Corrosion Monitoring – Managing and Acting upon the Data

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Information Overload!

There's no doubt that many operators in Africa today are facing the danger of being overwhelmed by raw, production data.

IBM Business Consulting Services recently estimated that advances in monitoring technologies have resulted in a single oil or gas field generating on average up to one terabyte of data per day[1].

And this figure may prove to be conservative as further developments continue to take place offshore West Africa, for example.

Nigeria's AKPO development operated by Total, Nigeria's Anyala Madu Fields operated by Chevron, the Pazflor project due to commence in 2010, and the BP Exploration discovery in the ultra-deepwater Block 31, offshore Angola which took place in January 2008, are just a few examples of fields likely to provide reams and reams of new production data.

No one would deny, however, that much of this data is crucial for E&P companies to gain a complete picture of their reservoir throughout the production phase. Information relating to corrosion, temperature, pressure or flow rates can be vital for determining the production capabilities of the field and each well. The challenge remains to manage this data in an integrated way and ensure that it can have maximum impact on decision-making.

This article will look at the increasing importance of corrosion monitoring and the current data management challenges facing today's operator.

The Causes and Importance of Corrosion Monitoring

With flow assurance, environmental compliance, and investment returns increasingly being key drivers within the oil & gas industry and with many pipeline and other infrastructure assets ageing, the need for the accurate pipeline corrosion and erosion monitoring has never been higher. The dangers of production losses, shut-downs or safety and environmental set-backs due to the corrosion of key infrastructure are simply not an option for today's oil & gas operator.

There are many causes for corrosion. Metals immersed in conductive mediums can lead to electrochemical corrosion, differences between casing joints can cause corrosion, as can changes in fluid compositions, such as changes in the concentration of dissolved gases or pH.

[1] IBM Business Consulting Services – Meeting the Challenges of Today's Oil & Gas Exploration and Production Industry.

Fields with high hydrogen sulfide (H_2S) concentrations – sour service environments – and their corrosion implications can also have a significant impact on the infrastructure of an oil and/or gas producing field. Such sour gas fields can be found in Europe, Africa, the Americas and the Far East, although the Middle East and Central Asia hold the largest volumes.

In wet gas fields, corrosion is also often caused by the presence of carbon dioxide (CO_2) in the gas with the corrosion rate highly dependent on the pH of the Monoethanolglycol (MEG)/water mixture – the lower the pH, the greater the corrosion rate. One wet gas field example is the Rosetta field, offshore Egypt, which has been developed and operated by joint venture Rashid Petroleum Company (Rashpetco), with BG Group as one of the main partners.

Going Offshore!

Just as unstructured data is a challenge, so is the need to generate data from ever more hostile and remote environments. Operators today are having to generate information from deeper and more complex reservoirs and are facing challenging operating conditions – particularly the case in many African fields.

The increased activities offshore in Africa have contributed to the increased importance of corrosion monitoring.

According to The Energy Industries Council's EICDataStream, which tracks the 6,500 most important projects in the global energy industry, there are 63 active and future offshore oil & gas projects with Nigeria leading the way with 17.

As operators have had to generate information from deeper and often more complex and remote reservoirs offshore, so have the corrosion challenges increased. Deeper and remote reservoirs normally come with higher pressure and temperatures, greater hydrate susceptibility and increased likelihood of corrosion.

Field Signature Corrosion Monitoring

Non-intrusive field signature technology has been applied for internal corrosion monitoring for more than 15 years, being most commonly used for subsea pipelines, land-based pipelines, high temperature applications in refineries, and sour production environments.

Installation is more cost effective and easier to apply than the intrusive coupons and probes. One of the most critical sections of the pipeline, for example, is the bottom section (6 o'clock) of horizontal pipelines, where water collection is most likely to take place. The ease of installation compares favourably to traditional corrosion probes which require concrete pits under the pipelines.

The field signature method measures corrosion or erosion by detecting small changes in current flow due to metal loss. This is achieved through non-intrusive sensing pins which are distributed over the areas to be monitored and detect changes in the electrical field pattern. Voltage measurements are then compared to the 'field signature', which provides the initial reference.

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The benefits to the operator include high levels of accuracy and sensitivity; and the non-intrusive nature of the corrosion monitoring, increasing operator safety in sour production environments, for example, and reducing costs.

Roxar's field signature method (FSM) technology 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 degree Celsius. And in sour service environments, whereas traditional corrosion monitoring encounters difficulties due to iron sulphide (FeS) deposits disturbing the measurements generated from ER and/or LPR probes, the FSM method is not disturbed by such conductive deposits.

Managing the Data - SCADA

Yet how can this data generated by the non-intrusive field signature technology be best managed?

One option is through Supervisory Control and Data Acquisition (SCADA) systems.

SCADA systems are playing a crucial role in transforming raw data into valuable decision-making information and in helping generate data from remote locations.

The growth in intelligent field devices, increased automation, expanded communication networks, and improved compatibility with IT have all helped SCADA generate real-time information from remote environments – information that can go straight to the operator desktop.

According to ARC Advisory Group, a research and advisory firm, the worldwide market for SCADA Systems for the oil & gas industry is expected to have annual growth rates of 9.3% over the next five years with the market forecast to be worth over US$1.3 billion by 2012[2].

However SCADA can only operate effectively if it is fully integrated rather than reflecting the different elements of the operator's responsibilities - exploration, drilling, completion or production, for example.

Online Corrosion Monitoring

The increase in the real-time monitoring of the reservoir and the need to prevent expensive corrosion failures has resulted in corrosion data being incorporated further into SCADA systems and has resulted in the data being seen as an important input into reservoir monitoring. Today, corrosion data stands alongside temperature, pressure, flow rates, and breakthrough water detection information.

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 and the need to use data more efficiently, at Roxar we have introduced online and real-time corrosion monitoring to the field signature method.

[2] SCADA Systems Worldwide Outlook for the Oil & Gas Industry, 2007

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.

Roxar's Fieldwatch and Roxar Fieldmanager software then analyses 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.

The ability to distinguish localized attacks and general corrosion in real-time as well as detect corrosion rates much earlier than traditional corrosion methods (allowing corrective action to be taken before damage occurs) is also crucial to operators as they look to guarantee real-time flow assurance.

A Complete Data Management System

Corrosion data is just one piece of data required to give the operator a complete real-time picture of the reservoir and ensure flow assurance integrity.

The FSM or any other corrosion monitoring tool must therefore work closely alongside other instrumentation – instrumentation which can often generate data which can affect corrosion rates. This can include everything from downhole pressure and temperature gauges to flow lines, manifolds, risers, and multiphase and wet gas meters which supply that all important rate and fluid property data.

In gas fields, water detection, for example, is critical for preventing hydrate, scale and corrosion in the pipelines and ensuring a reliability of supply. If preventative action is not taken and the pH of the MEG/water mixture is too low, there is a real risk of high corrosion rates. To this end, Roxar has installed its subsea multiphase and wet gas meters in a number of installations, offshore Angola, Congo, Egypt and Nigeria. The Rosetta field, offshore Egypt is one such example where its subsea wet gas meters are in use.

The same goes for sand in terms of its effect on corrosion. Sand clogged production equipment erodes completion components, and impedes wellbore and pipeline access, and sand erosion can be a major contributor to corrosion by removing protecting coatings.

With today's E&P operator demanding an integrated, reservoir monitoring and asset management system, where the economic impact and risk of reservoir management decisions can be fully assessed, SCADA and systems, such as Fieldwatch and online corrosion monitoring, are rising to the challenge and delivering.