the hunt for deep oil and gas intensifies
A few weeks ago the price of oil sailed effortlessly past USD 100 a barrel. It is now heading towards USD 120 after OPEC, at its meeting on 5 March 2008, decided not to boost production (some would say they are in fact unable to do so). This is bad news for the consumer and for most industries, but the high price will make it more profitable to extract hydrocarbons at depth, which will benefit specialised companies like Halliburton, Technip, Intec, Wellstream and many others. It is also good news for suppliers of duplex and, to some extent, of austenitics and titanium. Stainless Steel World surveys recent trends in the offshore industry and attempts to shine light through opaque waters.

By James Chater

Background
“Peak oil” has finally entered the mainstream of public discourse. Whether the peak is already past or lies somewhere in the future matters little; what is undeniable is that hydrocarbons are getting more expensive to produce just at the moment when demand is rising. The high price of oil has stimulated exploration and development in remote offshore locations that would have been deemed uneconomic only a few years ago. And companies are honing their technologies to make extraction faster, cheaper and more efficient.

A graphic example is provided by the history of the Panuke project off Nova Scotia, Canada. The project received regulatory approval in 1990 and had reached the end of its economic life in 1999. Originally, total production had been estimated at about 35 million barrels, but improvements in technology over the life of the project resulted in a total production of more than 44 million barrels. Not only that, but exploration of a deeper structure revealed a further resource of one trillion cubic feet of natural gas: Deep Panuke, which is now being developed.
Brazil leads offshore boom

By 2007, offshore oil had grown from 10 per cent of world crude production in 1977 to 38 per cent.1 With onshore production now in decline, offshore is booming. Fields are being developed at water depths of 2000+ metres in the Gulf of Mexico, offshore West Africa and offshore Brazil. The industry is looking to push the boundary towards 3000 metres water depth and beyond. An excellent place to start our survey of projects is with Petrobras in Brazil. After a string of successes, the national oil company trumped these with a remarkable hat trick, discovering three sizable fields in the last two years: Tupi, Jupiter and Carioca. The three fields lie close together in the Campos Basin, and together constitute a huge addition to the country’s reserves. The Tupi oil and gas bed was discovered 7000m below the water surface, beneath a salt barrier 2 km thick, and is said to contain at least 5-8 billion barrels of recoverable oil. Jupiter is a gas and condensate field in the pre-salt layer at a depth of 5000m that could equal Tupi in size. The Carioca oil field was found at 5100m water depth and could be the largest. However, Petrobras has distanced itself from initial rumours that the find could amount to 33 billion barrels. To put that into proportion, Brazil’s proven reserves stand at 11.8 billion barrels, the USA’s at 21.8 billion!

Petrobras’s Tupi find poses enormous technological challenges, being located 300km from shore and lying beneath a 2km-thick salt barrier that is hot and pasty. But Petrobras is no stranger to these types of challenges and is investing heavily in R&D to make the most of its discoveries. In March 2008 it announced it would become the first serial manufacturer of hulls for FPSOs, and so the Rio Grande dry dock is being prepared for the serial production of standardized hulls, reducing costs and increasing the production scale. This will help relieve a world-wide shortage of rigs. In February Petrobras announced that a new kind of FPSO specially designed to produce extra-heavy oil offshore would be installed in the Badejo field in the Campos Basin. The challenges include building a well with a 2km horizontal section and installing a high-power submersible centrifugal pump to ensure high flow rates for the oil that is produced. Oil processing will take place at the very high temperature of 140º C.

Petrobras is also behind a project, being developed in collaboration with Aker Kvaerner (now Aker Solutions), to build the SESV (Subsea Equipment Support Vessel), which will take over some of the tasks currently performed by deepwater drilling rigs, such as handling, testing, retrieving and installing subsea trees and related equipment. Aker is just one of several firms – others being Intec, Technip and Wellstream – with which Petrobras is working to develop fields offshore Brazil and in the Gulf of Mexico. A consortium of Technip and Keppel FELS will build a 50,000-ton semisubmersible platform for the Marlim Sul oilfield in the Campos Basin. Also working in the Brazilian fields are Norway’s Statoil-Hydro, in partnership with Anadarko. Its Peregrino field is its first venture in Brazilian waters.

Elsewhere in the Americas

Relatively close to Brazil is the Gulf of Mexico, where record depths have also been plunged and where the combination of deep waters, HPHT environment and high winds creates tough conditions requiring ground-breaking
technology. Petrobras’s Cascade and Chinook gas fields lie in 8200ft and 8800ft of water respectively and will be the first project in the GoM to use a FPSO. Meanwhile, Shell continues to develop its Perdido project, the deepest spar production facility in the world. In the last 18 months contracts have also been awarded for work on the Bass Lite, Great White, Green Canyon, Noonan, Shenzi, Silvertip, Tobago and Ursa & Princess fields.

Other hotbeds of offshore activity in the Americas include the Mexican GoM, the Caribbean and Canada’s east coast. Canada’s Deep Panuke, owned by EnCana, was approved in October 2007. In April 2008 Technip won the contract to supply flexible flowlines, umbilicals and manifolds to Husky Energy’s White Rose oil and gas field.

**North Sea**

Elsewhere in the world, the most active regions are the North Sea, Asia and Australia. In addition, the Arctic region is gearing up for expansion, whereas Nigeria is beset with security problems. The North Sea, first oil flowed from the Buzzard development, a very large field now operated by Canada’s Nexen, in January 2007. This field, which is still being expanded, is expected to produce 10 per cent of the UK’s oil demand. In the Norwegian sector, the big news has been the merger of Statoil, the majority-state-owned oil company, with Norsk Hydro (October 2007), a move which will allow the company to grow faster and take on more and bigger projects world-wide. Another important development was that the Norwegian government approved StatoilHydro’s proposals for the Gjøa field (June 2007). This will be developed with subsea templates tied back to a semi-submersible rig. The project will supply gas to Scotland and oil to the Statoil-operated refinery in Mongstad. Contractors include Technip (infield pipelines) and NKT Flexibles (flexibles). With reserves estimated at 82 million barrels of oil and condensate and 40 billion cubic metres of gas, Gjøa is StatoilHydro’s biggest current development after Snøhvit. StatoilHydro will also develop Alve (contracts awarded to Aker, Subsea 7 and Technip) and has recently submitted plans to develop the Yttergryta gas field. The Volund field will be developed by Marathon Oil Corp., with pipelay carried out by Acergy. The Troll field is being expanded. Like the GoM, the North Sea is renowned for its harsh conditions that have stimulated technological innovation. StatoilHydro and US oil services provider Schlumberger have been collaborating since 2000 in areas such as petrophysics, seismics, drilling & well technology, data management and production optimizing. As an example of new technology at work on the seabed we may cite the world’s first full field subsea separator, which StatoilHydro has installed on its Tordis field. The separator will boost recovery rates by carrying out part of the processing on the sea floor and re-injecting the separated water, avoiding the flow of water up from the subsea well to the production platform and freeing up pipelines and processing equipment for the oil and gas content. The system, whose development was funded by Eureka, was devised by CDS Engineering, with FMC Technologies, who “marinised and built the equipment and put it together with other key building blocks like subsea pumps for boosting into a complete subsea processing system”. StatoilHydro is also at the forefront of development of humanless, robot-operated platforms. This could actually harm sales of stainless steels and titanium, as fire protection equipment would no longer be necessary.

**Further north**

The toughest challenges yet could be posed by the Arctic, estimated to contain 14 per cent of the world’s known oil and gas reserves. The melting of the region’s ice has made any reserves more accessible, but problems remain, whether political (disputed territories), ecological or technical. Here, as in the North Sea, StatoilHydro has a role to play: it has been awarded a 24 per cent
stake in the huge Shtokman gas field in the Barents Sea (the other partners are Gazprom with 51 per cent and Total with 25 per cent).

Discovered in 1988, Shtokman has estimated reserves of 3.7 trillion cubic metres of gas. On 21 February 2008 the Shtokman Development Co. came into being. The new company has so far awarded contracts to Technip (onshore facilities), Doris (subsea system) and JP Kenny (pipeline to shore). It is predicted that TLP and spar-type platforms are likely to be used, and that 156 wells will be drilled from up to four platforms.

Asia also booming

In other parts of the world, oil has been discovered offshore Libya. In Angola, Aker and Technip have won a large contract on Total’s Pazflor project, and ExxonMobil has announced start-up of the Marimba North project. In the Middle East, China’s CNOOC is developing Iran’s North Pars gas field, and J. Ray McDermott is developing Saudi Aramco’s Manifa oilfield in the Persian Gulf, with help from Halliburton. Meanwhile the Asia Pacific region is developing at a furious pace. Several companies have opened up in the region, hoping to cash in on future growth: on Singapore’s Jurong Island, FTV Proclad (Singapore) will serve as the manufacturing hub for the Proclad Group and also as an R&D centre. Technip will set up a new flexible pipe manufacturing plant, Asiaflex Products, in Kuala Lumpur. The rig shortage is good news for Singapore’s Keppel Offshore & Marine Ltd, which has received orders from all over the world.

Stainless steels

Despite all the activity in the offshore industry, several insiders have said the sector is under-invested and short of human resources. There is said to be a need to invest in IT, 4D imaging, enhanced oil recovery, standardized components and streamlined production systems. Here surely there are plenty of opportunities for stainless steels. For instance, to lower the costs of drilling, expandable casings are beginning to be used, allowing wells to have the same diameter from top to bottom instead of being larger at the top and tapering down.

Flexible pipe, from NKT Flexibles.

Designed in supermartensitic and super duplex stainless steels. In 2007 Nexen installed 6,867 feet of an open hole solid expandable tubular (SET) system in the Aspen oilfield (GoM). Stainless steels are also being used in more traditional ways (see Table). In particular duplex stainless steels have become well established because their combination of corrosion resistance and mechanical strength offers protection against CO₂, chlorides, H₂S and the formation of water condensate in HPHT conditions. Shell led the way in the Groningen gas fields in the 1980s, with Statoil following. Duplex is increasingly the material of choice for process piping systems, separators, scrubbers, pumps, manifolds, X-mas tree components, flowlines and pipelines transporting corrosive oil and gas. Where resistance to design stress is important, super duplex (25% chromium) grades are preferred.

Duplex grades have become standard in the inner tubing (or carcass) of flexible pipe and in umbilicals, where a bundle of hoses and cables within free-floating stainless steel tubing are cradled within plastic profiles, all covered with an extruded thermoplastic overwrap. Not only do the duplex grades protect against corrosion, but they are capable of supporting their own weight during installation in deep water. Outokumpu’s grade LDX 2101® is used in the strip found in flexible pipes and is a good substitute for 304. Allegheny Ludlum’s AL 2003™ lean duplex has been successfully used in unbonded flexible pipe in the Kikeh field offshore Malaysia, and has been found to outperform 316L. Among the new grades designed for umbilicals at extreme water depths are Sandvik’s super duplex SAF 2906 and hyper duplex Sandvik 3207 HD.
Duplex grades have not completed ousted austenitics, however. Outokumpu’s super-austenitic 254 SMO® has been used on an offshore project in Qatar, on the topside of oil platforms in the Al Shaheen offshore oilfield. Also, titanium is an important metal in the offshore industry for its corrosion resistance, extreme lightness and resistance to bio-fouling in marine conditions. Its use on topsides can result in critical weight savings. Titanium is immune to crevice corrosion up to at least 70°C in seawater, conditions in which some stainless steels are limited to 10°C. It is used in taper stress joints, fire water systems, ballast water systems, fresh and sea water pipework, submarine ball valves and heat exchangers, to name only a few applications. For a cooling system on a Kashagan rig, titanium dosing pumps from Prominent were selected (see Table).

Flexible flowlines prior to shipment. Courtesy of Wellstream International.

To read the Table – Round up of offshore projects 2008, please go to the following website: http://www.stainless-steel-world.net/magazine/ShowPage.aspx

Recent orders referring to stainless steels and CRAs in offshore projects (2006-8)

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<thead>
<tr>
<th>Date</th>
<th>Supplier</th>
<th>Project Details</th>
<th>Details</th>
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<tbody>
<tr>
<td>Early 2006</td>
<td>Butting</td>
<td>Phase 3 of Miskar gas field in Tunisia. Operator: BG Tunisia Ltd.</td>
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<tr>
<td>10/2006</td>
<td>Allegheny Technologies</td>
<td>Flowline system for Kikeh Field Development Project, offshore Sabah, Malaysia.</td>
<td>1.2 million pounds (550,000kg) of proprietary AL 2003™ lean duplex delivered to Wellstream International for flexible pipe used in flowline.</td>
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<tr>
<td>9/2007</td>
<td>Outokumpu</td>
<td>Burhan West field in Oman (Operator: Petroleum Development Oman)</td>
<td>2205 duplex stainless steel coil for pipes for a natural gas flowline to be installed at the</td>
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<tr>
<td>10/2008</td>
<td>Outokumpu</td>
<td>Al Shaheen oilfield in Qatar. Operators: Maersk Oil Qatar and Qatar Petroleum.</td>
<td>BSL Tube &amp; Raccords placed order with Outokumpu for 408 metric tons of super-austenitic grade 254 SMO® for pipes, with an additional 140 tons in option, for topside of platform; 253 tons of plate and 155 tons of coil.</td>
</tr>
<tr>
<td>2/2008</td>
<td>Mardale Pipes Plus (UK subsidiary of Silindustrie)</td>
<td>Al Shaheen Block 5 Development Project operated by Maersk Qatar to raise pump capacity to 525,000bpd from present 240,000bpd.</td>
<td>6 Moly and duplex pipes and fittings.</td>
</tr>
<tr>
<td>2/2008</td>
<td>Silindustrie</td>
<td>Construction of the P-56 semi-submersible platform on Marlim Sul oil field in Brazil.</td>
<td>700tns of copper nickel pipes, fittings and flanges.</td>
</tr>
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1 www.simmonsco-intl.com/files/Offshore%20Technology%20Conference%20April%202007,%202007.pdf
2 http://www.eureka.be/files://3186335
4 http://www.sprottmoly.com/pdf/12_07_moly_writeup.pdf
5 Interview with Tor Eriksen of Statoil, Norway, Stainless Steel World, December 2007.