

Selecting and Using Gas Detectors in Ventilation Systems

Introduction:

Because of the effect that chemicals can have on peoples' health, there is an ever-increasing awareness of the need to keep human occupied areas as free as possible of dangerous gases. Toward this end, regulating agencies, such as OSHA and ANSI, have established maximum concentrations of many of the more commonly encountered contaminants. To meet these standards, most building designs rely upon ventilation systems that remove the unwanted gases and fumes, and replace them with fresh outside air. However, operating these systems continuously greatly increases the total operational cost of the building.

In order to meet the ventilating requirements, while keeping the operating costs as low as possible, many buildings are designed with an **on-demand ventilation system**. Using this type of system, the levels of dangerous gases are continuously measured, and the ventilating components are operated only as long as required to keep the gas concentrations below acceptable levels.

This brief paper discusses that portion of the system that monitors the gas levels and provides the on-demand control of the ventilating components. These control components are known as **gas detectors, gas controllers and gas sensors**. The most common gases encountered, desirable detector features and capabilities, and system design factors will be discussed, as well as some of the more common design mistakes.

What Is A Gas Detector/Ventilation Controller?

Simply stated, a gas detector/ventilation controller measures the concentration of a given gas within an enclosed area and actuates that area's ventilation equipment when the gas concentration exceeds a preset level.

The simplest detector/controller detects only one type of gas and has the capability to control only one piece of ventilation equipment or a single group of ventilation equipment. The more complicated detector/ventilation controllers can monitor for two or more gases simultaneously, and have the capability to control the ventilation equipment in stages. **Brasch Manufacturing's combination CO/NO₂ detector is one example of a controller with two sensors.** Some units can also communicate with a building management system thereby providing expanded capabilities.

The most common gases monitored are **carbon monoxide (CO), nitrogen dioxide (NO₂) and carbon dioxide (CO₂)**. CO and NO₂ occur where internal combustion

engines are operated, while CO₂ is most closely associated with human occupied office spaces and rooms.

There are other types of detectors produced to monitor gases such as ammonia, hydrogen sulfide, sulphur dioxide, hydrocarbons and oxygen. However, these detectors are used in very specific applications, and find less use than the major detectors mentioned above.

Where Are Detector/Ventilation Controllers Used?

CO and NO₂ detector/ventilation controllers are used in any enclosed space where internal combustions engines are operating. Places such as underground garages, service garages, maintenance sheds, fire departments, small engine repair shops and warehouses use these units for controlling the ventilation equipment only when required to remove the buildup of dangerous gases. **Many state, county and local codes require that ventilation equipment run continuously unless a detector/ventilation controller is installed.**

Carbon dioxide (CO₂) detector/ventilation controllers are used to remove the build up of carbon dioxide in office spaces, school rooms and conference rooms. These units address some of the problems associated with "sick building syndrome".

What Features Should The Detector/Ventilation Controller Have?

The simplest unit would have a sensor for the specific gas to be monitored and a set of relay contacts that would dose at a preset concentration and turn on the ventilation equipment. Although this unit is sufficient to cover a large number of installations, most units are equipped with extra features that allow them to operate in the most efficient manner.

Many units come standard with a display that indicates the actual concentration of the gas being monitored. Front panel lamps are usually supplied to indicate the current operating status. Extra relay contacts for controlling additional ventilation equipment is also common, as well as relay contacts that trigger an external alarm. Most units contain an internal alarm as well. A provision for adjusting the concentration of gas that will actuate the ventilation equipment is usually available. An adjustable time period may be available that delays the ventilation equipment actuation once the trigger concentration is reached. This delay period prevents the ventilation equipment from running in short cycles.

Other features that are desirable, but not always standard, are the capacity for two sensors, capability of operating directly from 120 VAC power, a self-test routine at startup, internal alarm silence switch, highly reliable electro-chemical sensors and provisions for replacing the sensors in the field when calibration is required.

All units must be tested to the correct UL standard, and listed by a reputable testing agency such as ETL or UL.

What Factors Affect The Design Of The Finished System?

The purchase of a high quality detector/ventilation controller is only part of designing a properly operating system. Many systems fail to operate satisfactorily because of improper wiring, incorrect placement of the controllers, or failure to consider the total size of the monitored area and the type of gases that will be present.

Effective Coverage Area:

Most controllers can effectively monitor between **5000 to 9000 square feet** of space in a room with a ceiling height of 13 feet or less. In areas, such as warehouses, where ceiling height can exceed 13 feet, the effective area that can be covered by one controller should be reduced to **3000 to 5000 square feet**. Controllers that are mounted against a wall should be considered as capable of monitoring only half of the areas stated above.

Mounting Height:

These units are installed for the health benefits of the people entering or working in an area. Therefore, they provide the best protection when mounted at a height from which most of the occupants acquire their breathing air. This usually means a **height of 5 to 6 feet above the floor**.

Types of Sensors:

The type of gases that may be present in the monitored area depends upon the source producing the gas. In office spaces and conference room, the unwanted compound is produced by the people occupying the area. Therefore, the gas that should be monitored is **carbon dioxide**.

In areas, such as underground garages, service and maintenance sheds, warehouses and the like, the most common gas produced is **carbon monoxide** that comes from the combustion of gasoline in internal combustion engines. However, **nitrogen dioxide** may exist if any diesel powered vehicles are present. In firehouses, both carbon monoxide and

nitrogen dioxide gases will be produced as both types of vehicles are found there. The proper design must consider the types of gas sources that will be present.

Mounting Location:

Although the coverage area and mounting height of each controller is important, other factors must be considered. The placement of the controllers in the area to be monitored has a large part to do with the success of the final design.

Avoid locations that may not contain the average gas concentration of the monitored area. These include locations near open doorways, ventilating inlets and outlets, heating and air conditioning discharge vents and other locations that tend to have large volumes of air movement. The gas concentration in these locations will most likely be less than the average values in the less disturbed areas.

Do not place the controllers in locations that would directly receive undiluted exhaust gases from the producing sources. These exhaust gases contain high levels of water, acids and other contaminants that could easily reduce the expected operating lifetime of the sensor.

Do not mount the controller in locations where damage from passing vehicles is possible.

Do not mount the controller near open containers of chemicals such as gasoline, diesel fuel, kerosene, alcohols or cleaning fluids. Exposure to these types of hydrocarbons can reduce the expected operating lifetime of the sensor.

Do not expose the controller to paint fumes. These fumes are especially damaging to nitrogen dioxide sensors.

Do not restrict the air flow to the controller housing. Restricting the air flow to the housing will increase the controller's response time to a change in the gas concentration.

Do not mount the controller in a location where it may get wet. Moisture from passing vehicles contains road salts that are corrosive. Chlorine, contained in tap water, can cause corrosion of P.C. board copper tracks and electrical components.

What Are The Most Common Design Mistakes?

As with all technical products, failure to apply basic rules of design and operation can cause degraded performance. A few of the more common mistakes are discussed below.

Many high-quality controllers are shipped from the factory with **default settings** that fall safely within the requirements of either OSHA or ANSI. Unless the requirements of a local agency are more stringent, use these settings as a starting point for optimizing your system. **As requirements often change when codes are updated, it is a good practice to check the appropriate agency's website for the latest information.**

Gas Concentration Trigger Levels:

A common tendency is to set the gas concentration at which the controller actuates the ventilation equipment to a level that is **too low** for the application. Doing this results in frequent and unnecessary cycling of the equipment, and defeats the original purpose of an on-demand ventilation system. Set the trigger level at the highest setting that will produce the most efficient equipment operation. **Remember to always stay within the range specified by the controlling agency's requirements.**

Setting the trigger level **too high** can also cause degraded performance. Although the ventilation equipment will operate less often, a dangerous situation can easily exist in which the gas concentration exceeds the recommended exposure level. Again, use the highest trigger level possible while staying within the requirements of the controlling agency.

Delay Period Set Incorrectly:

Most controllers allow the user to adjust the period between the time the trigger level is exceeded and when the ventilation equipment is actuated. A correct setting reduces the effect of a transient concentration of gas on the system operation. When properly set, this delay will cause the system to respond only to the average concentration of gas in the monitored area.

Setting the delay time **too short** will cause frequent operation of the ventilation equipment and waste energy. A delay time set **too long** can allow the concentration of the gas to reach a dangerously high level before the equipment begins to reduce this concentration.

Begin to optimize your system using the default delay time set at the factory before shipment. If your controller has field adjustable delays, but shipped with no default setting chosen, start with a setting of **three minutes** and make adjustments as necessary.

Nitrogen Dioxide and Diesel Smoke:

OSHA standards list a workplace **concentration of 5 PPM** and above as a dangerous level of nitrogen dioxide. This gas is produced in diesel engines as a result of the high temperatures and pressures that are present during operation. The gas is first produced as nitric oxide and is converted to nitrogen dioxide when the diesel exhaust exits the exhaust pipes and contacts the ambient air. **The components to produce this gas are oxygen and nitrogen, both of which are taken from the combustion air pulled in through the diesel's air intake.**

Although a diesel operates at a high level of efficiency, the exhaust contains soot and smoke produced by the combustion of the fuel inside the engine's chambers. **This soot and smoke would be present even if the engine produced no nitrogen dioxide.** The only component that smoke and nitrogen dioxide have in common is the oxygen contained in the intake air.

A detector/ventilation controller that contains a sensor to monitor for nitrogen dioxide operates the ventilation equipment in response to the concentration of that gas. Although the ventilation equipment does not discriminate between nitrogen dioxide and diesel smoke, using the detection of nitrogen dioxide to control the level of diesel smoke in a work area may not produce acceptable results. **If the removal of diesel smoke is the prime object, use a smoke detector in conjunction with the nitrogen dioxide controller.**

CO vs. NO2:

Simply stated, **gasoline engines** produce large amounts of **carbon monoxide** while **diesel engines** produce little CO but relatively large amounts of **nitrogen dioxide**. However, when a diesel engine is first started, the amount of carbon monoxide is larger and reduces in concentration as the engine reaches operating temperature.

If only gasoline engines are present in a monitored area, choose a carbon monoxide controller. If only diesel engines are present, choose a nitrogen dioxide controller. If both types of engines will be present, choose controllers that can monitor for both gases.

Conclusion:

Although brief, this paper attempts to highlight the most important considerations in the design and use of gas detectors/ventilation controllers. Undoubtedly, the designer will encounter situations that do not fall neatly within the range of the statements made above. When that occurs, please contact your local Brasch distributor, or the factory at:

Brasch Manufacturing Co., Inc.
2310 Millpark Dr.
Maryland Heights, MO 63043

(314) 291-0440
Fax: (314) 291-0646
Website: <http://www.braschmfg.com>
E-mail: braschmfg@braschmfg.com