FEATURE CORROSION

Make more of monitoring to combat corrosion

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Internal and external corrosion are a major threat to the integrity of assets in the upstream oil and gas industry throughout the Middle East. So how can we fight corrosion? Here we look at some of the latest corrosion monitoring technologies on the market and how they are meeting today's corrosion challenges.

With many pipeline assets ageing and operators focusing on effective production strategies to accelerate cash flow, pipeline integrity and the need for accurate corrosion monitoring of large surface areas have never been more important.

It is with this in mind that Emerson Process Management will be at ADIPEC this week highlighting its range of Roxar CorrOcean monitoring products.

There are many causes of corrosion today. For example, crude oil and natural gas often contain impurities that are corrosive, while metals immersed in conductive mediums can lead to electrochemical corrosion. Differences between casing joints and changes in fluid compositions, such as in the concentration of dissolved gases or pH, can also cause corrosion. The presence of saline water, a common occurrence in Middle East fields, can cause scaling, hydrates and corrosion. In the case of wet gas fields (such as the Rosetta field, offshore Egypt), corrosion is often caused by the presence of carbon dioxide (CO2) in the gas. Brownfield sites also face corrosion challenges as water cuts begin to increase in volume: today more than 70 per cent of the world's oil and gas production comes from fields that are more than 30 years old. Many of these are in the Middle East.

And then there are sour gas fields with high hydrogen sulfide (H2S) concentrations. These are not only vulnerable to corrosion but also offer challenges from a health and safety standpoint. Such fields are particularly pertinent to Abu Dhabi where the giant Shah sour gas field development is underway. Abu Dhabi today has more than 200 trillion cubic feet of gas reserves – much of it from sour gas reserves.

The impact of such corrosion can be considerable, leading to production losses, metal loss (which reduces the life of production and storage equipment), or safety and environmental setbacks, due to the corrosion of key infrastructure.

In the fight against corrosion, monitoring plays a major part. The traditional means of monitoring corrosion is through internal monitoring. This can consist of test coupons, electrical resistance (ER) probes, and linear polarisation resistance (LPR) probes. These coupons and probes are installed through a fitting system and placed within flow lines, process piping, or import and export pipelines, both topside and subsea.

Emerson offers a variety of arrangements for installing fittings into pipes and vessels under different conditions and requirements. Its internal corrosion monitoring solutions include weight loss coupons, where corrosion is determined from the weight loss over a period of time, and a range of electrical sensor-based solutions, such as ER and LPR probes or galvanic measurements. Common to all these methods, except weight-loss coupons, is a high resolution and thus an ability to respond fast to changes in corrosion rates, a factor that is particularly useful for corrosion inhibitor programmes.

Internal monitoring is also an effective means of monitoring corrosion further downstream, particularly in refineries. This has resulted in more efficient corrosion control where corrosives vary from batch to batch and where corrosion control is critical with respect to integrity, maintenance and economic performance.

For all their benefits, however, there are limitations to internal, intrusive monitoring. They include the fact that corrosion on the probe does not necessarily reflect corrosion at the pipe wall. This can mean limited success in detecting localised attacks, such as pits or weld corrosion.

Furthermore, corrosion is often most severe at the bottom section of the pipeline because this is the location where water is most likely to be present. Monitoring such locations with traditional probes requires access to the bottom of the pipe. This would require big pits under the pipeline with space for access fittings and space for operating retrieval tools quite a logistical challenge!

Given these factors, it is hardly surprising that non-intrusive corrosion methods, directly installed on the pipe, have become increasingly attractive to operators. Non-intrusive corrosion methods have also become particularly popular in sour production (H2S) environments (with significant applicability to the Middle East) where direct measurements at the pipe wall can give more reliable results and where safety is a concern for probe retrieval operations.

For any application where space is important and where direct measurement on the pipeline provides monitoring and safety advantages, non-intrusive corrosion has become a popular alternative to traditional internal methods.

So what form does non-intrusive corrosion monitoring take? The most common form is based on ultrasonic or electric field signature measurement technology. Here we focus on electric field signature monitoring, one of the most popular non-intrusive monitoring techniques. Known by Emerson as Roxar CorrOcean FSM, it is a technology that has been on the market since the early 1990s.

FSM is a non-intrusive method for monitoring corrosion,

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erosion or localised attacks and cracks inside pipelines, process piping or vessels. FSM can also be used in subsea pipelines and flowlines, underground pipelines, high temperature applications in refineries, applications in sour service environments, or in process piping and pipelines.

FSM is based on feeding an electric current through a selected section of the structure to be monitored. This is achieved through non-intrusive sensing pins, which are distributed over the areas to be monitored. An electrical current is induced into strategically located pipe sections and thus creates a pattern determined by the geometry of the structure and the conductivity of the metal.

Voltage measurements on each pin pair (up to 400 pin pairs can be applied in a matrix) can then be compared to the 'field signature' which provides the initial reference, and changes in the electrical field pattern can then be monitored. Conclusions can thereby be drawn relating to the general wall thickness and the initial signs of metal loss.

Figure 1 shows the installation of FSM, non-intrusive monitoring in Brazil where the sensing pins are welded to the external pipe surface, the instrumented pipe section is protected externally by a polyurethane compound, and the soil is then put back into position, with interface boards and connectors (installed on a post) the only permanent components above ground. Figure 2 shows installed sensing pins with field cables and termination in an on-line instrument on site at a refinery.

There are a number of benefits to FSM technology. Firstly, there is FSM's ability to distinguish localised attacks and general corrosion in real time (and to higher levels of accuracy and sensitivity), as well as its ability to detect corrosion rates much earlier than traditional corrosion methods. This allows corrective action to be taken before any damage occurs and is crucial to operators as they look to guarantee real-time flow assurance.

In sour service environments, for example, traditional corrosion monitoring encounters difficulties due to iron sulphide (FeS) deposits disturbing the measurements generated from ER and LPR probes. The FSM method is not disturbed by such conductive deposits.

Installation is also much more cost-effective and easier to apply in the FSM context than intrusive coupons and probes. One of the most critical sections of the pipeline, for example, is the bottom (6 o'clock) section of horizontal pipelines, where water collection is most likely to take place. The ease of installation with FSM compares favourably with traditional corrosion probes, which require concrete pits to be dug under the pipelines. This non-intrusive corrosion monitoring reduces installation and maintenance costs and increases operator safety - especially in the case of sour service fields.

As with any technology that has been available for 16 years, FSM has changed and evolved. For example, to reflect operator demand, Emerson has introduced online and real-time corrosion monitoring to FSM. The company's on-line system and new, on-line data logger can be used with a wide range of wireless communications methods (such as radio, telephone, GSM and satellite phone) and can be powered through solar panels.

The advantages to the operator of online corrosion monitoring are significant. These include a higher data collection frequency, thereby increasing the accuracy of the system and the operator's ability to distinguish trends from random variations; and the fact that an online system can allow remote and wireless data communications direct to the operators' offices.

Today FSM can detect corrosion in a wide variety of different and often challenging applications. For example, in refineries and high temperature applications, the FSM can operate at pipe temperatures of up to 500 degrees Celsius.

However, as we have hinted, FSM measurements generate a considerable amount of data, extensive information about corrosion rates and distribution. The growth of online systems, such as those offered by Emerson, which generate more frequent measurements, has increased this data output.

As well as the increase in data, there has also been a general trend among operators to more integrated monitoring systems which include not only intrusive and non-intrusive erosion

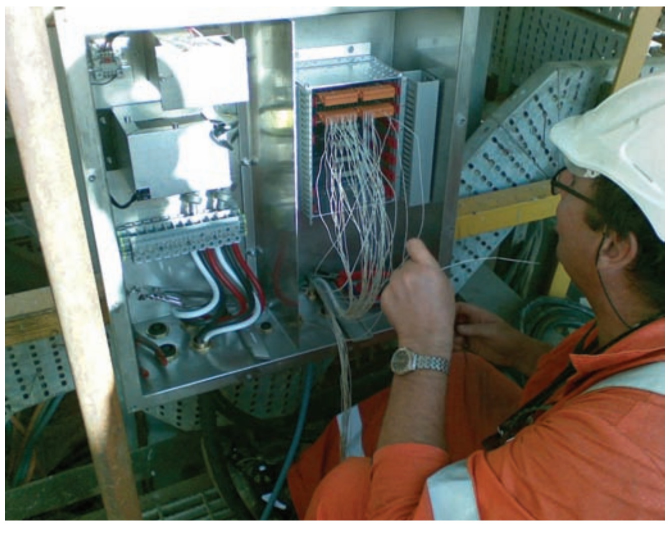

Figure 2: installed sensing pins with field cables and termination in an on-line instrument.

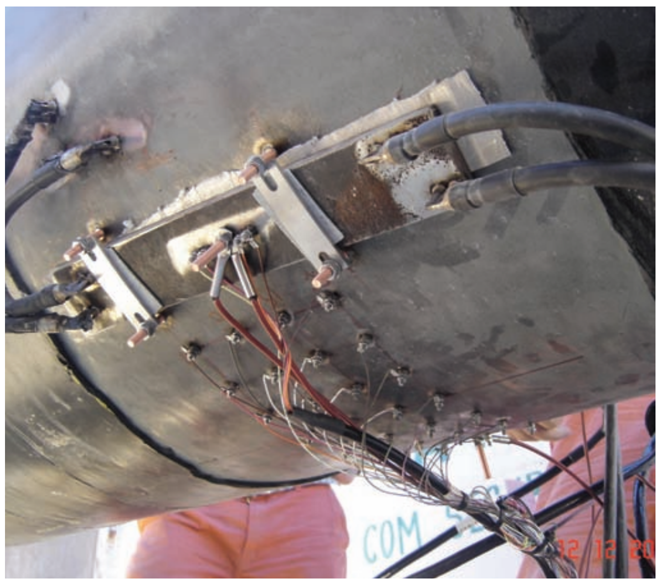

Figure 1: installation of FSM, non-intrusive monitoring in Brazil

monitoring, but also sand monitoring, pig detection and other downhole measurements. This, in turn, has resulted in an increase in users among the asset team who wish to access such a system.

All of which has increased the need to better manage, organise and interpret data, which is why Emerson has developed a new data management software solution to support non-intrusive corrosion monitoring and, in particular, FSM methods. The software forms part of the company's Roxar Fieldwatch data management solution.

Specific data management features include multi-user functionality with many users able to work simultaneously; fast data handling with real-time information available to all users; new data formatting; and an integrated, step-by-step software workflow which follows the product from system engineering through to data management and reporting.

The workflow includes the direct provision of technical documentation for the sensing pin matrix design; a service console for use by the service engineer during installation and commissioning for set-up, diagnosis, checking and verification; the receipt of data for data storage, analysis and reporting; and alarm facilities.

But corrosion data is just one part of the data required in providing the operator with a complete real-time picture of the reservoir. The FSM or any other corrosion monitoring tool must work closely alongside other instrumentation, everything from downhole pressure and temperature gauges to flow lines, sand monitors, and multiphase and wet gas meters, which supply that all-important rate and fluid property data.

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For more on the company's data management system and online corrosion monitoring visit the CorrOcean, Emerson or (local partner) Gasos stands at ADIPEC, or go to www.EmersonProcess.com or visit stand A04.