Midwest Healthcare Engineering Conference

Healthcare Ventilation Basics

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Ventilation

- **Facilities Guidelines Institute (FGI) for Design and Construction of Healthcare Facilities references ASHRAE 170 for ventilation.**
- **ASHRAE** – American Society of Heating, Refrigerating and Air-Conditioning Engineers
- **ASHRAE 170** – Year of the standard to be applied to testing is based on year built or designed of the system being evaluated.
- Purposes of applied standard to room types in a hospital vary based on intended use

Ventilation

- <u>Infection Prevention</u> – Positive Pressure Isolation rooms, OR, Procedure Suites, Cath Lab, Negative Pressure Isolation Rooms

- <u>Sterility</u> – Sterile Processing, Sterile Storage, Clean Utility, Sterile Compounding Pharmacies

- <u>Vapor/Hazardous Material Containment</u> – Laboratories, Decontamination, Soiled Utility, Scope Cleaning, Radiation Block Rooms, Etc.

Ventilation

- Differences in the ASHRAE 170 standard from year to year – new ventilation report
- 1987
- 1992-93
- 1996-97
- 2001
- 2006
- 2008
- 2013
- 2017
- 2021

Air Filtration

- Pre vs. final filters (MERV ratings)
- What is a HEPA filter?

Air Filtration

- **What Is MERV?**
  MERV stands for Minimum Efficiency Reporting Value. Or in English, "how effective is your air filter?" MERV ratings range from 1-16. The higher the MERV rating on a filter, the fewer dust particles and other contaminants can pass through it. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) designed the MERV scale to represent a filter's worst possible performance at removing particles .3 to 10 microns in size (that's really small!).
- Some of the common particles that filters are tested for include pollen, dust mites, textile and carpet fibers, mold spores, dust, pet dander, bacteria and tobacco smoke. Most residential systems can adequately remove airborne contaminants with a filter rated MERV 7-12. MERV 13-16 is typically found in hospital and general surgery settings.

HEPA Filters

- HEPA
- High Efficiency Particulate Air Filter
  - An extended medium dry type filter in a rigid frame when tested at rated airflow having a minimum particle collection efficiency of 99.97% for 0.3-micron size particles or larger.
  - HEPA filters do not filter out gases and vapors, they only filter out particles and aerosols
  - Used in OR’s, clean rooms, Bio safety cabinets, pharmacies

Ventilation

- Equipment to perform testing:

- Flow Hood- CFM
- Differential Pressure Meters – Inches w.c.
- Hot Wire/Rotating Vane- Velocity FPM
- Tape measure – Room Volume in cubic Feet

Ventilation

- Air Exchange Rates (Multiple ways to get there)
  - Continuity Equation
    - Q = V x A
    - Q - volumetric flow rate (Flow Hood)
    - V - Average Velocity (Hot Wire)
    - A – Cross Sectional Area where velocity is measured (square feet)

Ventilation

- Question:

  What is the flow rate (Q) through a diffuser with a face velocity of 500 fpm and a face opening of 2 ft. by 2 ft. ?

  Answer: 500 fpm x 4 sq ft = 2000 cfm

Ventilation

- Pressure
  - Unit of measure in our industry: inches of water column
  - Force/Area (Force exerted by a column of water over its cross-sectional area)

Ventilation

- Velocity Pressure (pitot tube)
    - Kinetic Energy (energy of movement)
    - Results of acceleration of air
    - Exerted by a Fluid (air) in motion
    - Exerted in the direction of flow

Ventilation

- Relationship between V & VP

  $V = 4005 \sqrt{VP}$ (in H_2O)

  - V – Velocity
  - VP – Velocity pressure (pitot tube traverse)

Air balancer Comparison Problem

Flow hood/Hotwire

What is the flow rate (Q) through a duct with an average velocity of 500 fpm and duct size of 2 ft. by 2 ft. ?

Answer: 500 fpm x 4 sq ft = 2000 cfm

Direct reading from diffuser with flow hood- 2000 cfm

Pitot Tube (Air Balancer)

- What is the flow rate (Q) through a duct with an average duct velocity pressure of .015 in. H2O and a duct size of 2 ft. by 2 ft.?

Answer: $V = 4005 \sqrt{.015}$

$V = 491$ fpm

491 fpm x 4 sq ft = 1964 cfm

Ventilation

Calculating and Air Change Rate:

ACPH = Supply/Exhaust (Cfm) x 60 / Room Volume(cubic feet)

Ventilation

- Calculating Minimum Supply or exhaust CFM values –
- CFM (x) x 60 /Volume = ASHRAE ACH min.

Ventilation

- Example: What is the minimum exhaust CFM required for a negative isolation room built in 2006 at a size of 1900 cubic feet?

- CFM x 60/1900 = 12.0 ACPH
- CFM = 12.0 x 1900/60
- CFM = 380 from exhaust

Exhaust vs. Return

- Exhaust –Airflow that is completely removed from the facility that could contain hazardous materials
(Labs, Negative ISO Rooms, Decontamination, Morgue)

- Return –Airflow that is returned back into the system, mixed with outside air, filtered and recirculated back into the system. (patient rooms, OR's, Sterile clean areas, etc.)

Ventilation

- Offset – difference between the total supply and the total exhaust/return in a room.
- Why is this important?
  - Direct relationship to pressure differential
  - Too negative – increase supply/decrease exhaust
  - Too positive – decrease supply/increase exhaust

Ventilation

- **Pressure Differentials-**

- Isolation rooms/Morgue/Bronchoscopy suites
  - Min -0.01 inches w.c.

- OR’s/Positive Isolation
  - Min +0.01 inches w.c.

Ventilation

- Local Exhaust Ventilation
  - Primary engineering controls (Labs)
    - Chemical Fume Hoods (Histology/General Labs)
    - Grossing Stations (Histology/Pathology/Frozen Section)
    - Biological Safety Cabinets (microbiology Labs)
      - Type II – A2 – recirculating
      - Type II – B2 – total exhaust

Ventilation

- When calculating air changes per hour in lab settings the local exhaust must be included in the total exhaust cfm value
- 1) measure general room supply/exhaust (flow hood – cfm)
- 2) measure local exhaust ventilation (anemometer –fpm)

Ventilation

- Example: Grossing station effective area of 70 inches x 6 inches, average face velocity of 90 fpm (6 measurements), what is the total cfm of this primary engineering control?
  - 70 x 6 = 420 sq inches/ 144 = 2.9 sq ft
  - Q = V x A (Q = 90 x 2.9)
    - Q = 261 cfm

Ventilation

- Recommendations on Correcting Deficiencies:
  - Reduced Supply/Exhaust Airflow Possible Causes:
    - Multiple Rooms
      - Supply/Exhaust fan down, fire damper, loaded filters in filter bank (increase of static pressure)
    - Single Room
      - Damper positioning, loaded filters (increase of static pressure)

  - Reduced Pressure Differentials
    - Supply/Exhaust Offset
    - Reduced supply/exhaust cfm values