# **Assessing Laboratory Ventilation Effectiveness**

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# **Learning Objectives**

- 1) Understand the Chemical Hygiene perspective on Laboratory Ventilation
- 2) Describe the importance of "Ventilation Effectiveness" and 2 ways to assess it
- 3) Review a case study to answer questions about a specific laboratory



## Lab Ventilation as an Chemical Hygiene Tool

The goal of general laboratory ventilation is to control:

- 1. Temperature
- 2. Fire Hazard
- 3. Odor
- 4. Toxicity
- 5. Humidity (sometimes)
- 6. Dust (sometimes)



# Elements and Functions of the Lab Ventilation System

- Fume Hoods: contain a chemical process
- Chemical Storage Cabinets: chemicals in storage
- General Laboratory Ventilation: delivers and removes air to spaces occupied by humans







### **The Macroscale Ventilation System**



Macroscale chemical hygiene issues include pressurization between spaces and ventilation diversity (both hood and lab space)

### **The Microscale Ventilation System**



Microscale chemical hygiene parameters include fume hood face velocity and containment assessment

## **The Mesoscale Ventilation System**



Mesoscale chemical hygiene issues include how ventilation rate (ACH) and how effectively the room is ventilated.

#### **The Importance of Ventilation Effectiveness**

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Time (minutes)

 Ventilation controls chemical contaminants by promoting exponential decay of the concentration of those contaminants

10

 The decay rate for a specific chemical **Exponential Decay vs Linear Decay** release depends 100 source relative to 90 this impacts the entration One measureme 60 general ventilatio place in the lab o % of I 30 lab. 20

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### Assessing Ventilation Effectiveness: CFD modelling

- Computational Fluid Dynamic models: about \$10,000/lab, usually used for new labs, where there is a project budget and easily available room dimensions to work with.
- 2. Usually assess a release in the form of a spill to assess magnitude of concentrations in dead spots..



### Assessing Ventilation Effectiveness: Another Approach

1. Use fire extinguishers to measure gas decay patterns within an existing laboratory by raising  $CO_2$  concentrations across the lab to 10,000 and then measure its decay in different locations.

> A BSL 3 lab, where decay is measured by eyeballing a smoke generator



# **Safety Considerations**



Organic class lab, about 40 ACH

#### **For People**

- Electrostatic discharge: put the extinguisher on the floor
- CO<sub>2</sub> exposure: size the extinguisher to the room
- Ergonomics: use carts to move the extinguishers
- **Noise:** wear hearing protection
- Eye protection: dry ice flies everywhere

#### For lab equipment and computers

• **Dry Ice Spatter:** Cover equipment to prevent dry ice from landing on it

# **Typical Results**

The goal is get an uniform concentration of  $CO_2$  of about 10,000 ppm in the space. This success of this is indicated by the shape of the curve.

Parameters of interest:

- Decay rate (expressed as ACH or half-life)
- r-squared of the decay curve (typically > 0.9)
- Peak CO<sub>2</sub> level suggests how strong the source was



Location of sensor	Southwest	Northwest	Central west		
Number of data points	441	331	397		
Observed ACH	11.82	14.96	13.00	per hour	
r-squared	0.99	0.99	0.97		
Concentration half life	3.52	2.78	3.20	minutes	



# **Guide to Interpreting Test Results**

1. Decay rate  $\approx$  building supplied decay rate: the room was effectively filled with CO<sub>2</sub> and that location was seeing what the building is providing

#### 2. **Decay rate > the building rate:**

the room was not filled, so the decay rate was increased by expansion of the contaminant gas away from the source.

#### 3. **Decay rate < the building rate:**

the monitor was located in a "dead spot" in the room.

This assumes that you have good data about what the building is delivered.



### A Sample Lab Case Study





#### Building Control System (10 ACH)

	North side		S	South side	side		
<b>Run</b> Sash closed	<b>nood</b> 13.04	10.70	וחג 8.52	Near door 2.45	Center Ir 3.90n	<b>isolation</b> o change	
r-squared	0.93	0.96	0.93	0.98	0.99n	o change	
Sash 18" open	22.51	12.34	11.73	68.99	10.88	-	

# **A Case Study**

• Will a new lab control odors from the biomass fermentation process?





#### **Air Movement in the Lab**





#### Building Control System (14 ACH)

	West Side	East Side		
NW	14.09	10.86	NE	
CW	14.22	8.45	Sink	
SW	11.74	9.69	SE	
				-

## **The Results**

- The building system supplies more air than we measure, but there are still more than 10 ACH in the critical areas.
- The sink and eastern walls are less well ventilated than areas along the western walls, where supply air is delivered. Locating the fermentation stands along the western wall is the best location for them.
- Pressurization of the room relative to other rooms is critical to avoid odors spreading.



# **Parting Thoughts**



"Thanks to yoga, I now gently stretch to conclusions instead of jumping to them"



# **Questions?**



- Cornell Lab Safety twitter feed:
  @cornelllabsafe
- ACS Division of Chemical Health and Safety: @acsdchas
- Laboratory Sustainability News: @labsustain







