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Overcoming the Challenges of Leak Detection and Repair

Continuous Touchless™ Monitoring for Upstream Oil & Gas Operations

White paper | systemswithintelligence.com | info@systemswithintelligence.com

Upstream operations include the exploration, drilling, and extraction of crude oil and natural gas for further distribution and refinement. As the first stage of the production process, upstream oil and gas companies play an important role in the global energy market.

Reducing the volume and impact of fugitive emissions from leaks is a key challenge for the sector. As financial, regulatory, and public pressures increase, upstream oil and gas companies must find new ways to detect, diagnose, and repair leaks quickly and effectively.

There are already various approaches to leak detection and repair, ranging from physical inspections to piloted aircraft or drones. And though there will always be a mix of techniques used in a successful program, new technologies are enabling oil and gas operations to become more responsive while reducing costs and minimizing the volume of wasted product.

This white paper will introduce the benefits of continuous monitoring with fixed optical gas imaging sensors. It will explore the limitations of traditional approaches to leak detection and repair and show how they can be overcome through Touchless™ Monitoring. It will further highlight the emergence of Energy 4.0 technologies and demonstrate how oil and gas companies can deploy these technologies to improve upstream operations.

With a new approach to leak detection and repair built on continuous monitoring, upstream oil and gas companies can ensure regulatory compliance, maintain the safety of personnel, and reduce the risk of catastrophic failure.

The Impact of Fugitive Emissions

Fugitive emissions can be defined as *"the unintentional and undesirable emission, leakage, or discharge of gasses or vapors,"* such as methane, volatile organic compounds (VOCs), or other pollutants.[1]

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According to the International Energy Agency (IEA), more than 260 billion cubic meters of natural gas is wasted each year through flaring or leaks.[2] While leaks can occur at any stage of production, they are most commonly found in pressure-containing equipment such as valves, flanges, pumps, piping, or compressors.[3]

Undetected leaks can have severe financial, regulatory, and legal consequences, especially as governments, investors, and the public increase pressure on facilities to reduce greenhouse gas (GHG) emissions and minimize the environmental impact of operations.

The Need for Leak Detection and Repair

Leak detection and repair (LDAR) programs monitor equipment, components, and parts to identify and diagnose unintended leaks. Effective LDAR programs use a variety of methods to determine the source and volume of the leak and prioritize repairs and maintenance to stop the leak and prevent the emission of GHGs or other VOCs.

This section will highlight some of the reasons to implement an effective LDAR program.

Emission Reduction

Methane is a commonly leaked gas that is also a highly potent GHG. Though shorter-lived than carbon dioxide (CO2), methane has a warming potential that is more than 80 times greater over a 20-year period.[4]

A recent Government of Canada report found that nearly 40 percent of total methane emissions can be attributed to the oil and gas sector, with much of this coming from upstream activities such as exploration, drilling, production, and field processing.[5]

On the other hand, this high potency and short lifespan means that reducing methane emissions can lead to significant near-term climate benefits. Further, a recent IEA survey has found that continuous LDAR programs and upgrades to leaky equipment can reduce total emissions by over 75 percent.[6]

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Investor & Public Pressure

The environmental benefits of LDAR programs are increasingly important as investors and the general public ramp up pressure on companies to reduce their emissions.[7]

Shareholders of major oil and gas companies are already using their voting rights to speak out against a perceived lack of climate action,[8] and recent climate-related resolutions are continuing to draw growing support among investors.

These actions follow similar campaigns toward large financial institutions as investors push for reduced funding of polluting industries.

Government Regulation

In both Canada and the United States, as well as other jurisdictions, LDAR programs must be conducted on a regular basis. But governments are also implementing additional policies to reduce emissions and hit Net Zero targets within the coming decades.

In the US, the Inflation Reduction Act will begin charging facilities that emit over 25,000 metric tons of carbon dioxide equivalent (CO2e) per year, starting at US$900 in 2024 and increasing to $1,500 in 2026.[9] If those fines were already in place, a recent leak in the US would have incurred a cost of $220,000 per hour.[10]

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The Act also provides $1.55 billion in funding to improve methane monitoring and reduce GHG emissions from the oil and gas industry.[11]

The Canadian Government has similar funding to help reduce sector methane emissions by 75 percent by 2030 relative to 2012 levels.[12]

Safety of Personnel and Surrounding Communities

Finally, undetected leaks create safety risks for personnel and surrounding communities. Large volumes of flammable gas can lead to catastrophic fires or explosions that can severely damage equipment and injure or kill employees.

Despite efforts to improve safety, a US Center for Disease Control (CDC) report found that 470 oil and gas workers died between 2014 and 2019, with explosions accounting for 14.5 percent of all fatal events.[13]

Energy 4.0 Technologies - The Benefits of Connected Sensors

Industry 4.0 has long been a buzzword in the manufacturing and industrial sectors. Representing the fourth industrial revolution, Industry 4.0 highlights the technological transition from early steam and electric power to modern advances in automation, cloud computing, data & analytics, and artificial intelligence.

Energy 4.0 takes the same concept and applies it to the oil and gas industry. New technologies designed and built specifically for the sector have the potential to transform exploration, extraction, transportation, storage, and refinement of oil and natural gas.

Data & Analytics

Access to data has exploded in recent years, allowing oil and gas companies to use data from multiple sources to gain deeper insights into their operation and improve strategic decision-making and performance.[14]

After several years of experimenting with smaller pilots, the industry is now fully embracing the potential of data with larger projects being implemented across the entire production process.[15]

Artificial Intelligence & Machine Learning

Though often used interchangeably, artificial intelligence (AI) and machine learning (ML) refer to different things. AI allows computers to analyze and contextualize data to provide information or automatically trigger actions without human intervention.[16] ML, on the other hand, is a subset of AI that uses algorithms to automatically learn and recognize patterns to increasingly make better decisions.[17]

According to a recent EY survey, 92 percent of oil and gas companies are already investing in AI or plan to do so in the next 5 years.[18]

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Cloud Computing & Storage

Cloud computing is the on-demand delivery of computing services over the Internet, including servers, storage, databases, networking, software, analytics, or other IT services.[19]

Compared to building an on-premises data center, cloud computing offers lower upfront costs, reduced IT infrastructure and maintenance expenses, and enhanced cybersecurity. When leveraging large volumes of data from multiple locations, the cloud provides greater flexibility, scalability, and access than on-premises IT infrastructure.

Comparing Approaches to Leak Detection and Repair

There are already numerous approaches and methods to detecting and diagnosing leaks. But many of these traditional methods come with significant limitations which reduce their effectiveness.

Physical Inspections

Physical inspections are the most common method of detecting and diagnosing leaks. Often equipped with OGI sensors or other specialized equipment, crews drive to facilities and manually inspect hundreds or thousands of components for leaks.

Despite their widespread use, physical inspections are incredibly expensive and time-consuming, and the periodic nature increases the likelihood of a gas leak going undetected between visits. They can also put workers at risk, either on-site due to an unknown hazard or in transit to or from the facility. Depending on the equipment being inspected, they may also require a partial shutdown of the facility, increasing costs and disrupting operations.

Piloted Aircraft

Some companies have turned to piloted aircraft for site-level emission surveys. Small airplanes equipped with sensors can take numerous samples over a wider coverage area and measure the volume of methane emissions at a facility.

These high-level scans, however, are less effective at determining the specific source of a leak. Further, the high cost of acquiring, maintaining, and operating a plane, as well as strict regulations dictating when and where flights can occur, further reduce the effectiveness of this approach.[20]

Unmanned Aerial Vehicles

Unmanned Aerial Vehicles (UAVs), often referred to as drones, offer many of the advantages of planes at a far lower cost. UAVs also offer greater flexibility and can be deployed at closer range, allowing for more precise detection and diagnosis.[21]

On the other hand, UAVs are highly impacted by weather. Increasingly strict regulations on when and where UAVs can be flown are further reducing their effectiveness. Similar to other methods, these periodic inspections are still highly time and location-dependent, meaning a leak that occurs outside of a scheduled flight can remain undetected.

Mobile Ground Labs

Mobile Ground Labs (MGLs) consist of a vehicle equipped with a sensor and a global positioning system to enable concentration mapping.

Operators can measure methane levels while either stationary or on the move at a relatively low cost, especially over long distances or in dense urban areas.

However, MGLs are extremely limited by weather, as the vehicle must be downwind of the leak. They are also dependent on the existing roadway network, and become less precise the further away they move from the facility. Finally, MGLs are unable to differentiate between fugitive emissions and routine, intentional venting.

Limitations of Traditional Approaches

- Time and Location Dependent
- Highly Affected By Weather
- Costly and Time-Consuming
- Restricted by Regulations
- Lack of Precision Measurements
- Put Personnel at Risk

A New Approach - Touchless™ Monitoring for Continuous LDAR

While each LDAR method mentioned above offers some advantages, a key challenge with each approach is that they are limited by the time and location the measurement was taken.

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The periodic nature of inspections, regardless of the technology used to conduct them, increases the likelihood that a leak forms and goes undetected. Left for weeks or months, an unrepaired leak results in wasted product, increased emissions, heightened safety risk, and a greater chance of catastrophic failure.

Instead, companies can implement continuous, 24/7 monitoring of upstream operations. Fixed OGI sensors continuously monitor equipment, assets, and facilities and automatically detect leaks, spills, flames, or other anomalies that indicate a fault.

A continuous approach bridges the gap between physical inspections using handheld sensors and manned or unmanned aircraft, while still using equipment that is familiar and validated by the Environmental Protection Agency.

Automated software immediately alerts the operations team, allowing them to identify and diagnose the issue remotely. A response plan can quickly be implemented to notify on-site staff, vacate the area, shut down equipment, and dispatch technicians to conduct repairs.

Touchless™ Monitoring solutions leverage advanced AI/ML capabilities to quantify the volume of the leak. Colorized plumes make it easy for operators to visualize the issue and identify the source, greatly simplifying repairs and reducing risks to on-site personnel. The sensors are not weather-dependent and can detect gas at night or penetrate through fog or smoke.

Compared to traditional approaches, Touchless™ Monitoring provides operators with a comprehensive view of facility operations, increasing responsiveness and reducing the cost of LDAR.

Benefits of Continuous LDAR

- Greater Situational Awareness
- Reduced Product Waste
- Fewer Greenhouse Gas Emissions
- Stronger Regulatory Compliance
- Reduced Travel Time and Costs
- Improved Worker Safety
- Enhanced Trend Analysis

Deploying Touchless™ Monitoring Solutions

The actual installation of fixed OGI sensors is relatively simple. But as with any new technology, the best results are achieved by developing a project plan and following a strategic implementation.

Below are the key steps companies should take to ensure a successful deployment of Touchless™ Monitoring solutions.

Step 1 - Determine Project Requirements

Before diving in and acquiring the sensors, it's important to take a step back and identify the project requirements.

Determine how sensors will be used, the challenges they will overcome, and the expected outcomes for the facility. Clearly articulate how an improved LDAR program fits into the rest of the business, and align these new capabilities with the work of the Operations & Maintenance department.

For example, an aging facility may be known to experience regular leaks and require sensors for specific components, while a newer facility may require fewer sensors to cover the entire site.

Step 2 - Access Facilities and Evaluate Site Conditions

Once the overall project requirements have been determined, work can begin on the more specific details of the deployment.

Access chosen facilities to gain a better understanding of the location, environment, and site conditions. Determine if any permits or required, or if there are any regulations or restrictions, such as safety areas or hazardous zones, that need to be considered during installation.

From there, establish what equipment needs to be monitored and determine the ideal location to mount the sensors. Depending on the site, there may already be suitable structures or poles. At the same time, identify additional equipment, such as networking, communications infrastructure, or power connections that need to be installed.

Step 3 - Develop a Deployment Plan

Once the overall project requirements have been determined, work can begin on the more specific details of the deployment.

Step 4 - Evaluate and Procure Hardware

The right hardware will depend on the site conditions and the equipment being monitored. Because of the presence of flammable gas, corrosive materials, extreme

weather, and other hazards, some sensors may need to be explosion-proof, corrosion-proof, or ruggedized for outdoor environments.

Similarly, the location and mounts of the sensors will determine the performance, capabilities, range, resolution, and features required for effective LDAR. Work closely with the vendor to ensure the optimal sensor at each location and facility.

Step 5 - Configure & Customize Software

Visualization software allows operators to view live and recorded video, control pan-tilt-zoom cameras, and manage alarms remotely. Because every company and facility is unique, the software can be tailored to meet each user's specific requirements. Work closely with the vendor to ensure that users have access to the most relevant data and capabilities for their roles.

Step 6 - Integrate With Existing Infrastructure

Oil & gas facilities already have numerous systems and technologies that capture data from various sources. That's why it's vital for new solutions to integrate with existing technologies and display data in a single dashboard.

One common application is to combine the OGI sensors with visual cameras and the Video Management System (VMS), providing both gas imaging and video feeds on the same display.

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Ensure the chosen solution offers APIs, DNP hooks for SCADA, or other standard protocols that make it easy to transfer and analyze data between systems.

Step 7 - User Training

Initial training should focus on the hardware and software and ensuring that users can access the data that is most relevant to their roles. Ongoing training can then provide more depth into the capabilities of the system while also building on users' ability to use data, monitor trends, identify patterns, report incidents, and respond to alerts.

Addressing Cybersecurity When Deploying Continuous LDAR

Oil and gas companies are right to be concerned about cybersecurity when deploying cloud-based applications. Upstream operations involve critical infrastructure and sensitive data that is vital to both national and global economies, making the industry a target for hackers, state-sponsored espionage, and other attacks.

A recent Government of Canada threat assessment stated that 25 percent of Canadian oil and gas organizations reported a cyber incident, the highest of any critical infrastructure sector.[22]

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When assessing cybersecurity requirements for Touchless™ Monitoring solutions, there are a number of steps that oil and gas companies can take to mitigate risk.

Segregation of Networks

Fixed OGI sensors require connectivity and communication networks to transmit data. However, connecting these sensors to the larger organization network could introduce potential vulnerabilities.

Instead, one of the most effective ways to eliminate the risk of infiltration is to segregate the monitoring system from the organizational network. Sensors should have no electrical or physical connections to equipment and should also be physically located outside of the security perimeter.

End-to-End Encryption

Comprehensive Transport Layer Security (TLS) encryption ensures data cannot be intercepted and viewed by hackers. Once stored, data should be encrypted using the Advanced Encryption Standard, the same standard used for other sensitive industries including financial services, government, and defense.

Access Control and Permissions

Data should only be available to authorized users who need it to perform their roles. Include authentication at every step and create user and role-based permissions to restrict access only to those with a legitimate need.

Reputable cloud service providers generally offer security features and access control as part of their solution, without requiring internal IT departments to build these functions in-house.

Regular Updates & Security Patches

Cybersecurity threats evolve quickly, meaning oil and gas companies need to ensure that all systems are continuously updated with the most recent security patches to address any new vulnerabilities.

This is another area where a reputable cloud service provider can help, as the size of their security team means they can typically respond to emerging threats faster than an internal team.

Firewalls and Network Monitoring

Oil and gas companies should constantly monitor network traffic to identify potential attacks or probes on network security and take appropriate measures to respond. Additionally, firewalls provide protection against outside threats by shielding the network from malicious traffic and software.

The Next Steps - Going Beyond LDAR With Touchless™ Monitoring

Leak detection and repair is just one of the ways that upstream oil and gas companies can leverage continuous monitoring to improve operations, safety, and performance. By implementing thermal & visual sensors as well as OGI sensors, companies gain a continuous, 24/7 view of critical assets for a range of applications.

Condition-Based Maintenance

Unlike traditional scheduled maintenance, a Condition-Based Maintenance strategy focuses on monitoring and assessing the actual health and performance of equipment to determine the optimal maintenance requirements. Instead of being reactive, Condition-Based Maintenance takes a proactive approach that extends the life of equipment, mitigates the risk of failure, reduces planned maintenance costs, and effectively allocates scarce technical resources.

Flare and Pilot Flame Monitoring

Flares are a necessary part of oil and gas operations to burn off waste and provide emergency pressure relief. But improperly managed and maintained flares can release toxic, combustible, and potent materials into the atmosphere.

Explosion-proof, thermal imaging sensors monitor the operating level of flare stacks and pilot flames to ensure safe operation and that there is an ignition source for flared gasses. Thermal imaging sensors can detect and visualize invisible flares, identify if flares are burning higher, lower, hotter, or cooler than expected, and monitor multiple stacks from a safe distance.

Safety and Surveillance Monitoring

Oil and gas facilities are difficult and sometimes dangerous places for workers. Hazardous conditions mean health and safety must always be the top priority for upstream operations.

Touchless™ Monitoring solutions allow workers to spend less time operating in hazardous areas, reducing potential exposure to harmful chemicals or gasses. Sensors can also be deployed to monitor access to secure areas while enabling the safety team to monitor adherence to safety protocols.

Better Leak Detection and Repair With Continuous Monitoring

As demand for energy recovers, upstream oil and gas companies will play a critical role in the domestic and global economy in the coming years. But faced with increasing financial, regulatory, and environmental pressure, companies must do more to reduce emissions and improve leak detection and repair programs.

New Energy 4.0 technologies, including cloud computing and storage, data and analytics, and artificial intelligence are driving new approaches to LDAR that overcome the limitations of existing methods. Continuous, 24/7 monitoring using fixed OGI sensors provides the operations team with a comprehensive view of facilities, reducing product waste, minimizing emissions, and mitigating regulatory risk.

By taking a strategic approach to deployment, upstream oil and gas companies can implement effective LDAR programs and monitor multiple facilities from a single remote location, further reducing operations and maintenance costs.

Through Touchless™ Monitoring solutions, oil and gas companies can be confident that equipment is operating effectively, reduce the environmental impact of operations, and continue to improve performance.

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systems with intelligence™

Systems With Intelligence is a renowned leader in providing trusted, intelligent, Touchless™ Monitoring Solutions for real time visualization of industrial applications in harsh, remote locations. With headquarters in Mississauga, Ontario, Canada, we help companies around the world, reduce operating and maintenance costs, while increasing reliability and safety.

Touchless™ Monitoring Solutions from Systems With Intelligence are designed and built for oil & gas applications across the entire production process. Explosion-proof thermal, visual, and optical gas imaging (OGI) sensors provide operators with a continuous, 24/7 view of critical equipment and processes, while advanced software and analytics make it possible to detect, verify, and diagnose issues remotely.

With better visibility and control, oil & gas companies can reduce operations & maintenance costs, improve safety, optimize performance, and mitigate the risk of catastrophic failure.