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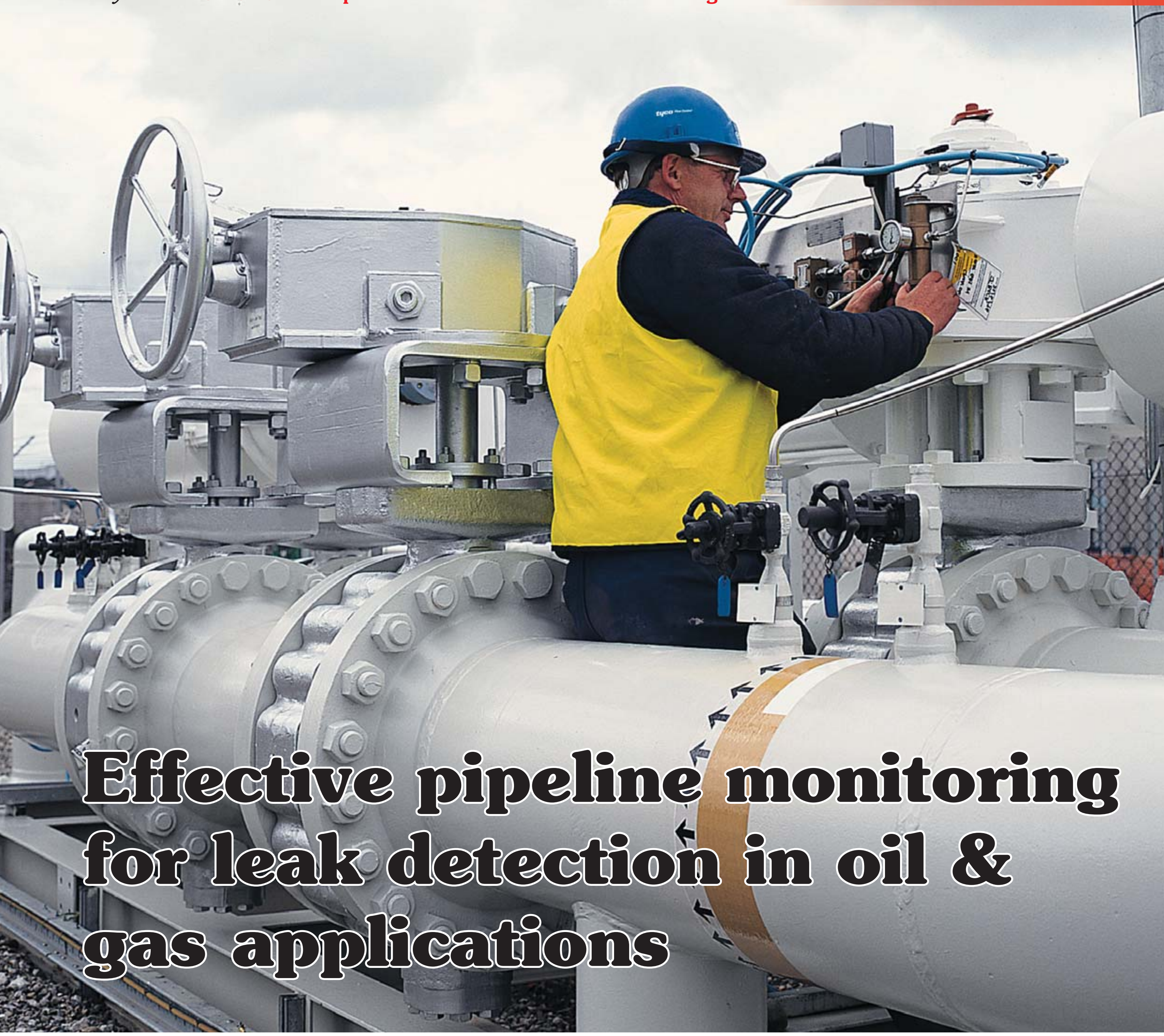

Effective pipeline monitoring for leak detection in oil & gas applications

In 1806, the first modern gas pipeline was laid under the streets of London, from Haymarket to St. James Street. Built from sheet lead, the pipe was laid for the purpose of providing coal gas for municipal street-lighting, and marked a turning point in energy transportation, creating a completely new industry. The concept was adopted in the USA in 1817, with the city of Baltimore granting a franchise to a group of local entrepreneurs to explore the economics of gas-lighting the city's streets. The idea caught on, and more and more cities began building municipal pipeline infrastructure to transport gas produced by local gasification plants to districts for community, industrial or residential use.

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Early pipelines were often built out of hollowed logs, as well as cast iron or lead tubing. Joints were typically threaded, since early soldered joints suffered from seasonal temperature variations, contracting and cracking in the winter, and expanding and warping in the summer. Massive product losses were a frequent hazard and spurred the drive for better materials, advanced technologies and improved processes to manage the end-to-end energy transportation business. Today there are approximately five million kilometres of high pressure pipelines around the world and constitute an essential component of the global energy industry infrastructure. The ability to move oil and gas resources has facilitated continued growth of the global economy over the past two centuries, and comprehensive management of pipeline integrity is essential to maintain the connection between suppliers and users of energy.

The risk of failures to pipeline integrity

Oil and gas installations are of vital importance and high value, which reinforces the need to ensure the safety and reliability of pipelines, particularly when they are located in remote locations or in environmentally sensitive areas. In a fragile economy, threats and damages to pipeline infrastructure carry repercussions far greater than the loss of the product itself. Industries and communities can be severely affected, with significant revenue loss and harm caused to the environment. Pipelines can be vulnerable to various threats, whether intentional disruptions or accidental damage. The natural environment can often be responsible for damage to pipelines due to ground movements, seasonal soil texture changes, corrosion and permafrost subsidence. However, incident accounts show that human intervention, whether accidental - typically due to excavation or construction work - or malicious, through vandalism, sabotage, terrorism or theft, is increasingly becoming the primary cause of pipeline failures. Pipeline integrity management, therefore, becomes a layered process of prevention, detection and mitigation of failures.

Prevention of pipeline damage

Prevention is a multi-faceted function of pipeline integrity management with wide-ranging implications. Human factors weigh most heavily in this area. For example, political and social concerns need to be considered in the prevention of intentional disruptions, such as theft or sabotage. Integrity management in this context can mean anything from working with local communities, to hiring private security – often a daunting undertaking given the lengths and remoteness of many pipeline structures. Accidental damage by human activity can be addressed by better communication, training and information of both communities and operators. Technology and engineering provide the tools for managing environmental risk factors and monitoring pipeline health to allow preventive maintenance and repair.

The need for effective detection

Detection is the second phase of pipeline integrity management. By identifying and isolating the leak early and accurately, leak detection systems can help minimise the consequences of such events. Small leaks are more difficult to detect and may fall below the threshold of leak detection systems due to pipeline hydraulics, detector accuracy and alarm thresholds. They take the longest time to actuate the system component to isolate the area. Larger leaks, on the other hand, are more easily detected, but must be actioned rapidly to prevent significant damage.
There are several types of leak detection methods available for varying purposes. Methods differ depending on numerous technical and environmental factors, such as length and complexity of the pipeline, whether it runs above or below ground, the pipeline's surroundings and possible exposures, and the type and volume of the product transported. There is also a choice to be made regarding the type of monitoring. Internal leak detectors use sensors to monitor pipeline parameters, such as pressure, temperature, flow rate and viscosity in order to detect any variants in the set values. The data obtained is analysed to determine flow conditions and potential loss of product. External detection systems use a variety of sensors, for example optical, thermographic and vapour, to measure physical properties around the pipelines. They sense any escaping product via technology, such as infrared, which detects its location and impact.

Parameters for effective leak detection

When selecting a leak detection system, pipeline operators should consider real-time monitoring, precise location detection capability and rapid remedial action to ensure that a leak is isolated and flow discontinued to keep consequential damage to a minimum. Additionally, sensitivity and reliability with a low false alarm rate need to be balanced to meet the twin objectives of pipeline safety and continued operation.
The system must be able to differentiate between normal and anomalous pressure drops. The compressibility of gas means that these pipelines are almost always in transient conditions. In these situations – and sometimes even in liquid pipelines - variables such as flow and pressure can change rapidly at various points. The detecting sensor must have the capacity to distinguish between operational variations in conditions and measurements that exceed the pre-set values.
When selecting a leak detection method for pipeline monitoring, companies must choose the best fit for their particular application, since the needs for oil and gas pipelines will vary in accordance with their individual conditions. Leak detection systems should be selected to fulfil the needs of their specific purpose.

Mitigation: limiting losses

Mitigation, the final phase of the pipeline integrity management process, covers the actions necessary to minimise human, environmental and economic damage and loss after a pipeline failure. Correct pipeline management must involve consideration of the necessary steps to take immediate remedial action on detected leaks, as well as repair and reclaim of eventual environmental damage. Human and resource asset management procedures, consisting of aspects such as rigorous training of operators to recognise and respond to leak alarms, are very important in this phase to limit the harm caused by the leak. Moreover, they involve codified and well-known emergency procedures and community response involvement.

One of the essential first steps is the isolation of the failed pipeline segment, usually carried out by installed isolation valves – the first responders in the leak scenario. With regard to the spacing of shutdown valves along a pipeline, there is no universally applied set of regulations, however some guidelines indicate every 12-15km as a reasonable measure. The isolation valve is actioned by an on-board actuator, in turn driven by a command that may come from a dedicated leak detection device.

The latest innovation in pipeline monitoring

The latest electronic pipeline monitoring system from Biffi Italia, a division of the Pentair Actuation & Controls platform, is an internal leak detection device specifically designed to monitor the integrity of gas and fluid pipelines. Together with the company's comprehensive range of actuators, ELBS-20 quickly and effectively detects and isolates leaks to ensure safe and smooth operation of a pipeline.

Crucial safety parameters including pressure increase, decrease and sudden drop, as well as low and high limit exceeded levels as part of 1000 events of highly accurate data are measured. This data can then be easily downloaded to any portable electronic device. Further benefits include ELBS-20's unique SOV integrity check function, which monitors system availability at all times, along with its ability to carry out a mitigation action by shutting down the pipeline to avoid further loss of product until the leak point is discovered by other means and repaired.

Based on Biffi's successful ELBS-10 range, the ELBS-20 system has been upgraded to offer improved electronic capability, an increased number of measured critical elements and a superior battery life. The company has implemented customer feedback, which included a specific request for a Bus control system, a feature which facilitates diagnostic data to be downloaded with only two wires. Bus communications allow monitoring and acquisition of several variables of pipeline flow data and valve and actuator performance to be integrated into the pipeline computational asset management system, assisting in predictive evaluation of pipeline status. The Bus system is one of the options offered by the ELBS-20 system for controlling valves. The alternatives include remote hardwired control, local control with an operator opening and closing the valve, and automatic control. Here, when a leak is detected, the detection system automatically isolates the relevant valve, with actuators being powered by the flow of the fluid.

Considerations for effective leak detection

Challenges to the safety and security of pipeline systems are diverse and evolving. Whether intentional or accidental, leaks can be detrimental in their impact. This calls for pipeline operators to recognise the importance of deploying an effective and reliable pipeline monitoring system. Advanced leak detection systems provide operators with detailed, real-time information at a rapid rate of response, which can significantly reduce the reaction time in the event of a leak. In turn, this helps minimise the loss of or harm to life, property and company reputation, the cost of lost products and downtime, as well as environmental damage.

Biffi's ELBS-20, its latest electronic pipeline monitoring system for accurate and reliable leak detection in high and low pressure environments.

About the author

Jacqueline Onditi is an actuation specialist with a long career in the industry. Trained in accounting, she was initially hired by a global actuator manufacturer in 1997 in an administrative role. An aptitude for technical aspects and human relationships meant that she soon transitioned into a technical sales position and within a year was Key Account Manager for one of her employer's leading revenue earners. In the ensuing years, she gained extensive experience in piston actuation applications with a strong focus on the North Sea offshore Oil & Gas segment. In 2003, Ms. Onditi transferred to Biffi Italia, a world leading actuator manufacturer, now part of the Pentair Actuation and Controls platform. In this position she specialised in electric actuators and widened her exposure to international markets in the Middle East and Asia. Today, she continues to dedicate her passion and enthusiasm for actuation in her current role as Global Product Manager for Piston Actuators in Pentair's Actuation & Controls division.