VENTILATION HELPS INSURE SAFE AIR

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Natural ventilation does not always provide a safe environment in confined work areas. Hazardous and often deadly gases can collect and build up inside confined or enclosed spaces not designed for human occupancy. Harmful gases enter into spaces or are created by decomposing organic matter. In some cases, there is not enough oxygen to support life due to oxidation (rusting), oxygen displacement, or anaerobic bacteria. In other cases, high levels of oxygen enter spaces from leaky welding hoses or from chemical oxidizers. An oxygen-enriched environment increases the combustibility of combustible materials, including workers' clothing and hair.

Ventilation helps insure proper oxygen levels and remove toxic, flammable, and noxious atmospheres. Mechanical ventilation also cools the work environment.

Compact and portable air-ventilation blowers are ideal for supplying fresh air or exhausting contaminated air around construction sites. Portable blowers can provide free flow between 600 and 5,000 cu.ft. per minute (cfm). Large air movers can move air at up to 15,000 cfm.

BEFORE WORK BEGINS

Construction managers and supervisors must always assume that a confined space or enclosed work area not designed for human occupancy is unsafe to enter until it has been tested with a proper gas monitor. Even confined spaces that test safe should be ventilated for at least five minutes before entry to insure a safe atmosphere. Always remember that air monitoring is just the first step to ensuring safe entry and that ventilation should never be relied on by itself. In fact, you should conduct air monitoring periodically or continuously even when using ventilation equipment.

PULLING VS. PUSHING

Deciding to supply or exhaust air is not a matter of just setting up a blower and turning it on. Supervisors must understand that blowers push air thirty times farther than they can pull it. Therefore, supplying air and creating a positive pressure in the space (by blowing) is generally the preferred method.

Several different methods can be used to ventilate a space:

◆ General dilution ventilation creates a safe atmosphere by constantly supplying fresh air, which maintains oxygen levels and dilutes contaminant levels. Contaminated air is pushed out by creating a positive pressure in the space. Limitations of dilution ventilation include possible dead air spaces in corners, drains, and other areas where air is not moved; possible inadequate dilution to ensure a safe atmosphere; and chilling caused by large volumes of air blowing into the space.

◆ General exhaust ventilation will remove contaminated air; however it also creates negative pressure in the space. This method is often misunderstood, and when done improperly, it can increase rather than lower contaminants. For example, most exhausted air is collected from a distance equal to the diameter of the duct. Adding a baffle can increase the air collection distance, but it is still limited. Air is pulled from the space, creating a negative pressure that can pull contaminated air from connected pipes or drains and possibly increase the hazards in the space.

◆ Local exhaust ventilation collects contaminants at their source and exhausts them outside the work area. For example, welders in an enclosed space can place a local exhaust ventilation duct near the work to remove fumes as they are created. OSHA requires general mechanical or local exhaust ventilation when workers are welding or cutting in enclosed spaces. This method is limited by the ability to place the ventilation close to the work and no farther away than the diameter of the duct. In some situations, general ventilation may be needed at the same time to avoid creating negative pressure in the space or to control other contaminants in the environment.

FINDING THE RIGHT EQUIPMENT

There are two basic types of ventilation systems: radial-flow and axial-flow configurations. They are powered by gasoline, diesel, propane, compressed air, or electricity (110-volt AC or 12-volt DC). Ventilator systems are constructed of aluminum, steel, or high-impact plastic.

When selecting a ventilation system for a specific job, carefully analyze all the factors at your jobsite. Each system has limitations. For example, you would want to use a system that is intrinsically safe (explosion proof) in a space that contains a flammable atmosphere.

You must determine the volume of space to be ventilated in advance. For cubical spaces, the volume is determined by multiplying length by width by height (V = L x W x H). For cylinders, the formula is volume = πR^2 x L, where π= 3.14, R = radius in feet, L = length or depth in feet. For example, a 10-ft.-deep manhole with a 6-ft. dia. has a volume = 3.14 x 9 x 10 = 282.6 cu.ft. 3 ft. radius

HOW MANY AIR CHANGES?

The volume of air required is based on space size and the number of air changes. At least six air changes per hour should be provided. However, the number of air changes required per hour varies depending on local and state requirements. For example, San Diego requires a minimum of twenty air changes per hour. (Blowers are generally rated in cubic feet per minute, which means you must multiply the rated cfm the blower can provide by sixty minutes to determine the number of cubic feet per hour that can be supplied.)

Space size and configuration, the number of required air changes, and the blower's delivery capabilities determine the size and number of blowers required. Jobs involving large confined spaces, such as pipelines, vaults, manholes, and lift stations, may require more than one blower or a blower capable of delivering large quantities of air.

One 90-deg. bend can reduce air flow by as much as 50 percent, and two bends will reduce air flow even more. Always refer to manufacturers' specifications to determine air flow capabilities and reductions.

Friction causes air flow to decrease as the length of the air duct increases, based on the square of the length of the duct. Some manufacturers say the maximum safe duct length is 25 ft., while others set a limit of 100 ft. Always follow the manufacturer's specifications. The size of the duct and the capabilities of the ventilation system will be the deciding factor. Minimum safe duct size is 8 in.

When exhausting air from a space, always ensure that enough make-up air is provided. Otherwise, the blower will not operate at its rated capacity. When exhausting air, make sure that the make-up air is not pulled from a contaminated environment into the work area.

Pop Quiz: Using the volume of the 10-ft.-deep, 6-ft.-dia. manhole above, determine blower size. Assume that local law requires a minimum of ten air changes per hour and that there will be a 60 percent reduction in air flow due to two 90-deg. bends in the duct. Will a blower capable of providing 1,200 cfm with an 8-in. duct be large enough for this job?

Answer: If we reduce the volume of air by 60 percent due to the two 90-deg. bends, the volume of air provided by the blower will be 480 cfm. Multiply 480 cfm by 60 minutes, which equals 28,800 cu.ft. per hour. We need a volume of 283 cu.ft. times ten air changes per hour, which equals 2,830 cu.ft. per hour. Provided we block off any pipelines entering into the manhole, we would be well within the required number of air changes.

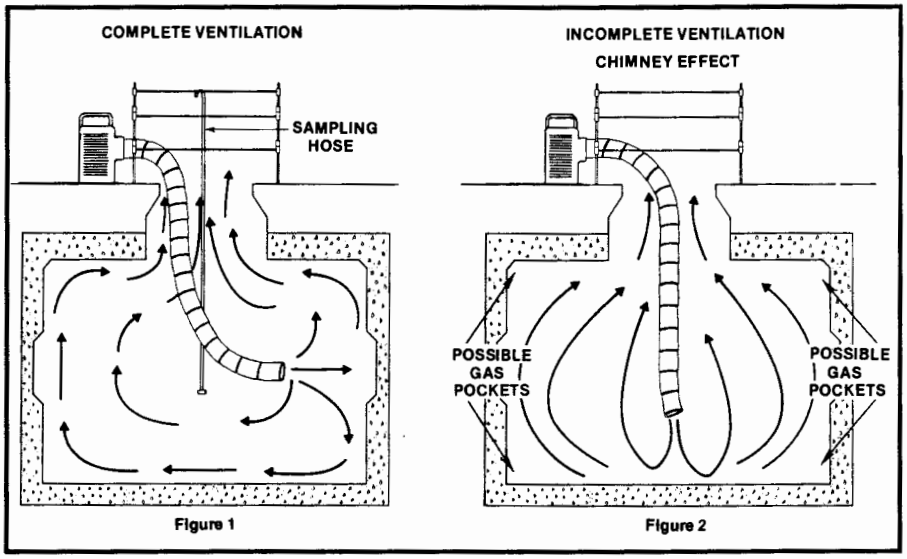
PROPER VENTILATION

The mechanics of mechanical ventilation vary from space to space. A space's atmosphere is affected by the type of entry; the volume, type, and configuration of the space; location; weather conditions; and contaminants.

Always make sure that the blower intake hose is away from any source of potentially harmful gases or fumes, such as vehicle exhaust pipes. Blowers should be placed downwind or to the side of the space's portal to prevent engine exhaust from the ventilator power source from entering into the intake or the portal. Use an intake hose, and be sure that it doesn't pull in the contaminated air that is being pushed out of the space.

Pockets of contaminated air can collect in the corners of confined spaces. To ensure even distribution of air in the space, place the ventilator hose about halfway up the side wall directed at the wall. This setup circulates the air around the space and pushes the contaminated air out the portal. (See diagram on next page).

In some situations, large-diameter hoses block the entrance to the space. In these situations, use a saddle vent to achieve continuous flow



into the space while providing continuous access through the manhole without hindering worker movement or flattening the hose.

IMPORTANT CONSIDERATIONS

Every space is unique, and there are many things to consider before entry begins.

Static electricity can build up as air flows through a hose or duct. When discharged in the form of a spark, this buildup can cause a fire or explosion in a flammable environment. Therefore, hoses and blowers should be electrically bonded and grounded to dissipate any static electricity. Blowers used in environments with flammable or combustible atmospheres must be intrinsically safe and rated for that purpose.

In spaces where pipe openings cannot be blocked off, such as active sewers, you may have to open manholes on both sides of the space containing workers. This will help prevent contaminated air from being pulled into the work space as air is forced into the manhole. If other manholes are not opened, the turbulence created in the space might pull contaminated air out of the attached pipelines and into the work space.

Worker hypothermia and dehydration must be considered. The air temperature in spaces deeper than 4 ft. is generally 50 to 60 degrees. When you move air around workers in the space, wind chill comes into play.

Noise generated by the ventilation equipment and construction work can be amplified in confined work areas. High noise levels can damage hearing and interfere with communication between entrants and attendants. Hearing protection may be necessary, along with some type of device to improve communication between the workers in the space and the attendant outside the space.

ESTABLISH A PLAN

Proper mechanical ventilation equipment reduces employee exposure to atmospheric hazards. The equipment is simple to set up and easy to use when you understand its limitations. Workers must be trained to use the equipment. Contact the distributor or manufacturer for additional information and assistance. Like everything else you want done right, you must establish a plan. And remember, a thorough plan for ventilation includes air monitoring. ■