Celebrating 20 Years

Whitepaper

Building Advanced Leak Detection Systems for Effective Pipeline Monitoring

Author: Erin Kinnevy

A Larsen & Toubro Group Company

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1. Abstract

Today, the United States is self-sufficient in meeting its energy needs more than ever before, thanks to large part of the shale revolution of the last decade. This unprecedented boom in oil drilling has led to a massive expansion of the domestic energy transportation network, which is now estimated to involve over 2.5 million miles of pipelines.

The case for effective monitoring of pipelines, therefore, has become all the more compelling, due to a number of factors. First, safe and reliable transportation of hazardous gas and liquids, from source to refineries, and then to distribution outlets, is critical for containment of risks concerning fluid spill, workforce security, and environmental damage.

Second, maintaining aging pipelines is comparatively a tougher task, given their vulnerability to increased wear and tear, deterioration in coatings, and welding failures. And, more than two-thirds of the US fuel pipelines were built before 1970.

Third, robust supervision of this aspect of energy infrastructure can generate significant economic savings. Research carried out by the American Congressional Research Service pegs per-barrel pipeline transportation costs at almost USD 5, way below a typical USD 10-15/ barrel range for the rail route.

2. Damaging leaks

Pipeline leaks can occur due to improper operating procedures, material failure, ground movement or corrosion, deliberate third-party intervention, or even cyber attacks. The consequent damage to the associated energy companies, the broader community, and the environment can be multifold. The various incidents in recent times have shown that leaks result in loss of life, property and natural resources, as well as significant environmental cleanup, lawsuits and regulatory fines.

In fact, 1% leak in a 20-inch line can mean a loss of 450,000 barrels per annum, a study projects. Such an incident, if left undetected, could see 10 square kilometers of lake getting contaminated within 24 hours, the study adds.

3. Regulatory crackdown

Recognizing the growing inherent operational risks in the midstream energy landscape, regulators have sprung to action, tightening statutory compliance norms for pipeline operators. Having enacted the Pipeline Safety Act in January 2012, the US ratified stricter oversight rules in October 2015, mandating institutionalization of leak detection systems for carriers of hazardous liquids such as oil and gas.

4. Leak detection focus

Accordingly, companies across the board have intensified efforts to implement reliable Leak Detection Systems (LDS), in order to streamline the complex pipeline integrity management lifecycle. After all, by accurately identifying and isolating leaks–in time–LDS can help minimize the resulting damages.

Many operators are currently using pipeline inspection gauges, or "pigs", that clean the line and inspect the same for cracks, dents, corrosion or damage to external coatings. The advent of the Internet of Things (IoT) has only increased the spotlight on this technique, with so-called "smart" pigs being tried out by some. These pigs harness magnetic flux leakage and ultrasonics techniques to collect data regarding the pipeline's interior condition, and transmit the information to a control center for further analysis.

5. Varying detection methods

Pipeline operators can look at adopting various types of leak detection methods, based on different environmental and technical factors, including the length and complexity of the pipeline.

Internal leak detectors deploy sensors to track pipeline attributes such as pressure, temperature, flow rate and viscosity, detect variations from preset values, and then mine aggregated data to assess flow conditions and potential product loss. The underlying methodologies here involve Balance (Line, Volume, Compensated Mass), Real-Time Transient Model (RTTM), Pressure/Flow Monitoring, and Statistical Analysis.

On the other hand, external leak detectors rely on optical, vapor and thermographic sensors to measure pipelines' physical properties, and flag any abnormal behavior.

6. Advanced leak detection

Considering the rising complexity of the pipeline infrastructure in the digital age, energy companies should seriously think of designing and rolling out a next-generation, Advanced Leak Detection System (ALDS). Such a setup should be able to recognize leak conditions rapidly, and without failure, enabling operators to minimize fluid loss, property damage, and risk of personal injury.

Any ALDS must have some core features. To start with, it should facilitate real-time supervision and Computational Pipeline Monitoring (CPM), as well as offer precise location detection capabilities. The system should be able to differentiate between normal and anomalous pressure drops, and recognize operational variations in pipeline conditions that exceed predefined values.

Having correctly measured and analyzed vital safety data relating to parameters like pressure spike and decline, ALDS must relay all leak warnings and alarms to the Supervisory Control and Data Acquisition (SCADA) system. It is, therefore, advisable for companies to either integrate ALDS directly with SCADA, or ensure an interface that acts as a middleware of sorts.

On the data representation front, organizations need to make sure all leaks are clearly indicated and presented via a Graphical User Interface (GUI) that is highly customizable, and provides relevant information to operators. Also, ALDS must have data archival and playback features for enterprise users to diagnose outages, and take swift remedial measures for isolating leak and discontinuing spill.

Finally, ALDS should provide functionalities such as batch tracking, scraper monitoring and anomaly tracking for robust, round-the-clock tracking of pipeline operating conditions.

7. Performance metrics

The so-called RP 1175 guidelines released by the American Petroleum Institute outline a roadmap for operators, to configure and implement a sustainable pipeline leak-detection program that promotes a culture of robust risk management across the organization. Essentially, the guidelines emphasize on the following four performance metrics:

- **Reliability:** The next-generation leak detection system should help companies take informed, timely decisions regarding the potential existence of a leak, under defined conditions. Specifically, ALDS should have a low false alarm rate, and detect as many real risks as possible.

- **Sensitivity:** This attribute relates to the system's ability to detect the size of a leak in a time-bound manner. For many setups, detection time is inversely proportional to the leak size.

- **Accuracy:** This metric denotes the accuracy of the values of different pipeline operating parameters calculated by the system, ranging from leak flow rate, total volume lost, type of fluid lost, and leak location.

- **Robustness:** This performance indicator gauges the leak detection system's capacity to keep functioning and providing actionable data, more so in case of variability in pipeline operational conditions or situations where data is lost.

8. LTI value proposition

LTI can help energy companies effectively mitigate pipeline operating risks by designing and implementing an advanced leak detection system that complies with API 1130, API 1149 and API 1155 norms.

Our experienced team of engineering professionals, with in-depth domain expertise, has a proven track record of architecting and building pipeline hydraulics applications and real-time leak detection systems

LTI's best-in-class project management and configuration methodologies are based on close interaction with various stakeholders across the client organization, ensuring an effective ALDS that is properly maintained, hydraulically representative of the pipelines, and well-tuned for all operational conditions. We also deliver the requisite training, documentation and support to ensure smooth system adoption..

By developing a system that provides quick access to real-time data, LTI's services foster faster decision making, and adoption of safer operating practices, translating into the following benefits:

- Compliance with various regulations and guidelines covered under API framework

- Cost-effective, robust, continuous monitoring of pipelines

- Validation of alarms and unexpected events through data trending and event logging

- Customization for user requests without vendor intervention

9. Conclusion

The importance of pipeline safety is only going to grow as the US keeps pursuing its long-held goal of energy independence, boosting domestic production. This secular dynamic will further accelerate the industrialized expansion of oil and gas networks.

Accordingly, the ability to leverage IT for generating a risk-weighted, real-time view of various pipeline assets, and ensure operational safety and reliability, will emerge as a source of competitive advantage. The industry must aggressively adopt IoT and other sensor technologies, in conjunction with SCADA and other tools, for capturing accurate, reliable pipeline data, in order to minimize leaks and create more business value.

About the Author

Erin Kinnevy has extensive knowledge and experience in hydraulics, and the implementation of both SCADA & pipeline leak detection applications, thus delivering comprehensive solutions for Midstream Operating companies in this space. Erin is a Technical Consultant at LTI, her focus areas are pipeline integrity and innovative solutions for clients in the US.