Principles of Ventilation

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Section A

Introduction
Opportunities for Control

Source: Peter Lees
Purposes of Industrial Ventilation

- Control of toxic air contaminants to acceptable levels
- Control of noxious odors
- Control of heat and humidity for comfort and health
- Prevention of fire and explosions
Types of Industrial Ventilation

- **General ventilation**
  - Control of temperature, humidity, and odors

- **Dilution ventilation**
  - Maintain control of low toxicity gases and vapors below acceptable levels through dilution of concentration

Continued
Types of Industrial Ventilation

- Local exhaust ventilation
  - Capturing and removing contaminants at or near their sources of emission
  - Prevents the transmission of contaminant to worker
  - Given priority in “Hierarchy of Controls”
Section B
Ventilation—Basic Principles
Ventilation Terminology

Adapted from ACJH Manual
Ventilation Terminology

- Capture velocity
  - Air velocity at any point in front of the hood necessary to overcome opposing air currents and to capture the contaminant at that point causing it to flow into the hood
  - Important hood/process design criteria

Continued
Ventilation Terminology

- **Face velocity**
  - Air velocity at the hood or slot opening
  - An important design parameter
  - Surrogate marker of performance (i.e., can be tested)
Ventilation Terminology

- Duct velocity
  - Air velocity through the cross-section of the duct
  - Must be sufficient to prevent gravitational settling of particulate contaminants
  - Important design parameter
  - Can be measured
Basic Ventilation Equation

Q = A*V

Where:
- Q = air flow rate (ft³/min)
- A = cross-sectional area of duct or opening (ft²)
- V = average air velocity (ft/min)

Also referred to as continuity equation
Basic Ventilation Equation

\[ Q = A \times V \]

Example
- If fan is unchanged and number of hoods is doubled, then the resulting hood face velocities will be 1/2 original velocity (possibly reducing air velocity to less-than-needed capture velocity)
Section C

Ventilation—Design and Testing
Hood Proximity and Exhaust Volume

- To maintain desired capture velocity, locate hood as close to source as possible
- Air volume requirement increases as square of the distance
- Reduces required make-up air and associated costs
Hood Proximity and Exhaust Volume

Good Location
1000 cfm needed

Bad Location
4000 cfm needed

Adapted from ACJH Manual
Use of Enclosures

- Using techniques such as enclosures, control capabilities are maximized
- Air volumes requirements are drastically minimized
- Reduces required make-up air and associated costs
Use of Enclosures

Adapted from ACJH Manual
Direction of Air Movement

- Direction of air movement should carry air contaminants away from breathing zone
- Results in reduced worker exposure
- Results in better hood capture performance
Direction of Air Movement

Bad

Good

Adapted from ACJH Manual

Continued
Direction of Air Movement

Adapted from ACJH Manual
Design Velocities

- All ventilation systems are designed to operate most effectively within a given air-flow range
- Usually measured by hood face velocity
  - Laboratory hood = 75–100 ft/min
- Operation at other than design velocities can often have unintended (bad) consequences

Continued
Principles of Supply Air Design

- Supply air volume = exhaust air volume (balanced)
- Avoid interference with exhaust hoods (currents and eddies may compromise exhaust systems)
- Air enter at living zone
Principles of Supply Air Design

- Supply air must be conditioned (temperature and humidity)
- Air entry points located away from source of contaminants to eliminate air currents which could interfere with exhaust
Testing Ventilation Systems

- Ensure it meets design criteria
- Comply with regulatory standards
- Determine system balance
- Determine if maintenance or repair required
- Determine whether existing system is capable of handling additional hoods