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CARBON CAPTURE UTILIZATION & STORAGE

Understanding how to optimally deploy Laser Based – Open Path Gas Detectors to meet the requirements for your Measurement, Monitoring, & Verification (MMV) Plans.

AMBIENT MONITORING APPLICATION

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SOLUTION OVERVIEW

AMTOSPHERIC CO_2 MONITORING

Unfortunately, the quantification of fugitive Carbon Dioxide (CO_2) is not a trivial matter – due mainly to the significant variability of its atmospheric background.

Your Local Environmental Regulator will require Atmospheric Monitoring capabilities to detect a specific *Release Rate* (i.e., a Discrete Threshold).

By using a quantitative volumetric measurement, such as Laser Based – Open Path Gas Detection, which can provide unambiguous raw release data that is independent of the diurnal and seasonal variations of Carbon Dioxide (CO_2).

If the Laser Based – Open Path Gas Detectors are positioned so the desired Release Rate(s) produce concentrations that are above the maximium atmospheric background, then the following assumptions can be made:

1) *Any concentration above atmospheric is likely fugitive* and from anthropogenic sources (i.e., should these concentrations be present – yes/no?).

2) Any concentration registered above atmospheric will *require some level of 'operation action/intervention'* (i.e., if this level of concentration shouldn't be present, should something be done about it – yes/no?).

QUANTIFY THE RELEASE

Different Release Rate scenarios under permissible windspeeds can be *modelled to determine the expected concentrations at specific distances* from the localized area of release.

With the modelling complete, the Laser Based – Open Path Gas Detectors oriented in a perimeter configuration around the Injection Skid/Well can:

1) Be placed at an *optimal distance* from the localized area of release to provide unambiguous results in the case of a fugitive release (i.e., gas concentrations from the release exceed atmospheric levels).

2) With this, you can report if the *'discrete threshold'* for the specific Release Rate you've submitted to your Local Environmental Regulator has been exceeded (e.g., remember any concentration above atmospheric level is likely from anthropogenic sources and should be dealt with).

3) To take this one step further, the expected concentrations can then be 'binned' into different categories based upon the size of each of the desired Release Rates (e.g., Small, Medium, or Large Release).

16646 114 Ave NW, Edmonton, AB, CA T5M 3R8 P +1.780.488.5173 E info@boreal-laser.com W boreal-laser.com REMOTE PRECISION. SURE DECISION.

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CARBON DIOXIDE (CO2)

ATMOSPHERIC BACKGROUND

Ambient concentrations of Carbon Dioxide (CO_2) fluctuate on a diurnal and seasonal bases ranging from concentrations of 400 to 1,000 ppm.

The high atmospheric concentrations and their associated fluctuation of Carbon Dioxide (CO_2) can significantly compromise the effectiveness of the measurement if the detection equipment is not properly deployed.

Laser Based – Open Path Gas Detection produces results in what is called Path Integrated Concentration which the unit of measure is Path Integrated Concentration (ppm-m). This essentially means that the concentration along the path is measured and totalled.

If there is 400 ppm within one cubic meter ($1m^3$), then if we measured over a 10 m path length, then the Path Integrated Concentration would be 4,000 ppm-m (e.g., 400 ppm x 10 m = 4,000 ppm-m).

Example #1 – Human Ear:

Our example is based around a 'normal healthy young person', with a detectable range for loudness from ~0 to 140 bB.

Let's assume that our 'normal healthy young person' Cell Phone's Ringer produces a loudness of 60 dB.

In the quiet of an empty auditorium, the 'normal healthy young person' can easily hear the 60 dB ringer at a distance of 100 m because there is no to low ambient noise.

However, our 'normal healthy young person' cannot hear their 60 dB ringer while they attend a rock concert at either 100m or 0.1m.

This is not because a lack of sensitivity or resolution on the ability to hear but because the 120 dB loudness of the rock concert is greater than 60 dB loudness of the ringer (i.e., Signal < Noise).

Example #2 – Gas Detection:

Our example is based around two 'Gas Detectors', each with a detectable range from 5-10,000 ppm.

Let's assume that both a Methane (CH_4) and Carbon Dioxide (CO_2) leak with release rates of 45 kg/hr and a duration of 1-hour produces concentrations of 25 ppm at 100 m.

Methane (CH_4) Leak: the 'Methane Gas Detector' can easily detect the 25 ppm leak because the atmospheric concentration of Methane is only 2 ppm (i.e., Signal > Noise).

Carbon Dioxide (CO_2) Leak: the 'Carbon Dioxide Gas Detector' CANNOT detect the 25 ppm leak because the atmospheric concentration of Carbon Dioxide is varying between 400-1,000 ppm (i.e., Signal < Noise).

SIGNAL TO NOISE RATIO

Regardless of the Minimal Detectable Limit (MDL) of the Gas Detection/Monitoring device, the *Total Expect Concentration of Plume* needs to be greater than the *Maximium Atmospheric Path Integrated Concentration* – the signal needs to be greater than the noise.

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INSTALLATION

CONCENTRATION + DISTANCE

While it is difficult, if not impossible, to predict the exact concentrations of gas within a plume, we can operate under the assumption that the relative concentration should exponentially decrease the further the distance from the localized area release.

We operate under the assumption that the distance of the paths should be:

Not too Close: The momentum jet resulting from the leak needs to decelerate before the plume can start to form and the probability of detection is maximized. The higher the pressures, the longer the momentum jet. The risk of mounting too close is the momentum jet will be push beyond the Laser Based – Open Path Gas Detector before it can be detected.

Not too Far: It is also important not to place the paths so far away that the concentrations of the plume are no longer detectable – especially with an atmospheric gas like Carbon Dioxide (CO_2).

CONSIDERATIONS

The Laser Based – Open Path Gas Detector has the dynamic detection range to be utilized for Incipient Leak Detection or Discrete Leak Detection – however, the deployment will dictate its effectiveness.

FIGURE 7 - PATH ORIENTATION

If the Design Philosophy requires the Fire & Gas Safety (FGS) System to Alarm for Incipient Leaks, then:

Path Orientation: Mount close to the Localized Area of Release to maximize the concentrations present but mount far enough back to allow the plume to form to maximize the probability of detection.

Path Lengths: Shorter path lengths provide greater Signal-to-Noise Ratios (i.e., less background CO_2), provides better alignment stability, and are less susceptible to Beam Block conditions caused by Fog, Snow, and Rain.

Alarm Thresholds: To avoid nuisance alarms, thresholds must be set above the expected ambient concentrations (e.g., 400-1,000 ppm x Path Length (m)).