The ABC's of Industrial CO2 Gas Detection
February 20th, 2013
Part I: Refrigerant Leak Detection
Part II: Process Leak Detection

Regulatory concentrations of interest for CO2:

OSHA PEL(Occupational Safety and Health Administration - Permissible Exposure Limit)

- 5000 ppm (0.5%) TWA (8 Hour Time Weighted Average).

NIOSH REL (National Institute for Occupational Safety and Health - Recommended Exposure Limit)

- 5,000 ppm (0.5%) TWA
- 30,000 ppm (3.0%) STEL (Short Term Exposure Limit =15 min time weighted average)
- 40,000 ppm (4.0%) IDLH (Immediately Dangerous to Life and Health)

ACGIH TLV (American Conference of Governmental Industrial Hygienists - Threshold Limit Value)

- 5,000 ppm (0.5%) TWA
- 30,000 ppm (3.0%) STEL

CO2 Gas Detection-*Refrigerant Leak Detection*

When CO2 is used as refrigerant in a cascade system

Choosing Alarm set points and actions for CO2:

The typical CO2 Gas Sensor for refrigerant leak detection should be ranged 0-3% CO2, with warning set points at 0.5% (8 Hour TWA allowable exposure) and alarm set points at 1.0% (10,000ppm) CO2.

With the above warning and alarm set-points, the recommended actions would be to investigate a potential Carbon Dioxide leak at 0.5%, and shut down valves to the evaporator and evacuate the room at 1.0%. A 1.0% evacuation is recommended rather than the 3.0% STEL, because it is a point measurement and CO2 concentrations can be higher elsewhere in the room.

One issue to keep in mind is that unlike ammonia, CO2 is always present in air, and concentrations can build up to these levels in a facility from sources other than a leak in the CO2 refrigeration system. Common examples of CO2 presence are from dry ice usage, and normal personnel respiration in a non-ventilated room. Field experience indicates that a Carbon Dioxide alarm at 0.5% is high enough that background CO2 levels will not reach that level in most cases; therefore 0.5% CO2 can be reliably used as a leak indicating set-point.

Table I:

Level of CO2	Action	Method
0.5%	Investigate potential leak.	Hand-held CO2 leak detector.
1.0%	1. Shut down valves to evaporator. 2. Evacuate the room.	1. set relays with valve shut offs. 2. Horn/Strobes and proper training.

*There are a few exceptions to this rule, including: Poultry processing plants, dry ice plants, and bottling plants. In these plants, trying to warn lower than 0.5% will usually result in frustrating "false alarms" due to CO_2 from sources other than a refrigeration system leak. – See Part 2: *Process Leak Detection* for more information.

Selecting your CO_2 Sensor range:

To select the proper CO_2 sensor range, two primary concerns must be balanced:

1. You want a range low enough to give you good resolution and accuracy at the 0.5% and 1.0% set-point levels.
2. You want the range to be high enough to give a real indication of truly dangerous situations.

If a 0-1% sensor is chosen and found in a leak situation at 1.0% CO_2, more information is necessary to make the proper response decision. It is very important to know if the STEL of 3.0% has been exceeded. If a level of 3.0% CO_2 has been exceeded, investigation and response must be executed with great caution.

Choosing a 0-5% sensor range does not give the desired resolution at the 0.5% warning level. A 0-5% CO_2 sensor can be desirable if paired with a 0-1% sensor, or if you are monitoring for catastrophic leaks only.

Choosing the 0-3% range is best for balancing concerns in industrial CO_2 detection. The 0-3% range provides accuracy and resolution at the 0.5% and 1.0% levels, and gives operators the crucial information for calculating the seriousness of the situation. In terms of danger, there is a big difference between 1.0% and 3.0% CO_2 and your fixed CO_2 gas detector should provide this information accurately and in a timely manner.

Mounting your CO_2 sensor:

The recommended method for mounting CO_2 sensors is to mount them in the *breathing zone* (~5 feet off of the floor). This is representative of what personnel are exposed to in an everyday environment. CO_2 vapor is heavier than air, so mounting a CO_2 detector lower than the breathing zone is okay. On the contrary, do not mount a CO_2 detector above the breathing zone.

CO2 Gas Detection-*Process Leak Detection*

When CO2 is used in a process

CO_2 monitoring when CO_2 is used in a process (rather than as a refrigerant) differs a bit in philosophy. These applications include:

Dry Ice Plants, CO_2 plants, Poultry Processing Plants, Bottling Plants, and any plant with CO_2 freeze hoods.

The main issues of concern in process leak detection are:

1. Warning and ventilation are key output functions with evacuation beginning at 3.0% instead of 1.0% CO_2.
2. Sensors need to be located where people frequent, not necessarily close to the CO_2 source.

   a.A sensor near a CO_2 source can result in unusually high readings.

Choosing Alarm set points and actions for CO2:

The typical CO_2 Gas Sensor for process leak detection should be ranged of 0-3% CO_2, with a warning set-point at 0.5% (8 Hour TWA allowable exposure) and alarm set-points at 3.0% (15 minute STEL) CO_2.

With the above warning and alarm set-points, the recommended actions would be to initiate ventilation at 0.5%, and set off alarms for evacuation at a level of 3.0% CO_2 has been reached.

Table III:

Level of CO2	Action	Method
0.5%	Initiate Ventilation	set relays with fans.
3.0%	Alarms for evacuation	Horn/Strobes and proper training

Selecting your CO2 Sensor Range:

For CO_2 process leak detection, you must consider the following issues:

1. The ability to initiate ventilation at 0.5%.

2. The ability to initiate evacuation at 3.0%.

A 0-1% sensor is out of the question unless directly paired with a higher range sensor. The accuracy on the low end is beneficial, but the inability to detect past the range of 1.0% renders this sensor inadequate for process leak detection.

A 0-5% sensor is not accurate enough on the low end of the scale to trip precisely at 0.5% to initiate ventilation. This sensor will only be beneficial if paired with a low range detector.

The 0-3% range provides accuracy and resolution at the 0.5% and 1.0% levels for ventilation and warning necessary at your plant. It will also trip relays set at 3.0% CO_2 for Evacuation. The ability to handle the ventilation and evacuation set-points, and everything in between, make the 0-3% CO_2 sensor the best sensor for process leak detection.

Mounting your CO2 sensor:

The recommended method for mounting CO_2 sensors in a process leak detection system is to mount them in the *breathing zone* (~5 feet off of the floor). Mount the sensor wherever people frequent, do not mount close to a leak source unless people are always there. Do not mount the CO_2 sensor lower than the breathing zone.