System deployment is relatively simple, small and non-invasive, with much of the technology employed being standard oilfield equipment: hydraulically activated 10 000 psi gate valves, modified Kelly valve submersibles and conventional high-pressure and low-pressure pipework. Systems can be operated remotely and are non-electrical. The key, patented technology of the system consists of the non-return valve in the side of the Kelly valve submersible, which is rated to 15 000 psi.

**Development of continuous circulation systems**

Following Eni's development of early continuous circulation systems for use in the Mediterranean, ExxonMobil pioneered use of the technology for drilling in remote locations where heavy losses were being experienced. Adrlitech has spent the last 11 years further developing the technology with lessons learned from over 100 operational deployments around the world; in multiple operating environments, including onshore, offshore, shallow water, deepwater and high-pressure, high-temperature (HPHT) – both alone or with MPD – the technology has delivered value.

As with many new technologies, development of the Non Stop Driller (NSD) system was driven by necessity. While drilling top hole sections in the mountains of Papua New Guinea with fresh water, ExxonMobil was driven to seek an alternative approach as a result of experiencing total losses, lost bottomhole assemblies (BHAs) and an inability to reach section total depth (TD). By switching to foam drilling with a 3-phase separation system, some of the issues were alleviated. The change required rotating control devices (RCDs) to be installed, yet with 1600 psi of air pressure there still existed the issue of bleeding down and defoaming over each connection. This could result in connections taking an hour, bringing into question the viability of foam drilling these wells. By introducing the NSD system, which is capable of continuous flow throughout the connection process, the need to bleed down and defoam was removed and continuous circulation could be maintained while the next stand was picked up. Several days of rig time were saved per well, giving ExxonMobil the confidence to attempt directional work and drive section TD and casing setting deeper in the formations. Following the technology’s first successful campaign, further improvements were sought – the next stage of any work where underbalanced drilling (UBD) and air drilling are being used to simplify processes. At the time, MPD technology was becoming increasingly viable and therefore, following detailed FEED engineering, the value of combining MPD and the NSD system was established, with the combination of technologies enabling very narrow pore pressure/fracture gradient (PP/FG) window wells. MPD with NSD was applied to difficult drilling environments in Malaysia, Egypt and the Netherlands on multi-well campaigns.

During the development of the technology much has been learned regarding the benefits of continually circulating the well. The process was seen to allow maintenance of stable equivalent circulating density (ECD) and continuous cleaning of the wellbore over connections, improve management of high specification mud systems and reduce weight-to-weight times during drilling and tripping operations. These improvements are seen whilst simultaneously reducing non-productive time (NPT) and assisting with the detection and management of well control events – often encountered during pump-off events and connections. Additionally, continuous circulation has been shown to enable the maintenance of the downhole tool temperature at safe, stable levels in HT applications.

**Responding to the downturn**

Despite these benefits, technology continuously evolves and during the recent downturn application of technology has been limited by many factors. Cost reduction, a lack of dedicated engineering resources to qualify new technologies, a switch in contracting philosophy to integrated services and changing regulatory approaches discouraging the use of new technologies are among the many issues faced when attempting to introduce innovative technologies. These constraints are driving developers to pivot into spaces where technology is most needed, applying R&D efforts towards increasing value though improved rate of penetration (ROP) and reduced NPT alongside removal of personnel from the rig site via digitalisation and automation. NSD’s development has sought to meet these challenges head-on, developing the technology to reduce the cost of deployment, automate systems, train rig crews to use and service the equipment and offer the system for sale to drilling contractors. Specifically, driven by industry-wide ambitions...
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