Oil and Gas Industry – Safety Monitoring

Flame, Toxic/LEL Gas, Ultrasonic, and Particle Detection

Oil refineries, processing plants, pipelines, storage farms, LPG/LNG plants, and offshore platforms all utilize or produce a wide range of hazardous combustible and toxic gases. In addition, the processes involved in each can produce nontoxic gases which when accumulated in high concentrations, depletes oxygen causing a hazardous condition to personnel who occupy the area without proper protection.

Where hazardous conditions are the greatest, it is essential to have monitoring system that constantly monitor a facility's conditions even if personnel are not present. Handheld/personal monitors don't have the ability to detect concentrations of combustible gases in unoccupied areas that are hazardous to equipment, personnel, and the facilities themselves. Depletion of oxygen is hazardous to individuals entering any unoccupied areas, whereas even small concentrations of toxic gases can have serious health implications (even death) for any personnel entering an unoccupied area where they are present.

Monitoring for hazardous gases in the Oil and Gas Industry can be broken down into the following applications which are covered in more detail in the preceding sections:

1. Gas Compressor Station/Buildings
2. Turbines
3. LPG/LNG Facilities
4. HVAC Systems
5. Wells
6. Pipelines
7. Refineries
8. Process Plants
9. Storage Farms
10. Loading Stations
11. Offshore Oil Rigs
12. Floating Production Storage & Offloading (FPSO) Vessels

EMERSON™
Process Management

Gas Compressor Stations/Buildings

Facilities with compressors, pumps, and valves require continuous gas, flame, and particle monitoring due to the constant high stress level present on machinery. These areas are prone to high pressure leaks, spills and fugitive emissions that, if undetected, can cause extensive damage to the entire facility and bring production transport to a stand still.

The combination of heat, pressure, and vibration in compressor decks can create leakage. Hydrogen sulfide, liquids, and undesirable particles in the natural gas stream can corrode pipelines and degrade components. Seals and gaskets in these valves or pumps will, over prolonged exposure, invariably fail and provide the fuel that can come into contact with heated parts and an ignition source to develop into a fire.

Flame and gas detectors minimize these risks, and even provide a system to monitor the maintenance requirements of equipment. Detectors should be installed in areas overlooking compressors and pumps. Comprehensive coverage is achieved through the use of air particle detection (indoors) as well as ultrasonic gas leak detection (indoors and outdoors).

Hazard	Source	Safety Solutions
Hydrocarbon gases	Gas leaks through seals and gaskets at: Chilling and cooling areas, gas compressor areas, pig launcher/receiver areas, HP inlet/ outlet areas and discharge vessels	Millennium II Series Transmitter (M21,M22, M2B) with any SC3 Series sensor, Incus Ultrasonic Gas Leak Detector
Hydrogen Sulfide (H_2S) (ppm - Toxic)	Gas leaks through seals and gaskets at: Chilling and cooling areas, gas compressor areas, pig launcher/receiver areas, HP inlet/ outlet areas and discharge vessels	Millennium II Series Transmitter (M21,M22, M2B) with ST320 [XChem] sensors, Incus Ultrasonic Gas Leak Detector
Fire	Ignition of hydrocarbons	UV/IRS and UVS Flame Detectors
Oil Mist	Lubrication oil leaks through seals and gaskets providing cooling and wear prevention	Millennium Air Particle Monitor and Oil Mist Detector

Turbines

Onshore and offshore installations contain dedicated turbine and power generation areas that produce energy to run the various processes. The turbine enclosures and generator rooms are high risk areas due to the combination of very high temperatures, moving parts, fuel, and lubricants. Fire and explosion hazards are located throughout a typical turbine enclosure. Most combustion turbines are designed to burn natural gas, light oils, diesel or different fuels in combinations. Modern designs incorporate combustors generally between the compressor and the turbine itself. Fuel is mixed with air and burned within the combustor through a delivery system similar to boilers, but with additional safety interlocks. Naturally, internal or external fuel leakage is extremely hazardous in these areas.

Lubricating oil systems are also critical to the function of the turbines. This system must continue to function even during a shutdown event to prevent destruction of the turbine. Unfortunately oils (diesel and lubricating oil) have auto ignition temperatures (AIT) significantly lower than gas. Combined with the large hot areas in the turbine enclosures, they form a high risk scenario. Even small leaks in this system can be extremely hazardous and must be identified as quickly as possible to allow turbine coast down.

In addition, the large amount of heat generated by the power generated must be continuously cooled while in operation. This is often accomplished using hydrogen, which is highly flammable and an asphyxiant. Air intakes and exhaust must also be accurately monitored for the presence of smoke or flammable vapor clouds to prevent pre-ignition within the compressor section.

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Combustion turbines are typically much more valuable than the surrounding structure. In many applications, numerous turbines will be installed within a single structure. In the case of gas turbine pipeline compressors, these structures are often situated in remote locations. This remoteness usually increases the fire hazard risk of the facility because any available emergency response team is often under-sized and can be located far from the site. In an offshore installation, an escalation could be truly catastrophic for the entire platform and its personnel.

Clearly early flame detection and preventative action is critical in order to prevent disastrous results and to minimize any potential shutdown. Turbine enclosures should have dedicated flame detectors aimed directly at the likely ignition point(s) and set to the desired sensitivity and required response time.

Fixed combustible gas detection will provide fast, reliable coverage against flammable gas concentrations before an ignition event occurs. Circulation systems, enclosures, fuel storage and transport lines, and pressure relief valves are typical installation locations. Often these areas operate in temperatures that require sampling systems in order to ensure sensor performance. An area that can be overlooked is floor drainage wells, where liquid leaks and spills can accumulate and generate potentially explosive levels of combustible gas. Toxic gas concentrations and oxygen depletion are also serious hazards that should be monitored using an advanced fixed gas detection solution.

Turbine enclosures have forced ventilation and both gas and oil mist detection should be installed in the enclosures intake and exhaust ducting. Most turbine enclosures are fitted with gas and flame detection but only a few have robust and reliable smoke and oil mist detection. Oil mist detection in the enclosed areas and exhaust ducts of the turbine enclosures will provide an early warning of any pressurized oil leaks. This allows for the rapid shutdown of a turbine thereby minimizing the amount of flammable material into the enclosure and hence minimizing its potential fire load. If an oil spray or gas leak ignites immediately, a fire results. If there is a delay in ignition it is probable that there will be a powerful explosion event. Should an explosion occur, even a 'low overpressure event', it is foreseeable that the turbine enclosure will be damaged such that it would lose its fire protection integrity. Hence any fire following the explosion could have the potential to escalate to a facility-wide emergency

Hazard	Source	Safety Solutions
Methane (CH_4), Turbine fuels (% LEL - Combustible)	Explosive vapors from liquid leaks and spills	Millennium II Series Transmitter (M21,M22, M2B) with ST320 [XChem]
Methane (CH_4), Turbine fuels (% LEL - Combustible)	Circulation systems, enclosures, fuel storage/transport lines, pressure relief valves	Millennium II Series Transmitter (M21,M22, M2B) with any SC3 Series sensor
Fire	Ignition of hydrocarbons	UV/IRS and UVS Flame Detectors
Oil Mist	Lubrication oil leaks through seals and gaskets providing cooling and wear prevention	Millennium Air Particle Monitor and Oil Mist Detector

LPG/LNG Facilities

With its major component methane is drilled from the ocean bed in various parts of the world (especially the North Sea) using either fixed exploration platforms or Floating Production Storage and Offloading (FPSO) vessels. The natural gas is transported via pipelines and tankers to the onshore facilities where it is stored in special tank farms before it is distributed to the various users.

Besides this natural resource, the petrochemical industry has developed various distillation and cracking processes that produce light hydrocarbon gases like methane, ethane, propane, butane and their derivates ethylene, propylene, butylene, etc. These refined gases are compressed and liquefied for storage purposes and known commercially.

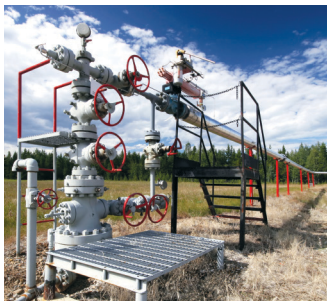
One of the major concerns associated with the LNG/LPG facilities is the fugitive emissions and liquid spills that evaporate very fast when exposed to the atmospheric pressure. The light methane gas migrates very fast over large areas hence the need for reliable, fast methane monitoring, over large areas of pipelines and storage facilities. The LPG, which contains light hydrocarbon mixtures (C1–C4), is heavier than air and tends to accumulate in low areas thus posing a fire/explosion hazard in the congested production and pipelines manifolds areas.

Fixed Gas Detection, Ultrasonic Gas Leak Detection, Optical Flame Detectors are critical in many areas throughout LPG/LNG facilities, particularly in older facilities.

HVAC Systems

Monitoring the air quality in heating, ventilation, and air conditioning shafts (HVAC) is crucial, especially in the oil and gas industry where all the processes involve toxic or combustible materials. Every area of the industry comes into contact with these hazards, whether in the ventilation ducts of living quarters on offshore rigs, or in air conditioning shafts of refineries, these combustible and toxic gases that are the product or by-product of the industry can result in the loss of millions of dollars in capital investment and hundreds of priceless lives if not continuously monitored. Monitoring HVAC duct work for the presence of smoke is a common and difficult requirement in many applications; our Millennium Air Particle Monitor & Oil Mist Detector has many unique features that make it ideal for this complex installation.

Wells



Hydrogen Sulfide (H_2S) is a major hazard encountered at drilling sites. Leaks in drilling applications can see large quantities of H_2S released, which becomes extremely hazardous to well-site personnel. Areas that are susceptible to leaks include the drillers stand, blow-out preventer, shale shaker, and mud tank.

Combustible gases can also accumulate at drilling sites, whether in primary oil recovery, where methane (CH_4) is usually present; secondary oil recovery, where methane is sometimes re-injected into reservoirs; or tertiary oil recover that uses fuel to power the turbines of cogeneration plants. As a result, combustible gas monitoring is a requirement, with flame detection equipment used as the last line of defense to safeguard equipment and personnel.

Remote well sites pose an extra challenge in the monitoring of toxic and combustible gases. As most remote sites are without a source of uninterruptible, low-cost power, a reliable and cost-effective source of power is required for these monitoring needs. Fortunately, the solution can be found in the form of autonomous solar power stations.

Hazard	Source	Safety Solutions
Hydrogen Sulfide (H_2S) (Toxic)	Leaks at drilling sites, removing H_2S contaminated water	Millennium II Series Transmitter (M21,M22, M2B) with ST320 [XChem] sensors, Incus Ultrasonic Gas Leak Detector
Methane (CH_4), Turbine fuels (% LEL - Combustible)	Primary oil recovery, Secondary reinjection, Tertiary cogeneration	Millennium II Series Transmitter (M21,M22, M2B) with any SC3 Series sensor, Incus Ultrasonic Gas Leak Detector
Fire	Ignition of hydrocarbons	UV/IRS and UVS Flame Detectors

Pipelines

Pipelines carrying combustible hydrocarbons like oil, gasoline, and LNG/LPG. Oil refineries, processing plants, storage farms, LPG/LNG (Liquefied Natural/Petroleum Gas) plants, and offshore platforms use or produce a wide range of hazardous combustible and toxic gases. Liquid spills or fugitive gaseous emissions may go undetected and create hazardous concentrations of combustible and toxic gases, putting equipment, facilities, and personnel at risk.

Monitoring of pipelines should occur at compressor stations for LNG/LPG, at pump stations for oil, and at metering stations for both.

Hazard	Source	Safety Solutions
Hydrogen Sulfide (H_2S) (Toxic)	Leaks at pump stations, removing H_2S contaminated water	Millennium II Series Transmitter (M21,M22, M2B) with ST320 [XChem]
Hydrocarbons (LNG/LPG, oil, gas) (% LEL - Combustible)	Leaks at compressor stations, pump stations, metering stations	Millennium II Series Transmitter (M21,M22, M2B) with any SC3 Series sensor, Incus Ultrasonic Gas Leak Detector
Fire	Ignition of highly combustible hydrocarbons at compressor, pump, and metering stations	UV/IRS and UVS Flame Detectors

Refineries

Continuous combustible and toxic gas monitoring is a critical facet of operation within refineries. There are many processes and special production units in a refinery that create specific safety hazards. These include:

- **Crude Desalting** - The potential exists for a fire due to a leak or release of crude from heaters in the crude desalting unit. Low boiling pointcomponents of crude may also be released if a leak exists. These are closed processes, however, heaters and exchangers in the atmospheric and vacuum distillation units could provide a source of ignition, and the potential for a fire exists should a leak occur. This process can also produce wastewater streams (commonly referred to as sour waters) which contain dissolved hydrogen sulfide (H_2S) and ammonia (NH_3) gases in the form ionic ammonium hydrosulfide (NH_4HS) at lethal concentrations.
- **Thermal cracking, coking, and catalytic cracking** - Additional closed processes with the potential for fire coming from liquid, gas, or vapor leaks that come in contact with an ignition source.
- **Catalytic dust** - Explosive concentrations of catalyst dust can accumulate during its recharge or disposal. The handling of coked catalyst creates the possibility for iron sulfide fires, which can occur when iron sulfide ignites spontaneously in air.
- **Hydrogen generation** - Hydrogen generation is required to provide for a continuous supply. This creates a hazard in the event of a leak or accidental release of gases.
- **Hydrogen Sulfide (H_2S)** - The hydrogen sulfide content of the feedstock must be continuously monitored to prevent personnel exposure to toxic concentrations, reduce corrosion, and prevent environmental pollution.
- **Isomerization** - Isomerization processes convert n-butane, n-pentane and n-hexane into their respective isoparaffins of substantially higher octane number. This is another closed process with hazardous implications in the form of leaks coming into contact with an ignition source.
- **Sweetening** - Air or oxygen is used in sweetening processes. If too much oxygen enters these processes, it is possible for a fire to ignite in the settler due to the generation of static electricity.

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Hazard	Source	Safety Solutions
Hydrogen Sulfide (H_2S) (Toxic)	Leaks from feedstock	Millennium II Series Transmitter (M21,M22, M2B) with ST320 [XChem] sensors
Sulfur Dioxide (SO_2) (Toxic)	By-product of Sweetening Process	Millennium II Series Transmitter (M21,M22, M2B) with ST330 [XChem] sensor
Hydrocarbons (% LEL - Combustible)	Leaks from crude desalting, thermal cracking, coking, catalytic cracking, isomerization, and sweetening	Millennium II Series Transmitter (M21,M22, M2B) with any SC3 Series sensor, Incus Ultrasonic Gas Leak Detector
Hydrogen (% LEL - Combustible)	Leaks from hydrogen generation	Millennium II Series Transmitter (M21,M22, M2B) with the SC311 Infrared sensor, Incus Ultrasonic Gas Leak Detector
Catalytic dust (Explosion)	Can ignite spontaneously if released into the air	UV/IRS and UVS Flame Detectors
Fire (Liquid/vapor or gas ignition)	Combustible gas leaks coming into contact with ignition sources	UV/IRS and UVS Flame Detectors

Processing Plants

Combustible and toxic materials found at processing plants are extremely hazardous to the facility and its personnel, especially in highly congested production areas that contain reactors, turbines, valves, and high pressure distribution pipelines.

Some of these materials include:

- Hydrogen feedstock fuel
- LNG and LPG - used as feedstock, or as energy sources for various distillation processes
- Organic monomers and polymers (Ethylene and Polyethylene, PFE- Perfluoroethylene, PVC - Poly Vinyl Chloride, Urethane and Polyurethane)

Hazard	Source	Safety Solutions
Toxic Gas/Chemicals	Leaks in tanks, pipelines, reactors, valves	Millennium II Series Transmitter (M21,M22, M2B) with the applicable ST3 Series sensor
Hydrogen Gas (H_2) (% LEL Combustible)	Feedstock fuel	Millennium II Series Transmitter (M21,M22, M2B) with any SC3 Series sensor, Incus Ultrasonic Gas Leak Detector
LNG/LPG (% LEL Combustible)	Feedstock fuel, distillation	Millennium II Series Transmitter (M21,M22, M2B) with any SC3 Series sensor, Incus Ultrasonic Gas Leak Detector
Fire	Ignition of fuels	UV/IRS and UVS Flame Detectors

Storage Farms

Continuous monitoring of storage-tanks for leaks and fugitive emissions is a must for the safety of equipment and personnel, and is mandatory in most countries.

Petrochemical storage farms require the monitoring of Hydrogen Sulfide (H_2S) close to pipes and valves around leakage points, and also require monitoring of heavy combustible hydrocarbon gas leaks that stay close to the ground.

Hazard	Source	Safety Solutions
Hydrogen Sulfide (H_2S) (Toxic)	Leaks in storage tanks, pipes, and valves	Millennium II Series Transmitter (M21,M22, M2B) with ST320 [XChem] sensors
Combustible gases (% LEL Combustible)	Leaks in storage tanks, pipes, and valves	Millennium II Series Transmitter (M21,M22, M2B) with any SC3 Series sensor, Incus Ultrasonic Gas Leak Detector
Fire	Ignition of combustible gas leaks	UV/IRS and UVS Flame Detectors

Loading Stations

Whether used as refined fuels, raw materials for processing, or feedstock for other industries, petrochemicals have to be shipped from a processing plant or storage farm. They have to be offloaded at loading stations in either gas, liquid or compressed form - all of which are highly combustible and a major hazard to any equipment or people working in or living close to these areas. Railway loading platforms and Truck filling stations require combustible gas and flame monitoring capable of detecting fugitive emissions and alerting in case of explosive concentrations or the incidence of fires.

Hazard	Source	Safety Solutions
Hydrocarbons (% LEL Combustible)	Leaks at loading platforms and filling stations	Millennium II Series Transmitter (M21,M22, M2B) with any SC3 Series sensor, Incus Ultrasonic Gas Leak Detector
Fire	Ignition of hydrocarbon leaks	UV/IRS and UVS Flame Detectors

Offshore Oil Rigs

Drilling vessels are used for the exploration of new, and the expansion of existing, oil and gas fields. There are a number of common types of offshore structures in use, depending on the depth of the water, the water state, and field potential. The most common structures used are steel jacket and gravity based concrete platforms, as well as tethered platforms and spar structures. The typical offshore oil rig is composed of several modules, including the wellbay, personnel quarters, process areas, power, and drilling areas.

The closeness of the modules on offshore rigs calls for the continuous monitoring of fugitive emissions while their concentrations are small and for highly reliable flame monitoring. Areas requiring protection from combustible and toxic gas hazards include oil de-watering plants, gas compressors, accommodation blocks (HVACs), turbine/power skids, well heads temporary refuges (TRs), cranes, shale shakers, battery rooms, bottled gas stores, and water treatment areas. In any case, the monitoring solutions' signals need to be accurate and rapid to allow the crew to perform emergency and preventive measures that can save their lives and reduce damage to the oil rig.

The highly corrosive nature of marine environments requires that the monitoring solutions used on offshore oil rigs should be made of the most anticorrosive materials available (316 stainless steel).

Hazard	Source	Safety Solutions
Hydrogen Sulfide (H_2S) (Toxic)	Accumulations at well-head, process, drilling areas, H_2S refuge, temporary refuge (TR), shale shakers, HVACs, accommodation module	Millennium II Series Transmitter (M21,M22, M2B) with ST320 [XChem] sensors
Carbon Monoxide (CO) (Toxic)	Accumulations in Temporary Refuge (TR), and Air Intakes	Millennium II Series Transmitter (M21,M22, M2B) with ST360 [XChem] sensor
Hydrocarbons (% LEL Combustible)	Accumulations at well-head, process, battery rooms, compressor packages, cranes, shale shakers, HVACs, control room, accommodation module, and temporary refuge (TR)	Millennium II Series Transmitter (M21,M22, M2B) with any SC3 Series sensor, Incus Ultrasonic Gas Leak Detector
Fire	Ignition of combustible gas accumulations	UV/IRS and UVS Flame Detectors

Floating Production Storage and Off-loading (FPSO)

FPSOs are new build or converted super tankers that provide flexible means by which oil ad gas may be extracted, processed, stored, and off-loaded easily. Continuous flame and gas monitoring solutions are required to protect highcost FPSOs and minimize the risk to personnel that operate and live on them.

Various facilities on the vessel are used for processing the production fluids and gases, and therefore susceptible to leaks and extremely hazardous concentrations of combustible and toxic gases. These include the turret, moon pool, and topsides (pipework, pump, compressors, separators). These process facilities are commonly located above the main vessel deck in order to achieve safe separation from storage tanks. The utility systems, such as power-generation, separate the process area from the temporary refuge (TR), to provide enhanced protection to personnel.

The process and production areas are not the only sections that require continuous monitoring. Due to the compact design of FPSOs, monitoring for fugitive combustible and toxic gas emissions should be done throughout the vessel, including accommodation and control rooms. Also, being located in highly corrosive marine environments, monitoring solutions used on FPSOs should be made of the most anticorrosive materials available (316 stainless steel).

Hazard	Source	Safety Solutions
Hydrogen Sulfide (H_2S) (Toxic)	Accumulations at processing, and storage areas	Millennium II Series Transmitter (M21,M22, M2B) with ST320 [XChem] sensors
Hydrocarbons (% LEL Combustible)	Accumulations at separation, dehydration, metering, and gas compression systems	Millennium II Series Transmitter (M21,M22, M2B) combined with any SC3 Series sensor, Incus Ultrasonic Gas Leak Detector
Fire	Ignition of combustible gas accumulations	UV/IRS and UVS Flame Detectorsr

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