6.6 grams/kg)
Benefits of using a liquid desiccant system

- Economical system to operate
- 100% modulation of heat and coolant
- Cooling and dehumidification regardless of inlet conditions
- Precise humidity control +/- 1% RH
- Humidification
- Desiccant is an effective biocide scrubbing the air of bacteria and viruses
Hospital acquired infection (HAI) linked to HVAC

HAI and HVAC

- ASHRAE/ASHE/CHES recognize HVAC as possible source for microbial contamination
  - Moist surfaces promote growth of biofilms that are reservoirs for pathogens
  - Contaminated HVAC system operates as an aerosol generator of viable microbial matter
  - Environmental microbial contamination impacts patient outcomes
### Women and Children’s Hospital of Buffalo study

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<th>Microorganism</th>
<th>Remote HVAC</th>
<th>Ceiling Diffusers</th>
<th>Linen Hamper</th>
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Testing of Pathogens associated with HAI

September 2013- March 2014

• State University of New York at Buffalo- in vitro testing - complete destruction of pathogens in LiCl solution

  • *Pseudomonas aeruginosa*
    Causes pneumonia, blood infections and urinary tract infections

  • *Klebsiella pneumoniae*
    Causes pneumonia, urinary tract infections and diarrhea

  • *Acinetobacter*
    Causes pneumonia, skin and wound infections and urinary tract infections

  • *Staphylococcus aureus*
    Causes surgical site infections and bloodline infections

  • *Serratia marcescens*
    Causes urinary tract and respiratory infections

  • *Streptococcus pneumoniae*
    Causes pneumonia, meningitis and bloodline infections
Liquid desiccant technology

- Able to meet demanding OR environment for low temperature and humidity control (+/- 1%) per ASHRAE Std. 170 (20-60% RH)

- Germicidal treatment of supply air for critical environments

- Desiccant solution extremely germicidal to pathogens associated with HAI
Aerosol efficacy testing

ASHRAE 52.2 Standardized Air Test Duct

- Analytical capability to determine efficacy of liquid desiccant technology on pathogens associated with HAI
Conclusion

• Precise humidity control (20 to 60% RH +/- 1% RH)
• Energy efficient
• New construction and retrofit installations
• Germicidal to pathogens associated with HAI

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