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ABSTRACT

This student module on exhaust, dust collection, and ventilation systems is one of 50 modules concerned with job safety and health. This module discusses the types of contaminants that can be controlled by ventilation, the types of ventilation systems, and the component parts of local exhaust systems. Following the introduction, 10 objectives (each keyed to a page in the text) the student is expected to accomplish are listed (e.g., Compare general and local exhaust systems). Then each objective is taught in detail, sometimes accompanied by illustrations. Learning activities are included. A list of references and answers to learning activities complete the module. (CT)

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SAFETY AND HEALTH

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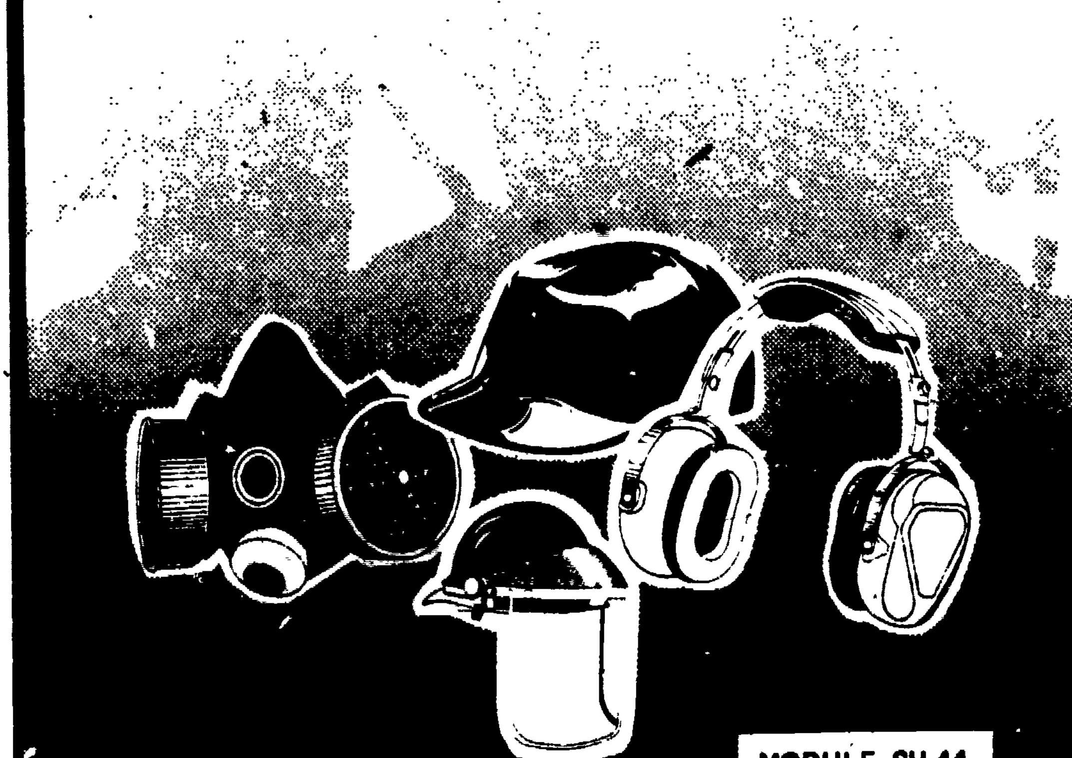
EXHAUST, DUST COLLECTION, AND VENTILATION SYSTEMS



MODULE SH-44

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INTRODUCTION

Ventilation is the primary means of controlling the exposure of workers to dusts, fumes, mists, gases, and other forms of airborne contamination. Sometimes, however, ventilation systems do not work properly because of poor design, mechanical failure, improper use, and poor maintenance. For these reasons, it is important to have a basic understanding of ventilation systems so that any suspected problems can be reported to a responsible official. Those who have responsibility for the design, maintenance, or inspection of ventilation systems must be knowledgeable of the limitations and characteristics of the types of systems used in industry.

This module discusses the types of contaminants that can be controlled by ventilation, the types of ventilation systems, and the component parts of local exhaust systems.

OBJECTIVES

Upon completion of this module, the student should be able to:

1. Describe five functions of a ventilation system. (Page 3)
2. Write a short definition for dust, fume, gas, vapor, and ventilation. (Page 5)
3. Summarize in a few sentences the function of the makeup air and exhaust ports of a ventilation system. (Page 6)
4. Describe briefly the function of the industrial hygienist concerning exhaust, dust collection, and ventilation systems. (Page 9)
5. Compare general and local exhaust systems. (Page 10)
6. List and give at least one example of the three basic classifications of hoods. (Page 12)
7. Describe the function of four types of hoods for exhaust systems. (Page 14)
8. Name the two groups of fans and at least one type in each group. (Page 17)

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9. Describe the relative size of dust particles and list the health hazards associated with dusts and fumes. (Page 21)
10. Identify three types of dust collectors and how they are supposed to work. (Page 23)

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OBJECTIVE 1: Describe five functions of a ventilation system.

Proper ventilation is important to any industrial setting for several reasons. Ventilation systems are used to correct many conditions in industry - to provide comfort for employees and to protect them from contaminants that cause illness or disease. Broadly defined, ventilation is a method of controlling the work environment with air flow. Ventilation is generally divided into two categories; general dilution ventilation and local exhaust ventilation. Some of the functions of both types ventilation are discussed in this section to show why the study of ventilation systems are important.

Whenever air is removed from a building, it must be replaced, usually through a ventilation system. In old buildings, cracks and openings around doors and windows allow some air to enter. In most cases, the amount of air that seeps in from the outside is not enough to replace air removed by the exhaust system. When buildings are closed up in the winter time, the exhaust system gets "starved" for air, and the quantity exhausted may be greatly reduced. The control of contaminants is also reduced.

If the exhausted air is not replaced by "make-up air," contaminant control will not be kept up, doors will be hard to open, and reverse flow can take place in exhaust systems such as furnaces. These conditions can cause injury to people and bring contaminants back into the work area.

Ventilation systems are used also to dilute airborne dusts, fumes, and heat. General or dilution ventilation should not be considered adequate for control of fumes or dusts. Dusts or fumes are frequently very poisonous and are not generated in steady amounts in most industrial operations. Few if any industrial hygienists consider dilution ventilation as an acceptable method to control dusts and fumes.

Temperature control is a function of ventilations systems. Under some conditions the outdoor air is cooler than the inside air and can be brought

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indoors to cool hot operations. In many other situations, the air for controlling the temperature of working areas has to be heated in winter months and cooled in the summer months.

Pressure equalization is necessary between the inside and outside of the building when exhausted air is replaced. However, it may be desirable in some buildings to have greater pressures in certain rooms or work areas than others. When this is the case, the areas or rooms where the contaminant generation is least are kept under a greater pressure than the areas that have more contaminants generated. The reason for this is that the clean air is put into the cleanest area and as it passes into areas of more contamination, it dilutes the contaminant and also tends to move those contaminants toward the exhaust system where they are collected or discharged.

Ventilation systems serve to reduce cold drafts. When local exhaust systems are installed and no planned make-up air is provided, the air coming in the cracks in construction and other openings around doors and windows will be the temperature of the outside air. During the winter months these drafts will be uncomfortable for the workers and may contribute to more illness among the workers. The make-up air system will prevent this from happening.

Another function of the ventilation system is to provide air motion to either dilute the contaminant to a low level, or to collect the contaminant by drawing air into the hood of a local exhaust system. Air is in motion all of the time inside industrial facilities because of the activity of people and movement of equipment, and because of the wind pressures on the sides of the building. In tall buildings, air motion will also be caused by thermal air currents which make the air rise. If openings are provided in or near the roof, cooler outside air is drawn into the building near the ground where openings exist. Air is always in motion; the purpose of the ventilation system is to control that motion.

ACTIVITY 1:*

Describe five functions of a ventilation system.

1. ______________________________

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2. ______________________________

____

3. ______________________________

____

4. ______________________________

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5. ______________________________

____

OBJECTIVE 2: Write a short definition for dust, fumes, gas, vapor, and ventilation.

Ventilation is used in the control of dusts, fumes, gases, and vapors. Particles that are present in the air and are generally formed by a mechanical action such as from grinding and crushing operations are called dusts. Dusts may be composed of either solid organic or inorganic materials. Dust particles vary in size from those visible to the eye to those submicroscopic in size. Fumes are minute particles, generally made of metals, that are formed as a result of high temperature processes such as in welding and metal smelting. Typical fumes include oxides of zinc, iron, lead and cadmium. Individual fume particles are very small and cannot be seen without the use of a high power microscope. Smoke refers to airborne particles resulting from incomplete combustion or organic materials. Carbon and soot are a result of incomplete combustion. The individual smoke particles are extremely small in size. Materials that are in a physical state such that

*Answers to Activities begin on Page 27.

they occupy the entire space in which they are enclosed are known as gases. Gases do not appear in solid or liquid states at atmospheric temperatures and pressures. Examples are oxygen, nitrogen, and carbon monoxide. Vapor is the gaseous form of a material that is normally a liquid or solid at atmospheric temperatures and pressures. Examples are water and organic solvents. Mists are very small droplets of liquids suspended in air by mechanical means (atomization) or by condensation from a gaseous state.

ACTIVITY 2:

Write a short definition for:

Dust ______________________________

____

Fume ______________________________

____

Gases ______________________________

____

Vapors ______________________________

____

Ventilation ______________________________

____

OBJECTIVE 3: Summarize in a few sentences the function of the make-up air and exhaust parts of a ventilation system.

As explained in Objective 1, ventilation is a means of controlling the work environment by air flow. When an exhaust system is operating, large amounts of air can be removed from the workplace. In order to assure good operation of the exhaust systems, it is necessary to replace the air that is exhausted with make-up air.

Unless air is introduced to replace the air removed by the exhaust systems and the process itself, the workplace will develop a negative pressure or potential vacuum (a pressure lower than that existing outside the building). This negative pressure will cause problems in the operation of the exhaust systems. Back drafting of stacks and flues can result from air flowing from the higher outside pressure to the lower inside pressure. If the stacks and flues normally discharge combustion products or other contaminants, these products or contaminants will be drawn into the work environment. Also, a negative pressure may cause a reduced air flow in local or dilution exhaust systems, and contaminants will not be properly controlled.

Negative pressures will cause air to be drawn into the workplace through cracks around doors and windows of the building. Air entering in this manner can cause high velocity cross drafts that may interfere with the operation of exhaust systems. In addition, the workers will feel cold drafts during the winter, especially near the outside walls of the building.

Insufficient make-up air can result in potential hazards in the workplace. The poor operation of local exhaust and dilution systems can result in a buildup of air contaminants. Cross drafts from open doors and windows can cause contaminants to be carried away from hoods into the other areas of the workplace. Carbon monoxide contamination caused by back drafting of gas or oil-fired space heaters may also occur. Negative pressures inside the building will cause outward opening doors to be hard to open and to slam shut quickly. Personal injuries have resulted from this condition.

The amount of air supplied to a building should be equal to all of the local exhaust and dilution exhaust systems as well as to any stacks and natural draft flues. The make-up air will generally require filtering and perhaps heating in the winter and cooling in the summer. The supply air should be delivered at multiple points throughout the work area to eliminate high velocity air streams that may interfere with local exhaust hoods. The delivery points should be from eight to ten feet above the floor to obtain the best air distribution in the work area.

As can be seen, make-up air is essential for the adequate operation of any exhaust ventilation system. Most facilities that do not take this into account are likely to encounter problems with contaminant control.

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Exhaust air is the air which is removed from a building by natural or mechanical means. Natural exhaust occurs as a result of temperature differences between the inside and outside air or by wind pressure exerted on the walls of the building. Fans are generally used to exhaust air by mechanical means.

Natural ventilation can move large amounts of air, but is highly dependent upon the prevailing atmospheric conditions. In tall buildings housing hot processes such as metal refining and forming, the inside air temperature is higher than the outside air temperature. The inside hot air rises because of its lower density (weight), and if openings are provided in the roof, the hot air passes out into the atmosphere. As the rising air leaves, fresh air flows into the building through openings near ground level to replace the discharged air. This flow is illustrated in Figure 1. The amount of air that is discharged is dependent upon the air temperature difference between the inside and outside air and the height of the building.

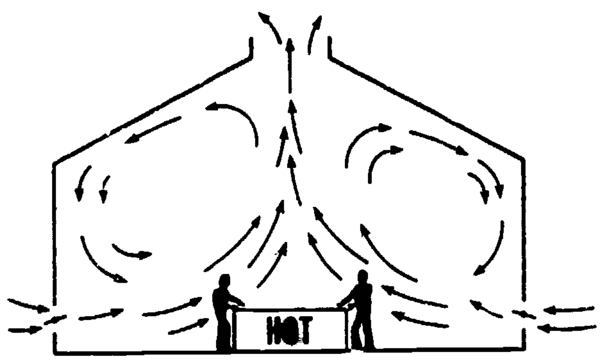

Figure 1. Air currents in tall buildings.

Ventilation resulting from wind pressures is extremely variable and not very reliable. The amount of air flow caused by wind pressure is dependent upon the wind velocity, its direction, the number and size of openings in the building, and their location in relation to the wind direction. For these reasons, ventilation caused by wind pressure is seldom considered for control of contaminants in the workplace.

Mechanical exhaust ventilation makes use of fans of various types to move air at low pressures either into or out of a building. Most industries use these mechanical air movers because of their reliability and their ability to move large amounts of air. While they are not foolproof, mechanical exhaust systems are the most satisfactory means of controlling contaminants in the workplace. Local exhaust systems are particularly desirable because

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they collect the contaminant at the location where it is generated. Fans, which are considered to be the "heart" of local exhaust systems, will be discussed in a later section of this module.

ACTIVITY 3:

Summarize in a few sentences the function of the make-up air and exhaust parts of a ventilation system.

Make-up air: ______________________________

____

____

Exhaust: ______________________________

____

____

OBJECTIVE 4: Describe briefly the function of the industrial hygienist concerning exhaust, dust collection and ventilation systems.

The industrial hygienist has several responsibilities regarding ventilation systems. Usually, it is this individual who recommends the installation of ventilation if the dusts and other contaminants in the workroom are above acceptable standards. In some organizations, the ventilation system design is reviewed by the industrial hygienist for approval, although in most organizations the plans are sent to the fabrication shop or an outside contractor without review by the industrial hygienist.

After the ventilation system is installed, the industrial hygienist is responsible for making a complete evaluation of the system and of the work environment to assure that the airborne contaminants are controlled. After a complete evaluation of the ventilation system (assuming that everything is satisfactory), the industrial hygienist must see to it that regular inspections and maintenance are carried out on the system. Often the inspections are done by tecnnicians and the results are reviewed by the industrial hygienist to determine whether corrective measures need to be taken.

ACTIVITY 4:

Describe briefly the function of the industrial hygienist concerning exhaust, dust collecting, and ventilation systems.

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OBJECTIVE 5: Compare general and local exhaust systems.

Exhaust systems can be divided into two categories, general and local. General exhaust is a term used to describe a system which draws large amounts of air through a workplace to control the comfort of the worker. These systems are used to remove air that has been heated beyond a desired temperature by the process in the building. Sometimes general exhaust is used along with natural ventilation to keep a minimum amount of air flowing through the building for worker comfort.

One type of ventilation is dilution ventilation. Its purpose is to dilute the contaminants generated in the workplace to very low levels before workers are exposed to them. Dilution ventilation has only limited application for control of gases and vapors. It should not be used for control of dusts and fumes. Dilution ventilation has been successfully used when a large number of work stations are generating small amounts of contaminants, generally vapors. In these cases, the toxicity (poisonous properties) of the chemical is low, the contaminant is generated rather uniformly during the work day and the dilution air is distributed to the work stations. Generally, large quantities of air are required to provide good control of the contaminants through a dilution ventilation system. The increased costs of power to operate the large fans to heat the make-up air in winter make this method of control a poor choice. Unfortunately, it is used in many

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situations where those responsible for its installation are not aware of its limitations and associated problems.

The purpose of a local exhaust system is to collect and remove the contaminant as it is generated at or near the source of its origin. This type of ventilation is used to control all types of contaminants that can become mixed with the air the workers breathe. Thus, it is used to control dusts, fumes, gases, vapors, and mists. When properly designed, installed, and maintained, local exhaust ventilation is an effective control measure. Unfortunately, many of these systems are poorly designed and are not always properly inspected and maintained. Since a local exhaust system is a mechanical system, its maintenance and upkeep should be considered as important as the maintenance and upkeep of an automobile, a materials handling system, or any other mechanical system.

Local exhaust ventilation systems consist of a group of elements which collect, transport, clean and discharge the air from the workplace as shown in Figure 2. Each of these components plays an essential role in the

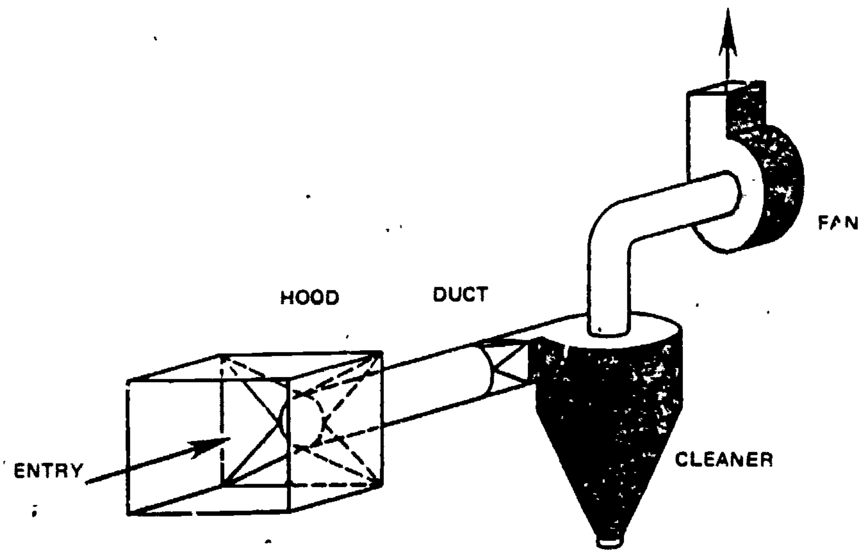

Figure 2. Elements of a local exhaust system.

control of worker exposures. The HOOD, or inlet into the system must collect the contaminant effectively with a minimum of air; the DUCT should transport the contaminated air with the best efficiency for the material being collected; the AIR CLEANING DEVICE (if one is used) should remove the contaminant effectively; the FAN should be adequate to move the amount of air against the resistance of the ducting and air cleaner; and the DISCHARGE of the exhaust air to the exterior of the building should be designed to prevent reentry into the building. Each of these will be discussed in more detail in the following sections.

ACTIVITY 5:

1. What is the method by which dilution ventilation works? ______________________________

____

2. Name the five parts of a local exhaust system.
   a. ______________________________
   b. ______________________________
   c. ______________________________
   d. ______________________________
   e. ______________________________

OBJECTIVE 6: List and give at least one example of the three basic classifications of hoods.

A hood, as it was defined in the previous section, is an inlet that collects exhaust air efficiently and uses a minimum amount of air.

Air flow into a hood is caused by an exhaust fan which creates a negative pressure (relative to atmospheric pressure) within the hood and ducting sufficient to cause air to flow into the opening. The velocity of the air flowing into a hood decreases rapidly as the distance in front of the hood is increased. The effectiveness of a hood is dependent on the type opening that is used, the flanges on the inside and outside of the opening, and the fans creating the movement of air.

The different types of hoods used in local exhaust systems can generally be grouped into three classifications: ENCLOSURE hood; EXTERIOR hood,

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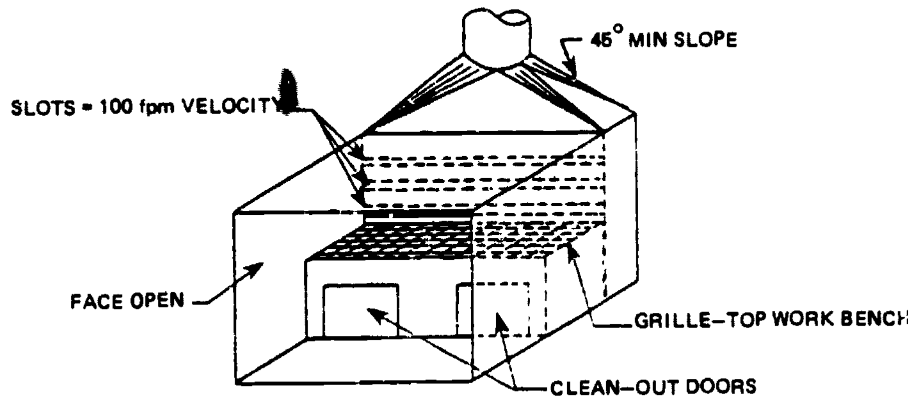
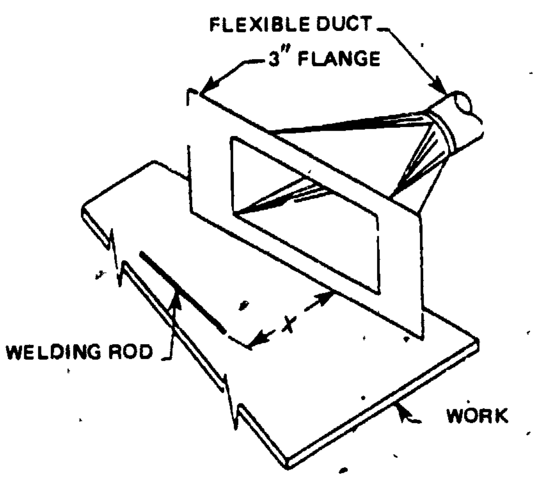
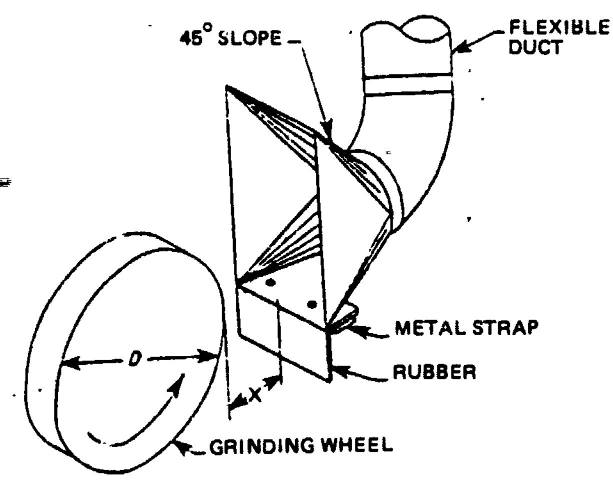
and RECEIVING hood. An ENCLOSURE hood is one in which the contaminant source is either partially or totally enclosed and the air velocity is adequate to prevent escape of the contaminant from the enclosure. An EXTERIOR hood is one which draws the contaminant into the hood by creating enough air movement at the source of contaminant generation to draw the contaminant into the hood. A RECEIVING hood is one which receives the contaminant that is generated by a source and that is directed into the hood opening. Examples of these basic hoods are shown in Figures 3. Table 1 lists several types of hoods and their applications for each classification.



a. Enclosure: metallizing booth.



b. Exterior: welding table hood.



c. Receiving: surface grinder hood

Figure 3. Work hoods.

TABLE 1. TYPES OF HOODS AND THEIR APPLICATIONS.

TYPE		APPLICATION
Enclosure:	Booth	Laboratory
		Paint and metal spraying
		Bagging machines
	Machine enclosure	Bucket elevators
		Vibrating screens
		Storage bins
		Belt conveyors
Exterior:	Slot	Open surface tanks
	Downdraft	Hand grinding, open surface tanks
	Sidedraft	Foundry shakeout, open surface tanks
Receiving:	Grinding	Surface grinders
		Stone and metal polishing
	Woodworking	Shapers, saws, jointers
	Sanding	Belt and drum sanders
	Canopy	Hot processes

ACTIVITY 6:

List the three basic classifications of hoods and give at least one example of each.

1. ____________________
2. ____________________
3. ____________________

OBJECTIVE 7: Describe the function of four types of hoods for exhaust systems.

The most effective enclosure hood is the booth type. A booth-type hood is one which encloses the contaminant on three sides and air is drawn

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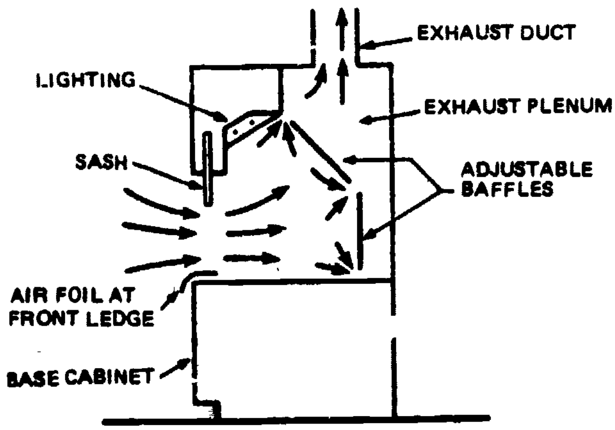


Figure 4. Standard laboratory fume hood.

through an access opening. A typical example is a laboratory hood, shown in Figure 4.

Booth-type or enclosure hoods are generally the best type of hood because the contaminant is controlled within the hood and lower air volumes are required, depending upon the degree of enclosure. The more completely enclosed a process or operation can be made, the more effective contaminant control can be established by exhaust ventilation.

Exterior hoods are often side draft and downdraft. Side draft hoods can be used in several different operations, for example venting open surface tanks and foundry shakeouts. A side draft hood is one that draws the air to the side of the operation or process, away from the workers. In this way, clean air is always drawn from behind the worker and the contaminant is removed before reaching the worker's breathing zone.

A special case of the side draft hood is one which uses slots in the hood to provide uniform distribution of the air across the work surface. This type of design is used for welding operations and open surface tanks to control the contaminant emissions.

A downdraft hood is simply a work surface which is made up from a grating through which the exhaust air passes, collecting the contaminant. Downdraft tables are frequently used in metal cutting and hand grinding operations.

Receiving hoods can be of several types and shapes. The canopy hood, shown in Figure 5, is a most useful receiving hood for the control of contaminants from hot processes when workers are not required to work under the hood. This type of hood should not be used for welding and similar operations where the contaminant is drawn through the breathing zone of the

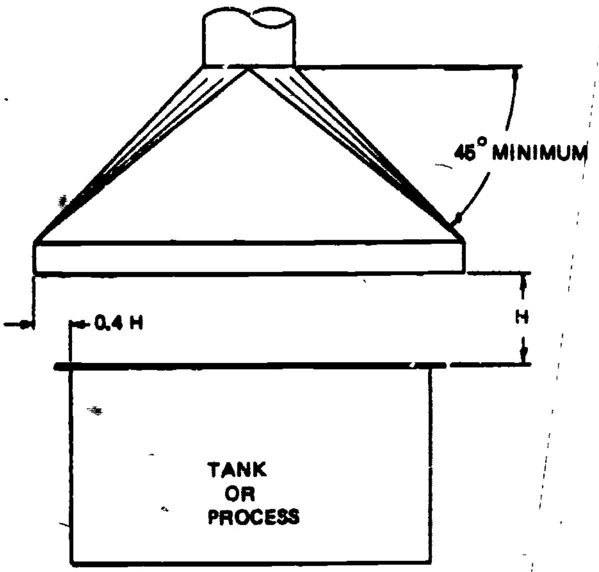


Figure 5. Canopy hood.

workers are not required to work under the hood. This type of hood should not be used for welding and similar operations where the contaminant is drawn through the breathing zone of the worker, although it is sometimes seen in these kinds of situations. Figure 6 shows the use and misuse of canopy hoods.

Canopy hoods are subject to cross drafts created by man-cooling fans and wind currents from open doors and windows. The higher the hood is above

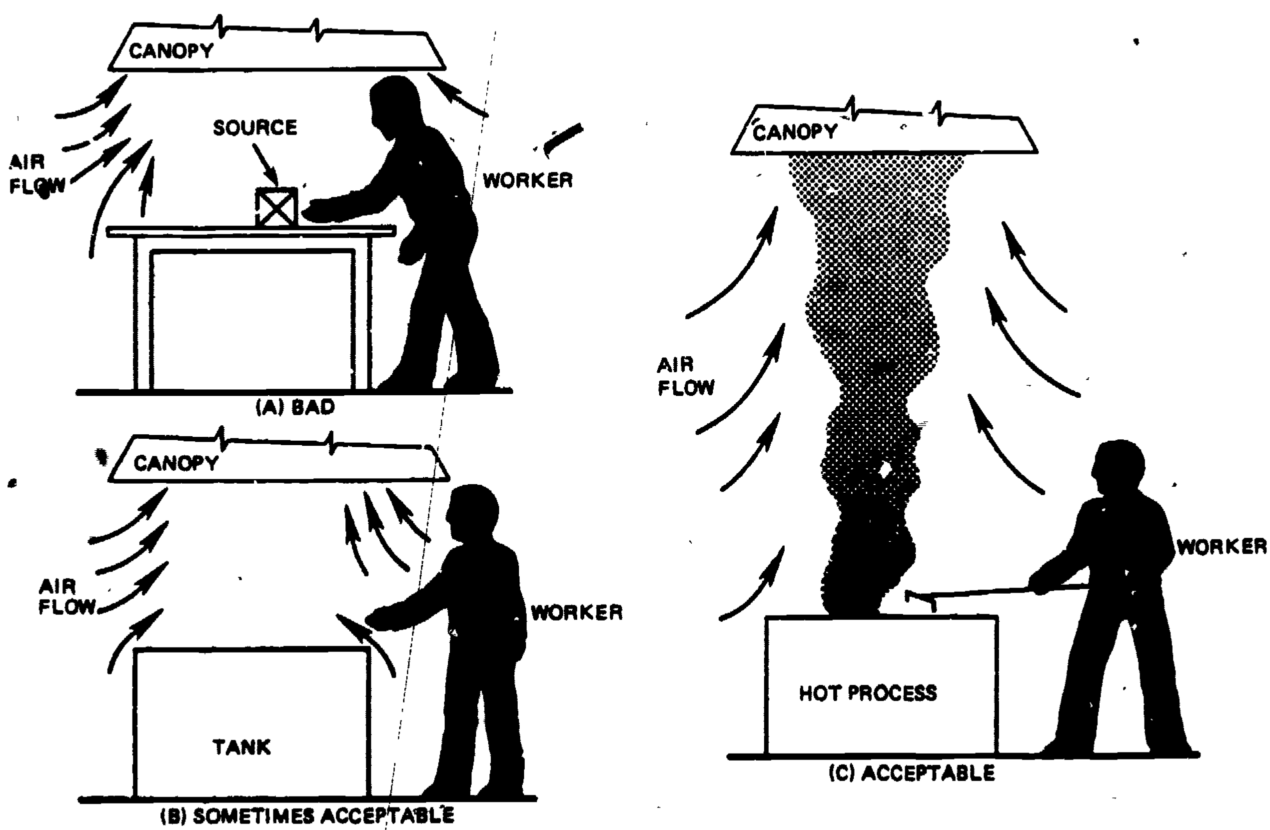


Figure 6. Use and misuse of canopy hoods.

ACTIVITY 7:

Fill in the blanks.

1. A _______________ hood is one that encloses the contami. .nt on three sides, with air drawn through an access opening.
2. A ____________________ hood can be used in venting open surface tanks, and foundry shakeouts.
3. A ___________ hood is a work surface made up from grating.
4. ____________ hoods are subject to stray air currents from open doors and windows and room-cooling fans.

OBJECTIVE 8: Name the two groups of fans and at least one type in each group.

In order to move air in a local exhaust system, it is necessary that a moving force be present. Generally, the moving force is provided by a mechanical fan.

Fans can be classified into two major groups: the AXIAL FLOW fan, where the air passes through the fan in a direction parallel to the axis of rotation of the fan blades; and the CENTRIFUGAL fan where the air passes through the fan perpendicular to the axis of rotation of the fan blades.

AXIAL FLOW FANS

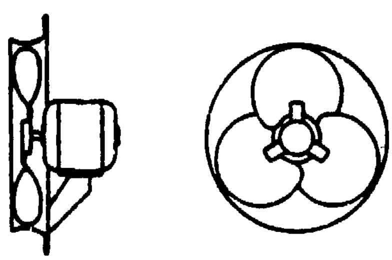


Figure 7. Disc fan.

The disc fan, shown in Figure 7, is used for moving large amounts of clean air for purposes of general ventilation. This type is mounted in the side walls or the roof of a building and has no ducting connected to it. This type of fan is also used as a man-cooling fan, frequently referred to as a "pedestial

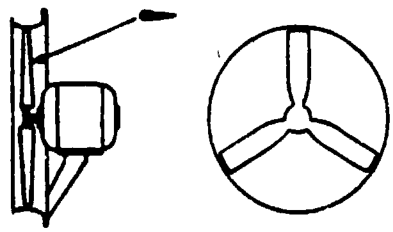


Figure 8. Propeller fan.

fan." The propeller fan consists of two or more blades as shown in Figure 8. This type of fan is also used for general ventilation purposes and where very low resistance to air flow is present. This fan is frequently used in spray paint booths. It tends to be noisy and inefficient, and is used only with very short lengths of ducting. The propeller blades tend to become coated with dust and paint overspray which reduces their efficiency and increases the noise level.

A vane axial fan is fabricated within a section of ducting as shown in Figure 9. The vanes holding the fan in place tend to straighten the helical air flow pattern and improve fan efficiency. This type of fan is best suited for clean air applications and where space for installation is limited.

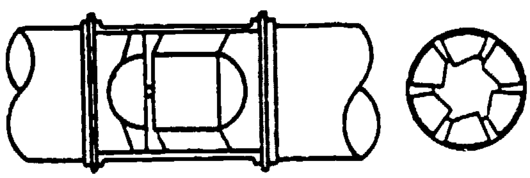
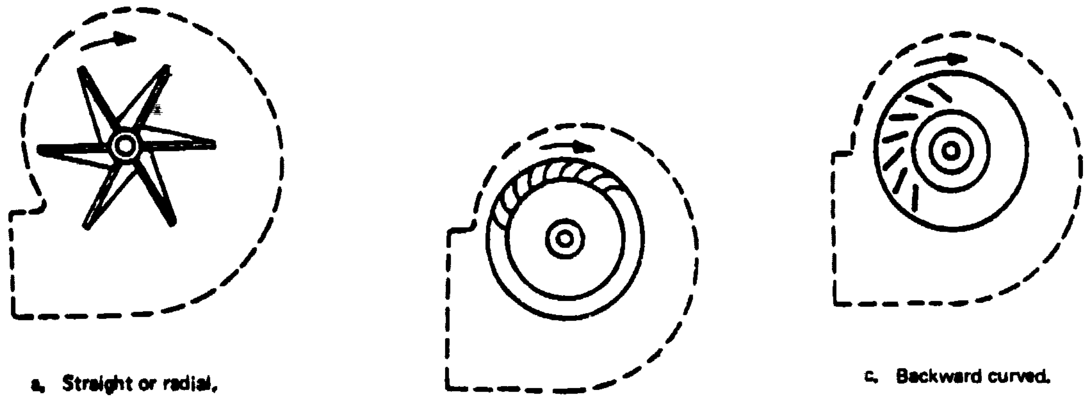


Figure 9. Vane axial fan.

CENTRIFUGAL FANS

A radial or straight blade fan is most commonly used in local exhaust systems, especially when the air passing through the fan contains particulate materials. The radial blade fan is frequently referred to as the "workhorse" of industrial exhaust systems because of its many applications. This fan will move large amounts of air in systems where the resistance to air flow is high. It tends to be a relatively noisy fan and is very rugged in construction. Figure 10a shows the typical configuration of the fan blades.

A forward curved blade fan usually has a large number of closely spaced shallow blades, which are curved forward in the direction of rotation as shown in Figure 10b. This type of fan is frequently referred to as the "squirrel cage" fan and is used in a number of ventilation applications. It is generally the type of fan used in air conditioning and heating systems because it is relatively quiet. This fan should be used only with clean air because dust builds up on the fan blades and reduces it efficiency. This



a. Straight or radial.

b. Forward curved.

c. Backward curved.

Figure 10. Fan blade arrangements.

The backward curved blade fan has blades that are tilted in a direction opposite to the direction of rotation as shown in Figure 14. The blade shape is conducive to the buildup of materials and fans of this type should be used only with clean air. This fan is capable of moving large amounts of air against moderate to high resistances of air flow.

One characteristic of all centrifugal fans is that they can be operated in reverse rotational direction and still move air into the ventilation system. However, the amount of air moved will be reduced by 40-50 percent. For this reason, it is always a good procedure to start making an inspection of a ventilation system at the fan.

ACTIVITY 8:

Fill in the blanks.

1. __________ fans, frequently used in spray paint booths, tends to be noisy and inefficient.
2. The __________________ fan is often referred to as the "workhorse" of industrial exhaust systems because it is so widely used.
3. _____________ of a ventilation system should begin with the fan.

OBJECTIVE 9: Describe the relative size of dust particles and list the health hazards associated with dusts and fumes.

Dusts were defined in the beginning of this module. However, particulates of many different kinds and from different sources are of concern to the worker and to the employer. With airborne materials, particle size is very important because only particles smaller than certain sizes are considered hazardous to health.

Particles vary in size from quite large and readily visible to sizes that can be seen only with the help of a very powerful microscope. Since particles, especially those that may be a health hazard, are very small, a standard unit of measurement has been used to indicate their size. The sizes are given in micrometers. A micrometer is one-one millionth of a meter (or 1/25,400 of an inch) in length.

The human eye can see individual particles down to about 50 micrometers. But particles even smaller than this are of primary concern for health hazard reasons. Table 2 lists the particle size ranges for a number of common particles.

TABLE 2. PARTICLE SIZE RANGES.

Particle Type	Size Range (Micrometers)
Coarse sand	200-2000
Fine sand	20-200
Mist	70-200
Coal dust	1-100
Cement dust	30-100
Paint pigments	0.1-5
Zinc oxide fume	0.01-30
Tobacco smoke	0.01-1
Metallurgical dusts and fumes	0.001-100

Generally only particles smaller than ten micrometers in size are of concern from the standpoint of their presenting a health hazard. Particles larger than ten micrometers either are not airborne long enough to be inhaled, or they are removed in the nasal passages and do not reach the lungs where they can cause injury. The health hazard is dependent upon the type of material in the air, its size, the concentration (amount per unit volume of air) and the length of exposure (total time a person stays in that concentration).

A number of occupational diseases can result from overexposure to airborne dusts and other particulates. Generally, these diseases develop over many years, although overexposures to certain metal fumes can produce illness within a matter of days or even hours. For example, the development of silicosis from the inhalation of fine sand particles containing silicon dioxide will generally take many years of exposure to produce the disease, whereas zinc fumes generated when welding or brazing on galvanized metal parts can cause "metal fume fever" in a matter of hours. Other types of lung diseases and the dusts which cause them are shown in Table 3.

TABLE 3. DISEASES CAUSED BY VARIOUS AIRBORNE PARTICULATES.

Disease	Caused by
Asbestosis	Asbestos fibers
Black lung	Coal dust
Byssinosis	Cotton dust
Farmers lung	Moldy hay

ACTIVITY 9:

1. Which dust particle size is of greatest concern from a health hazard standpoint.

2. Name four diseases caused by airborne particulates.

   a.

   b.

   c.

   d.

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OBJECTIVE 10: Identify three types of dust collectors and how they are supposed to work.

Air cleaning means removing contaminants from an air stream. The contaminants may be gases and vapors or particulates such as dusts and fumes. An air cleaning device is simply a piece of equipment that is designed to remove the contaminants. In this module, only three main types of air cleaners used for removing dusts and fumes from the exhaust air will be discussed.

In the first type, the cyclone cleaner, the air enters a circular, cone-shaped chamber at the side where it is caused to swirl around the inside wall of the chamber. Particles in the air are forced to the inside wall of the chamber; then they follow the walls downward to the bottom of the cone. The particles drop into a hopper at the bottom and the cleaned air is discharged out the top. Cyclones do not have moving parts, they are relatively cheap in construction cost and operation, and the maintenance problems are few. This type of air cleaner is frequently used with woodworking equipment, but is not a good choice unless it is followed by another type of air cleaner. A drawing of a cyclone is shown in Figure 11. With the cyclone cleaner, the fan is almost always located ahead of the cleaner.

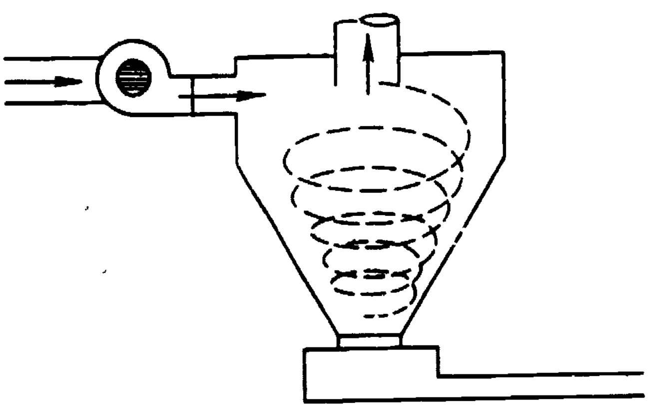


Figure 11. Cyclone collector.

A second type of cleaner, the bag-type, is frequently referred to as a fabric filter air cleaner. The filter separates the particulate materials from the air as the air passes through the fabric. As the particles build up on the surface of the filter, the resistance to air flow increases. It becomes necessary then to replace or clean the filter to keep the desired air flow. In most cases, the filter air flow. In most cases, the filter is cleaned by mechanically shaking it or by changing the direction of air flow through the fabric.

Bag-type collectors are contained in an enclosure called a "bag house." The bag house has an inlet for the dusty air, a hopper to catch the collected dust, and an outlet for the cleaned air. The bag house also holds the equipment used to clean the bags. A typical bag-type collector is shown in Figure 12. In this case, the dust air passes through the fabric so that the dust is collected on the inside of the bags. When this type air cleaner is used, the fan is normally located on the clean air side of the cleaner.

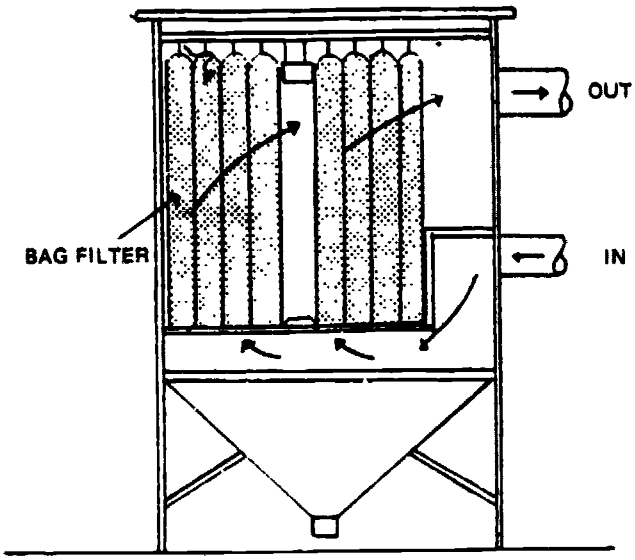
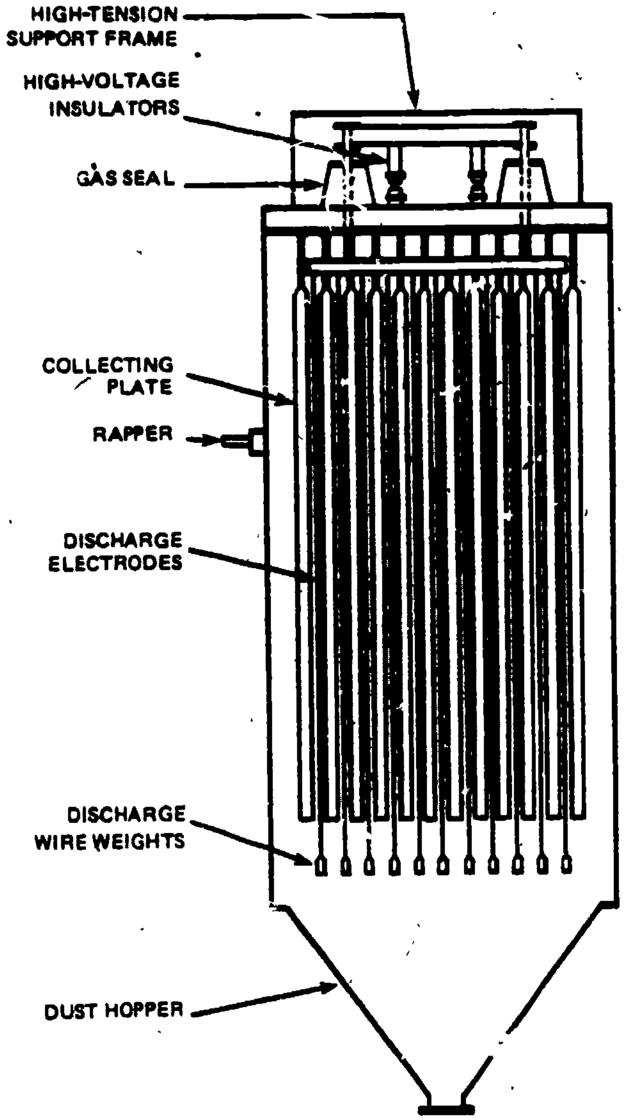
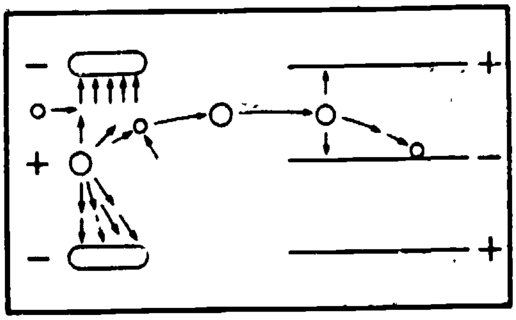


Figure 12. Bag-type collector.

Electrostatic precipitation, the third method of cleaning, involves charging the dust particles in the air with an electrical charge that is opposite to the charge applied to plates where the particles are collected. To charge the particles, a high direct current (DC) wire or electrode is placed between the collection plates, which are grounded. As the particles pass the charged electrodes, they pick up an electrical charge which is opposite to that of the collection plates. As the air passes between the collection plates, the particles are attracted to them and removed from the air stream.

The electrostatic air cleaner is generally quite large in size and only economical to install where large amounts of air must be cleaned. However, some quite small units for use in collecting welding fumes are now available. Figure 13 shows the general arrangement and construction of an electrostatic precipitator.





PRINCIPLE OF ELECTROSTATIC PRECIPITATION

Figure 17. Electrostatic precipitator.

ACTIVITY 10:

Identify three types of dust collectors and how they are supposed to work.

1. ______________________________

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2. ______________________________

____

3. ______________________________

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REFERENCES

American Industrial Hygiene Association. Heating and Cooling for Man in Industry. 2nd ed., 1975.

National Institute for Occupational Safety and Health. The Occupational Environment - Its Evaluation and Control. 1st ed. 1973.

National Institute for Occupational Safety and Health. Division of Training and Manpower Development. Industrial Ventilation. 8th ed. 1964.

ACGIH. Industrial Ventilation - A Manual of Recommended Practice. 16th ed. 1980.

ANSWERS TO ACTIVITIES

ACTIVITY 1

1. Replace exhaust air - air exhausted has to be replaced to keep the exhaust system working right, and prevent reverse flow in furnaces and other natural stacks.
2. Provide temperature control in the hot industries by bringing outdoor air into the building near the ground and discharging the hot air at the roof level, or by cooling in summer and heating in winter.
3. Pressure equalization - equalize the pressure between inside and outside the building, prevents doors from slamming, and can be used to create greater pressures in certain parts of a building for contaminant contr .
4. Reduc cold drafts - this is done by providing make-up air to keep cold air from coming into the building through cracks and openings around doors and windows.
5. Provide air motion to dilute and/or remove contaminants - air is always in motion, the ventilation system controls the motion by directing or drawing the contaminants into the exhaust system.

ACTIVITY 2

Dust - Solid particles in the air formed by crushing and grinding operations.

Fume - Very small particles of metals formed by high temperatures as in welding.

Gases - Occupy the entire space in which they are enclosed. Always a gas at atmospheric temperature and pressure.

Vapors - The gaseous form of a liquid or solid at atmospheric temperatures and pressures.

Ventilation - A method of controlling the work environment by air flow.

ACTIVITY 3

Make-up air - Make-up air replaces the air removed from the building by exhaust systems or processes. This keeps the building from developing a negative pressure inside. prevent backdrafting of natural stacks and flues, prevents high velocity air from entering around doors and windows and prevents interference with the operation of local exhaust systems.

Exhaust - Natural exhaust is caused by temperature differences between indoor and outside air. The wind can cause large amounts of air to move through a building but is extremely variable. Mechanical exhaust is provided by a fan which is considered to be the heart of the system and is more reliable than natural ventilation.

ACTIVITY 4

The industrial hygienist recommends ventilation controls, gives guidelines for design, does design review, evaluates the system, and monitors the work environment for airborne contaminants before and after installation.

ACTIVITY 5

1. Dilution control is used to control contaminants by moving large amounts of air through the building.
2. a. Hood.
   b. Duct.
   c. Air cleaner.
   d. Fan.
   e. Discharge.

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ACTIVITY 6

1. Enclosure - booth, machine enclosure.
2. Exterior - slot, downdraft, sidedraft.
3. Receiving - grinding, woodworking.

ACTIVITY 7

1. Booth-type.
2. Side draft.
3. Downdraft.
4. Canopy.

ACTIVITY 8

1. Propeller.
2. Radial blade.
3. Inspection.

ACTIVITY 9

1. Dust particle sizes of concern from a health hazard standpoint are measured in micrometers. Those which are less than ten micrometers in size are of most concern. This is smaller than we can see without a microscope.
2. (Any four.)
   a. Metal fume fever.
   b. Asbestosis.
   c. Black lung.
   d. Byssinoisis.
   e. Farmers' lung.

ACTIVITY 10

1. Cyclone cleaners - dust particles are removed by spinning the air inside the cyclone which forces the dust to the wall where it drops into a hopper at the bottom.
2. Bag-type collectors - these are made of a fabric filter in an enclosure that collects the dust as the air passes through the filter. The bags have to be cleaned frequently.
3. Electrostatic precipitator - this air cleaner charges the particles in a charging zone by means of a high voltage. The particles are then collected on plates and removed from the air stream.

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