

REAL DEAL:

Schlumberger uses RealView technology to study the effect of pressure, temperature, shear, flow regime and chemical inhibitors on solid deposition rates and deliver scalable results.



Putting it all together

Images: Schlumberger

Proper sampling and analysis create a firm foundation for minimising potential disruptions to hydrocarbon flow. **Jennifer Pallanich** looks at one service company's integrated approach to flow assurance embracing the well perspective alongside reservoir, production and facilities considerations.

Quality samples are first base when it comes to accurately analysing the composition of reservoir fluids, says John Nighswander, reservoir sampling champion at Schlumberger. For sampling to be most effective, he adds, retaining a clean fluid sample at reservoir rather than surface conditions until the laboratory can analyse it is vital as failure to do so could result in asphaltenes coming out of solution. "Once they come out of solution, they

may not go back. You can't always reverse that," he notes.

Maintaining pressure and temperature ensures waxes and asphaltenes do not drop out of the fluid. The Single-Phase Multisample Chamber (SPMC) a sampling tool Schlumberger has long relied on, has canisters pre-charged with nitrogen to maintain pressure at reservoir levels. The company lays claim to a 98%-plus success rate in obtaining useful sampling fluids using this tool and its reusable canisters.

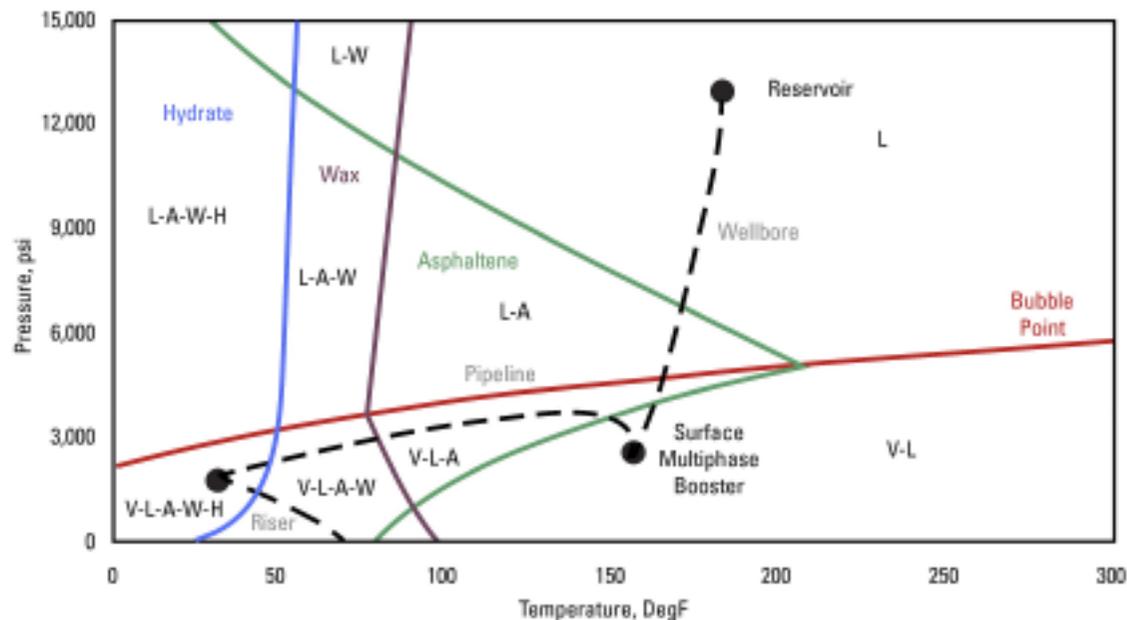
With canisters coming to

the surface holding contents at pressures as high as 20,000 psi, the downside was that for many years the recovered fluid samples could not be shipped until regulatory approval came through in 2012 to transport the chambers from wellsite to the lab. "That regulatory approval has changed the cost structure of getting the sample," Nighswander says.

Knowing when to obtain a sample can also be tricky. "On slickline, you can always run a clock, but on drill stem tests,

clocks don't work so well," he says. "There're only X amount of operations you can do on a well test."

Quartet, a conveyance communication technology enabled by Muzic introduced by Schlumberger last year, permits real-time wireless communication down the toolstring to acoustically trigger a sample. The resulting bi-directional signal means "you can send the wireless command down to capture the sample, but you also have Muzic going



PRODUCTION POINTERS: The phase boundaries of asphaltene, wax and hydrate precipitation superimposed on the pressure-temperature (P-T) profile of a typical offshore oil production system. Where the P-T crosses the phase boundary of any solid phase, the solid phase will precipitate. Asphaltene precipitation can be a concern in the near wellbore or wellbore. Wax and hydrates are of concern in the subsea flowline or riser.

says John Ratulowski, research director at Schlumberger's DBR Technology Center in Canada. Otherwise, there is the possibility that analysis could propagate uncertainty about flow assurance risk unknowns, such as wax.

Sample validation includes confirming the sample has been maintained at the original reservoir pressure. Then a small sample is displaced for compositional analysis to establish the gas-oil ratio and the composition of the fluid from the light end of the scale to the high end of the scale, or from methane at C2 all the way up to C30, Nighswander explains.

Variations will occur since samples are frequently taken at different zones or slightly different depths, so each sample comes with a brief analysis and recommendation as to which should be considered for analysis given the customer's flow assurance scope.

"Customers ultimately want to know the properties of their fluid," Nighswander says. Transport properties include viscosity and density, while density — heavy or light — also signals the value of the fluid. "Flow assurance characterisation comes down to tests to quantify the fluid property issues."

The analysis will seek to determine when waxes and



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*John Nighswander,
Schlumberger*

asphaltenes will drop out of solution as the system cools or depressurises, he notes, adding: "We can correlate that if we have a crude with this many asphaltenes and this many saturates, it's this likely to have an asphaltene problem or not."

One early analysis tool, the InSitu Fluid Analyzer, checks photometric properties. "By

looking at the colour of the fluid, we can deduce some of the properties," Nighswander says. "Technology in the tool monitors the colour of the produced oil as it gets more oil-like in colour and less mud-like in colour." Other analysis goals are to predict the formation of hydrates, which could collect and block the flowline.

"Knowing these things is important for designing the system," Nighswander observes. In short, flow assurance analysis aims to define phase boundaries. "At what temperature and pressure wax will form out is not the whole answer. It is not necessarily going to plug the pipeline," he notes. "The next question is the likelihood of deposit and plug off the line."

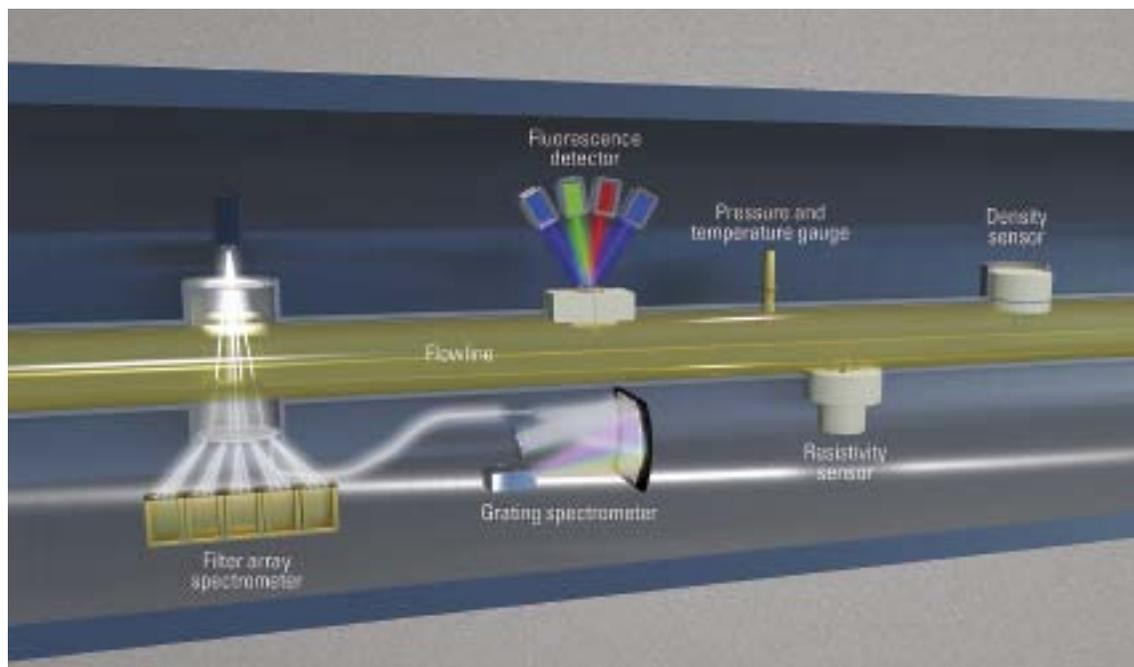
The RealView test vessel is employed by Schlumberger to simulate a pipeline and establish how long it would take waxes and asphaltenes to form on the pipe wall in a real production environment, and how thick they would become over time. "It's a complicated mechanism," Nighswander says.

Other modelling tools such as OLGA software, for transient conditions, and the PIPESIM simulator, for steady state conditions, have also helped pave the way for improved pipeline flow by calculating a system's expected thermal hydraulic

the other way saying, 'Hey, we received the signal to capture the sample,' explains Schlumberger testing services' marketing communications manager Bengt Arne Nilssen. "We talk to the tool and the tool talks to us."

Nighswander calls the new technology — currently able to carry six to eight sample chambers on tools, enabling sampling on a larger scale — "a significant advantage over the previous technique because now in theory you can sample at any time you want".

Having obtained clean samples, the next step is to validate them, assess the quality of each one and recommend which should be used for flow assurance analysis. "We would prefer to focus on the highest quality samples we can get,"



FAMILY AFFAIR: The InSitu Fluid Analyzer system integrates InSitu Family downhole quantitative fluid properties measurements.



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» behaviour and in turn helping to determine whether thermal management will be needed and, if so, whether via heating, fluid circulation or insulation.

Integrated approach

“To make those decisions, you need to understand the temperatures and pressures along the system,” says Ratulowski, stressing the importance of considering flow assurance from a well perspective as well as from the reservoir, production and facilities perspectives.

“In the past, the disciplines were separate,” he explains. “The pipeline guys would look at waxes, the facilities guys would look at hydrates... Without integrating these, you’ll actually make some significant errors.

“There are a lot of pitfalls associated with not understanding the fluids in the reservoir,” he adds, pointing out as an example that “if the gas oil ratio is misjudged, the hydraulic performance of the system will not be as expected.”

According to Ratulowski, such issues typically stem from failure to design for the full range of fluid compositions, a situation that requires re-sampling and re-evaluation. “In the past, reservoir engineers had always assumed that it’s one big tank down there — that if you

take one sample the composition is the same through the whole tank. But that’s not the case.”

Wax for example may not show up in a heavily biodegraded sample, or if the sample came from a location far from the oil-water interface. “If you sample in the wrong place, you might get a hugely different idea of what will happen with wax,” he says.

Nighswander says his team frequently hears of situations where systems in production have a wax problem and the design based on the reservoir sample is not meeting a client’s expectations. “But by that time it’s built, and then your options are a little more limited.”

As much as an operator may try to future-proof a system to allow for changes in fluid composition, uncertainty remains. “Each time you tie in fluid from a new zone into existing production, you introduce the risk for potential flow assurance issues,” Nighswander observes, stressing the importance of testing samples of both fluids in the lab to see how they might behave.

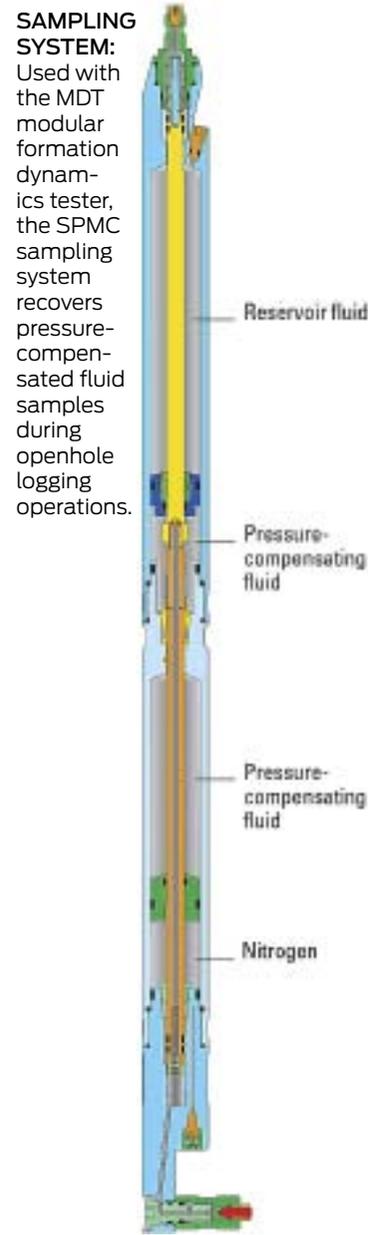
Catching changes in the composition of fluids over the life of the system requires ongoing effort, Ratulowski says. “Some might be anticipated. It’s great when you can anticipate that upfront,” but the unknowns require monitoring



TEST MATCH: Enabled by Muzic wireless telemetry, the Quartet downhole reservoir testing system provides data in real time for validation.

and responses to the changes detected, he notes.

Future efforts to improve flow assurance will centre on monitoring and measuring, Ratulowski believes. “We’ll make them more frequently, we’ll make them onsite and use them onsite, if we can, to optimise the system performance,” he says. “That’s one area of future research I’d like to be involved in.” [U](#)



SAMPLING SYSTEM: Used with the MDT modular formation dynamics tester, the SPMC sampling system recovers pressure-compensated fluid samples during openhole logging operations.