

# TANKS & TERMINALS

A SUPPLEMENT TO HYDROCARBON ENGINEERING

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Figure 1. Jetties allow tankers to load and unload crude oil, feedstock and finished products close to a refinery. The maze of pipes is subject to corrosion.

# KEEPING AN EYE ON CORROSION

**Jake Davies, Emerson Automation Solutions, UK,** examines continuous corrosion monitoring methods for jetty pipelines in order to protect against an interrupted supply to and from the refinery.

**M**any refineries and oil terminals are located beside major stretches of water, either sea or river, to provide a cost-effective transportation route for incoming crude oil and feedstock, and for outgoing finished products. Ships and barges need a certain amount of water depth to be able to safely load and unload product without the danger of running aground, so most facilities use jetties (Figure 1) to enable the vessel to moor in deeper water away from the shore.





**Figure 2.** Suspended pipelines are difficult to inspect with manual ultrasonic methods, requiring access by boat or a ladder.



**Figure 3.** Permasense ET210 wireless ultrasonic wall thickness sensors provide continuous corrosion monitoring of jetty pipelines.

Jetties can often be several hundred feet long, with multiple berths and the capability to handle many different products simultaneously. To accommodate the various oil products and feedstocks, multiple product lines are run from shore in pipelines above and below the jetty.

In most instances, it is not cost-effective to construct these jetty pipelines from stainless or alloy steel, so carbon steel is used instead. The use of carbon steel, however, creates a risk of internal corrosion, particularly where higher sulfur content oils (such as fuel oils) are concerned, or when fuels contain potentially corrosive additives. The presence and build-up of water allows for the accumulation of bacteria that cause microbial-induced corrosion. This issue is especially likely to occur in jetty lines since they have intermittent or slow flow rates, allowing water to settle in low points.

If undetected, a hydrocarbon leak resulting from corrosion in a jetty line will go straight into the water course, interrupt jetty operations while the leak is sealed, and necessitate complex oil spill response procedures to clean up the water. Many jetties suspend pipes underneath to allow vehicle traffic above, making regular manual inspection and maintenance difficult.

To reduce the risk of leaks from corrosion, and to avoid the associated costs and regulatory issues, most jetty owners will regularly inspect suspended pipelines from a boat or by a suspended scaffold, mainly using manual methods such as ultrasound wall thickness inspection (Figure 2).

In many jurisdictions, this regular inspection activity is mandated by the local environmental regulator. Access to the pipelines by boat is not always possible – for example, during bad weather – and incurs a regular cost that, in today's tight margin environment, operators would rather avoid.

### Continuous corrosion monitoring systems

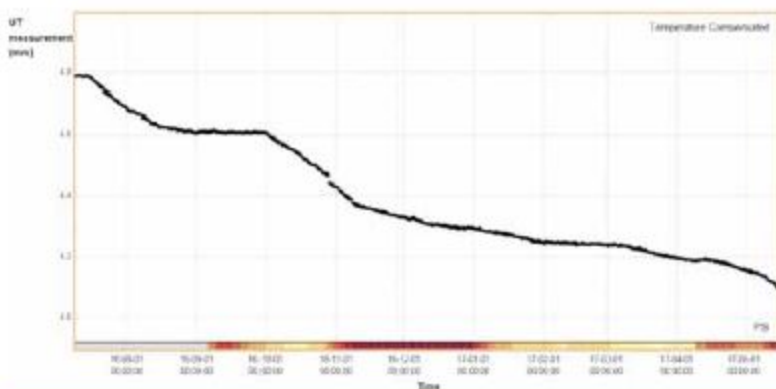
Continuous corrosion monitoring with ultrasonic wall thickness measurements provide an effective and continuous check of pipeline integrity (Figure 3). Elevated corrosion rates and wall loss are detected, eliminating the need for manual inspection. Corrosion inside jetty lines is normally uniform in nature or restricted to specific well-known areas, such as microbial-induced corrosion in low points of the lines. Therefore, corrosion sensors can be spread uniformly at strategic points to enable continuous sampling, and targeted at specific high risk locations with additional sensors.

Data from the ultrasonic sensors is transmitted wirelessly from the sensors to a gateway, which can be mounted at a control system onshore, or locally in the jetty control room. The gateway feeds the data in relevant time to a computer or server, where it is stored in a database accessible from anywhere on the company's network – enabling data visualisation and analysis at the engineers' desks.

This technology makes it feasible for integrity data across multiple locations to be monitored by experts at a central location, such as at company headquarters or a technical centre. Specialised data visualisation and analytics software, such as data manager from Emerson (Figure 4), provides corrosion rate calculations and flags variations as they arise, enabling end-users to focus on issues at specific locations. Corrosion rate data can be used to forecast when lines need to be replaced with a high degree of accuracy.

### Installing ultrasonic sensors

Low-powered ultrasonic corrosion sensors, such as the Permasense ET210, can be permanently deployed in areas of hydrocarbon processing facilities zoned hazardous (Zone 0, ATEX, IECEx, etc.). Based on electromagnetic acoustic transduction principles, the sensor is wireless and battery operated, so there is no



**Figure 4.** Data manager software monitors data from ultrasonic sensors, calculates corrosion rates, detects problems, and predicts when pipelines need to be repaired or replaced.

The installation and commissioning procedure can be completed in just a few minutes, without the need for multiple installation trade specialists (mechanical, instrument/electrical, welding, etc.). A complete monitoring system for a jetty with 25 or more sensors can be installed, commissioned and transmitting data within one day. This simple installation procedure provides advantages, particularly when working in the inaccessible locations or outside in extreme ambient conditions often found near jetties.



**Figure 5.** Installing Permasense ultrasonic corrosion sensors is a simple matter. Approximately 25 sensors can be installed in one day per installation technician.

requirement to lay cables for power supply or communications. Therefore, installation avoids the need for expensive conduit or cable trays.

The sensor uses the WirelessHART® communications protocol to form a wireless mesh network with other corrosion sensors installed on the jetty's pipelines, and other devices such as temperature, pressure, flow or level sensors used to monitor and control flow to and from the tankers and onshore tanks. Typically, only a single gateway is needed to acquire data from all the sensors on the jetty, and send it to a control or monitoring system. Mounting of the ultrasonic sensor is a simple and quick task.

The sensor is fixed to the pipe surface by integral magnets, with a restraining strap used to prevent dislocation (Figure 5). External corrosion protection coatings, often used to protect the outside of the piping from external atmospheric corrosion, do not need to be removed as the sensor will measure through the coating.

## Benefits of continuous corrosion monitoring

Performing manual inspections for pipeline corrosion requires the services of a trained ultrasonic technician, and access by boat or scaffolding for suspended pipelines. Typical access and manpower costs are US\$1000 per measurement location for suspended pipelines, and manual inspections are typically carried out every two months at a cost of US\$25 000 per inspection. This results in an annual inspection cost for a jetty with 25 monitoring locations and inspections of US\$150 000.

Environmental clean-up costs following an oil leak can run upwards of US\$250 000, depending on the size of the spill, and are likely to incur significant fines, regulatory pressure, reputation damage, and losses due to operational outages, which are often far more than clean-up costs.

At a cost of approximately US\$125 000 for a monitoring system at 25 locations, gateway and corrosion monitoring software is a continuous corrosion system that could quickly pay for itself and greatly reduce the risk of unplanned outages and leaks.

## Conclusion

Jetty pipelines often experience internal corrosion and hydrocarbon leaks, which can result in feedstock or products discharging directly into the water. The cost of a leak includes ceasing jetty operations while the leak is repaired, and the cost of spill response and clean-up, as well as closer scrutiny from environmental regulators and potential reputation damage. Therefore, most jetty owners carry out routine inspections from boat or suspended scaffolding using labour-intensive methods such as manual ultrasound inspection.

In many jurisdictions, environmental regulations force an enhanced inspection and reporting regime in order to minimise the probability of a leak. Continuous corrosion monitoring systems provide a means to measure and report corrosion rates.