Pin-point

precision for pipeline protection

Jun Zhang, Atmos International, considers the growing significance of produced water pipeline leak detection in gathering networks.

The oil and gas industry continues to boom with major projects under development across the world.[1] In North America for example, this is in part due to factors like the shale boom, which has resulted in oil producers needing to expand gathering pipeline networks by hundreds of miles to keep up with demand.[2] Oil and gas is similarly booming in Africa, Asia and the Middle East due to the regions' abundance of reserves.[3,4,5]

Increased production of oil and gas worldwide brings with it an increase in gathering networks.

Gathering networks are a crucial component of oil and gas production because they transport hydrocarbons between the production site, processing facilities and to end customers. Gathering pipelines typically operate in multiphase and carry a mix of products before they are separated, such as crude oil, natural gas, natural gas liquids, impurities like sulfur compounds and other trace elements and sediments and solids like sand and clay. This article focuses on produced water, which is generated in large amounts during the oil and gas extraction process and in some cases is transported on a journey that includes upstream, midstream and downstream sectors.

As the global oil and gas industry continues to grow, so will the amounts of produced water, with 2020 marking the first year that the annual global quantity of produced water from oil and gas operations exceeded 240 billion bbls.[6]

While produced water sounds harmless on the surface, failure to appropriately dispose of or reuse produced water can have severe environmental impacts.[7] This article discusses the significance of pipeline leak detection for produced water management.

What is produced water?

Produced water or 'brine' is a byproduct of the oil and gas extraction process and it typically takes a brackish or saline water form when it is collected. There are many sources of produced water too. For example, most oil and gas bearing rocks contain formation water, which is collected when oil and gas reservoirs are mined.[8]

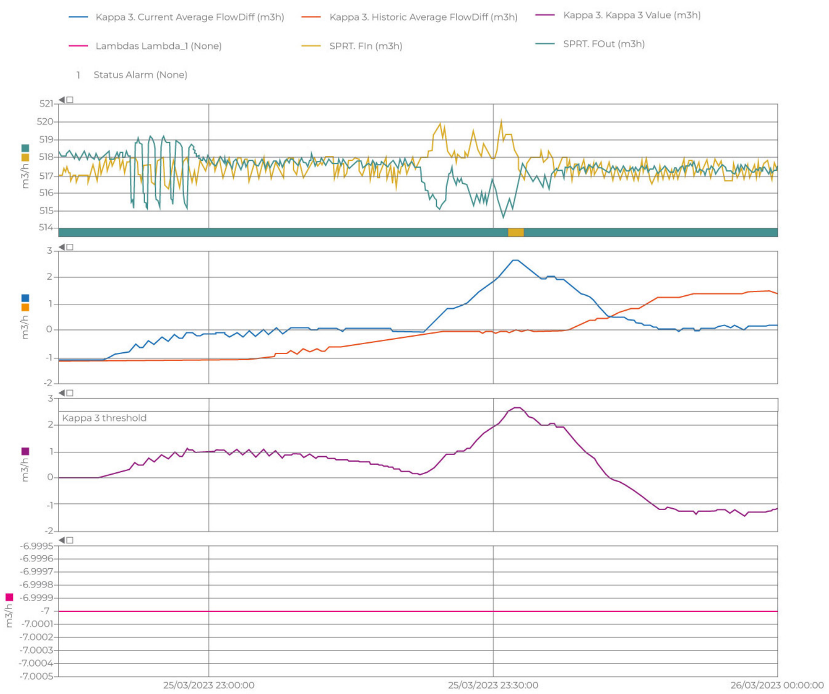

Figure 1. **The new algorithm alarmed for a small product loss on a UK pipeline company's network (red bar in the top chart indicating leak/theft alarm).**

Produced water is also created during water injection, which is when oil recovery involves forcing oil towards a well for extraction by injecting water.[9] The injected water returning to the surface takes on the form of produced water.

Water vapour present in the production of natural gas can also condense out of the gas stream due to pressure and temperature changes, becoming produced water. A final example source of produced water occurs during fracking operations. Similar to water injection in the oil industry, fracking involves injecting water mixed with chemicals into a well to fracture the rock and release oil and gas, but the water returning to the surface becomes flowback water.[10]

Managing produced water transportation

Pipelines are the safest means of transporting any fluid, which is why produced water upstream is typically transported via pipelines from wellheads to central processing facilities to remove hydrocarbons and solids. Pipelines are also crucial in the midstream transportation of produced water for further processing so it can be purified for disposal or reuse. While being the safest means of transporting produced water, a pipeline leak can still have severe consequences.

The significance of pipeline leak detection

Environmental risks

Brine (produced water) is a saturated solution of dissolved salts, oil, and drilling chemicals that exhibits elevated levels of total dissolved solids (TDS), electrical conductivity (EC), and sodium adsorption ratio (SAR). Environmental exposure to brine through accidental releases or abandoned evaporation pits can have severe deleterious effects on soil quality and vegetative health. For example, the concentrations of sodium (Na) within brine can invoke swelling and dispersion of soil particles, and the elevated EC levels most often kill salt-sensitive agricultural crops and native plants and vegetation.[11]

Produced water leakage occurring offshore can impact water quality by introducing contaminants such as biocides, hydrocarbons, metals, salts and more into the environment. These can affect marine life by altering oxygen, pH, salinity and temperature levels in the environment and impact the survival of marine organisms. If the leak occurs in a water source used for drinking, irrigation or recreation, produced water can also be hazardous to human health.

Wasting resources

Some regions with high reserves of oil and gas face water scarcity. For example, 15 of the 20 most water scarce countries are in the Middle East and North Africa, but these are also two regions which use water to produce oil and gas. Produced water pipeline leaks in regions where there are water scarcity issues can have severe consequences on water supply and management.

Considering the climate

Produced water can contain traces of dissolved gases, such as carbon dioxide, hydrogen sulfide and methane. These are greenhouse gases and contribute towards global warming if they are released into the atmosphere.

Regulatory requirements

Depending on the region an oil and gas company operates in, produced water leakage can risk violating regulatory requirements related to spill prevention and response.

To avoid the environmental, financial, reputational and social risks associated with produced water leakage, oil and gas companies should consider installing a leak detection system.

Produced water leak detection

A pipeline leak detection system that optimises sensitivity and accuracy on the most complex pipelines, such as gathering networks, is crucial to minimising the potential damage associated with a produced water leak.

Leak detection systems comprising of advanced statistical analysis algorithms are proven to be the most effective approach to leak detection in gathering networks.

Figure 2. The failure point of this customer's pipeline was roughly 14 in. long.

Algorithms like the sequential probability ratio test can analyse pressure and flow to optimise leak detection using data from SCADA, DCS, PLC or RTU systems. Self-trained filters in some leak detection software can also compensate for measurement errors to maximise performance. Recent algorithm updates can also improve leak detection in high consequence areas, where gathering lines transporting produced water are typically located.

One example of an upgraded leak detection algorithm relates to onset leak detection. This method can be used as an additional leak detection alarm to provide an added level of protection.

On a produced water pipeline, this means high sensitivity can be achieved without increased false alarms because transients and density changes are identified automatically.

Case study: produced water gathering network in the Americas

A leak occurred in the well node of a customer's produced water network which has multiple inlets and outlets and transports produced water.

The leak began as a small leak and caused a rupture when the customer started the pumps at one of their wells. The leak was detected quickly using a statistical corrected volume balance leak detection system which was able to identify that the pipeline's flow was displaced.

The system was able to alarm within seven minutes, with the total volume spilled being 170 m^3, and the failure point was roughly 14 in. long (Figure 2).

Leak detection is key to minimising produced water pipeline risks

Produced water pipeline leaks can have serious consequences including threats to human safety, damage to the environment, property and reputation, not to mention the financial loss through fines and clean-up costs. The installation of a suitable leak detection system can detect produced water leaks quickly, locate them accurately, issue minimal false alarms, be easy to retrofit, work effectively under all operating conditions and use sensors with high reliability and low maintenance.

References

1. https://www2.deloitte.com/us/en/insights/industry/oil-and-gas/oil-and-gas-industry-outlook.html
2. https://undergroundinfrastructure.com/magazine/2018/august-2018-vol-73-no-8/features/challenges-of-leak-detection-on-produced-water-crude-gathering-networks
3. https://www.reuters.com/business/energy/saudi-aramco-oil-colossus-2024-05-30
4. https://www.investorschronicle.co.uk/news/2024/06/13/the-energy-industry-s-booming-region
5. https://energycouncil.com/articles/southeast-asias-oil-and-gas-boom/
6. https://www.iom3.org/resource/mining-produced-water-from-oil-and-gas-operations.html
7. https://www.linkedin.com/advice/3/what-environmental-impacts-produced-water-discharge-skills-oil-gas-vo48c
8. https://www.sciencedirect.com/topics/engineering/formation-water
9. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/water-injection
10. https://www.sciencedirect.com/topics/chemical-engineering/flowback-fluid
11. https://acsess.onlinelibrary.wiley.com/doi/full/10.1002/agg2.20042