SIMULATING GAS IN THE AMERICAS

Bob Truman, Business Development Director (Gas) and Rodrigo Salgado, Sales Engineer (Latin America), Atmos International, discuss minimising pipeline risks in the Americas with online (real-time) gas simulation.

The gas industry is expanding, fueling industry, power plants, domestic homes, vehicles and electrical power stations. The Americas is one of the biggest producers of natural gas in the world, with the US experiencing astronomical growth as a gas supplier in the past eight years (Figure 1) owing to the ongoing expansion and addition of gas pipeline projects to the country's gas transmission network, such as the Louisiana Energy Access, Matterhorn Express and Mountain Valley pipelines.[1,2,3] Similarly, in Latin America the Texas-Tuxpan pipeline was recently completed and Argentina and Brazil are currently investing in the expansion of their existing gas transmission network.[4,5,6]

Gas transmission networks in the Americas will become increasingly more complex as new pipelines are developed to support growing global energy demand. Now more than ever, operators will need a complete view of pipeline activities to overcome the risks associated with gas transportation. Below are some of the main risks and how the installation of pipeline simulation software can provide support.

The increasing cost of operating gas transmission and distribution systems

In addition to global challenges such as rising labour and material costs, a range of Americas specific factors are contributing towards the increasing cost of operating gas pipelines. For example, in the US a large amount of gas pipeline infrastructure is ageing

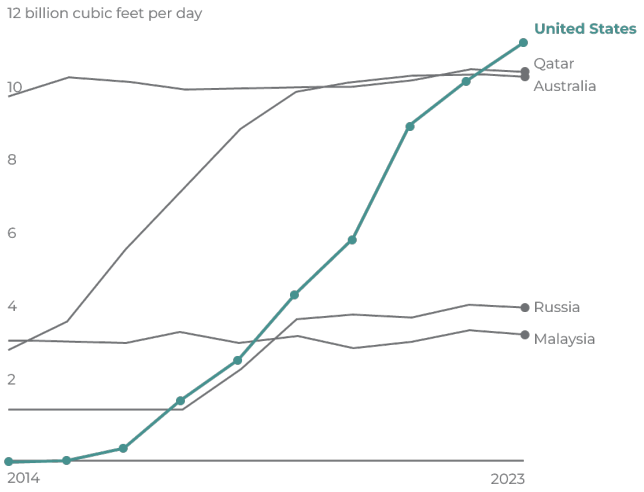

Figure 1. Top exporters of LNG. Data represents the annual average of LNG exports by country.[7]

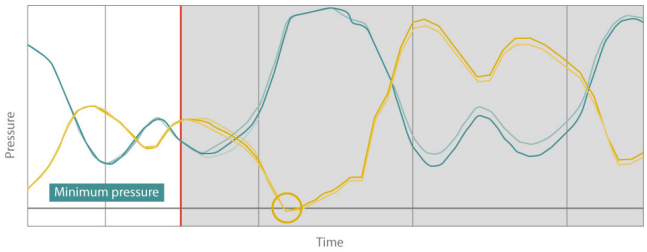

Figure 2. Trending data from a live pipeline's recent activity (light background), along with the look-ahead's prediction of a future scenario. The circled area signposts a potential minimum pressure violation that can be prevented by taking actions early.

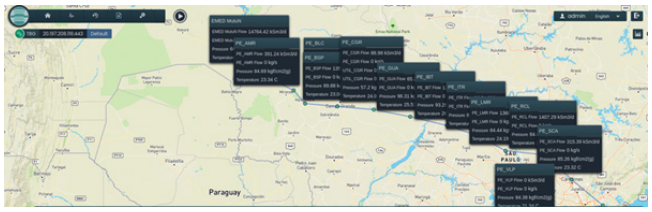

Figure 3. An example in Brazil of proposed flow and pressure set points recommended by simulation tools.

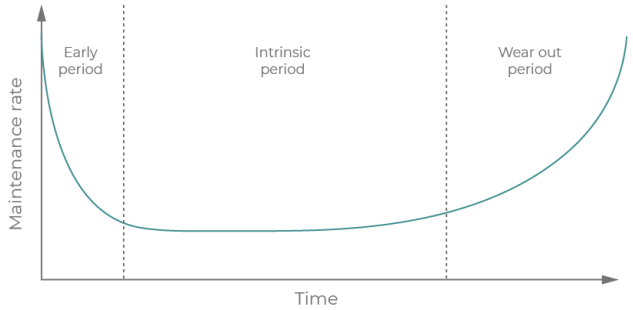

Figure 4. A visualisation of the bathtub curve, as used to define the reliability of a product.

and stringent regulatory requirements require companies to make substantial investment in their repair if they pose a risk to the surrounding area.[8] In Latin America, currency volatility continues to affect the cost of imported materials, resulting in increased operational costs.[9]

To keep gas pipeline companies' costs down, simulation software can help reliably meet gas contract requirements of pipeline customers. It reduces costs for gas pipeline operators by informing the control room of the best course of action when it comes to planned and unplanned operating events in gas transmission and distribution networks.

Cross-border pipelines

To support multiple countries in the region, there are many cross-border pipelines in the Americas. The Tennessee Gas Pipeline (TGP) covering Canada, the US and Mexico; the Los Ramones pipeline between the US and Mexico; and the Southern Cone gas pipeline connecting Argentina, Bolivia and Brazil are some notable examples of border crossing pipelines in the Americas. With plans to develop more in the future, it's important for pipeline companies to consider the challenges associated with border crossing gas pipelines, such as navigating the different regulations and rulings of each country which a pipeline route passes through.[10]

Each country has its own regulatory body, pipeline construction and customer requirements, which will affect the operating requirements of the pipeline. The maximum allowable operating pressure (MAOP) and lowest allowable operating pressure (LAOP) can differ between countries, for example the United States' is dictated by the Pipeline and Hazardous Materials Safety Administration (PHMSA) while Canada is bound by the Canada Energy Regulator (CER).

Simulation software can factor the differing requirements into a cross border pipeline model, providing under and over pressure alarming in each country. Forecast models can also provide an early warning if a pressure violation is anticipated in the future (Figure 2).

Managing risks

Gas pipelines are typically operated in an imbalanced condition, so they rarely reach a steady state. Customer requirements and the operational integrity of a gas pipeline also need to be met so LAOPs and MAOPs are in place to manage risks.

Simulation tools with machine learning capability can make recommendations that reduce the risk of operating a gas pipeline outside allowable limits (Figure 3).

Ageing infrastructure

Over half of natural gas transmission pipelines in the US were built before 1970 and can be classified as "ageing".[11] Similarly, Latin American countries like Argentina have a substantial but ageing gas transmission network.[12]

The challenge with ageing infrastructure is that the pipeline reaches a 'wear out period', increasing operational costs and volatility and a higher risk of hazardous leakage events (Figure 4).

The corrosion caused by ageing infrastructure is unavoidable, however pipeline simulation tools – especially those with machine learning built in – can automatically generate an optimal and actionable operational plan each day including set points for flow, pressure and equipment and ensuring the smartest use of a gas pipeline network and creating less risk of accelerating pipeline ageing.

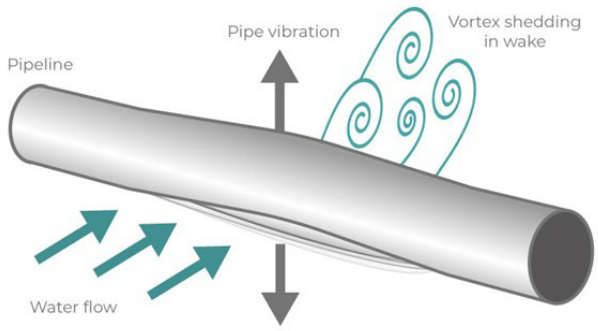

Figure 5. Riverbed scour exposes pipelines to the elements and the fast-flowing water can cause vibrations that weaken pipeline integrity, also known as vortex induced vibration.

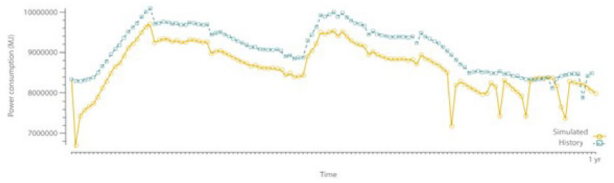

Figure 6. Calculated compressor power consumption (yellow) compared with historical data (green).

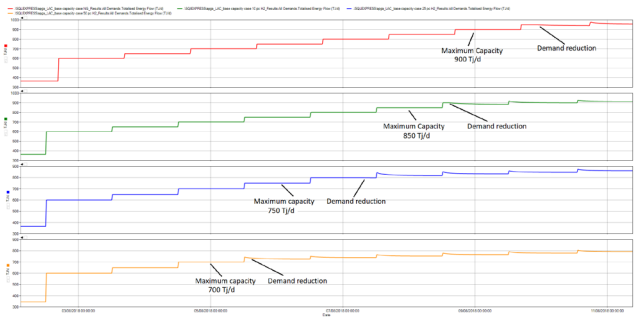

Figure 7. Hydrogen blend maximum capacity calculated by Atmos SIM (red 0%, green 10%, blue 25% and orange 50% hydrogen) in an example pipeline network.

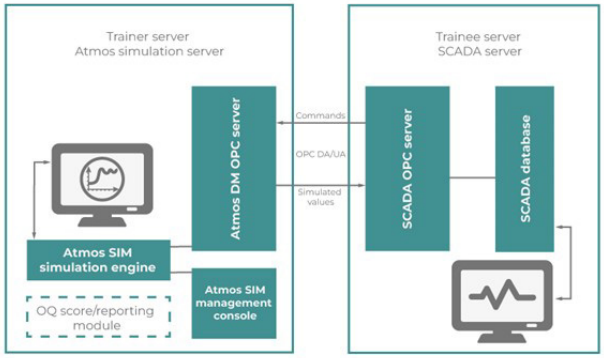

Figure 8. Example training system architecture.

Leaks and explosions

Gas pipelines across the world are at risk of leakage and explosions, but there are some factors unique to the Americas that make the region more at risk. For example, a significant portion of pipelines in the Americas are ageing, but there are also factors relating to external damage that impact the region. Clashes with indigenous communities over pipeline routes have historically resulted in pipeline vandalism, which can impact pipeline integrity and create a heightened risk of leakage.[13]

Similarly, gas pipelines with sections running offshore require additional care to safeguard against the marine environment. Trinidad and Tobago's cross-island pipeline, sections of the Los Ramones pipeline in Mexico and many routes in Brazil have offshore sections. Failure to protect offshore gas pipelines can accelerate corrosion and be susceptible to other harsh environmental forces that can lead to a catastrophic leak event that not only results in product loss, but endangers the environment and marine life in the surrounding area.

The topography of the Americas is also highly variable. Latin America alone is made up of mountains and highlands, river basins and coastal plains. Extreme geographic variation presents a risk of geohazards, such as landslides, laharas and volcanic eruptions impacting pipelines in the vicinity of mountains or riverbed scour and underground erosion affecting pipelines (Figure 5).

Pipeline simulation tools can equip a leak detection module that provides fast, sensitive and reliable leak detection. Utilising a sequential probability ratio test (SPRT), it's possible for simulation tools to provide leak detection by calculating the ratio of leak probability over no-leak probability, which are then tested against threshold values to provide reliable leak warnings and alarms.[15] For gas transmission networks in the Americas which are already at high risk of leakage and explosions, pairing leak detection with simulation software is vital.

Managing the complexity of gas networks

When gas networks in the Americas can contain multiple compressor stations and many delivery points, determining the best course of action can be difficult for pipeline operators when multiple changes occur simultaneously on the system.

Simulation software can provide a detailed model of the network, with machine learning even being capable of presenting where energy savings are possible. Figure 6 presents an example of a 548 mile gas transmission pipeline across three countries where an energy saving of 5% is achievable, resulting in a saving of US$5 million/yr.

Greenhouse gas emission reduction

To reduce greenhouse gas emissions, a solution being explored is the introduction of hydrogen into the gas stream. Hydrogen doesn't generate greenhouse gas emissions and countries across the region are exploring hydrogen as part of their energy transitions. For example, Canada has a hydrogen strategy in place to position itself as a global leader in hydrogen production and export,[16] Mexico's National Institute of Electricity and Clean

Energy (INEEL) is researching hydrogen projects and Chile has plans to become a green hydrogen exporter.[17]

Pipeline operators in the Americas will have to account for hydrogen's differences to other natural gases when it's introduced into the gas stream. Simulation software can help operators model the behaviour of various hydrogen blends as well as managing the network's capacity (Figure 7) and tracking gas quality.

Operator training

With everything that needs to be considered in the safe and efficient operation of a pipeline today and with the rapid growth in new pipeline facilities, proper operator training is now more important than ever. Simulation software can be adopted to mimic the operator's SCADA interface (Figure 8), allowing the operator to experience operating a gas pipeline with a digital simulation and actual SCADA interface. This experience can prove invaluable in making sure that the operator knows how to react to changing pipeline conditions and prevent potential loss of life and facilities.

Gas simulation is key to keeping control of transmission networks in the Americas

Whether it's managing ageing pipeline networks or incorporating new pipelines, safe and efficient gas pipeline operations should always be the highest priority. A range of challenges continue to face gas pipeline operators in the Americas but the installation of a simulation software solution can alleviate operators' concerns. WP

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