Industrial Ventilation - 6. Air Cleaning Devices

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What is covered in this document?

This document is part of the following series of documents on industrial ventilation, and includes general information about air-cleaning principles and equipment as well as considerations to be taken into account when selecting an air-cleaning device.

What are air-cleaning devices?

In a ventilation system, an air-cleaning device removes or captures the contaminants that are present in the air. The type of air cleaner used will depend on:

- type of air contaminant to be removed,
- the concentration of the contaminant in the air,
- how much contaminant must be removed to meet regulations or standards,
- type and size of dust particles,
- temperature, humidity, etc.,
- fire safety and explosion control, and
- air pollution control regulations.

What types of air-cleaning devices are used to remove particulates?

Particulates include the suspension of fine solid or liquid particles in air, such as dust, fog, fume, mist, smoke, or sprays. Air-cleaners for particulates include:

- fabric collectors,
- centrifugal collectors,
- electrostatic precipitators, and
- wet scrubbers/collectors.

Fabric Collectors

These filtration devices capture particulate contaminants as they pass through a specialized fabric filter. The most common example of a filtration device is a "bag house". It traps dust by slowly passing air through many layers of fabric. Gradually, a dust layer accumulates on the fabric. This dust also acts as the filter and initially improves the dust-collecting effectiveness of the system. After the continued build-up of dust, the fabric becomes too clogged. The dust must be removed by either an automatic system, which shakes the dust from the fabric or by replacing the fabric bags.

Industries that commonly use a fabric collection system include foundries, grain handling, material handling, and crushing and grinding operations.

Centrifugal collectors

The most common type of centrifugal collector is the cyclone collector. These collectors separate particulates from the air by forcing the air to "spin" (similar to a cyclone or tornado). Spinning the air "throws" the contaminant into the outside edge of the air stream, and causes the particulates to fall or settle out of the air. Cyclone collectors are commonly used for the removal of coarse dust from an air stream and often as a pre-cleaner before a more efficient dust collector, or as a product separator. It is not suitable for the collection of fine particles.

Common uses are in woodworking operations, rubber grinding, and as pre-cleaners before fabric filters.

Electrostatic Precipitators

Electrostatic precipitators remove fine particles from the air by placing an electrical charge on the particles. The particles are then attracted to an oppositely charged collection plate. Electrostatic precipitators are very efficient at collecting fine particles but cannot be used in very dusty operations because they clog easily.

They can effectively remove fumes and fine particles but not gases or vapours from the air. Electrostatic precipitators should not be used around flammable chemicals because an explosion could result if a spark is given off in the collector.

Common uses are in coal burning, plastic extrusion, and metal mining operations.

Wet scrubbers or collectors

Wet collectors, or scrubbers, are available in many different designs and they are also used with gases and vapours. Wet collectors use water to help force dust, gas or vapour contaminants from the air. The principle mechanism is the impaction of the dust particulates on water droplets. The wetted particulates are removed by centrifugal force or impingement (hitting) on baffles. These collectors have the ability to handle high-temperature and moisture-laden gases. The collection of dust in a wetted form can minimize a secondary dust problem when disposing of collected material. In addition, some dust represents explosion or fire hazards when a dry and a wet collection system can minimize this hazard. However, the use of water may introduce corrosive conditions within the collector, and protection from freezing may be necessary if collectors are located outdoors in cold climates.

Common uses include in foundries, metal refining, and metal working operations.

What processes are used to remove the gases and vapours from the airflow?

Gases and vapours can be removed by using the following processes:

Adsorption

The removal of a contaminant by superficial contact (adhesion) with other materials such as activated alumina, activated charcoal and silica gel (referred to as adsorbers).

Absorption

The removal of soluble or chemically reactive gases from the air stream by incorporation into the bulk volume of an appropriate liquid.

Catalytic conversion

In this process, a contaminant is converted to a chemical form not considered to be hazardous in the presence of a catalyst. Catalysts are substances that increase the rate of a chemical reaction without being affected by the chemical reaction.

Thermal Oxidation (Combustion)

The combustion process (also called incineration) converts volatile organic compounds (VOCs) to carbon dioxide and water vapour by burning them. It is a very effective means of eliminating VOCs. Typical applications for incineration devices include odour control, reduction in reactive hydrocarbon emissions, and reduction of explosion hazards.

What should be considered when selecting an air-cleaning device?

Following are some tips for selecting an air-cleaning device in your workplace. Remember that a qualified professional should make final decisions regarding the suitability of an air-cleaning device.

- Before the air cleaning device is selected, it is very important to know about the maintenance and access requirements, the physical size of the equipment and how it will be installed in the plant as well as the methods of removing the collected contaminants.
- The air cleaner must be reliable. Many installations require monitoring or proof of continual operations by measuring conditions in the system.
- Maintenance and operating costs must be considered. The air cleaner must operate in stable conditions as well as variations such as plant start-up and shutdown. Considerations also include if it must be accessible for maintenance or if the air cleaner must continue to operate while maintenance or repairs are being done.

- The device must meet local and national regulations for environmental pollution control.

Are there any legal standards for air-cleaning devices?

Yes. Since the 1970s, all installations of air-cleaning devices require approval by municipal, provincial, and federal air pollution control authorities such as the ministry or department of environment. In addition, approval is required by the jurisdiction responsible for health and safety if an air-cleaning device is installed to allow re-circulation of exhaust air into the building (for energy conservation). Some legal standards require that re-circulated air must be cleaned up to the extent that it does not contain more than 1/10th of the permissible standard of any contaminant. Consult with your local jurisdiction for more details.

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