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Confined Spaces:

Blowing It Out

Like to change the atmosphere in your workplace? Many people would, especially if they're working in a confined space.
By Tim Morrison

Ventilation can be simply defined as the process of continuously moving fresh air into an area. This process is the best way to control most atmospheric hazards found in a confined space. Effective ventilation systems can provide a method of maintaining a breathable atmosphere within the space by achieving a reduction in the level of atmospheric contaminates (gases, vapours, mists, fumes and dust) within the space; and by heating or cooling air in the space to make the temperature comfortable to work in.
There are essentially three methods of ventilation: the natural method;
mechanical supply; and mechanical exhausting. Choosing the best method will depend on the size and configuration of the space, the work being performed, how many people are inside the space working, and the nature of contaminates and hazards to be managed. In addition, a building's own ventilation system may also impact the process.

Natural ventilation

Natural ventilation occurs when the space is opened and the natural air currents cause air flow into, through and out of the space. These currents develop because of thermal conduction within the space; heavier or lighter gases within the space; or a variance between the inside and outside atmospheric pressures.

Natural ventilation is quiet, requires no power source, doesn't cost money to operate, will not cause ignition of combustible gases or vapours, and is maintenance free. This method is highly unpredictable (as to what part of the space is ventilated) and very inefficient (in regard to consistency of contaminate dilution throughout the space). In addition, its passive nature makes this practice difficult to adjust to changes in the conditions in the space.

Supply ventilation

Supplied ventilation is the process of moving fresh air into the space and forcing the contaminated air in the space out to dilute the atmospheric contaminates. Depending on the legislation, supplying fresh air equivalent of up to 20 air changes per hour, or ACH, is required to achieve adequate dilution of contaminates. Supply ventilation is very effective in managing atmospheric hazards.
Forcing air into the confined space creates turbulence that will ventilate a greater area and increases air pressure and that will help to eliminate the chance of gas seeping back into the confined space through crevices or ducts. As well, blowing air into the confined space reduces the chance of flammable gases being drawn across the ventilator motor, particularly in the case of an axial ventilator where the motor lies directly in the air path.

Disadvantages of supply ventilation include the fan noise, stirring up dust, and during cold weather, the supplied air will lower the temperature within the confined space. However, most of these drawbacks can be controlled with accessories (such as heating units) that are available.

Exhaust ventilation

Exhaust ventilation pulls air (and contaminates) out of the space and decreases air pressure causing fresh air to be drawn into the tank through any available opening. Exhaust systems operate best when the air intake is positioned close to a very localized work area to carry away any contaminate that is generated before it can spread throughout the space. It can also work in dusty areas where supply ventilation could stir up the dust and cause eye injuries or disrupt the work in progress.

However for most applications, general area exhaust systems are not recommended. For instance, it is difficult for exhaust systems to create sufficient air movement to cause all the air in the space to move around and dilute the contaminates to acceptable levels. Supply ventilation can force air into the space up to 30 times the distance that an exhaust system
can effectively draw it out. Other disadvantages to exhausting systems include fan noise, stirring up dust, and drawing in cold atmospheric air.

Much has been written about ventilation systems by various organizations, most notably the American Conference of Governmental Industrial Hygienists (ACGIH). However with the many variables in confined space work, there is only limited information on confined space ventilation practices. Most information on confined space ventilation theory is based on industrial hygiene theory combined with empirical data developed by Bell Telephone Laboratories in the early 1970's. Their study looked at how to get smoke out of a standard below ground telephone vault. They found success at clearing the vault required the hose and fan to be in a set position with a fan and air flow large enough to supply seven times the volume of air in the space per hour.
The researchers do caution that changing the space or contaminates will alter the outcomes. In the early 1990's, the School of Public Health at the University of Michigan also conducted a study on confined space ventilation. This study looked at a variety of different gases,

shapes of spaces and other variables and prescribed 20 air changes per hour. However, no matter what source or standard is the basis for your ventilation procedure, you must use a gas monitor with an appropriate sensor to verify that your ventilation is performing as desired.

No matter the method, to achieve any form of reliable ventilation, a mechanical moving device with some form of directional device (usually a duct) must be used. The equipment will create noise, block the entry point and may even create a potential ignition source. But despite the problems, they are a necessary hazard control system. The selection of a specific ventilator should be based on the following factors:

* job details such as the atmospheric hazard, the size of the confined space, etc.;
* the airflow required
* the volume required at the end of the duct to control the hazards present; and
* the breeze to ensure worker comfort in the space.
* duct friction loss to ensure adequate air volume reaches the end of the duct.
* fan performance details such as fan design, it's weight, sound levels, as well as power supply and demand.

Job details: Before any ventilation can be planned, it is important to know the contaminate's density (whether it is heavier or lighter than air) and how fast is it created. In addition how much space is available for the ventilation equipment.

Airflow: Airflow is the amount of air delivered at the end of the ventilation hose to create the desired air changes per hour in the space.

Breeze: Another instance where air volume is important is the ACGIH "air velocity ranges" for work areas. According to the ACGIH, work areas air motion should have a specific range of air velocities. For workers who are sitting, the range is 75 to 125 feet per minute (fpm); for standing workers, it's 100 to 200 fpm.

Fan performance and design: Ventilators come in a variety of designs. Knowing performance information supplied by the manufacturer such as fan speed, design, and motor drive size can make the selection process easier.

The most important factor in determining air volume at the end of the hose is friction loss, or the amount that the breeze decreases from point A to point B. Friction loss can reduce the airflow by over 50 per cent in a 15-foot length of hose. The manufacturer usually provides friction loss information, however, the unit must be set up according to their instructions to obtain their stated airflows.

VENTILATION OPERATION

Mechanical ventilation of a space will require a fan that generates enough air flow to achieve 20 air changes per hour, sufficient ducting hose and webbing or rope to position and secure the hose.

Supply ventilation

1. Position the fan four to six feet from entry point with the fan intake pointed into the wind. For eight feet from the fan intake, the area should be free from airborne contaminates and loose stones.
2. For vertical spaces, position the hose in approximately 75 per cent of the distance to the bottom of the space, and no more than maximum 15 feet from the work area.

Tie a rope approximately 2' from the end of the hose and lower the hose into the space. Raise the end of the hose with the rope to achieve a second bend (inside hose angle between 120 and 150 °) in the hose and secure the rope to keep the bend in place. For horizontal spaces, lay the hose on the floor with the end of the hose within 10 feet of the far wall.

3. Turn the ventilator on before placing the hose into the space and let the unit run for time enough for two complete air changes before performing any gas testing. When testing, ensure the detector is out of the direct ventilation airflow pattern.
4. Ensure there is no "short circuiting" of the air. If the space has a second opening, place the ventilator at the smaller opening to create better air circulation through the space. If the space has only one large opening, place the ventilator on the opposite side farthest from the area where the workers will enter the space.

Exhaust ventilation

1. Position the worker three feet from source of contaminate generation point. If the entire space is contaminated and to be cleaned with exhaust ventilation, keep the hose three feet from the worker
2. Position the duct one foot from the contaminate source, and one foot below the worker's breathing zone.
3. Position unit so that the exhaust end of the unit is out of the wind and the exhausted air is not pull back into the space. If the exhaust contaminates are explosive, make sure the air does not come in contact with the fan motor. In addition, the unit should be grounded.
4. If the contaminates being purged are potentially lethal, an area 10 feet in front of all openings should be considered hazardous, barricaded and monitored periodically with the gas detector. In addition, the attendant should wear appropriate respiratory protection.

In all cases

1. Ventilation of the confined space should continue while the space is occupied to ensure a safe working environment. Since ventilation can help control heat and humidity and therefore it should be turned on even if the workers inside are using supplied air breathing apparatus.
2. If there is a potentially hazardous environment exhausting from the space near the ventilator, attach a four foot hose to the intake side of the fan to prevent recirculating the polluted air coming from the space. In addition, monitor the area around the entry point with the gas detector and have the attendant wear appropriate respiratory protection.
3. For both supply and exhaust operations involving atmospheres that present a LEL reading on the gas detector, always remove or retract the ventilation hose before the ventilator is turned off. With no velocity pressure in the hose to keep combustible gases out, the gases can come up the hose, across the hot motor and possibly ignite.

Tim Morrison is president of Safetyscope Inc. a firm that specializes in "getting people to work in confined spaces".