

Sand Monitoring Key For Subsea Wells

By Jan Olaf Gomnaes

STAVANGER, NORWAY—Sand remains a major threat to subsea production. Global energy services firm, Senergy Group, estimates that 70 percent of the world's oil and gas reserves are contained in sandstone reservoirs where sand is likely to have an impact on production.

Sand's abrasive impact on downhole tools, the erosion and plugging of processing equipment and flowlines, and the manner in which sand-clogged production equipment erodes completion components, impedes well bore access, and interferes with oil and gas infrastructure, means sand management is high on the agenda for operators today.

Just as the use of in-line tools for inspection and cleaning is accepted as essential for the safe and profitable operation of subsea pipelines, the need to identify when sand is present in the well before any damage occurs is viewed as equally important.

There are a number of key industry drivers to sand management. The first is the increasing age of oil and gas assets in certain parts of the world. While unconventional resources are on the increase, the fact remains that more than 70 percent of the world's oil and gas production comes from fields that are more than 30 years old. Such fields often have rising water production and more sand, as well as increasing amounts of gas, leading to higher velocities and a greater risk of erosion damage from sand particles.

Linked to the age of many of the world's fields is the need to introduce greater efficiencies into production operations. With a growing focus on making smaller fields more viable, predictive sand monitoring tools are crucial to ensuring maximum returns from the fields' production systems.

Third, there is growth in deepwater fields and the need to manage risk in these high-cost assets. With completion times in complex deepwater operations often accounting for 50 percent or more of total well time, it has become increasingly important to better predict sand production and incorporate monitoring strategies into risk models. The high fluid velocities in deepwater fields also can result in sand production that causes significant damage.

Finally, there is a growing trend toward linking sand monitoring with other seafloor treating and processing activities. While the majority of subsea processing still takes place adjacent to the well or above the water line, the push into deepwater operations has meant a growing trend toward processing hydrocarbons, water, mud and brine on the seafloor through a variety of equipment, including subsea separators, injectors and multiphase pumps.

Such processing also often takes place under huge water and wellhead pressures, with any sand monitoring technologies having to operate reliably in harsh environments with minimal human intervention and limited or no interruption.

It is against this backdrop that sand monitoring needs to be part of a broader and more complete production system, delivering intelligent real-time information and operating alongside existing instrumentation.

Are today's sand monitoring systems rising to these challenges? Let us first take a look at some of the technologies available.

Advanced Sand Monitoring

In the past, sand monitoring tended to be fairly rudimentary, with information on flow rates, water cuts, pressure drops and temperature distributions, or techniques such as drawdown management (the difference between the average reservoir pressure and the flowing bottom-hole pressure and production rate control) being used as approximate guides to sand production. Today, however, the emergence of acoustics and erosion-based sand sensors has resulted in much more immediate and accurate responses.

Acoustic sensors utilize the acoustic energy generated by sand particles to calculate sand production in oil, gas or multiphase pipeline flows, with the quantification of sand often measured in grams per second. Alarm settings also help operators to implement sand management systems based on either no sand at all (maximum sand-free rate) or a certain amount that is acceptable (maximum allowable sand rate).

Benefits of the acoustic sensors include easy installation (the devices can be mounted in fixed, preinstalled clamps on the outside of the pipe), the immediate

detection of sand production, and low power consumption.

Erosion-based sand monitoring, on the other hand, provides direct measurement of sand erosion. Many are based on the electrical resistance principle, where metal loss on the element is measured as increased electrical resistance in a sensing element exposed to sand erosion. Sand production rates then can be quantified by combining measured metal loss rates with average sand particle size and flow data.

Both acoustic and erosion-based sand monitoring sensors are being used on key deepwater fields. One example is the Petrobras-operated Cascade/Chinook development in the Gulf of Mexico Lower Tertiary trend, where the Gulf's first floating production, storage and offloading facility is deployed in record water depths to accept production from subsea wells in the two fields.

At Cascade/Chinook, the sand sensors are working alongside multiphase meters and pressure/temperature sensor systems to help Petrobras meet challenges such as sand erosion and other threats to subsea infrastructure, as well as ensuring each well is operating at its peak.

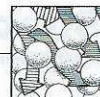
Another Gulf of Mexico example is the Independence Hub multifield development operated by Anadarko, where acoustic-based sand monitors operating alongside subsea wet gas meters are helping the field's production engineers minimize erosion damage, optimize production flow rates and prevent equipment clogging. If necessary, the operator also can look to remedial actions, such as sand cleanouts or a sand bailer.

In both of these Gulf applications, the sand monitoring is part of a wider production monitoring system.

Complementary Technologies

Today, acoustic and erosion-based sand monitoring systems often are combined into a single system and integrated with other process instrumentation placed down hole at the wellhead or on the pipeline.

The two technologies complement each other well. Acoustic monitors provide an immediate response to sand production, but are complemented by intrusive sand/erosion probes that generate accumulated erosion data and are able to pro-



vide highly accurate measurements of the accumulated long-term effect of sands, even with very small quantities.

Furthermore, the operation of acoustic detectors alongside intrusive sand probes will help cover measurements of a wider range of sand with respect to particle size and velocity, since intrusive erosion probes only measure erosive sand. This could be beneficial for installations with limited sand handling capacity topside that are producing fine sand at low velocities.

In addition, the field signature method (FSM), which measures corrosion or erosion directly on the pipe wall by detecting small changes in current flow related to metal loss, can operate alongside sand monitoring. The long-term verification of changes in wall thickness can be monitored using FSM technology and combined with fast-response measurements using erosion-based or acoustic sand monitoring.

Sand monitors also can operate alongside other subsea production equipment, such as multiphase and wet gas meters, with the digital signal processing in the subsea sand monitors, for example, combining with the velocity measurements from the subsea multiphase and wet gas meters to more accurately determine actual sand production rates.

Integrated Approach

An integrated approach to reservoir management and combining the benefits of subsea equipment, however, can only work if the user is able to work within an integrated and intuitive software interface.

To this end, a specialized Windows-based field monitoring system has been developed that enables operators to "watch" their fields remotely. The software is installed on a rack-mounted hardware server and connects to a wide variety of reservoir monitoring instrumentation.

Through this flexible, scalable and distributed architecture, the system provides a unique way to distribute detailed data from subsea instrumentation, combining real-time data to the desktop with efficient online analysis and condition monitoring, and allowing the user to have greater confidence in the veracity of the production data.

The data also can be applicable to a variety of different users and agendas, including the operator in the control room, the production engineer supporting short-term decision making and production

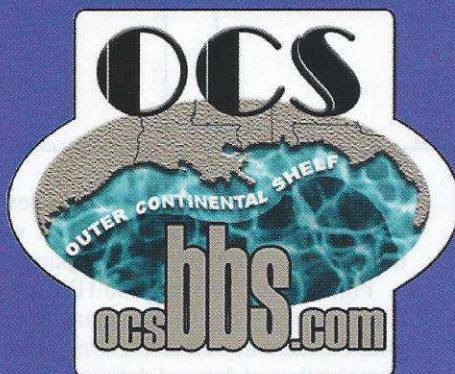
planning, the instrumentation engineer ensuring good instrument performance, the reservoir engineer responsible for long-term field planning, and managers wanting an instantaneous status report of production or flow assurance data.

Giving reservoir and production engineers, flow assurance engineers and integrity engineers access to the same detailed data and analytical tools ensures a better cross-discipline understanding of

areas such as reservoir and well performance, system dependencies and bottlenecks, and ultimately, better collaboration and decision making.

There are also significant sand management features found in a specialist sand management module that combine intrusive and acoustic sand instruments, ensure early sand detection, reduce downtime and deliver real-time analysis.

Additional capabilities include a virtual



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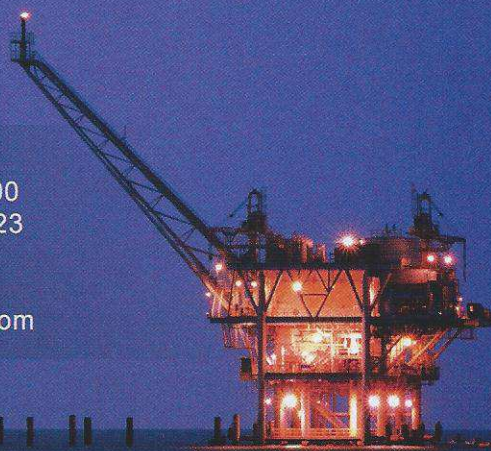




FIGURE 1A
Before Installing Smart Alarm System

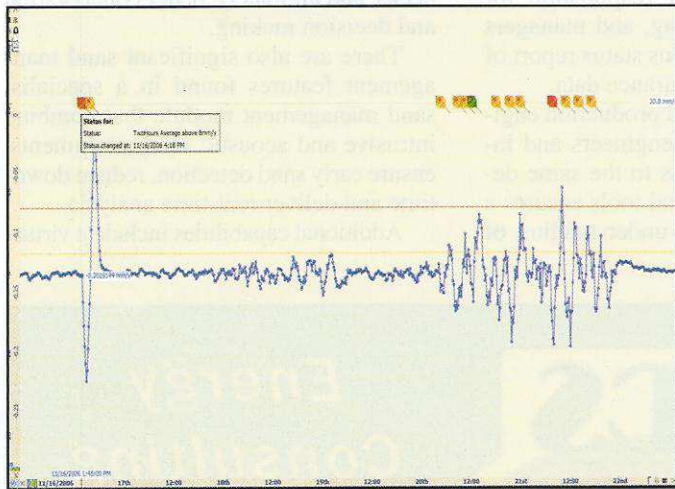
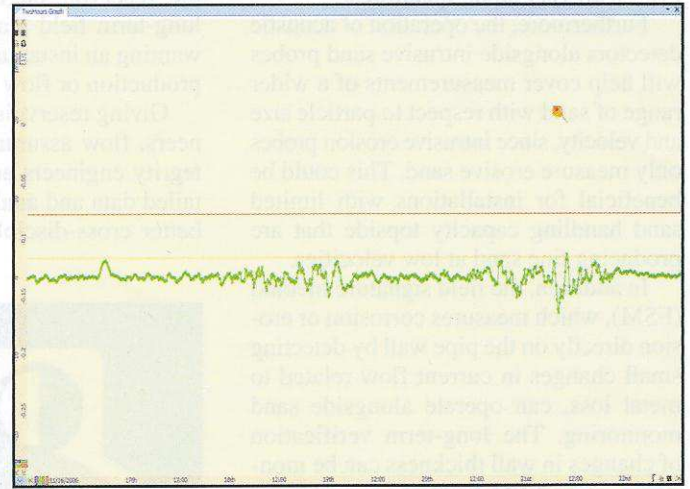


FIGURE 1B
After Installing Smart Alarm System



erosion modeling feature that predicts erosion in bends and reducers, and enables operators to determine erosion modeling at other pipeline locations based on measured sand erosion rates. New algorithms for sand erosion (and corrosion) dramatically reduce the number of false alarms. The algorithms help counteract some of the main causes of false alarms, such as

changing temperatures, and changes to production regimes or noise, and were tested successfully on a Norwegian field.

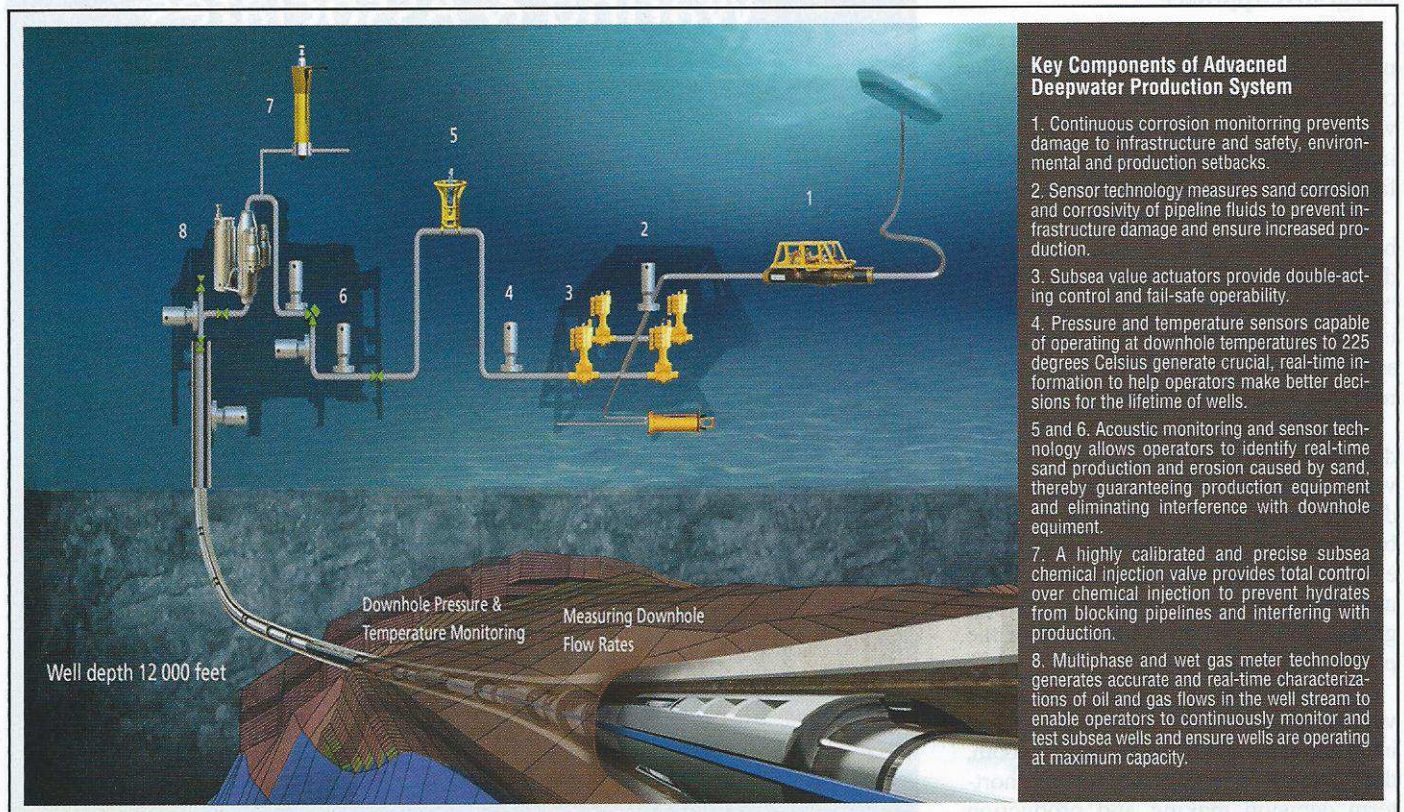
Figures 1A (“before”) and 1B (“after”) illustrate the benefit of smart alarms, with the accuracy of such alarms leading to sophisticated data validation, enhanced trend analysis and smart filters. The result is increased subsea intelligence from mul-

tiple upstream instruments with subsea sand monitoring at the fore. Figure 2 shows how sand monitoring fits into a complete production system alongside other advanced instrumentation.

Heidrun Field

Statoil’s Heidrun Field is located in the Norwegian Sea on the Norwegian

FIGURE 2
Sand Monitoring as Part of Complete Production System



Key Components of Advanced Deepwater Production System

1. Continuous corrosion monitoring prevents damage to infrastructure and safety, environmental and production setbacks.
2. Sensor technology measures sand corrosion and corrosivity of pipeline fluids to prevent infrastructure damage and ensure increased production.
3. Subsea valve actuators provide double-acting control and fail-safe operability.
4. Pressure and temperature sensors capable of operating at downhole temperatures to 225 degrees Celsius generate crucial, real-time information to help operators make better decisions for the lifetime of wells.
- 5 and 6. Acoustic monitoring and sensor technology allows operators to identify real-time sand production and erosion caused by sand, thereby guaranteeing production equipment and eliminating interference with downhole equipment.
7. A highly calibrated and precise subsea chemical injection valve provides total control over chemical injection to prevent hydrates from blocking pipelines and interfering with production.
8. Multiphase and wet gas meter technology generates accurate and real-time characterizations of oil and gas flows in the well stream to enable operators to continuously monitor and test subsea wells and ensure wells are operating at maximum capacity.

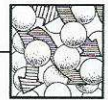
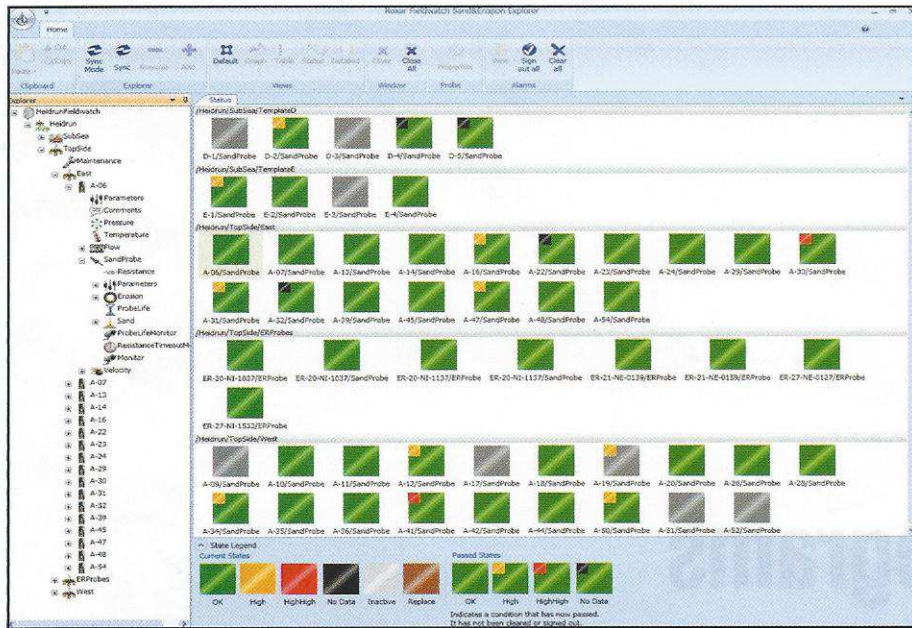


FIGURE 3
Screen Status Image from Heidrun Platform Control Room



Continental Shelf, where according to the Norwegian Petroleum Directorate, “continuous efforts are being made to find new methods to increase oil recovery.” Production in 2008 was about 100,000 barrels of oil a day. The field is an extensive user of both intrusive corrosion probes and intrusive sand/erosion probes, and also has a few locations with combined corrosion and sand/erosion probes.

As is the case with a number of Statoil’s other maturing fields, the Heidrun license

Devon Energy Finishes Drilling Fourth TMS Well

NEW ORLEANS—Devon Energy has completed its fourth horizontal well in the Tuscaloosa Marine Shale (TMS), according to the Louisiana Department of Natural Resources (DNR).

Devon says its newest well is in the northern St. Helena Parish and follows Devon’s successful drilling of two productive horizontal TMS wells in East Feliciana Parish and another in Tangipahoa Parish.

Devon also has two additional TMS well projects in Tangipahoa and West Feliciana parishes, DNR confirms.

The department says it issued its first permit for a TMS well last month in Avoyelles Parish, and the energy industry has been observing the development of the TMS, which is believed to be a primarily oil-rich play, DNR says.

is 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 developed jointly by Statoil and Emerson. Figure 3 shows the screen status in Statoil’s platform control room, while Figure 4 demonstrates a maximum sand-free rate test and outlines some of the software tools available. Note that there are three

parallel readings from the different elements on the sand probe in Figure 4. The comparison of the measurements at each individual element, as well as readings of the reference element, is used to verify that the probe data are valid.

The software is enabling early detection of sand burst and is allowing Statoil to respond faster to changes in sand production conditions, making it possible for the company to secure control of significant sand production from a well and establish maximum sand-free production rates for daily production optimization.

As operators’ subsea deepwater operations continue to increase, incorporating greater subsea intelligence and integration into sand monitoring is likely to become an ever-more pressing issue. Through the ability to monitor and manage both intrusive and acoustic sand monitoring instruments, detect sand early, access real-time instrument information, generate virtual erosion sensors for bends and constrictions, and have strong trending capabilities, sand monitoring and its role within an integrated and intelligent subsea production system is likely to remain a crucial technological capability for many years to come.

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FIGURE 4
Heidrun Field Maximum Sand-Free Rate Test

