

Drilling Failure Costs Quickly Add Up

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Annual downtime during drilling or running casing is only marginally better than it was 20 years ago. Operators' estimates suggest that drilling efficiency is approximately 50% when taking into account all rig activities from spud to completion, including running casing tubing.

Trying to estimate the cost of this is not straightforward, but if 50,000 wells are drilled each year worldwide, ranging in day-cost from USD 135,000 on land to USD 450,000 for a semisubmersible, or a drillship at USD 1 million, then the average daily cost could be approximately USD 250,000. For wells that encounter trouble, the average time lost per well is probably approximately 6 days, which would give average downtime costs of USD 1.5 million for each well. Stuck drillstrings are one of the major contributors to drilling downtime, and a common cause of sticking downhole is a failed centralizer. A conservative estimate is that, annually, 400 wells worldwide (less than 1% of active drilling operations) are affected by centralizer problems, at a probable cost of 400 times USD 1.5 million, or USD 0.6 billion.

With downtime attributed to centralization problems reaching that amount, industry improvement in this area is essential. Centralizers are relatively

cheap, but when they fail because of damage, breakage, or simply getting stuck in hole due to insufficient fitting at the correct intervals, then they assume a consequential cost out of proportion to their price. Losses at this level would not be tolerated in other industries, such as the automotive, marine, or aeronautical industries. Why should the oil industry be different?

Most centralizer failures are caused by using an incorrect unit for the job. Every day someone, somewhere, is pulling casing and leaving debris in the hole for the simple reason that the wrong type of centralizer was used. The oil industry seems surprisingly tolerant of these failures.

Centralizers since the early 1950s have been of multipart design and construction, being either welded or interlocked and having hinges and pins to hold them together. That design has remained largely unchanged to this day. With vertical wells, this type of construction is ideal as the string is in tension and no radial loads are applied. However, these units were oversized to the borehole, had high start and drag forces, and were weak in restoring force. This type of centralizer is still a regular choice in the industry but it is the single largest contributor to downtime and overspend.

As the industry developed, and well trajectories and types changed, the demands on centralizer technology increased. Some wells now have extremely close tolerance casings, some are under-reamed, and many are horizontal. The gravity effects on casings in angular and horizontal wellbores have made radial and axial forces crucial factors.

The latest advances in centralizer technology center on single-piece, non-

welded units offering greater robustness that address the failings of multipart and solid-body centralizers. Unitary construction centralizers offer key benefits such as zero start force and zero running force, which reduce drag significantly. Reducing torque ensures that casings can be rotated without wear, in both cased and open holes, at a deeper level than before. The low profile of the single-piece centralizer improves the flow by area, reducing packoff and improving circulation.

The lower equivalent circulating density (ECD) signature allows the operator to pump at a slightly higher rate, which improves well cleaning, and the low torque aids rotation and minimizes stall-out, all of which contribute to improved cementation. Robustness ensures that both radial and axial loads are absorbed without deformation, while flexibility allows units to pass well tight spots, squeeze down, and then expand back to the original outer hole size.

Minimizing accidental loss in complex high-temperature/high-pressure, extended-reach, deep water, underbalanced, multilateral, or horizontal wells is challenging. So is running tubular strings to their required depth, and ensuring zonal isolation and annulus isolation. But all are vital to delivering good well-life-cycle productivity.

In tubular running, loss can result from not getting to the bottom because of friction or mechanical interference or getting packed off or stuck. In addition, poor cementation can result in production delays and early water entry directly attributable to incorrect tubular placement in the wellbore. These problems can be resolved by correct centralization.

Centralizer choice should be determined by the flow by area, desired

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standoff, well strength and geometry, zonal isolation required, and the degree of centralizer flexibility needed to traverse known formations, as well as an evaluation of start and running forces.

Under-reamed wells present particular problems. Most bow-spring centralizers will break if they have to locate in a hole of larger diameter than the casing they have just passed through. Modern wells are highly complex and run to increasing lengths. The preload of an oversize bow-spring centralizer results in an accumulative resistance that can prevent passage of the tubular to final depth.

A case study from a Brazilian field illustrates some of these points. The Bonito field in Brazil's Campos Basin is a carbonate reservoir located in 145 m of water. It has been producing oil for more than 25 years but recent oil recovery was low. In an attempt to improve oil recovery, a horizontal drilling project with selective stimulation was designed. Effective zonal isolation was essential to the stimulation treatments. Simulation showed that if 7 in. casing was run in a hole less than 9½ in., that ECD could become a problem. The 9½-in. hole was drilled, and cement was successfully circulated. The results showed that with proper planning, horizontal legs in excess of 2000 m, can be effectively isolated and then stimulated, allowing operating companies a better return on investment.

Two wells were cemented according to plan and full circulation was maintained, and an effective annular seal was achieved. The effectiveness of the annular seal was further proved when the wells were stimulated. The 10 selective stimulation treatments were pumped according to plan, indicating that effective zonal isolation had been achieved.

While some operators are concerned about running casing with centralizers attached, centralizers can actually help get the pipe to bottom when properly matched to wellbore conditions. In these two Bonito wells 126 and 127, centralizers were run in the openhole section. The ability to rotate a pipe can also greatly assist the mud-removal process. The pipe movement does not need to be fast to be effective, and in this case 6 to 10 RPM was helpful. **JPT**

reduce the generation of CO₂ and other emissions. Keynote Speaker Mohammed Al-Fodari of Kuwait Oil Company (KOC) discussed initiatives his company has implemented to reduce emissions in facilities, and highlighted that it has achieved a reduction in the amount of produced gas flared from just under 14% to 4.35% during 2002–2009.

KOC's Fatima Abdali then discussed the company's strategy for carbon management, saying that a pilot study is planned to investigate using CO₂ for EOR operations. She said that the first stage will focus on acquiring a source of CO₂ for the EOR trials, and that CO₂ capturing technologies for KOC's own processes has yet to be explored.

Optimization of energy consumption in plants was the topic of the next two presentations. Anne Rocher of Total said that plans for improving energy efficiency should commence during a project's conceptual stage with the inclusion of energy-efficiency indicators and multidisciplinary energy reviews that incorporate best practices recommendations. Energy efficiency plans for existing plants should include detailed benefits of the new plan, a thorough implementation plan, and an impact analysis for each site. Montaser ZamZam of Adco reiterated these points, adding that typical areas of energy waste for all plants should be clearly identified up front and that successful optimization of energy usage will only come with commitment from all players.

Waste Management

In addressing new developments in water treatment and oil recovery, Keith Robinson of Oil Plus reminded attendees of the driving forces for new water treatments, namely increasing water cuts, challenging new fields, tighter supplies of water, and more stringent environmental requirements. He highlighted the importance of advances in filtration system technology, particularly related to seawater nanofiltration for sulfate removal, seawater deoxygenation, and seabed treatment of injection water.

Ahmed Nabi Hasan of KOC reviewed his company's experience with bulk handling of treatment chemicals and outlined several benefits over handling of chemicals in drums. KOC has experienced a reduction in chemical exposure to individuals when moving chemicals in bulk, as well as less spillage, reduced

operating and disposal costs, and more streamlined chemical delivery logistics.

Dalal Al-Whaib of KOC discussed the latest health, safety, and environment (HSE) practices in the engineering and design phases of a project. She stressed that HSE issues must be captured at a project's earliest stages to avoid costly and time-consuming variation orders. Key issues to consider can include an environmental impact assessment; a risk management plan; a project behavioral safety plan; and studies on fire/explosion risks, noise effects, and smoke/ventilation factors. The major challenges to effectively managing these HSE practices at a project's initial stages include obtaining strict compliance from contractors, said Al-Whaib.

Ahmed Al Quraan of the Bahrain Petroleum Company presented his company's centralized sludge treatment facility as a cost-effective means to ensure compliance with stringent environmental regulations. The facility takes sludge from various oilfield sources and processes it to yield solids that are suitable for disposal in a municipal facility or landfill.

Plant Monitoring, Maintenance Strategies

Corrosion monitoring and mitigation in KOC was the topic of Hasan Sabri's presentation, in which he stressed the importance of both internal and external corrosion monitoring and corrosion mitigation measures that encompass material selection, chemical injection, coatings, and cathodic protection. Ghassab Fahad Al-Ajmi of KOC then reviewed the company's experience with risk-based inspection in process plants, stating that 20% of the plant equipment commonly carries 90% of the total risk.

The final presentation was a case study of Abu Dhabi Marine Operating Company's in-situ chemical cleaning technique for a heat exchanger at its Zakum West facility. Ramesh Nagarajan of the company said that significant fouling in the heat exchanger due to using seawater as the cooling media necessitated the cleaning job. An in-situ technique using carboxylic acid was chosen, which required fewer resources, provided less HSE risks, and was more cost-effective compared with conventional hydro-jet cleaning. To avoid the problem of fouling in new plants, the company will use air coolers. **JPT**