KEEPING PIPELINES IN TUNE WITH ULTRASOUND

Norwegian company Halfwave has developed a patented method for the internal inspection of pipelines using acoustic resonance technology (ART). Halfwave's ART possesses marked advantages that none of the large, well-known in-line inspection companies seem currently capable of matching. The technology is also making inroads into other integrity-related areas such as the external inspection of subsea oil and gas flowlines, and, perhaps, cased-hole evaluations.

Halfwave was spun out from Det Norske Veritas in 2012 with the support of leading private equity company Energy Ventures and Chevron. Shell's investment in Halfwave was made towards the end of 2016, though it actually already had a small financial connection, having acquired a stake in Energy Ventures about a year earlier.

Jermaine Saaltink, a senior investment associate with Shell Technology Ventures, reports that the decision to invest directly was the result of Halfwave's successful trial of ART in a Shell Mars field pipeline in the Gulf of Mexico, plus a growing realisation of the technology's potential in a wider range of applications important to Shell. At the time of the Shell investment, Halfwave already had a subsea flowline inspection system called ARTEMIS on the stocks and there was talk of using ART downhole and for inspecting the hulls of floating production, storage and offloading (FPSO) vessels while in service, a hugely important application from the global regulatory standpoint.

Jermaine says, "Halfwave has an exciting future. One of Shell's objectives, as an investor, is to help the company decide on the best way forward and to make that future as successful as possible."

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To learn more about the Shell–Halfwave relationship and to find out where the technology currently stands, *TechXplorer* interviewed Paul Cooper, chief executive officer of Halfwave, and Kelly Angelette, who is in charge of the integrity and maintenance of all of the Shell-operated pipelines in the Gulf of Mexico. ▸▸▸

The ART of inspecting gas pipelines

The mainstays of the pipeline inspection or pigging business are ultrasonic testing (UT) and magnetic flux leakage (MFL). Each has its strengths and weaknesses in terms of the quality of the measurements that can be made and the sorts of defects that can be reliably detected. If accuracy of wall thickness measurement and the ability to inspect heavier wall pipes are big issues, then UT probably comes out on top. However, one significant drawback of UT is the need for a liquid coupling medium between the signal transducers and the pipe wall. Understandably, this makes the UT inspection of live gas pipelines problematical.

This is where Halfwave comes in. For, after years of work to address this limitation, the company can offer a new type of UT for pipeline inspection called ART. The technique involves using swept-frequency ultrasound signals, or chirps, to induce half-wave acoustic resonances in the pipe material. These resonance signals correlate particularly well with the thickness of even the heaviest pipe wall.

Significantly, the acoustic signals transmit readily through gas, so there is no need to have a liquid coupling medium. The signals also penetrate coatings and any loose debris and surface deposits such as wax within the pipe far more effectively than traditional UT. Finally, the signal emitters and receivers do not need to be that close to the pipe wall. They can stand off several inches and the distance is not critical. This makes Halfwave's ART pipeline pigs more mechanically flexible than normal and, consequently, capable of negotiating pipelines with the sort of constrictions and internal diameter changes that seriously impede other UT pigs.

Shell
Technology Ventures

INTERVIEW

Paul Cooper & Kelly Angelette

What difference does the Shell–Halfwave relationship make?

Paul: What strikes me is the enthusiasm and the support there are within Shell for Halfwave technology. Shell seems very proactive; it is keen to find ways of doing things better, particularly in the integrity area. We have frequent meetings to discuss developments and I am constantly answering questions about the status of different projects. You feel that the Shell people are really engaged and on your side.

Shell is also good at pointing out the challenges in different oil and gas applications and helping us to understand them. It is not enough to have marvellous technology; you have to have practical solutions to genuine problems.

Of course, we do also get introductions to new markets and new geographies – and new potential customers. I have to say that, although Shell provides us with a certain credibility, it does not mean we get an easy ride. Shell customers are generally the most demanding and enquiring we meet. We constantly have to prove our technology and ourselves.

Kelly: Picking up on Paul's last point, I am naturally going to be interested in a technology that has Shell's backing, but I then have to put that relationship to one side. My responsibility is to pick the best tool for the job. The integrity of the asset must come first, as set out in Shell's internal Global Asset Integrity Review process. Then I have commercial responsibilities too. I have to achieve the biggest bang for the bucks we spend in this area.

Halfwave's ART pigging tool.

Halfwave's ART came to the attention of a senior colleague, Brent Byrd, who subsequently visited the company in Norway. His view was that we should definitely consider this technology. And that is what we have done, in the same way we would any new inspection technique.

Just how well has ART been received generally and within Shell?

Paul: ART was developed by Halfwave with the inspection of high-pressure gas pipelines in mind where traditional UT has well-known problems [see boxed text, "The ART of inspecting gas pipelines"]. Over the past couple of years, we have broken through in this business area and we are definitely now an established player. We have just won the contract for precommissioning inspection work on the Nord Stream 2 project: twin 48-in. pipelines each running 1,200 km under the Baltic Sea. This is on top of a contract award last year from Inpex for inspection work on a 42-in., 890-km natural gas pipeline, part of the Ichthys liquefied natural gas project in the Timor Sea off Western Australia. Before that, we secured a two-year contract with Woodside Energy for inspection services on the 36-in. Pluto trunkline and the 30-in. Angel export pipeline in the same region.

And it is not all about gas. Alongside these three gas pipeline projects, we also recently won oil pipeline inspection work for a leading deepwater operator in Gulf of Mexico (the details of this award have yet to been announced). Together, these contracts will generate a large part of our total revenue in the near future.

Kelly: The inspection of gas pipelines was not the issue for us, at least to start with. Rather, we were attracted by the ability of Halfwave's tools to negotiate difficult pipeline sections offshore. By that I mean high-pressure lines having heavier walls, containing considerable paraffin deposits and, most notably, with internal protrusions and variable internal diameters. We have some lines where the diameter can change by 3–4 in. Because of the way ART signal transducers stand off the pipe, the same tool is capable of conforming to quite different diameters relatively easily. This feature is also of benefit when it comes to getting through branches in the system.

We have successfully performed four runs now of 65–130 km each in liquid lines in the Gulf of Mexico. There have been no problems with the tool, apart from an occasional unnecessary cut-out owing to a slightly overcautious control philosophy, which we worked together to iron out. We will use the tool more in the future I am sure. I would like to run it in some less-pristine lines onshore: our offshore lines are generally in very good shape. We also have plans to put it through a gas line in which we would normally employ MFL, not just because of the liquid coupling issues with UT but because MFL does have its advantages. For example, MFL detects localised pitting corrosion particularly well; it also picks up any external metal interference effects at pipeline crossings.

The choice of tool is rarely straightforward and we can debate the relative technical merits of the basic inspection methods forever. But, I go back to my first point. A big value driver for us is a tool's ability to make it from A to B without becoming stuck in the pipe. We have occasionally had to cut tools out of pipes. When some of our lines are transporting over 200,000 bbl/d of crude oil, upsets of this nature cost a lot of money and make integrity engineers like me extremely unpopular. Pipeline integrity will always be the primary driver, but if you cannot retrieve the tool and, therefore, its data, then your attempts to improve integrity go out of the window. Halfwave's ART definitely has a role to play for this alone.

So, where do Halfwave and ART go from here?

Paul: We have already succeeded in adapting ART for subsea work, in particular, the external inspection of smaller pipes such as flowlines and risers, including flexibles, that cannot generally be pigged. The tool, which we call ARTEMIS, is deployed using a remotely operated vehicle and is designed to be clamped around the pipe. The main benefit of ART in this application is its ability to penetrate the thick protective coatings often applied to these pipes.

In a recent ARTEMIS commercial demonstration, we were able to make wall thickness measurements on a pipe with a nominal thickness of 43 mm through 5 in. of various functional coatings. This represents an exceptional value proposition, as it was previously virtually impossible to inspect pipes of this kind. A trial like this also makes you begin to think about monitoring corrosion under insulation, which has been a problem for decades in the process industries and for which there is still not really a single outstanding answer.

You could easily see technology of this kind being used to inspect ships' hulls. Shell is encouraging us to think about the in-service inspection of FPSO facilities, for example. Again, the value proposition could be compelling: hull inspections have to be done at set intervals for regulatory reasons and are currently undertaken from inside the tanks, which means the tanks have to be emptied, which halts production, of course.

With Shell's help, we are also examining the use of ART for downhole applications. Who knows where this will go? It is an interesting area, as it brings together pipeline inspection and well-logging technologies, which are not always considered at the same time.

I think one of the things that Shell has made us realise is that ART is a technology platform that provides potential entries to numerous application areas. But, before we stray too far away from our origins in pipeline pigging, I should say that our current primary research and development objective is to develop ART for detecting cracks in gas pipelines, which requires a slightly different approach to wall thickness measurements. We are working with various companies on this and, assuming the trials planned for this year go well, we are looking at commercial runs in 2019.