**A CASE STUDY: Obtaining laboratory-quality fluid analysis downhole**

**Unique Statoil reservoir validates accuracy of new technology in downhole fluid analysis**

In East Africa, an offshore, dry gas reservoir proved that Halliburton’s new ICE Core™ technology could provide lab-quality analysis downhole.

**OVERVIEW**

In four deepwater wells offshore East Africa, Statoil used Halliburton’s new ICE Core™ fluid analysis service to accurately characterize fluids downhole. (ICE stands for Integrated Computational Element.) The reservoirs all contained dry gas. Statoil tested Halliburton’s new ICE Core technology against laboratory analysis of the fluids from each well.

ICE Core technology recognizes the chemical fingerprints of various fluids when a light shines through them. Each ICE Core sensor detects the fingerprint of a specific analyte and calculates its proportion of the total fluid stream. In each well, ICE Core technology accurately predicted the results of laboratory analysis. Statoil’s Leading Advisor of Geology Formation Evaluation & Geo Operations, Kåre Otto Eriksen, describes it as a “game-changing” technology for downhole fluid scanning when additional ICE Core sensors are available to detect other critical fluid components.

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### CHALLENGE

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<th>Accuracy of spectroscopy downhole</th>
<th>Photometric analysis</th>
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<td>Downhole spectroscopy has long been used during pumpout tests downhole. It is good at telling when a reservoir fluid is pure enough to begin sampling. However, because bandwidth only extends to about 2100 nm, it is not very good at characterizing fluids and their proportions in the stream.</td>
<td>ICE Core sensors have a much wider bandwidth – to about 5500 nm. This is where the differences between reservoir fluids become most apparent. Plus, ICE Core sensors each use 100% of the available light instead of splitting up the spectrum. Result: much greater fluid analysis accuracy.</td>
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### Limitations of fluid collection

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<th>Ability to sample unlimited number of zones</th>
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<td>All sampling tools have limited collection capacity. In very long and deep wells, enough capacity may not exist to sample every part of a well without making additional runs. This presents a dilemma: escalate costs or uncertainty. The risks of making bad assumptions are enormous.</td>
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### Field-planning delays and risk

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<th>Accurate, real-time readouts</th>
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<td>Laboratory analysis can take months or even years. During that time, samples may be lost, contaminated or experience phase change. The cost of bringing a rig back to the site to collect more samples would be prohibitive, but alternatives could be even more costly – bad field planning.</td>
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Dry Gas in Each Case

Statoil tested ICE Core™ technology against laboratory results in four deepwater wells in East Africa. The reservoir in which the wells were drilled presented a perfect test case; it contained a high proportion of methane. There were no other variables or sources of interference that could have confused the findings or made them ambiguous.

Statoil tested ICE Core™ technology against physical samples they had already collected and found the downhole readings corresponded highly with laboratory analysis. The downhole readings were 97.5% accurate.

Most of the differences between reservoir fluids occur toward the mid-infrared out to 5500 nm where conventional downhole spectroscopes cannot reach.

ICE Core technology is based on photometry, not spectroscopy. A light shines through a fluid onto a sensor programmed to recognize the chemical fingerprint of a specific analyte. Up to 20 sensors can work simultaneously, each recognizing a different fluid. Unlike spectrophotographs that divide light into different portions of the spectrum, 100% of the light falling on an ICE Core sensor is used to characterize the fluid. This yields a stronger signal and higher accuracy than previously possible.

Solving challenges™
Perfect test of new downhole, fluid-analysis technology
Statoil was exploring a deepwater, natural gas field in East Africa. The operator wanted to know the nature of the natural gas and whether there was enough to justify the construction of an LNG plant. Halliburton proposed using its new ICE Core™ technology to analyze fluids downhole. Statoil, seeing the potential future value, agreed to test the new approach on four exploratory wells.

New technology tested against independent lab analysis
Statoil collected physical samples independently and sent them to a lab for analysis. Then Halliburton ran ICE Core sensors into the same four wells. Unlike physical samples that can take months or even years to analyze, Halliburton and Statoil were able to see results immediately.

Watching cleanup of liquid drilling filtrate in real time
Statoil had used oil-based mud (OBM) in drilling all four wells. OBM can contaminate physical samples and skew fluid analysis, so the first job was to remove as much OBM as possible. Halliburton used its field-proven Reservoir Description Tool (RDT™ tester) to accomplish this task by pumping out the mud in the sampling area. The tool then channeled the reservoir fluid stream through the Integrated Characterization Section (ICS) of the RDT tester, which contained the ICE Core sensors.

Calculated fluid density approaches that of methane
Halliburton monitored the flow in real time and watched as contamination levels quickly dropped. After meter readings stabilized, the measured density readings of the fluid approached that of methane in high proportions. This indicated Statoil had discovered dry gas.

The measured value of 0.236 g/cc compared well with the theoretical value of 0.232 g/cc for methane at given reservoir temperature and pressure conditions.

ICE Core technology accurately predicted lab results
Laboratory analysis showed an average methane composition of all samples within 0.4% of Halliburton’s findings, and well within the stated uncertainty range of +/- 1%.

Statoil calls this a “game-changing” technology
Statoil was extremely pleased with the results. The company’s leading advisor for Geology Formation Evaluation & Geo Operations called it a “game-changing” technology when additional ICE sensors for detecting other critical fluid components are characterized.
In East Africa, an offshore gas reservoir proved the ability of Halliburton’s new ICE Core™ technology to provide lab-quality analysis downhole.

**Ability to continue analyzing fluids when collection capacity reached**

After a sampling tool has exhausted its collection capacity, ICE Core™ technology can analyze additional zones downhole without the time and cost of an additional trip. Being able to collect fluid data from more zones without the extra cost and time of a second trip gives field planners valuable information about fluid stratification in the reservoir.

**Quick preview and backup of lab results**

Statoil sees numerous potential benefits of new ICE Core technology. It represents a valuable backup in case physical samples become lost or damaged. It also gives field planners an instant preview of lab results which could take months to obtain from a lab.

**Reliability and accuracy of new technology proven**

Statoil validated the reliability and accuracy of ICE Core technology. The results were clear and unambiguous. Since the Statoil test, ICE Core technology has proven its worth in more complex reservoirs in other regions.

**Accelerating production**

The data that Statoil gathered in East Africa enabled them to begin planning budgets, platforms, tubulars, treatment facilities, and more – faster than ever before. By mitigating uncertainty and risk, the company was able to make decisions about the wells it tested with a higher degree of confidence. Statoil sees the value of ICE Core technology in accelerating the company’s E&P processes by compressing cycle time from discovery to production. Planning their next wells and production facilities can now happen much more quickly.

**Statoil and Halliburton co-author SPE paper**

Statoil has already co-authored an SPE paper with Halliburton on its successful test. For more information, see *SPE 166415: Field Tests of a New Optical Sensor Based on Integrated Computational Elements for Downhole Fluid Analysis.*

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