

System Integrates Reservoir Monitoring

By Vincent Vieugue

STAVANGER, NORWAY—With oil and gas companies continuing to focus on managing costs and optimizing operating efficiencies, the importance of effective production strategies to accelerate cash flow and ensure that each well is operating at the very limit of its capabilities has never been higher.

Furthermore, the growing geological complexity of offshore oil and gas fields, increasingly being found in remote deep-water locations in challenging and environmentally sensitive operating conditions, has increased the need to put effective reservoir monitoring processes in place.

Consequently, operators today need an integrated and flexible reservoir monitoring system that can monitor pressure, temperature and flow rates, and face down threats to production, such as water encroachment, sand erosion and corrosion. They also need to be able to effectively visualize, manage and interpret these data, and ensure a seamless flow of information from the field to the desktop. And if there is a need for equipment upgrades or maintenance, this needs to take place with minimum interruption on production.

Unfortunately, no such system is prevalent in the oil and gas industry today. While many very technically sophisticated reservoir monitoring solutions come to market every year, the fact remains that there is still a lack of an integrated and flexible approach to reservoir monitoring. Too often, the very reservoir monitoring technologies that help operators optimize production and manage costs are viewed as commodities, procured in an ad hoc manner and suffering from a lack of in-

tegration with other reservoir monitoring and subsea activities.

In order for operating companies to have complete control and knowledge over their production processes, an integrated and flexible reservoir monitoring system is essential. The system should be able to react immediately to problems before they have a significant impact on production, incorporate all instrumentation onto a single intuitive user interface, and have the flexibility to allow the upgrading and maintaining of instruments, where necessary.

The first key issue is integrating and interpreting reservoir monitoring data. In fact, one of the biggest challenges in reservoir monitoring today is managing the vast reams of data that monitoring and other subsea equipment generates.

IBM Business Consulting Services estimates that advances in monitoring technologies have resulted in a single oil or gas field generating an average of up to one terabyte of data every day. While exploration, drilling and production companies require a complete picture of their reservoirs, there is a real danger of being overwhelmed with raw production and monitoring data.

What are the potential solutions to this?

Supervisory control and data acquisition (SCADA) systems continue to play an important role in generating real-time information from remote environments. According to ARC Advisory Group, a research and advisory firm, the worldwide market for SCADA systems in the oil and gas industry is growing at an average annual rate of 9.3 percent, with the SCADA oil and gas market forecast to be worth more than \$1.3 billion by 2012.

However, despite these optimistic figures, many SCADA systems remain fragmented and address only specific segments of the operator's responsibilities.

Comprehensive System

It is against this backdrop that a comprehensive field monitoring system has been developed that can integrate a wide variety of monitoring instruments within a single Windows®-based system. Since the system is modular, it can be configured to meet different requirements, such as a dedicated sand management and monitoring system.

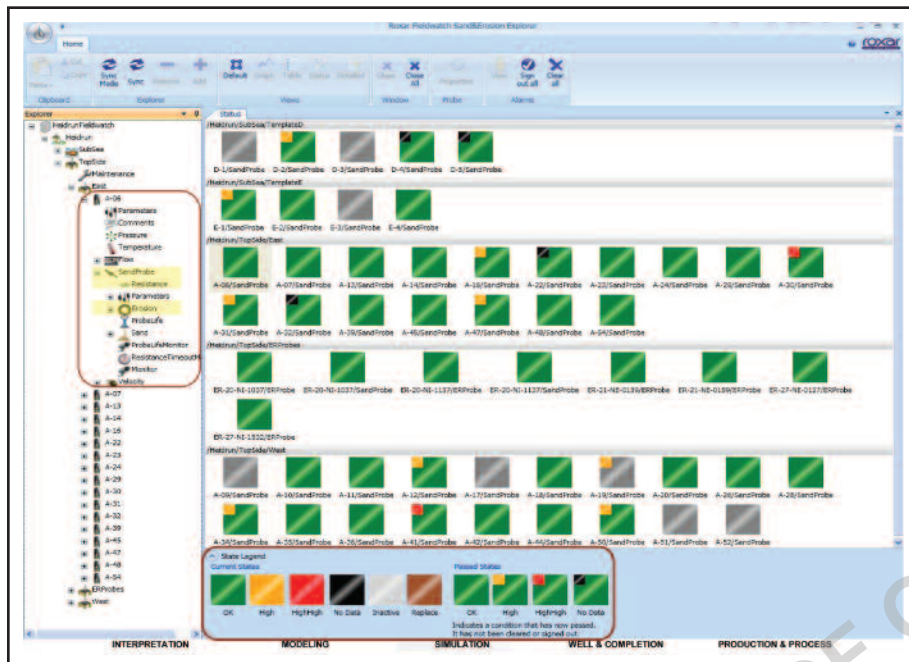
The monitoring system is designed to provide the operator with a complete picture of the reservoir and the production process. The software is installed on a rack-mounted hardware server and then connected to a variety of reservoir monitoring instrumentation, including subsea acoustic sand monitors, subsea wet gas meters, and downhole pressure and temperature gauges. The scalable and efficient architecture allows remote connectivity and enables multiple users to access the same data and instruments.

There are three core components to the system: a server, an "explorer" user interface, and interface modules that connect the system together.

The server connects and integrates the interface modules linked to the different instruments. It organizes the data flow, and structures the connected instruments into a logical tree structure that is visualized in the field explorer user interface. The interface modules can also convert sensor data into higher-level data, such as sand rates or metal loss rates. Some of the modules also include automated data



FIGURE 1
Sand Management Module Screen Capture



validation functionality.

The field explorer is the desktop user interface, which can be distributed to both local and remote user desktops. It contains the service consoles for the configuration, condition monitoring, diagnostics and service of all the subsea monitoring instruments.

At the heart of the system is a hydraulic calculator that already has been tested on a number of high-profile developments, including the Ormen Lange Field on the Norwegian Continental Shelf and the Shtokman Field in the Barents Sea. The hydraulic calculator operates in real time, where sensor data are fed into the calculator and results are mapped back into the server before being converted into the visualization tools for viewing and analyzing in the desktop user interface.

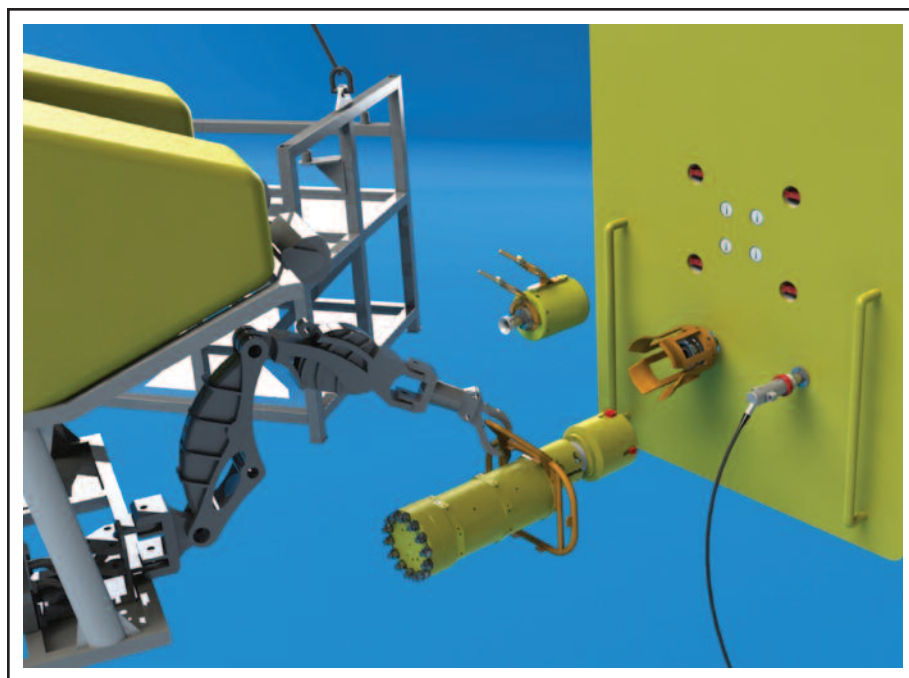
Typical computations might include well and flowline profiles and boundary characteristic calculations, well and flowline calibration, network snapshot calculations, network “what if” calculations, well or flowline transient calculations, and the interpretation of stationary sensor signals to establish well phase production rates.

Furthermore, the system can also provide a comprehensive hydrate and corrosion management system when used in combination with third-party monoethyleneglycol (MEG) and chemical injection valves, wet gas or multiphase meters, and corrosion sensors.

This is what I believe the reservoir monitoring system of the future should consist of: a closed-loop process in which all instruments are integrated and aligned with one another, and where a field monitoring system provides “the glue” that links the information and instruments together and takes data to the reservoir en-

FIGURE 2

Subsea Retrieval System



gineer’s desktop.

Sand Management Module

As a case in point, consider an integrated reservoir monitoring system in action. In this case, it is a sand management and monitoring system installed in the Heidrun Field located in the Norwegian Sea on the Norwegian continental shelf. With the field seeing an increase in sand production, there was a need to increase the field’s sand monitoring capabilities to allow for the maximum amount of sand without affecting production and to meet the challenges of increased water content and more gas (more sand and higher velocities).

A new sand management module was specified and developed jointly by the operator and the system provider. The software enabled the operator to respond faster to changes in sand production conditions, thereby securing control of significant sand production from a well, and establishing maximum sand-free production rates for production optimization. Figure 1 shows the screen status in the operator’s platform control room

What this example shows is how operators can monitor and manage both intrusive and nonintrusive sand monitoring equipment through a common software platform. And the same goes for other reservoir monitoring data as well, all of which can have a crucial impact on pro-



duction strategies.

The ability to predict and measure the water production profile in a well, for example, has become critical for preventing hydrate, scale and corrosion in the pipelines and ensuring the reliability of supply.

Corrosion is also often caused by the presence of carbon dioxide in the gas with the corrosion rate highly dependent on the pH of the MEG/water mixture. The lower the pH, the greater the corrosion rate will be.

Whether it is developing a chemical hydrate system, preventing water encroachment, or integrating erosion and acoustic-based sand and corrosion monitoring techniques, operators should be able to monitor production continuously, observe and control fields from remote locations, and make immediate decisions to face down immediate production threatening problems.

Maintenance And Upgrades

Finally, as well as the integration and the means of managing the data, there is the issue of how to best keep on top of the reservoir monitoring instrumentation.

In excess of 1,500 subsea sensors and transmitters are installed globally each year. Too often, however, operators are faced with difficulties and costly subsea interventions in maintaining, upgrading and replacing these sensors and transmitters.

There is, therefore, an understandable demand for greater flexibility and control over live hydrocarbon systems. For example, a recent survey of subsea specialists found that if a system was available that could individually retrieve sensors, nearly

90 percent of those surveyed would use it.

With this in mind, a remotely operated vehicle-based subsea retrieval system has been developed that can both retrieve and install instrumentation on trees, manifolds and process systems during production (Figure 2). The system is the result of a joint industry project with BP, Chevron, Shell, Total, Statoil and Roxar, and sponsored by Demo 2000, a Norwegian government research initiative.

There are four main components to the system:

- A mechanical interface, which is machined and installed onto the subsea structure;
- A sensor/transmitter, which consists of a probe carrier, an electronics canister and a power/communications cable;
- The ROV retrieval tool, which replaces the sensors during operation; and
- A hydraulic and control system.

Whereas in the past operators had to rely on their original selection choices, this new system brings with it complete flexibility and allows operators to better maintain existing instruments, replace failed ones and install improved versions as they come to market.

From flow rates, pressures and temperatures, to potential obstacles to production—such as the buildup of sand or corrosion—operators need regular and reliable information from their monitoring instruments. For this information to have maximum value, however, it must be accessible in a user-friendly and integrated form on the user's desktop.

Operators also require flexibility to be able to tackle any reliability issues head on. And should a superior solution

come to market, they need to be able to seamlessly and safely upgrade their existing infrastructure without any impact on production.

The component technologies are available to create a new generation of flexible and reliable reservoir monitoring systems. The challenge now is to ensure that the instruments, data and software-based control systems are tied together to provide a complete and integrated picture of the reservoir. □



**VINCENT
VIEUGUE**

Vincent Vieugue is vice president of sales and marketing at Roxar Flow Measurement, part of Emerson Process Management. Based in Norway, Vieugue has 16 years of experience in the oil and gas industry with previous roles at WesternGeco, where he was account manager for Hydro, Shell, ExxonMobil and ChevronTexaco in Norway. He holds a master's in geophysics from the Ecole et Observatoire de Physique du Globe, a master's in earth sciences from the IPG Physics Institute University Louis Pasteur, and a master's in marine sciences from the University of Toulon.