Gas Monitoring for Ventilation Control and Energy Management (Vehicle Garages)

The growing demand for underground and enclosed parking and maintenance garages (resulting from limitations on land availability) has increased the awareness and need for proper ventilation and control systems. In addition, increased health and safety programs have only added to the concerns of toxic and combustible gases in confined or enclosed spaces.

Historically, ventilation and make-up air fans were operated on a continuous or time-cycling basis. Advances in the gas detection industry have made alternative approaches to this control not only reliable and cost effective, but benefits are realized to other management issues as well.

This is a short review of gas detection as it pertains to ventilation control in parking structures. Carbon Monoxide, a deadly by-product of the combustion engine, will be the target gas.

BENEFITS OF A GAS DETECTION SYSTEM

1. SAFETY Obviously, safety is a major concern to landlords, workers, and the general public. A continuously operating gas detection system ensures 24 hour per day monitoring of ambient air quality. By placing the sensors close to the toxic gas source of automobiles and trucks throughout the facility, the owner can be confident of breathable air at all times, in all areas.

2. REDUCED MAINTENANCE COSTS Without proper gas monitoring, fans must operate, in many cases by law, on a required complete air change strategy. This could be accomplished by using time cycling relays or running the fans continuously. This means that whether the area requires ventilation or not, the ventilation and make-up fans must be operated.

A zoned dual level gas detection system allows the fans to be operated as needed and on low speeds in only the areas that require ventilation due to carbon monoxide build-up. If high activity causes the levels to continue to rise, a second alarm level can automatically turn the fans to high speed or call upon additional fans within the zone or from other zones.

Reduced fan run time reduces wear on bearings, belts, and motors. Increased fan life and $avings are realized.

3. ENERGY SAVINGS A major benefit to a gas detection system is from energy savings which becomes evident in two ways.

A. Ventilating warm air conjures up the old cliche of money flying out the window. Reducing the air changes will reduce the strain on the building HVAC system by maintaining a stable air temperature within the structure.

B. Reducing the run time of fans to an ON DEMAND basis will reduce energy requirements for the actual fan operation. This can be realized for both the exhaust fans AND the make-up air fans.

4. OCCUPANT AESTHETICS Increased confidence in building operational safety and reduced noise from fan operation will increase the occupants satisfaction level of building operations. In off hours (nights and weekends), fans in non-active areas will not need to operate, which will decrease the nuisance gray noise caused by fan operations.

TYPICAL PRINCIPLES OF GAS DETECTION

There are a number of styles of gas detection available in the marketplace today. The following looks at three of the more popular sensor technologies used to detect carbon monoxide in parking structures.

1. ELECTROCHEMICAL CELL This sensor contains an acid electrolyte and teflon membrane which is porous to gas but non-porous to liquid. The air diffuses into the cell while the sensor contains the acid. The toxic gas oxidizes on a sensor and voltage differential is determined.

This sensor is relatively specific to selected gases (ie. carbon monoxide) and will not, for the most part, respond to alternate gases in the air such as gasoline, paint fumes, etc.. The accuracy is good and the output is linear over it's determined range. The cell has a limited operating life of under two years and is expensive to replace.

2. METAL OXIDE SEMICONDUCTOR (mos) A popular sensor due to it's low cost and long life (minimum 3-5 years in a typical environment), this small sensor changes it's resistance across a fine filament wire when carbon monoxide reacts with the oxygen absorbed on the filament surface. This resistance is monitored and used to activate alarms.

The sensor is not specific to carbon monoxide and will respond to other toxic gases. This can provide added ventilation safety when there are gases due to paint spills etc.

3. INFRARED This type of instrument passes the air sample through a chamber and analyses the light (energy) absorption properties of the air sample. Different gas molecules possess different characteristics and a gas "thumbprint" can be determined. While this technique is quite accurate and gas specific, the initial cost due to sample pumps and optics can be high.

To offset the high sensor costs of the electrochemical and the infrared sensor, sample pump systems are sometimes used. A pump and valve assembly draws an air sample from various locations throughout a facility in a timed sequence. Therefore, a limited number of sensors are required by having the entire garage area share only a few sensors. The drawbacks to this style are the lagtime between sensing points (only one small area is being monitored at a time), contamination to the sample tubing, and the high maintenance of the continuous running pump.

INSTALLATION CONSIDERATIONS

There is no set guideline as to the number of sensors required for a facility. Based on the general dispersion rate of carbon monoxide, typically one sensor for every 5,000 square feet of open garage should be considered.

Look for "dead zones" tucked around corners and where ventilation may be lacking. Spread the sensors evenly throughout the garage with special attention to public areas such as pay booths and elevator waiting areas.

Carbon Monoxide is close to the same molecular weight as air (air = 29, CO = 28) and will disperse evenly throughout the room. Initially, the carbon monoxide is hot from the vehicle engine and will rise, but it will quickly cool to room temperature. The sensors should be mounted in the "breathing zone" about 5 to 6 feet up from the floor.

Keep the sensor away from the direct outside air and away from the direct airstream of the fans. Also, keep the sensor away from direct intake vents as outside air may cause false alarms if contaminated (such as from passing or waiting vehicles).

Zone the garage to interlock the fan operation in a sensible manner. There is no exact science to sensor placement since every facility is different in layout and HVAC operations.

SUMMARY

In vehicle storage facilities (parking and maintenance garages), carbon monoxide is generally the target gas chosen. CO is most prevalent due to gasoline powered vehicles. Recent Alternative Fuel vehicles have increased the concerns of explosion gas leaks such as Natural gas and Propane. In addition, Nitrous Oxides from diesel vehicles are of a concern to workers. It is, however, carbon monoxide that is odourless and lethal and should be considered as the most influential toxic gas that may be present in a vehicle facility.

It is important to review all the requirements of a facility and select a system that best suits the overall building interests and intentions.

A properly designed system should be able to meet all of the these demands:

- low installation costs
- continuous all points field monitoring
- low sensor replacement costs
- easy maintenance and calibration
- low initial capital cost
- simple operation
- expandable to other gases and structural growth

Consideration of the above will provide not only the Safety and Ventilation Control needed, but should provide a healthy energy and maintenance savings as well.