Natural gas pipeline safety: Leak detection technology’s quantum leap
Pipelines are both the safest and most economical means for transporting natural gas (i.e., methane). According to the US Energy Information Administration (EIA), nearly all gas shipments in the US happen on the almost 3 million miles of the nation’s pipeline infrastructure.

A Manhattan Institute report using data from the Pipeline and Hazardous Materials Safety Administration (PHMSA) show that pipelines are 22 times safer than road transport and 2.3 times safer than rail as measured by the number of serious incidents (those involving injury or death) per billion ton-miles transported per year.¹

However, when pipelines do fail, the damage can be catastrophic. PHMSA data show that from 2000-2019 a total of 686 serious incidents occurred on gas pipelines, accounting for 253 fatalities and 1,111 injuries.² That’s an average of more than 12 deaths and 55 injuries per year—well below the rates for some other natural resource sectors like coal mining, but still sobering.

These incidents also come with financial consequences that are borne by industry and the public. According to PHMSA data, between 2005 and 2020, serious incidents on pipelines resulted in more than $7.7 billion in damages with the industry picking up around 83.3 percent of the cost and the public the remaining 16.7 percent³. EPA estimates that around 1.4 percent of all produced gas is lost to leaks.⁴ In 2019, that amounted to more than 471,000 mmcf⁸, which at the “city gate” price of $3.80/mcf is roughly equivalent to $1.8 billion.

However, due to the growing appreciation of the total cost to the environment due to climatic changes, some studies indicate that the effective price of fugitive emissions could be $27/mcf⁹ which would be equivalent to $12.8 billion.

Gas pipeline leaks also negate some of the environmental benefits of switching from coal to gas-fired power generation because methane is a potent greenhouse gas, 21 times stronger than CO₂ over a 100 year time horizon but 84 times stronger than CO₂ over a 20 year period.¹⁰

Natural gas is king, but leaks remain a challenge
EIA forecasts US gas production to grow steadily through 2025 at 1.9 percent annually under the agency’s “reference case” scenario.¹ The industrial sector (e.g., gas used as feedstock in chemical plants or for process heat) accounts for the bulk of the growth. The biggest users remains electric utilities as they continue their transition away from coal and toward gas-fired generation.

Additionally, exports of liquified natural gas (LNG) are set to double by 2030 while exports to Mexico and Canada are projected to rise as well. Both trends are driving the addition of new pipeline capacity. In all, EIA estimates that more than 16 billion cubic feet per day (Bcf/d) of natural gas pipeline capacity was added in 2019 alone.⁶
While our reliance on pipelines is increasing, our gas pipeline infrastructure is aging. More than half of it was built before 1970 and can be prone to leaks, though estimates vary as to the total amount of gas lost. A November 2019 study published in the journal Science estimates methane emissions from both oil and gas operations at 2.3 percent of total production per year, significantly higher than the EPA estimate.

Regardless of the topline figure, America’s pipelines suffer thousands of leaks and ruptures every year and they can be triggered by a wide range of causes (see sidebar).

Regulatory response
On 27 December 2020, the Protecting Our Infrastructure of Pipelines and Enhancing Safety (PIPES) Act of 2020 was signed into law. The Act directs gas pipeline operators to use advanced leak detection technologies to conduct leak detection and repair programs that protect the environment and pipeline safety.

To understand what makes modern leak detection technology better, it’s important to know where we are starting from.

Finding a needle in a needle stack
The first step to fixing leaks is finding them, but traditional methods are slow, inaccurate, and insensitive. Bottom line: they miss leaks. Technicians must walk the area being inspected using hand-held detectors that can take up to 45 minutes to calibrate once on site. Because these systems test the air only every few seconds, the technician must move slowly through the suspected leak site. Test results are manually entered in reporting systems, adding more time to the process.

Recent advances in sensing, analytics and mobile technology have created a wave of gas leak detection solutions that perform significantly better than traditional methods. These systems can detect methane from natural gas leaks at concentrations of 1 part per billion (ppb) or less and respond in less than a second.

More than digging accidents
Gas pipeline leaks occur at all points in the network from collection systems at the well to pipelines under streets and buildings. Causes of leaks can vary:

- Excavating accidents that result in the rupturing, nicking or puncturing of a pipeline
- Placing extremely heavy materials or equipment over buried pipelines
- Water main breaks that weaken roadways and pavement
- Excess accumulation of snow and ice on meters, gas pipes, and gas appliance exhaust and combustion air vents
- Fire or explosion near a pipeline
- Too much or not enough pressure in the gas system
- Equipment failure or corrosion
- Natural disasters such as floods, tornados or earthquakes
Detecting natural gas leaks of 0.5 standard cubic feet per hour (SCFH)

Locating and estimating the size of leaks

Policy Recommendations

The digital age has transformed natural gas leak detection practices, enabling exponential improvements in sensitivity, accuracy, speed, and cost. As Congress contemplates legislation to ensure a safe and reliable natural gas pipeline system, we encourage lawmakers to take recent advances in commercially available technologies into account when designing a new pipeline safety law.

Any gas leak detection law should include the ability to do three basic things: (1) detect leaks, (2) precisely identify their location, and (3) accurately estimate their size. To accomplish this, we recommend that any leak detection system be capable of the following:

1. **Detecting**
   - Detecting natural gas leaks of 0.5 standard cubic feet per hour (SCFH)

2. **Locating**
   - Providing an accurate estimate of the location of the leak source

3. **Estimating Size**
   - Estimating the volumetric emissions rate of the leak.

ABB's mobile gas leak detection solutions leverage advanced laser-based sensors, GPS technology and analytic software to dramatically improve both the speed and accuracy of gas leak identification and location. The difference in precision and accuracy between this technology and previous approaches is greater than 1,000 to 1. That is analogous to the difference between today's high-definition TV and the black and white sets of old.

How it works

Combined with a GPS module, an onboard ultrasonic anemometer to measure wind velocity, and advanced proprietary analytics, ABB's MobileGuard™ can detect, precisely locate, and accurately estimate the size of natural gas leaks at a rate that covers 10 to 25 times more land area per hour than traditional methods. Importantly, it eliminates false positives associated with biogenic sources of methane like sewage and animal waste by also detecting ethane, found only in thermogenic pipeline gas, along with methane.

This technology can detect methane from leaks from up to 300 feet away in a vehicle moving at 55 mph. ABB offers similar solutions for detecting, mapping and quantifying leaks while flying a drone (HoverGuard™), walking (MicroGuard™) and in stationary applications (EverGuard™). All of these solutions are also cloud-connected and cybersecure to enable immediate sharing of the comprehensive results describing locations and sizes of leaks in real time.

The combination of speed, accuracy and operational efficiency helps pipeline operators and service providers meet the demand for fast, accurate and transparent data while streamlining their operations. Most importantly, these new solutions based on ABB's proven LGR-ICOS technology are currently being used by companies up and down the natural gas value chain across the US and around the globe.
Endnotes


[5] EIA demand forecast


[10] https://www.carbontax.org/methane/