

KEEP YOUR WORKERS SAFE & HEALTHY – A GUIDE TO INDUSTRIAL VENTILATION

Concerned about worker safety and air quality in your facility? Discover the power of ventilation.

Industrial ventilation aims to control heat and airborne pollutants. This course provides you with the skills needed to establish safe, healthy, and efficient work environments across various industrial settings. It covers dilution ventilation technique, which regulate temperature and maintain air quality by introducing fresh air. Additionally, it addresses the local exhaust ventilation (LEV) technique to eliminate contaminants at the source. Embedded within the course are essential metrics, practical tips, and handy rules of thumb to help you make well-informed decisions.

You can find **Key Rules of Thumb in Annexure - 3** for quick and easy reference. These guidelines, metrics, and thumb rules are based on sound engineering practices and the author's experience, but they may vary depending on operating conditions and other factors. This document is a live resource that will be updated regularly as new information becomes available.

Let's get started!

CHAPTER - 1: INDUSTRIAL VENTILATION OVERVIEW

Industrial ventilation refers to the controlled and deliberate movement of air within a workplace or industrial setting. It encompasses the design and implementation of systems and equipment that manage air quality, temperature, humidity, and the removal of airborne contaminants to maintain a safe and comfortable environment.







1.1 Objectives



The main objectives of industrial ventilation include:

- a. Worker Safety: Protects employees from harmful airborne contaminants and heat stress.
- b. Air Quality Management: Dilutes and removes pollutants for clean and healthy indoor air.
- c. Improved Comfort: Regulates temperature, especially crucial in areas with high heat loads.
- d. Contaminant Control: Captures and minimizes worker exposure to hazardous substances like dust, fumes, and mists.
- e. Fire & Explosion Prevention: Reduces the risk of fire and explosions by limiting the accumulation of flammable materials.
- f. Compliance: Ensures adherence to air quality regulations and prevents legal ramifications.

1.2 Key Codes and Standards

There are various regulations and standards pertaining to adequacy of ventilation. Following resources can be very useful for industrial ventilation.

	Standard	Requirements
	ACGIH	Guidelines for industrial ventilation and exposure limits
	ASHRAE 62.1	Minimum ventilation rates for indoor air quality
	ANSI/ASSP Z9.10	Dilution ventilation systems in industrial occupancies
	ANSI/ASSP Z9.5	Laboratory ventilation
	AMCA Standard 500-L	Laboratory exhaust systems (hoods, fans, filtration)
	SMACNA	Duct standards

	Standard	Requirements
	ISO 14175	Welding fume control
	OSHA 29 CFR 1910.94	Local Exhaust Systems for worker protection and ventilation compliance

The ventilation system should comply with the requirements laid down in the current statutory legislation or any revisions currently in force, and consideration should also be given to any relevant insurance company requirements.

1.3 Types of Industrial Ventilation Systems

Ventilation in industrial and commercial settings primarily falls into two categories: dilution and local exhaust ventilation.







1.4 Dilution Ventilation



Dilution ventilation mixes contaminated air with fresh air to reduce pollutant concentrations. It's particularly effective in larger, open areas where contaminants are generated intermittently, and worker exposure is widespread.

1.5 Local Exhaust Ventilation

Local Exhaust Ventilation (LEV) is designed to capture process emissions before they can spread into the workplace. It's effective for controlling pollutants generated at or near their source, ensuring minimal exposure for workers.

Table 1. Comparison of Dilution and LEV System

	Features	LEV (Local Exhaust Ventilation)	Dilution Ventilation
	Target	Contaminants at source	Overall air quality
	Capture Method	Hoods, enclosures	Supply & exhaust fans
	Airflow	High velocity, low volume	Lower velocity, higher volume
	Efficiency	More efficient for concentrated contaminants	Less efficient for strong contaminants
	Energy Consumption	Lower energy consumption	Higher energy consumption
	Applications	Welding, grinding, spray painting	Paint booths, chemical storage, warehouses

	Features	LEV (Local Exhaust Ventilation)	Dilution Ventilation
	Suitability	Potent contaminants, minimize worker exposure	Moderate contaminants, large spaces
	Cost	Higher initial cost	Lower initial cost, higher ongoing energy costs

As a rule of thumb, dilution ventilation (DV) is a good choice for general air quality improvement and maintaining comfortable temperatures, while local exhaust ventilation (LEV) is required for controlling exposure in hazardous settings.

The subsequent chapters explore the principles, design, and application of both DV and LEV systems, providing a thorough grasp of how these methods enhance worker safety, adhere to environmental regulations, and optimize industrial processes.

CHAPTER - 2: DILUTION VENTILATION SYSTEMS

The saying "Dilution is the Solution to Pollution" is particularly relevant when it comes to workplace ventilation.

Dilution ventilation is the dilution of contaminated air with uncontaminated air for the purpose of controlling potential airborne health hazards, reduce fire and explosion risks, and manage odors and nuisance pollutants. It is also used to control airborne contaminants (vapors, gases, and particulates) in enclosed buildings.

Effective control of airborne contaminants relies on three principles:

- a. **Air Quantity:** Bringing in enough fresh outdoor air to dilute contaminants below safe occupational exposure limits (OELs).
- b. **Mixing:** Distributing fresh air effectively to weaken contaminant concentration across the space.
- c. **Movement:** Setting up airflow patterns that continuously sweep away diluted contaminants, preventing buildup in occupied areas.



Together, these principles make ventilation a powerful ally in maintaining safe, healthy indoor environments.

2.1 Dilution Ventilation Basics

Dilution ventilation plays a dual role in controlling both temperature and airborne contaminants. This adaptable approach strategically introduces a controlled amount of fresh outdoor air into the designated space, effectively diluting and removing the pollutants and moderating the heat buildup.

- a. **Heat Control:** Dilution ventilation effectively cools the workspace by offsetting temperature increases caused by equipment and processes. It ensures indoor temperatures remain within reasonable limits of outdoor conditions.
- b. **Contaminant Control:** Dilution ventilation is crucial for controlling airborne contaminants to stay under permissible exposure limits (PEL). It determines the necessary ventilation rate based on contaminant type and concentration, introducing fresh outdoor air to maintain safe air quality.

Table 2. Techniques for Heat and Contaminant Control

	Parameter	Principle
	Heat control	Calculate the ventilation air requirement in cubic feet per minute (CFM) based on the heat load (BTU/h) and acceptable temperature rise (ΔT in °F) using equation: $CFM = \frac{BTU/h}{1.08 \times \Delta T}$
	Contaminant control	Calculate ventilation air needs using air changes per hour (ACH) based on the type and concentration of contaminants.

2.2 Operation, Applications and Limitations

Dilution ventilation works by introducing fresh outdoor air into a space to dilute airborne contaminants and control temperature using supply air, exhaust, or a combination of both.

Table 3. Working Principle of Dilution Ventilation








	Mode of Operation	Principle
	Supply mode	Fresh air is introduced using fans or blowers to dilute contaminants, reducing concentration.
	Exhaust mode	Contaminated air is removed with exhaust fans, allowing fresh air to enter. Creates negative pressure.
	Combined mode	Fresh air is supplied, while exhaust fans remove contaminated air for better ventilation.

Table 4. Scenarios where Dilution Ventilation is Effective

	Scenarios	Rules of Thumb
	Contaminant Type	Suitable for low-concentration contaminants (general dust, fumes, odors).
	Workspace Size	Large workspaces e.g., warehouses, general painting, assembly lines where contaminants disperse easily.
	Temperature Control	Maintaining comfortable temperatures in hot environments by introducing fresh air.
	Cost Considerations	Offers lower upfront costs compared to some Local Exhaust Ventilation (LEV) systems.

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