WORLD FEATURE

> *One of our goals is to help the industry understand the risks, the challenges and of course the benefits of composites.*
> DNV GL senior engineer Ramin Moslemian

65% **THE EXPECTED SAVING** on installation costs at Tullow Oil's TEN project off Ghana brought about by the use of TCP for the flowlines.

TECHNOLOGY

Piping in a new way to lighten the load

A lighter, **corrosion-resistant alternative** to metal pipe is building a **track record** in the oilfield as its proponents eye **the ultimate prize**, a **deep-water riser** made entirely of **composite materials**

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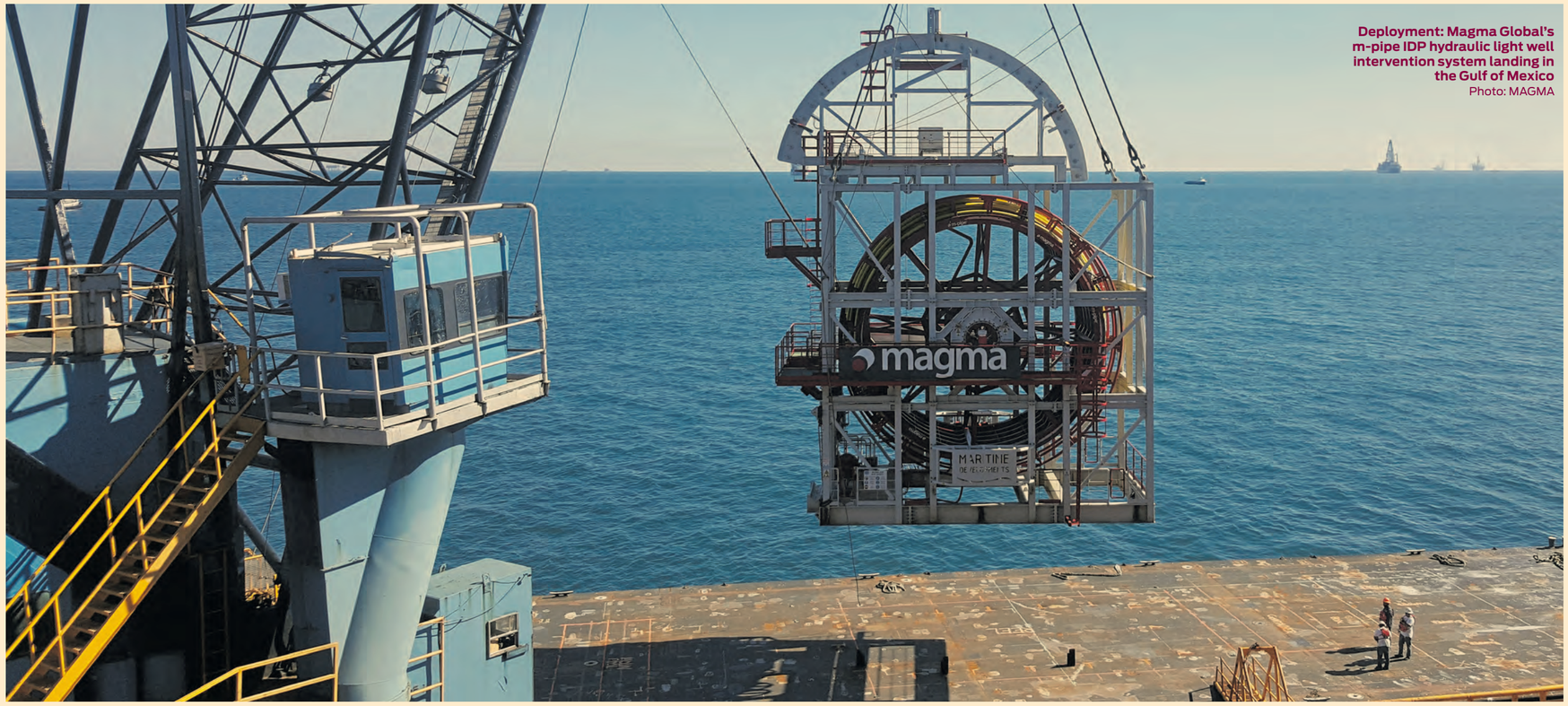

Deployment: Magma Global's m-pipe IDP hydraulic light well intervention system landing in the Gulf of Mexico
Photo: MAGMA

THE past couple of years have witnessed a flurry of activity for the manufacturers of bonded thermoplastic composite pipe (TCP), a product that its makers say addresses many cost and safety concerns of operators.

The technology has recently been deployed in several oilfield applications following a decade of development and trials.

In the past year alone, Airborne Oil & Gas, one of the two chief TCP manufacturers, saw the installation and start-up of what it claims is the first thermoplastic composite pipe in a full wellstream application. The company supplied 550 metres of six-inch diameter TCP for the flowline, installed between two fixed platforms at a shallow-water Petronas project off Malaysia.

The Netherlands-based company also supplied three acid stimulation jumpers to Enpro Subsea for a project in Ghana, won a contract for a crude oil spool in the Gulf of Mexico and delivered a gas lift jumper made of TCP for the Anasuria Operating Company project in the North Sea — another first, says Airborne commercial director Martin van Onna.

"We now have, after working on it for many years, a track record in crude, methanol, gas lift and chemical injection, with jumpers, spools and a flowline," he says.

UK-based Magma Global, which manufactures a high-end, bonded carbon composite product branded m-pipe, also had a banner year, seeing its TCP light well intervention system deployed in the ultra-deepwater US Gulf of Mexico.

Application

Magma delivered several high-sour gas TCP jumpers to Eni for use in the Adriatic Sea, supplied a number of high-sour hydrocarbon risers for onshore application in the Middle East and, early this year, announced a contract with Tullow Oil for two 2.5-kilometre, six-inch spoolable carbon composite flowlines at its Tweneboa, Enyenra and Ntomme (TEN) project off Ghana.

The company has been "building operational experience" in different applications, says Magma chief operating officer Charles Tavner, noting that m-pipe was the first TCP product to receive third-party verification under a DNV GL recommended practice issued in 2015.

"It's the same product every time," Tavner says. "What we've done is put that same qualified product into high sour gas applications, high sour hydrocarbon applications, water injection applications and high-temperature lines."

Both companies are anticipating what van Onna calls "the holy grail for composite pipe" — the first use of TCP in a deep-water production riser — and are steadily building track records in less demanding applications.

Bonded composite pipe resembles steel pipe in that it has a single solid wall, but unlike steel it is lightweight and mostly impervious to corrosion from seawater, hydrogen sulphide (H_2S), carbon dioxide (CO_2) and many harsh chemicals used in oil and gas production.

While much more expensive than steel, its advocates say it can cut costs considerably in installation and over the life of a field and offer a durable alternative to steel flexible pipe in many applications.

The TEN flowline, for example, will save Tullow 65% in installation costs immediately, Magma says, because the 100-tonne pipe and deployment package can be mounted on a small offshore construction vessel rather than a large lay ship, which would be required for an equivalent steel flexible pipe package weighing 500 tonnes.

"That's very exciting for us. It's a validation of what we've been saying for a long time, that the light weight allows you to use much smaller installation vessels. It's great to see a customer proactively identify that and come to us and put together a package that takes advantage of it," Tavner says.

The aerospace and automobile manufacturing industries have used thermoplastic composite materials in non-load bearing applications. Offshore has been an early proving ground for TCP use in load-bearing applications, but a conservative oil industry has been slow to embrace the technology, van Onna says.

Part of that had to do with timing. Before the current industry downturn, he says, Airborne had no trouble finding operators to help test its TCP product, but few were willing to take a chance on it when oil prices were high and the emphasis was on getting projects up and running quickly.

"Now what we see is that there's a very strong push to get the costs down, and people are being asked to look actively at alternatives to reduce cost," he says.

Alliances

"The downturn created many (project) delays, but we also see that if there had not been a downturn, people would not be looking at new technology the way they are now," van Onna says.

Both Airborne and Magma have formed important alliances to help push the technology along. Last year, subsea service giant Subsea 7 became a major shareholder in Airborne, joining operators Shell, Chevron and Saudi Aramco.

Van Onna calls the investment "a big step" for the company because it heralds new opportunities for TCP to be considered as an option early in a project's design phase, maximising its benefits.

Subsea 7 and BP have worked with Magma to qualify m-pipe for increasingly demanding subsea applications, and last year Magma reached an agreement with Odebrecht Oil & Gas (now renamed Ocyan) to supply its product for use in composite multi-bore hybrid risers in high-CO_2 pre-salt projects off Brazil.

Debutant: Airborne recently delivered to Petronas what it says is the first thermoplastic composite pipe in a full wellstream application
Photo: AIRBORNE

Airborne last year formally launched a qualification programme with Brazilian state oil company Petrobras for a TCP riser application, another signal that the TCP grail is within reach.

"Everyone is working towards a composite pipe deep-water riser," van Onna says. "However, nobody will install a deep-water riser with new technology until they have first seen the technology used in less critical applications."

Tavner agrees: "That's why the (m-pipe intervention) downline is exciting, because it's effectively a small riser system. It's only three inches (inner diameter) but it's a dynamic system. By deploying it, we underpinned what the testing shows - that the product is effective in dynamic scenarios."

A TCP riser could deliver significant savings, he says, because it would require fewer buoyancy modules and allow shorter flowlines by rendering lazy-wave systems unnecessary. Installation costs would also be much less, he adds. "It's always been about riser systems, because that's really where the biggest cost benefits are."

The corrosion-induced failure of two steel flexible gas re-injection risers last year at Petrobras' pre-salt Lula field has lent some urgency to the quest, highlighting the potential life of field benefits of TCP.

Both Magma and Airborne report a significant increase in interest in TCP and in the number of actual projects in the works.

Tavner says: "What has surprised me over the past few years is how there will be periods when you don't see huge amounts of progress, and then you'll see a number of operators move quite quickly. We seem to be in that period at the moment."

Ongoing drive to prove the mettle of thermoplastic composites

THE subsea industry's growing interest in thermoplastic composite pipe has been aided by third-party qualification and an ongoing joint industry project held under the auspices of DNV GL, *writes Russell McCulley.*

The organisation issued recommended practice RP-F119 in 2015, setting out qualification guidelines for TCP in subsea uses.

The following year, it helped set up the Affordable Composite joint industry project, which is developing advanced modelling techniques for qualification and design with a focus on composite pipe.

The joint industry project launched with a half-dozen participants and $1.5 million in funding for researchers at the Norwegian University of Science & Technolgy (NTNU). Now with 14 participants and growing, it is due to wrap up near the end of 2019, says DNV GL senior engineer Ramin Moslemian.

"The industry is very much used to metal, so it struggles to some extent to adopt this new technology," he says. "One of our goals is to help the industry understand the risks, the challenges and of course the benefits of composites."

An immediate driver for TCP technology is the material's ability to resist corrosion and help avert pipe failure in harsh operating conditions.

Middle East and Persian Gulf operators are particularly interested, he says because of the high hydrogen sulphide content in much of the oil and gas produced there.

However, there is another, more forward-looking motive behind the region's interest. Hydrocarbon-rich countries such as Saudi Arabia looking at life after oil exports are seeking more profitable alternatives to crude exports, and products like TCP offer such an option, Moslemian says.

"(Oil) demand is expected to peak in 10 to 20 years, so there is a push to promote oil products, especially petrochemicals and polymers, as alternatives to conventional metallic solutions," he says.

A flexible friend for industry

COMPOSITE pipes are made of plastics combined with other materials for enhanced strength, flexibility and fatigue resistance, and are much lighter than all-metal pipes or steel flexibles, *writes Russell McCulley.*

They resemble steel in that they have a single solid wall, unlike "non-bonded" flexible pipe, which comprises separate layers that can slide relative to each other in the pipe wall.

Bonded thermoplastic composite pipe (TCP) has a thicker wall than steel pipe but weighs about one-tenth as much as steel when immersed in water, vastly reducing the load at the surface. The material is strong enough to resist both internal pressure and external crush forces in extreme water depths.

TCP is more flexible than steel — although more rigid than non-bonded flexible pipe — and performs well in high-temperature and high-fatigue applications. Advocates say it is less prone to wax build-up and resists corrosion from hydrogen sulphide, carbon dioxide and some of the most aggressive chemicals used in oil and gas production.

Magma Global takes a uniform approach to its m-pipe, using the same premium ingredients — PEEK (polyether ether ketone) and carbon fibre — in all applications. The pipe is manufactured by fusing the materials in a thin tape, then layering the composite over a polymer inner liner to create a homogenous composite pipe.

Airborne Oil & Gas offers TCP in different combinations of materials for different specifications. The manufacturing process involves melt-fused glass or carbon fibre with a choice of polymers — polyethylene, polypropylene, polyamide and, at the top end, PVDF (polyvinylidene fluoride).

Airborne and Magma have long been the main players in TCP and their rivalry is mostly amicable, says Airborne commercial director Martin van Onna, noting that the companies have worked together to develop standards and to set up a joint industry project to further TCP use in the oil and gas industry.

"I think that by working together we have successfully positioned TCP as a third solution along with flexibles and rigid steel. This is something that we both have worked toward for a long time," he says.