Optimized Protection against Explosion Hazards and Toxic Gases

USING PHOTO IONISATION DETECTORS

GAS Detection

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A lot of combustible gases and vapours are toxic long before they reach their lower explosion warning limit. An additional measurement of volatile organic compounds (VOC) in the ppm range with a photo ionisation detector (PID) provides the optimal protection for exposed workers. Thus, a combination of LEL and ppm measurement is the ideal solution.

The Benefits of LEL and VOC Detection Simultaneously

One of the most commonly used techniques to measure explosion hazards is the catalytic bead technology. On the hot surface of an active pellistor, flammable gases or vapours are oxidized by the oxygen in the air. This process forms a heat of reaction and the temperature of the active pellistor rises. The resulting signal is a measurement of the gas concentration. With these catalytic bead combustible sensors, all flammable gases can be detected down to the percent LEL range.

However, for most VOCs, long before they reach a concentration high enough to activate the alarm of a common LEL detector, they could have easily exceeded the toxic exposure limits. To detect VOCs, PID technology is the best solution. An ultraviolet lamp is used to break down the gases and vapours for measurement. The molecules are ionized through radiation and produce a current. This electrical current is proportional to the gas concentration and is displayed on the meter. Most common PID detectors operate with a 10.6 eV lamp, so that any gas or vapour with an ionisation energy lower than 10.6 eV can be detected in the ppm range.

Confined Space Entry and Area Monitoring in Utilities

Throughout the industrial workplace, confined space entries are a part of the daily routine. Testing a confined space for atmospheric hazards should be done before entering. Focus of the measurement should be to check that proper oxygen levels are present and to ensure that combustible gases are not present. Additionally, the workers must be sure that toxic gases are below the permissible exposure limits.

Common toxic gases in sewers are hydrogen sulphide (H2S) and carbon monoxide (CO). For this application, the instrument should be ideally equipped with an infrared or catalytic bead sensor for the detection of combustibles in the LEL range and a PID sensor that measures toxic VOCs in the ppm range. Oxygen, hydrogen sulphide and carbon monoxide are monitored by reliable electrochemical sensors. In this combination, an essential advantage of the infrared sensor is that it is in no way influenced by another gas (e.g. H2S) such as the catalytic bead sensors are. With a powerful integrated pump, remote sampling over greater distances can be conducted using a long hose. When the situation is clear, each worker equipped with a small, light-weight personal air monitor can enter the space and do their maintenance or repair work. During the work period, a confined space entry attendant should continually monitor the space. This can be done outside the duct with remote sampling. On the other hand, under certain circumstances it may be necessary to take the instrument into the confined space and leave it there in order to monitor the area. Here it is important that the detector does not lose any functionality in wet atmospheres and can be fully immersed in water as per IP 67. That means that all sensors have to be protected by water-repellent membranes. In addition, the sampling pump must be protected by water-tight membranes, which prevents damage to the pump due to water. Should one of the gases to be detected reach its alarm level, a very loud audible alarm (over 100 dB) should be activated. The visual alarm must be bright and visible from all directions. Together with the instrument's robustness, this makes such an instrument ideally suited for use in area monitoring applications.

Confined Space Entry and Area Monitoring in Chemical / Petrochemical Plants

In tanks used to store organic substances, an all-clear measurement should be done before personnel enter the tank. There is a clear trend towards assessing organic substances not only in respect to the explosion hazard they pose, but also in respect to their toxicity. This is something which can be done for a wide range of organic substances using PID sensors. Especially when personnel are entering tanks, pipelines and other confined spaces, it is important to ensure that the concentration of the substances stored inside them is sufficiently low enough to prevent any harm to personnel.

A good example of VOC measurement with PID technology is the shutdown of a crude oil tank for maintenance and repair. In order to inert the atmosphere within the tank, it is pumped dry. Before the maintenance crew is allowed to enter the tank they must be sure that no harmful substances are inside. A typical configuration of a gas detection instrument would be a PID sensor, an infrared (IR) sensor and electrochemical sensors for O_2, CO and H_2S. The IR sensor is preferred because the H_2S from the crude oil could poison a catalytic bead sensor. Additionally during the inerting process, the necessary oxygen is not available for the proper operation of the catalytic sensors. When the inerting process is finished and the tank is flooded with air, the workers can then enter the tank and carry out their maintenance work. If one of these tasks is welding and therefore ethylene is used, the IR sensor can easily be exchanged with a catalytic bead sensor and again full protection is guaranteed.

The advantage of the PID, once again, lies in the fact that it allows measurements in the ppm range. If the PID detector is equipped with a calibration memory, different substance calibrations can be stored inside the instrument. This means that benzene can be measured first, for example, followed by a toluene measurement sometime later. Calibration of the individual memories can be performed prior to the measurement process, so that only the calibration memory in question needs to be selected when it is time for measurement.

A further application in the chemical and petrochemicals industry is the classic workplace monitoring, for example, when concentrations of hazardous substances need to be checked during particular work activities (e.g. moving substances from one container to another).

Confined Space Entry and Area Monitoring in Aircraft Wing Tank Entry

Instruments equipped with an infrared sensor are ideal for measuring jet fuels. The IR sensor can easily detect these heavier hydrocarbons much better than the typical catalytic bead sensors used in most portable instruments. While a catalytic bead sensor has a harder task in oxidizing the larger molecules, these larger molecules will typically absorb more infrared energy than smaller hydrocarbons.

Aircraft tanks constitute a particularly extreme example of confined spaces. Since maintenance and inspection personnel have to conduct their checks in the furthest corners of the tank, the use of respiratory protective equipment is only recommended to a limited extent. This makes it all the more important to perform an "all-clear measurement" and to ensure, for example, that the kerosene concentration is below 10 ppm. Because catalytic and infrared sensors cannot reliably measure such low concentrations of organic substances, this situation is also a typical example of a PID application. The instrument can be operated as an area monitor within the wing tank or outside with an extension hose as remote area monitor, while the employees inside the tank are equipped with small light-weight personal air monitors.

Leak Detection and Environmental Analysis

A photo ionisation detector is also well-suited for leak detection in several different settings, e.g. pipelines in refineries, tanks in chemical factories, refineries and petrol stations, and on ships and other means of transport. If a leak is identified or an accident involving hazardous goods occurs, it is important to determine whether the soil in the vicinity of the leak has been contaminated. Thanks to its high sensitivity and fast response time, the photo ionisation detector is well-suited for such tasks, as well as conducting a preliminary classification of soil samples (by performing a screening test to decide whether a laboratory analysis is necessary).

Multi-Gas Detectors including PID Technology

The Dräger X-am 7000 PID can be equipped with 5 sensors, whereas 2 of them consist of any combination of an infrared sensor, a catalytic bead sensor or a PID sensor. With this configuration all relevant measuring tasks concerning area monitoring can be carried out. All sensors are smart, i.e. they carry all relevant sensor data on an on-board EEPROM. That means that the software is configured automatically when a sensor is inserted. This is a big advantage because the new developed smart PID sensor fits in all the X-am 7000s that are already in use. Only a software update is necessary. The 3 remaining sensor ports are for substance-specific electrochemical sensors. A combination of over 25 different smart sensors allows flexible adaptation to nearly all individual measuring tasks. If there is any new application with an unknown VOC, Dräger's application service can easily determine the individual response factor for this gas or vapour.