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DECEMBER 2020

ADDRESSING WELLBORE INSTABILITY FOR SAFER OPERATIONS

In Australia, wells are typically between 2,000 and 4,000 metres deep, but globally, wells beyond 10,000 metres are gradually becoming more common. These depths are demanding innovative measures to ensure the safety of operations in increasingly challenging production locations.

Drilling, the first step in constructing a well, presents a number of potential risks to well integrity. Mud weight is vital in maintaining well integrity before the casing is cemented. If the mud pressure is less than the formation pore pressure, formation fluid may enter the well. Uncontrolled influx of large volumes of hydrocarbons may lead to a blowout at the surface, which may in turn have a significant impact on the environment.

Low mud weight can also result in wellbore instability. While it is not a direct risk to well integrity in terms of containing and controlling the flow of wellbore fluids, the significantly enlarged wellbore may result in poor displacement of mud during cementing and therefore a poor quality cement sheath behind the steel casing, which may lead to loss of well integrity.

Wellbore instability can be a significant problem for oil and gas operators. Research has found that wellbore instability issues cost the oil and gas industry more than $500 million each year, and wellbore failures as a result of instability can account for over 40 per cent of all drilling related non-productive time.

The causes of wellbore instability are often classified into either mechanical (such as failure of the rock around the hole because of high stresses, low rock strength, or inappropriate drilling practice) or chemical effects which arise from damaging interaction between the rock, generally shale, and the drilling fluid. Often, field instances of instability are a result of a combination of both chemical and mechanical causes.

Regardless of the drilling techniques employed, if a wellbore is kept stable throughout, integrity issues of the wellbore are unlikely to occur during oil and gas production. Therefore, planning and executing drilling operations with wellbore stability in mind is the focus of many studies and a priority for drilling projects.

Due to the significant risks involved in wellbore instability, the industry is demanding improved systems for mitigating it. To maintain wellbore stability, it is essential to use a drilling fluid of appropriate density (mud weight) to control induced wellbore stress.

One method to control wellbore stability is to apply a wellbore shield which forms an ultra-low permeability barrier on the face of the formation. This thin, flexible shield minimises fluid and pressure invasion, quickly sealing pore throats microfractures to stabilise and strengthen the well.

The Alpha field, located offshore of Malaysia in a water depth of approximately 26 metres, has historically been classified as a 'high risk' drilling environment due to clastic deposition and unstable coal formations.

However, the operator implemented a process that stabilised troublesome zones and enabled the wells to be drilled with mud weight higher than the maximum density predicted by leak-off tests or formation integrity tests.

The process stabilised microfractures and mitigated many of the issues associated with wellbore instability. The use of a wellbore shield allowed the use of a higher mud weight which eliminated well influxes while concurrently achieving zero mud losses to the formation.

The technology delivered additional wellbore strength to weak formations, allowing the drilling operation to be completed as per plan.

As a result, the operator significantly reduced the challenges associated with lost circulation, stuck pipe, and well instability, thereby facilitating easier logging and delivering a quality, and less costly, producing well.

Operators are also examining their approaches to geomechanics to solve wellbore instability issues.

An operator in the United States planned to drill a horizontal well in an unconventional formation in which two previous attempts to do so had been unsuccessful.

Past campaigns in the region had resulted in wellbore instability issues and hole collapse due to weak rocks and insufficient mud weight.

The success of this horizontal campaign rested on making better-informed decisions that would mitigate instability, drilling risks, and geohazards while ensuring long-term production.

To gain a greater understanding of wellbore stability and to discover the safest mud-weight window, the operator requested a geomechanical evaluation for its planned trajectory in the shale play.

Collaborating with the operator, petrotechnical experts combined geomechanics data, a mechanical earth model (MEM), and wellbore-stability analysis with a depth-of-damage approach.

Recommendations were also offered on lateral landing targets to increase the chance of drilling a successful horizontal wellbore.

A previously drilled pilot well was analysed by creating a MEM that comprised a suite of log-derived rock mechanical properties.

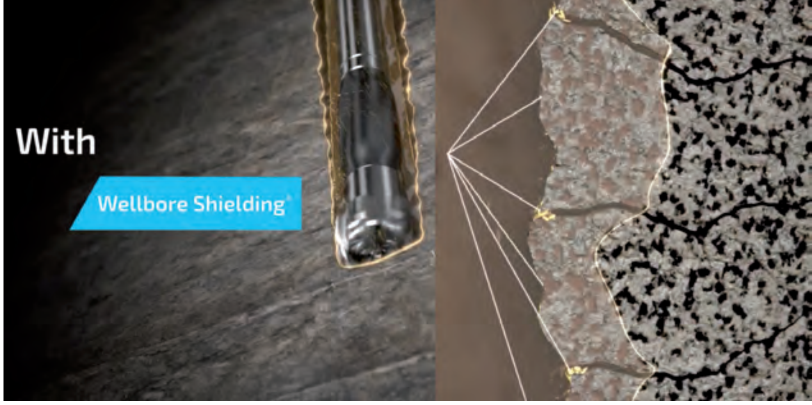
The MEM assisted the team in determining the in situ stress in the subsurface and the mechanical stability of the wellbore in the context of that stress state.

Wellbore stability analysis data helped calibrate the MEM by matching instability predictions with log-derived observations. The data was also used to determine the safest mud weight for optimal wellbore stability.

Sources: Report into the shale gas well life cycle and well integrity, Cameron Huddlestone-Holmes et al., CSIRO; Wellbore stability analysis to determine the safe mud weight window for sandstone layers, Darvishpour Ayoub et al.; Wellbore instability: Causes and consequences, Borivoje Pašić and Nediljka Gaurina-Medimurec; Stress, porosity, and failure-dependent compressional and shear velocity ratio and its application to wellbore stability, Jincai Zhang et al.; Simulation of Wellbore Stability during Underbalanced Drilling Operation, Reda Abdel Azim

PROFILE

Wellbore shielding technology prevents instability problems in Offshore Western Australia



Operators grappling with wellbore instability issues have sought to address them through a broad range of strategies. In conventional wellbore strengthening methods, for example, black powder and other lost circulation materials are added to the drilling fluid. Another approach is so-called 'stress caging', in which fractures are created and then sealed using specific concentrations of bridging agents. However, these tactics are typically reactive and often costly, requiring extra rig time and the management of multiple additives in the drilling fluid formulation.

Increasingly, operators are seeking ways to confront project-delaying wellbore instability problems before they occur. As this quest intensifies, an alternative, preventative approach—using Wellbore Shielding technology—was recently implemented for the first time in offshore Western Australia.

Wellbore Shielding technology is used in drilling fluids and spacer fluid systems where it generates a fast, effective seal, or 'shield', at the fluid-rock interface. This barrier against fluid and pressure invasion enables operators to successfully drill unstable, mechanically weak formations while mitigating losses. An important feature of this technology is its environmental compliance both in onshore and offshore environments. Wellbore Shielding technology has been used in producing fields around the globe, and most recently, in Australia.

OFFSHORE WESTERN AUSTRALIA CHALLENGE

A major operator was planning a drilling campaign consisting of four gas and condensate wells in the Carnarvon Basin offshore Western Australia. Drilling engineers identified a significant risk of seepage loss and differential sticking in the lower part of the 12¼-in. intermediate sections due to high permeability. Additional challenges included high wellbore angles (up to 72 degrees) and elevated temperatures (139°C/282°F). These conditions put the operator's advanced drilling tools, wellbore integrity and—ultimately—the entire campaign at risk. Adding to the complexity, any products deployed would have to meet the highest standards for ecological protection to fulfill the operator's Environmental Agreement.

WELLBORE SHIELDING SOLUTION

Impact Fluid Solutions worked closely with the operator and a local university to conduct extensive testing on Wellbore Shielding products alongside other potential solutions, including commodity blends and specialty products from various drilling fluid companies. The team found that Wellbore Shielding technology offered superior sealing capabilities for pores and microfractures, quickly forming a strong barrier over simulated thief zones to minimise both fluid invasion and pressure transmission. In addition, while Wellbore Shielding products are available in a range of particle sizes, only one was needed to achieve the required seal—rather than a blend of multiple products—improving ease of management at the well site. Wellbore Shielding technology also offers greater convenience due to its low specific gravity (around 1.5 g/cm3 or 12.5 lb/gal). As a result, the products do not add significantly to the fluid density or equivalent circulating density, or affect the rheological properties of the drilling fluid.

Wellbore Shielding technology was added to the non-aqueous drilling fluid at the recommended concentration for approximately 200 metres (650 ft) prior to entering the troublesome zone. This was achieved by bleeding over a concentrated pre-mix into the active system while drilling was ongoing. Using API 80-100 shaker screens, the operator was able to minimise the loss of Wellbore Shielding additive over shakers while keeping low-gravity solids to an acceptable level (around 5 per cent).

TECHNOLOGY RESULTS

The operator reached section total depth (TD) in all four wells with no differential sticking events, mud losses or non-productive time, despite recording an overbalance of more than 2,000 psi (13,800 kPa). The deployment of Wellbore Shielding technology had no adverse effects on the operation, the functioning of downhole tools or surface equipment such as the solids control system and cuttings dryer.

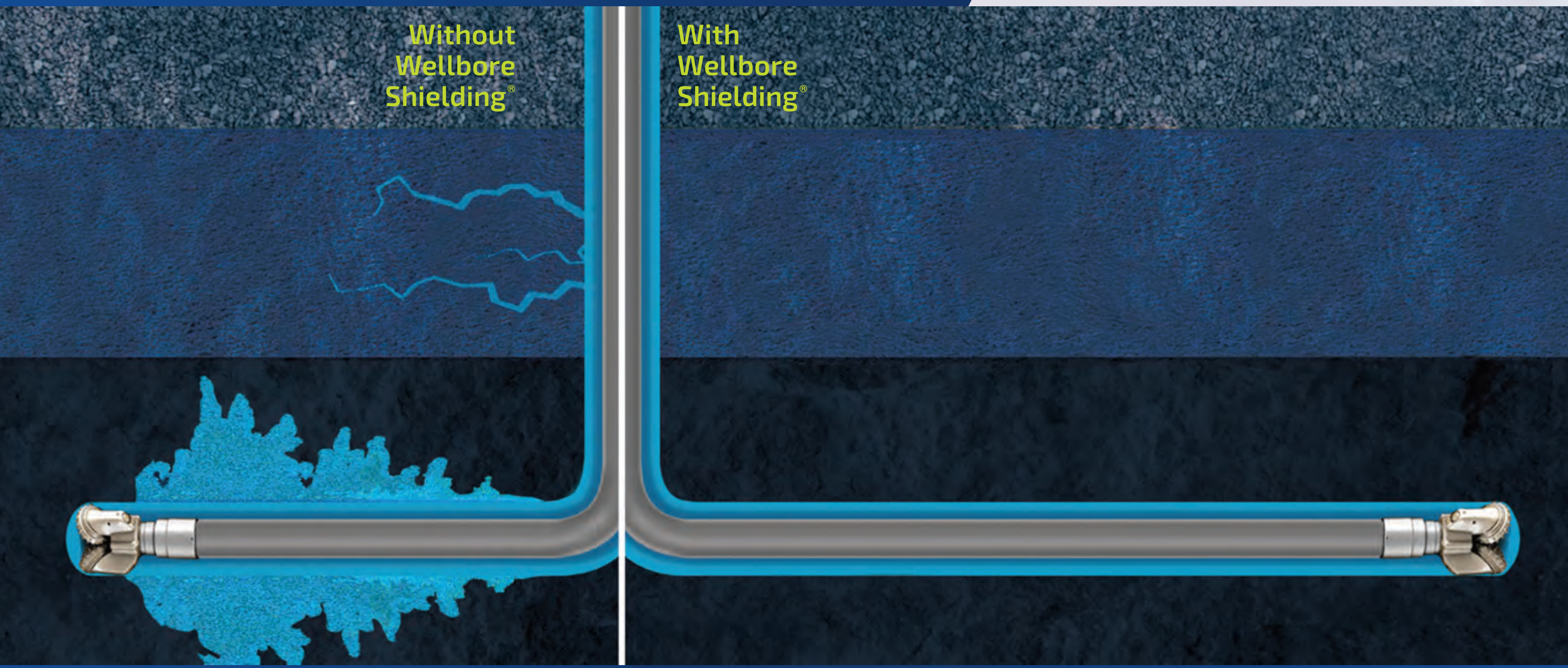
CONCLUSION

Reactive approaches to wellbore instability issues can be extremely expensive for operators, driving up costs through fluid losses and additional rig time. Further complications may include sidetracks, unexploited reserves, loss of wellbores and—ultimately—abandoned wells. Now operators can implement field-proven preventative solutions such as Wellbore Shielding technology instead. These products protect the wellbore to prevent problems before they occur in the face of a broad range of drilling challenges.

ADDITIVE PERFORMANCE. MEASURABLE RESULTS.

Best-in-Class Solutions for Complex Wellbore Challenges

Impact Fluid Solutions is a premier provider of specialty additives to oil and gas operators, fluid companies and oilfield service providers. By combining advanced chemistry with oilfield expertise, we deliver fluid solutions purpose-built to solve complex wellbore challenges-minimizing NPT and increasing ultimate recoveries. **We call that Additive Performance™**.



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