



VAV and Low Flow: Which Strategies Save More?

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Speaker Biography

- Victor Neuman, PE, MSME
- Co-Author ANSI/AIHA Z9.5, "Lab Ventilation"
- Precision Environments Group of TAC is a nationwide design/build general contractor for remodeling labs and cleanroom, and part of a Fortune 500 Company.



Presentation

- Overview - Safety and Energy Use
- Advanced Low Flow Fume Hoods
- Variable Volume Fume Hood Controls
- Fume Hood Sash Closers
- Active Chemical Monitoring in Labs
- Snorkels, Chilled Beam & VAV Exhaust



Safety Is our First Concern

- Energy and the Environment were my first priorities when I became a lab designer in 1983. Safety of building occupants became my first concern with sustainability % energy reduction second.
- What if we don't do it right?
Widow of lab worker at Firestone of Texas receives \$11 million in 1990.
- Engineering firm goes broke when multiple 5,000 cfm fume exhaust fans, 7' tall they designed blow toxic chemical vapors back into University Health and Safety Lab. Stack raised to 40' above roof.



Example One of Costs and Savings

- Base Case: 50 hoods at 1200 cfm each, \$3/cfm per year = \$180,000 per yr. total
- (\$3/cfm about half nationwide average)
- Low Flow Hoods: 50 hoods at 720 cfm each at \$3/cfm per year = \$108,000. Payback: 1.25 yrs
- VAV hoods: 1200 cfm for 50 hoods for 1000 hours per yr., 600 cfm for 1000 hrs/yr, 300 cfm for 6,760 hours /yr = \$67,000 per year. Payback: 2.65 years



Example Two of Costs and Savings

- Tal Rabiah of University of Michigan studied how often fume hoods are used in September 2003.
- Per 8 hour work day, hood usage averaged 2.6 hours per day Monday-Friday



Example Three of Costs and Savings

- Using the Michigan average hood usage of 2.6 hours per day and other assumptions from Example One, a sash closing system would use about \$55,000 in energy per year for a 50 hood building.
- Adding hood occupancy sensors to Example One would save nothing additional because the users are keeping the sashes closed. However, even if sashes were never closed VAV & occupancy sensors would reduce CV cost/yr. of \$180,000 to \$114,000 per yr.



Example Four of Costs and Savings

- Vulcan Lab in Design, Perkins + Will Architects
- Stantec, Mechanical Engineers
- 215,000 SF of labs and Vivariums
- Using Aircurity Technology
- Minimum ventilation in labs changed from 8 ACH fixed to between 4 – 16 ACH
- Vivariums changed from 15 ACH to 8 to 16.
- \$250,000 per year utility savings
- Lower installed cost by \$1,025,000
- (No payback needed. Lower first costs)

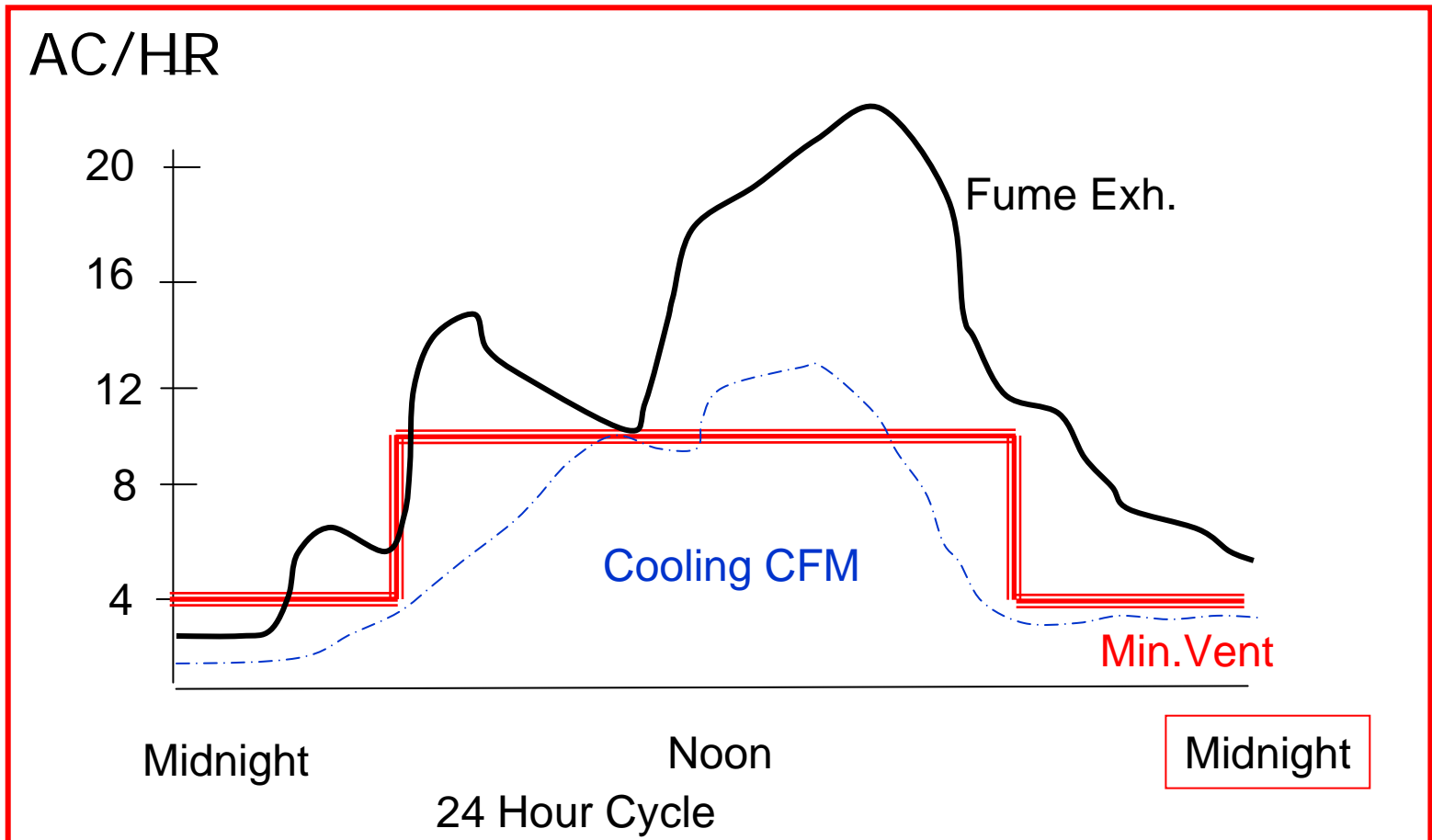


Three Part Curve of Lab Airflow

- Underlying curve, minimum outside airflow for health. May be expressed as 4 air changes per hour of outside air, 20 cfm per person of outside air or similar.
 - Airflow curve that drives design is usually either max airflow for cooling or max airflow for fume hood exhaust.
 - As fume hoods become more advanced, the cooling curve will come to dominate.



The Three Curves of Lab Airflow





For Energy Conservation in a Fume Hood Dominated Lab

- Reduce number of fume hoods, their width, and or their sash opening dimensions Design for easy removal and additions
- Use variable air volume
- Reduce hood face velocity
- Increase diversity

Advanced Low Flow Fume Hoods

- Designs less than 5 years old
- Safe at face velocities of 60 feet per minute
- Advanced Testing
 - ASHRAE 110
 - LBNL Human as Mannikin





Hood Choices- Fisher Hamilton Pioneer

Labconco XStream

- Esco Hood
- Kewaunee, Mott, Labcrafters, HOPEC, AccuAire, and more to come





Advanced Low Flow Hoods

- First cost is higher than standard hoods
 - HVAC costs usually lower leading to lower first installed costs
- Most advanced designs are deeper, taking up more laboratory floor space.
- Most new designs are safer at 60 feet per minute than older hoods at 100 feet per minute
- Can't operate below 100 fpm in California (except unoccupied).



Why Use the New Hoods?

- They are probably safer.
- For this reason, use them if you have just one fume hood or hundreds in your building.
- Definitely use ASHRAE 110 test when installed and periodically after that.
- Consider using LBNL developed human-as-mannikin test to choose fume hood mfr.



Cost Savings for Low Flow Hoods

<u>City</u>	<u>\$/CFM</u>	<u>Savings/yr</u>
• New York City (100 fpm vs. 60 fpm)	\$ 5.11	\$2,550
• San Diego	\$ 4.10	\$2,048
• Chicago	\$ 4.41	\$2,203
• Miami	\$ 5.06	\$2,527
• Seattle	\$ 2.82	\$1,410
• * http://fumehoodcalculator.lbl.gov		



VAV control systems For Hoods

- No way to ensure adequate safety in chemistry and biology labs without room pressure control and safety monitoring.
- “Old” constant volume design was uncontrolled and unmonitored. Cheap and nasty alternative that gives false sense of security.
- With proper VAV, can add/delete hoods.
- In some cases, VAV with diversity will be lower in first cost than constant volume.



Designing with Airflow Diversity

- For a 50 hood building, you may be able to reduce total airflow in the building by 25% or more by designing with diversity.
- Diversity can possibly pay for all the costs of the VAV controls on the fume hoods.
- This is an advanced design capability and should be left for design teams specializing in laboratory buildings.



Minimum fume hood air volumes

- NFPA 45 calls for all fume hoods to have a minimum air volume of 25 cfm per square feet of spill area (bench top).
- This reduces hood corrosion and lowers expected flammability conditions from chemical spills below the 25% of Lower Flammability Limit.
- This applies to ALL Chemical Fume Hoods.



Fume Hood Sash Closers

- Achilles heel of VAV fume hood controls is users who leave sashes open all the time.
- “Shut The Sash” Campaign at Harvard has achieved good results with operator training \$280,000 per year additional savings.
- Occupancy sensors are one possible solution.
- The other technology is hood sash closers.
- Sash closers should be safer than occupancy sensors. Princeton University is currently installing some of these.



Active Chemical Monitoring

- A new technology by Aircuity of active chemical monitoring is bringing scientific analysis into the operation of lab buildings.
- Effects of vapors from about 90% of common laboratory chemicals are sensed every few minutes and the minimum exhaust rates raised accordingly.
- Basic strategy is to lower minimum ventilation from 10 to 6 ACH with possibilities to purge at 16 ACH.



Combinaton Designs

- All of these options are combinable.
- It is possible to have variable volume hoods with occupancy sensors, sash closers, active chemical monitoring and advanced low flow fume hoods.
- Certainly, All of the above would be overkill but 2 or 3 together would have good synergy.



Snorkels

- Snorkels to be at all effective need to be 4-6" from contaminant.
- Since snorkels are rarely this close, it would be better to eliminate most snorkels except for Atomic Absorption and other specific cases.
- Gives false sense of security and are energy wasters.



Chilled Beam and Chilled Water

- Labs often have high exhaust airflow rooms with many fume hoods while other rooms have high heat loads like ovens.
- Running chilled water piping throughout the lab building so as to use chilled beams or similar techniques in high heat load rooms can reduce reheat and increase energy efficiency.



Variable Volume Exhaust Stacks

- Too many fume hood exhaust stacks aren't tall enough, or lack velocity or volume.
- However, this applies to high wind conditions.
- With weather station and wind tunnel analysis, chemical fume hood exhaust fans can be variable volume.

Lower Volumes of Exhaust May Cause Re-Entry of Fumes



Even when the hazard is down wind, the chemicals can still spread to the intakes.



Wind Tunnel Consultants

- RWDI, www.rwidi.com/ddc
- Ddc is a free downloadable tool to check if your chemical exhaust fans are safe.

in Guelph, Ontario.

Principal: Glenn Schuyler, P.Eng.

- Cermak Peterka Petersen
- www.cppwind.com
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Lab Design Guidelines

- REFERENCES:
- Lab Design Newsletter/ R& D Magazine
- ANSI/AIHA Z9.5 "Lab Ventilation"
- ASHRAE 110 Fume Hood Test Standard
- US National Research Council, "Prudent Practices for Handling Chemicals"
- US OSHA 29 CFR 1910.1450:
Occupational Exposures to Hazardous
Chemicals in Laboratories
- NFPA 45: Fire Protection for Labs Using
Chemicals
- Labs for the 21st Century Publications



Questions and Discussion?

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