Detecting Corrosion in Critical Oil & Gas Applications

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The Importance of Corrosion Monitoring

With the increased complexity of reservoirs today and the need to deliver increased flow assurance and investment returns, optimized production is becoming central to operators' success.

As operators strive to become more competitive and demonstrate greater shareholder value through the discovery of new fields and increased returns from existing ones (while at the same time reducing costs), the need for accurate, non-intrusive corrosion and erosion monitoring of large surface areas has never been higher.

The demand for such monitoring is only exacerbated by ageing pipeline assets and an increased reliance on mature fields. Today more than 70 per cent of the world's oil and gas production comes from fields that are over 30 years old[1].

The dangers of production losses, shut-downs or safety and environmental set-backs due to the corrosion or erosion of key infrastructure are there for all to see, with BP's Prudhoe Bay field and Russia's Druzhba pipeline, the world's longest pipeline stretching from Central Russia to Central Europe, two recent examples of the dangers of corrosion.

Roxar's CorrOcean FSM (Field Signature Method)

Roxar's Field Signature Method (CorrOcean FSM) is the leading monitoring method for large surface areas and has been in use commercially since 1991. FSM is highly versatile and can operate on offshore platforms, on deepwater pipelines, in refineries, on oil and gas production platforms, and on underground/remote pipelines.

The FSM measures corrosion or erosion by detecting small changes in current flow due to metal loss. With FSM, sensing pins or electrodes are distributed over the area to be monitored, with a typical distance between pins of 2-3 times wall thickness. An initial voltage measurement is taken, and subsequent changes in electrical field pattern are detected and compared against the initial measurement to infer structural changes in the monitored area.

The system presents graphical plots indicating the severity and location of corrosion, and calculates corrosion trends and rates. Both sensitivity and repeatability for general corrosion for on-line FSM-systems are typically better than 0.1% of remaining wall thickness, which means that the actual sensitivity increases as the corrosion attack increases.

Installation is also more cost effective and easier to apply on the most critical positions of a pipeline than traditional corrosion probes which require concrete pits

[1] World Energy Organization, 2002

under the pipelines. With the FSM method, installation is on the bottom section (6 o'clock) of horizontal pipelines, where water collection is most likely to take place.

Other benefits of the FSM method include the ability to detect changes in corrosion rates much earlier than ordinary methods, allowing corrective action to be taken before damage occurs; the ability to detect general corrosion as well as localized attacks; the ability to operate in high-temperature environments with no reduction in accuracy; and the non-intrusive nature leading to increased operator safety in sour production environments, for example, and virtually no maintenance.

The Importance of Versatility

With corrosion happening in all manner of critical oil & gas applications, it's essential to have a versatile and robust solution that can operate accurately in all conditions.

FSM technology allows internal corrosion monitoring to take place directly on subsea pipelines or flowlines, for example, without adding artificial measurement elements or samples into the flow. This leads to the increased integrity and lifetime of the pipe.

In refineries, FSM can be used for pipe temperatures at up to 500 ℃. The ability to monitor high temperature pipelines without the risk of leaks and without reduced integrity allows the active monitoring of the corrosive effect of "opportunity crudes". With various crude oils having different acid levels and corrosive properties, active corrosion monitoring and mitigation can have a significant effect both on the economics of the refining process and on the safety and maintenance of the plant.

Combined with a temperature rating from -40 ℃ to + 60 ℃, and the ability to communicate via a range of wireless options, FSM can also be applied to remote pipelines almost anywhere in the world, and can provide on-line data continuously to the user's office.

And in the case of sour production environments, FSM can detect and follow localized attacks and is non-intrusive, not requiring interventions that cause hazards for personnel. FSM also represents an attractive alternative to intrusive corrosion and erosion monitoring at oil and gas facilities, such as production platforms and FPSOs.

Online Corrosion Monitoring

Yet how is the corrosion data managed? Can the operator access corrosion data in real-time?

The increase in the real-time monitoring of the reservoir and the need to prevent expensive corrosion failures – through a localized attack like weld root corrosion, for example – has resulted in online corrosion monitoring. Today, corrosion data stands alongside temperature, pressure, flow rates, and breakthrough water detection information as information the operator can source.

And for the operator, there are also cost savings as collecting data separately at remote locations can be extremely costly in terms of both money and resources.

To reflect operator demand, at Roxar we have introduced online and real-time corrosion monitoring to the field signature method.

By inducing an electrical current into strategically located pipe sections, changes in the electrical field pattern can be monitored and the slightest initial signs of metal loss through uniform and localized corrosion can be identified at an early stage.

Our on-line system and new, on-line data logger can be used with a wide range of wireless communication solutions (radio, telephone, GSM, satellite phone) as well as being powered through solar panels. It is based on sensing pin matrixes similar to those used previously, with the same sensing pin options and the same temperature ratings for the pipe mounted components.

The FSMLog instrument is charged and communicates via a FIU (Field Interface Unit) with up to four field signature instruments connected online to one FIU. Power consumption is also only seven watts, making the system suitable for solar panels. Options for direct power to the FSMLog instrument are also available for areas where hazardous area limitations do not apply.

The MultiTrend software then analyzes and filters the data and presents it through comprehensive and explanatory graphs in real time. The monitoring software indicates the severity and location of defects and also calculates corrosion rates.

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 ability to distinguish trends from random variations; and an online system which allows remote and wireless data communications direct to the operators' offices. Continuous data will also increase the system's resolution.

And the initial market reaction has been encouraging. Take-up for our new online corrosion monitoring system has been taking place, particularly in China and the Far East.

Making Best Use of the Information

We have seen how real-time data is accumulated from an online corrosion monitoring solution but how can we ensure that the data can be turned into valuable decision-making information?

Until now, the FSM systems have been operated by using the MultiTrend software, with the same software used to store and analyse the data. MultiTrend displays the instrument configurations, and the data can be presented in various 2- and 3-dimensional plots.

Now, Roxar has developed Roxar Fieldwatch, a specialized Windows-based field monitoring system which enables E&P operators to 'watch their fields' remotely. The Fieldwatch system is a modular system with modules for different monitoring applications. A new generation of software modules for corrosion and sand management is also now being developed and tested by oil companies. The new software modules offer significantly more powerful functions for the handling of large amounts of data, reporting and data overview facilities. Multiple users can also access the modules simultaneously.

Real-time data can be accessed directly at the desktop via a graphical user interface and, if worthy of further analysis, transferred at regular intervals to Roxar

Fieldmanager which, based at the field's onshore control centre, provides a suite of more detailed analysis and interpretation tools and local storage for the data.

It is Roxar's goal that corrosion monitoring becomes a major element of the Fieldwatch system through a component – Fieldwatch Sensor Manager. This will allow operators to be more proactive in taking the necessary remedial action to prevent corrosion failure and access this data along with other real-time field production data. This can include anything from temperature or pressure data through to multiphase flow, sand, or the generation of water production profiles.

Winning the Corrosion Battle

At a time when the industry is looking for reservoir management solutions that can optimize production from increasingly marginal assets and protect flow assurance, it has never been more important to address the scourge of pipeline corrosion and erosion. Today, this demand is being met.

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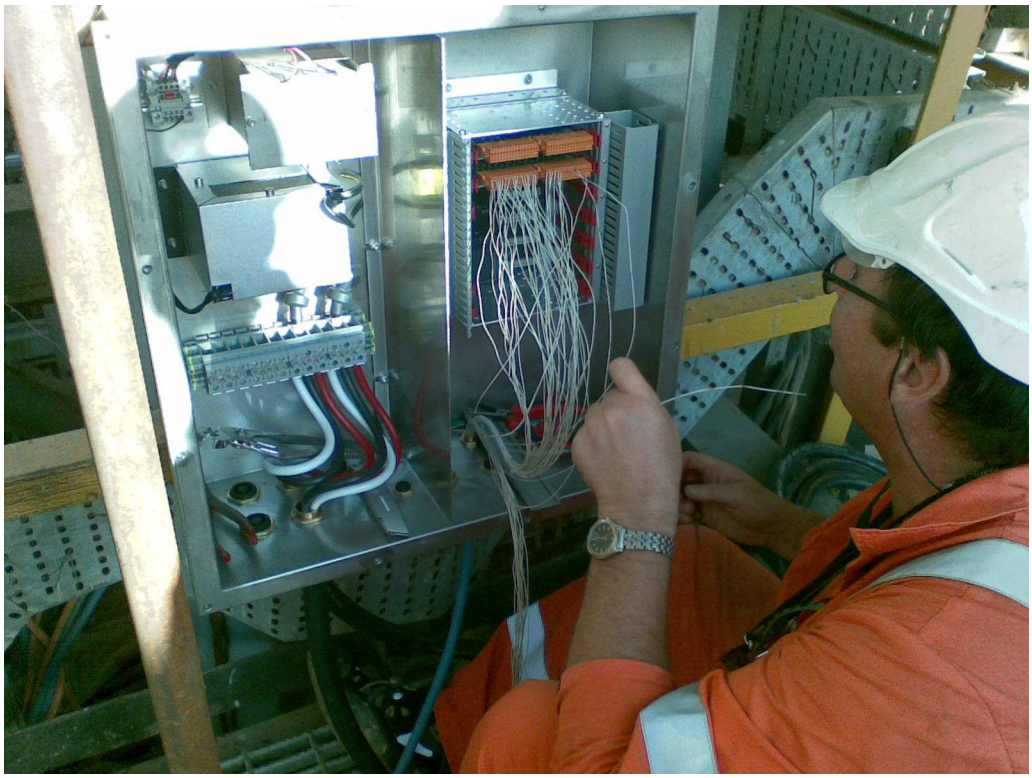

Termination of the cables in the FSMLog instrument

The FSM matrix installed on an underground pipeline.