The need for better information

FOR ALL THE technological developments in reservoir monitoring, remote sensing and offshore information gathering over the last decade, the fact remains that offshore operators are often making crucial reservoir management decisions without all the information they could potentially have access to.

The operators' goal of monitoring production continuously, changing production profiles without the need for intervention, observing and controlling fields from remote locations, and using the most recent information from the field when making operational decisions, is often an aspiration rather than a reality.

No more so is this information gap more marked than offshore and subsea, where subsea wells, according to a 2004 report, provide a 15 to 20 per cent lower hydrocarbon recovery rate than their topside counterparts. Reasons cited included accessibility and lack of data.

Nearly 2700 templates, manifolds and trees are forecasted to be installed globally by 2009. With Africa's major oil and gas provinces continuing to attract huge investment, and with 32 per cent of these templates, manifolds and trees likely to be in Africa, it is clear that operators need better access to information.

Integrated reservoir management

Making decisions in an information vacuum no longer has to be the case, however.

The last few years have seen a rapid increase in the accuracy, sensitivity and reliability of multiphase and wet gas metering, the development of highly accurate and resilient high pressure and high temperature (HP/HT) gauges, and complete remote sensor systems which provide real-time downhole production surveillance.

Reservoir models that can predict future performance and associated uncertainty in their forecasts are becoming more widespread, and, with operators accessing right-time reservoir data, models that are rapidly and continually updated are becoming possible.

Let's take a look at a typical new subsea field development offshore and see how remote monitoring, subsea technology and reservoir management can work in practice.

The field in question

Consider a new subsea development, 75 kms off the coast of Africa with a subsea tieback to an existing production platform.

Oil & gas production will come from a series of deviated or horizontal wells with perhaps several branches radiating from the main borehole, and production data required not only from each wellhead but also from each producing zone along the wellpath.

The key drivers for the operator are to increase recoverable assets and optimise production, guarantee flow assurance and ensure that operational decisions can be made in a timely manner with the most up to date information available.

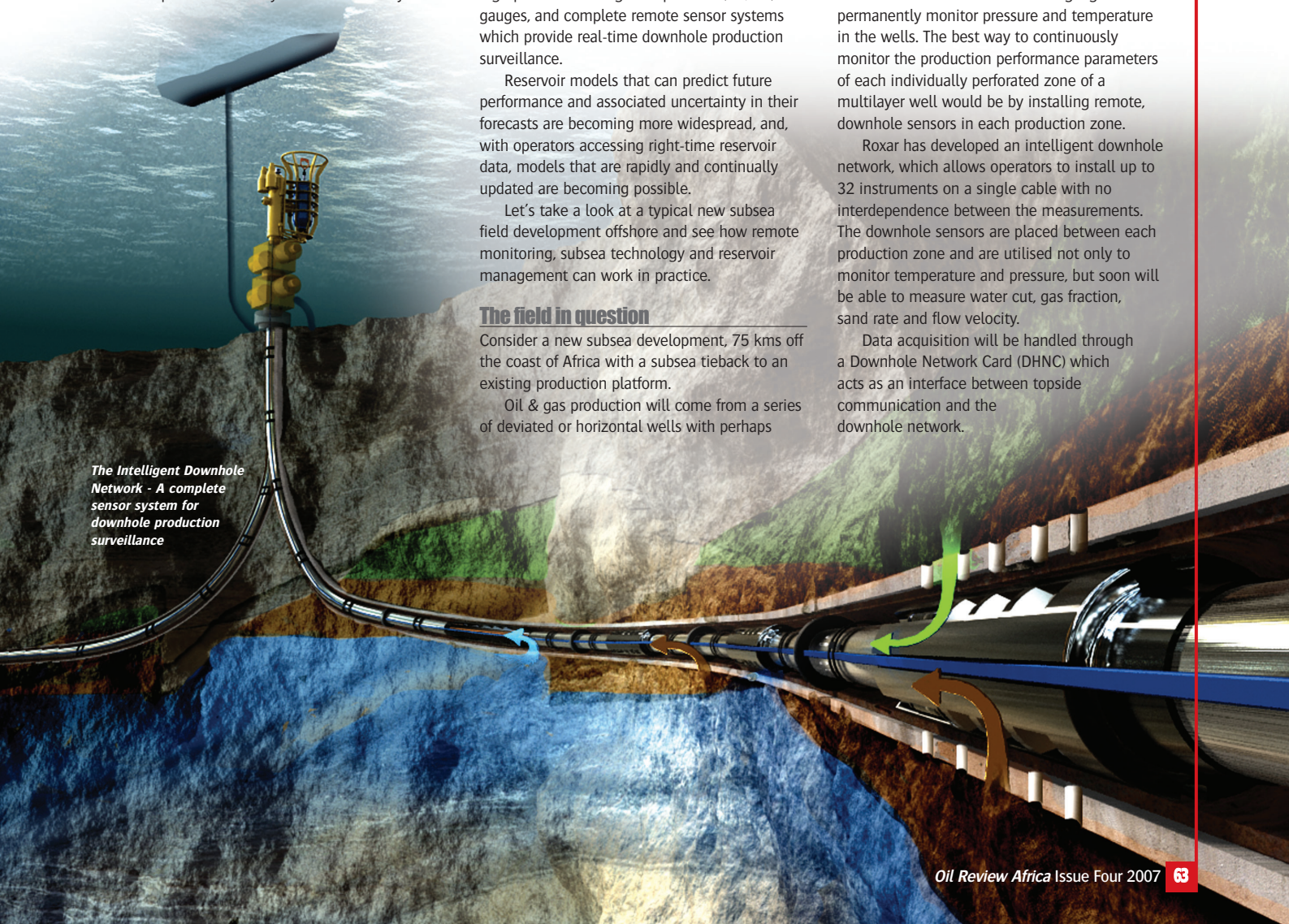
Going downhole

Such a field will ideally require a fully integrated solution which combines downhole measurement tools and remote sensors, subsea measurement technology and reservoir management software.

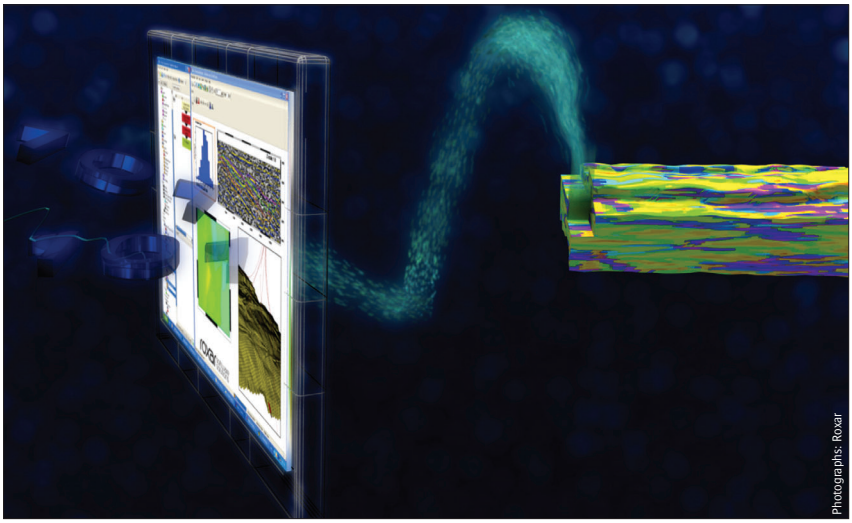
Looking downhole, the field would benefit from the installation of downhole gauges to permanently monitor pressure and temperature in the wells. The best way to continuously monitor the production performance parameters of each individually perforated zone of a multilayer well would be by installing remote, downhole sensors in each production zone.

Roxar has developed an intelligent downhole network, which allows operators to install up to 32 instruments on a single cable with no interdependence between the measurements. The downhole sensors are placed between each production zone and are utilised not only to monitor temperature and pressure, but soon will be able to measure water cut, gas fraction, sand rate and flow velocity.

Data acquisition will be handled through a Downhole Network Card (DHNC) which acts as an interface between topside communication and the downhole network.



The Intelligent Downhole Network - A complete sensor system for downhole production surveillance



Right-time data to rapidly update the reservoir model

Multiphase metering

Subsea metering would be a central component of offshore technology in the field with multiphase meters deployed on oil producers and wet gas meters on all gas wells.

Through placement of the multiphase meter on the jumper or manifold, the meter will be able to provide critical, reliable and easy-to-use, near real-time information on well capabilities during production, such as water saturation and possible breakthrough, gas coning, permeability and flow characteristics.

This valuable new information for the diagnosis and optimisation of a well's performance will then be used to determine the optimal production capacity of each well over the lifetime of the field, avoiding the risk of operating conditions detrimental to the well's long term viability, while accelerating production and increasing recovery.

In a sense, multiphase metering at the well head is an insurance policy that can quite literally save the cost of a well. Take, for instance, a well with rising water cut. In a multi-well cluster, the traditional way of investigating a rising water cut is to shut in wells one by one for observation through a test line to a test separator. Multiphase meters, however, will immediately detect the change in the multiphase flow characteristics at the subsea wellhead. And by allowing the meter to work in conjunction with remote sensors and permanent downhole pressure and temperature instrumentation tools, the operator will be able to quickly locate the problem zone and implement remedial action.

The Kizomba C development

Moving away from our fictional field for a moment, the Kizomba C development, offshore Angola is an example where subsea multiphase meters are to be a central part of operations.

Roxar is installing 19 subsea multiphase meters in the Mondo and Saxi/Batuque fields of the development , located 370 kms west of Luanda, Angola, in 740 ms of water. Two FPSOs will be used to develop the fields with initial production set for early 2008 and peak production estimated at 200,000 bpd.

Through the continuous measurement of the amount of oil, condensate, gas and water at the wellheads on the sea bed, the operator, ExxonMobil, will be able to track production capacity for each well, increase flow assurance, and optimise the production process.

Each meter has a retrievable canister containing electronics, CPU (Central Processing Unit) and power, and weighing only 680 kgs. The development of the canister followed extensive qualification testing by Roxar with ExxonMobil in Africa. Through a standard remotely operated underwater vehicle (ROV), maintenance of the meter canisters can take place with no impact on production and without the need for test lines and manifolds – particularly useful in the deep waters of Kizomba. The same key drivers for multiphase meters can also be seen in the 44-well Akpo development, offshore Nigeria and the deepwater Rosa oil field, off the Angolan coast. In both case, Roxar's meters will continuously measure the flow rates of oil, water and gas in the well stream without the need for separation. The Rosa field, located 135 kms off the Angola coast, came on stream in the first half of 2007. First oil from the Akpo field is scheduled for the end of 2008.

Wet gas metering

With the increase in the development of deepwater gas fields with subsea tiebacks (as is the case with our fictional field), the ability to measure the water production profile in a gas well is also critical for optimising production, preventing hydrate, scale and corrosion in the pipelines and ensuring a reliability of supply.

Unchecked water can lead to scaling in the production system and catastrophic water breakthrough with water coning and impairment of the well causing a significant reduction on well production. The worst case scenario in these situations is the well being shut down or having a shorter lifespan.

With Africa today having 50 mn tonnes a year of LNG capacity - almost 30 per cent of the world's total and with much coming from offshore gas fields, it will be essential that our fictional African offshore field has wet gas meters in place. This will provide sensitive and accurate water production profiles and if there is early onset of formation-water production, enable the operator to take preventative or remedial action.

The Simian/Sienna, Sapphire and Rosetta fields, offshore Egypt, and operated by joint venture Rashid Petroleum Company (Rashpetco), are fields where Roxar subsea Wetgas meters are in place.

The meter's ability to measure water in very small amounts is an important input parameter for controlling hydrates, corrosion and scale in the subsea production system.

In the words of Rashpetco: "the Roxar Wetgas meters reported formation water breakthrough on some wells earlier this year. With this information instantly available, we were able to initiate immediate steps to choke down production, thus avoiding catastrophic water break-through and loss of the wells. Because of the Roxar Wetgas meters, there were major cost savings related to such loss of wells."

Whether it be production well testing, improved reservoir management, or hydrate and corrosion prevention, the accurate measurement of wet gas flow is crucial to managing offshore fields.

Don't forget sand

Going back to our fictional field, an acoustic subsea sand monitor could also play a vital role in calculating sand production in pipeline flows and monitoring the integrity of the gravel packs located in the gas wells.

Recently, 20 Roxar subsea sand monitors were installed on the Akpo field, offshore Nigeria. The Roxar subsea sand monitor is an intelligent, sensor device that utilises acoustic energy generated by sand particles to calculate sand production in oil, gas or multiphase pipeline flows.

Real-time monitoring and analysis

There is no doubt that our fictional African field has highly effective reservoir monitoring, sensors, and subsea information gathering systems in place.

Yet, is the offshore technology giving us a complete picture of the reservoir and the behavior of each well? Are we able to manage the sensors, gauges and meters remotely?

Roxar has developed real-time monitoring and analysis software to provide that all important data overview – crucial for generating the data on which decisions can be made.

Roxar Fieldwatch, which will be based on the field's offshore platform, will be used to store, monitor and manage the measurement data from all meters, sensors and gauges within the field and will establish an important link between real-time production optimization, right time reservoir characterisation and production forecasting.

Roxar Fieldmanager will be based at the field's onshore control centre to provide a suite of analysis and interpretation tools, local storage

for the data from the flow measurement instruments over the lifetime of the field, and to receive the most recent data from Roxar Fieldwatch. The two systems will integrate instrument data such as downhole temperature, pressure and flow rates, from a variety of field instruments into a common desktop for visualisation, field monitoring, analysis and interpretation. A broad range of powerful data interpretation and analysis capabilities are also available, including the ability to calculate quantities from measured data, such as the dynamic calculation of flow stream hydrocarbon composition. The rapid retrieval and display capabilities of both applications also give the user the ability to quickly visualize the data and identify trends, patterns or areas of interest for further analysis.

The result is a complete solution from the field instruments right through to the end user's desktop – sometimes thousands of miles away.

Tying it all together - rapid model updating

Playing a crucial role alongside the instrumentation and monitoring software installed offshore will be predictive modeling software. Using modeling, simulation and assisted history matching software alongside each other, the operator will gain a rapid understanding of production behavior and be able to create robust forecasts from a shared earth model. These models will be built by integrating all available data including seismic, well log and other geological data, and attempting to quantify all structural and reservoir property uncertainties.

The models will be validated by matching the models to production data. Then, using knowledge of the uncertainties, these models will be used to forecast and optimise future performance providing confidence intervals based on the models' estimated uncertainty.

Whereas current modeling technology only offers 'what-if type' analysis, Roxar is looking to close the loop. It is using right-time data to rapidly update the reservoir models. By using real-time data from its meters and gauges and its modeling, simulation and assisted history matching technology to rapidly assimilate new production data into the reservoir models, it keeps the models 'evergreen' up to date for better operational decision making. Today Roxar's African software customers include The Suez Oil Company (SUCO), Rashpetco, The Gulf of Suez Petroleum Company (GUPCO) and Ganoub El Wadi Holding Petroleum Company (GANOPE). Furthermore, a new joint venture has also been set up with SONAR Ltd of Nigeria to meet the increasing demand in Nigeria and West Africa for reservoir management solutions.

Remote sensors, reservoir monitoring and subsea information have come a long way, better characterising the subsurface, closing the subsea information gap and increasing offshore reservoir performance.

With many of Africa's large deepwater deposits offshore Nigeria, Angola, Algeria and Egypt, currently being developed, and at a time when few big new fields are being found elsewhere, these technology developments could not have come at a better time for the offshore industry. ■

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Roxar is a leading international technology solutions provider to the upstream oil and gas industry. The company creates value for its customers through innovative products and services that help achieve maximum performance from oil and gas reservoirs. More information can be found at www.roxar.com.