Inert LEL Monitoring

Detection of Combustible Gases in Inert Atmospheres

Application Note 2001

Certain applications such as refinery catalyst replacement, cargo holds, etc. may require that the vessel or confined space be blanketed or purged with an inert gas to reduce the potential of a fire/explosion or to prevent possible damage to the product in the vessel.

Nitrogen (N_2) is most commonly used for these applications; however, CO_2 or other inert gases may also be used. Monitoring the actual oxygen (O_2) concentration to determine that that the space has been properly purged is easy.

Testing an inert space for the presence of combustible gases may, however, not be so simple and while it can be said that an oxygen free environment poses little of no combustible hazards, “pockets” of O_2 may still pose a huge hazard i.e. near the exhalation valve of a self contained breathing apparatus or a supplied air respirator where static can be the source of ignition. Regulatory agencies require that the space be verified to not exceed a set limit for combustible gases; usually 10% LEL, regardless of the O_2 concentration.

Catalytic Combustible Sensors

The most common sensor used for the detection of combustible gases is the catalytic combustible sensor.

The basic operating principle of this type of sensor is to oxidize (burn) combustible gases that may be present on a heated catalytic bead.

Catalytic LEL Sensor

This process, however, requires a minimum concentration of 10% oxygen to be present for the sensor to work properly, which is not an option in an inert environment.

A common work around is to use a dilution orifice or similar methods to mix enough oxygen with the inert air sample before the point of detection. See dilution monitoring section below for details.

Another drawback of the catalytic sensor is that the required safety flame arrester prevents hydrocarbons with more than 9 carbons to enter the sensor and thus they will not be detected. Diesel fuel is a good example; more than 95% of hydrocarbons in the mix has more than 9 carbons (most around 15) resulting in a seriously deficient response. Other similar products includes kerosene and jet fuel.

Catalytic combustible sensors also “suffer” from deficiencies such as being prone to poisoning by silicone, lead, being inhibited or damaged by hydrogen sulfide (H_2S), halogenated hydrocarbons, or high concentrations of combustible gases. (See also GfG TN1001 – Catalytic Sensor Damage).

Dilution Monitoring

A dilution orifice (or a dilution-pump system) is designed to mix the atmosphere sampled from the inert space with fresh air in a 50% ratio. Since fresh air contains 20.9% O_2 the resulting air mixture will have a concentration of at least 10.45% O_2.

A big problem with the dilution methods is that the ratio of mixing the two sources of air is subject to great variations which can result in significant or even hazardous inaccuracies.

Another problem is that a manual calculation (or specialized equipment) is required to figure the actual concentration in the sample air from the vessel. For example the formula for determining the O_2 concentration is:

Actual Concentration = (Reading - 10.45) x 2

Again that is provided that the dilution ratio is exactly 50%; any deviation will skew the results and potentially create a hazardous condition.

Infrared (NDIR) Sensors

A great alternative and a near perfect solution for the detection of combustible gases in inert environments is using an infrared sensor. Infrared sensors do not require the presence of any oxygen to detect combustible gases, hence eliminating the need for dilution sampling, the hassle of calculating the actual readings and assuring that the dilution ratio is correct.

Infrared sensors offer a few more benefits over the catalytic combustible sensor. One is that an infrared sensor does not get poisoned, inhibited or damaged by compounds such as silicone, lead, H_2S, halogenated hydrocarbons, high concentrations of combustible gases, etc. Another benefit is that infrared sensors are much more stable over the life of the sensor and require less frequent calibration. As noted earlier a catalytic sensor cannot detect heavier hydrocarbons (like diesel fuel), whereas an infrared sensor does not suffer from such deficiency.

One possible drawback of an infrared sensor is that it cannot detect hydrogen (H_2), so where hydrogen may be a hazard an additional sensor capable of detecting hydrogen in inert environments may be required. The good news is that are electrochemical H_2 sensors are available and works perfectly well in inert atmospheres and they are relatively inexpensive. A common carbon monoxide (CO) sensor may even be used as it also responds well to H_2 in an inert atmosphere.

Conclusion

An infrared sensor (possibly in conjunction with an H_2 capable sensor) is technically superior to a catalytic sensor in all respects.

Aside from the greater accuracy, damage immunity and ease of use an infrared instrument configuration requires less mechanical parts (dilution orifices or additional pumps), thus there is less maintenance and there are fewer possibilities for errors.

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