CLEARING THE RUNWAY

Sean O'Neill and Georges Ishak, Rubicon Oilfield International, USA, urge operators not to overlook basic concepts when addressing wellbore conditioning issues.

As operators around the globe continue to push the envelope in terms of step out ratios and horizontal lengths, the importance of basic drilling fundamentals often receives less emphasis in the quest for more powerful rigs, larger pump capacity, and innovative casing/liner deployment solutions. However, the reality is that sound drilling practices aimed at ensuring the delivery of a consistent wellbore are the foundation for extending the limits of step out ratios and lateral lengths.

A wellbore with ledges, doglegs, poor cuttings transport, key seating etc., is the equivalent of an F-18 Super Hornet trying to take off on an aircraft carrier with a hard deck riddled with speed bumps, pot holes, and debris. Although the carrier's catapult system has sufficient power to be able to still propel the plane forward, the forces subjected on the plane's tricycle landing gear will almost certainly cause the gear to fail before the jet ever achieves lift.

As it relates to the downhole environment, the removal of wellbore imperfections is akin to constructing as perfect a runway as possible for successful drilling, tripping, and deployment operations. Figure 1 shows a typical example of a properly conditioned wellbore vs a common wellbore with imperfections created by the bottomhole assembly (BHA). If the downhole runway is riddled with obstructions – particularly in the case of wellbores that aim to achieve greater step out ratios and horizontal lengths – not even the market's most powerful rigs or the industry's most innovative deployment solutions can always guarantee successful execution through rig release. While wellbore inconsistencies may not always end in non-productive time (NPT) or an equipment lost in hole event, not placing any emphasis on this issue will almost always result in slower tripping speeds and more time spent on casing/liner deployment. Fortunately, delivering a smooth downhole runway does not need to be a case of reinventing the wheel, as the industry has several proven solutions to address the variety of wellbore conditioning issues. That is not to say the following does not require an open mind and a willingness to revisit basic concepts.

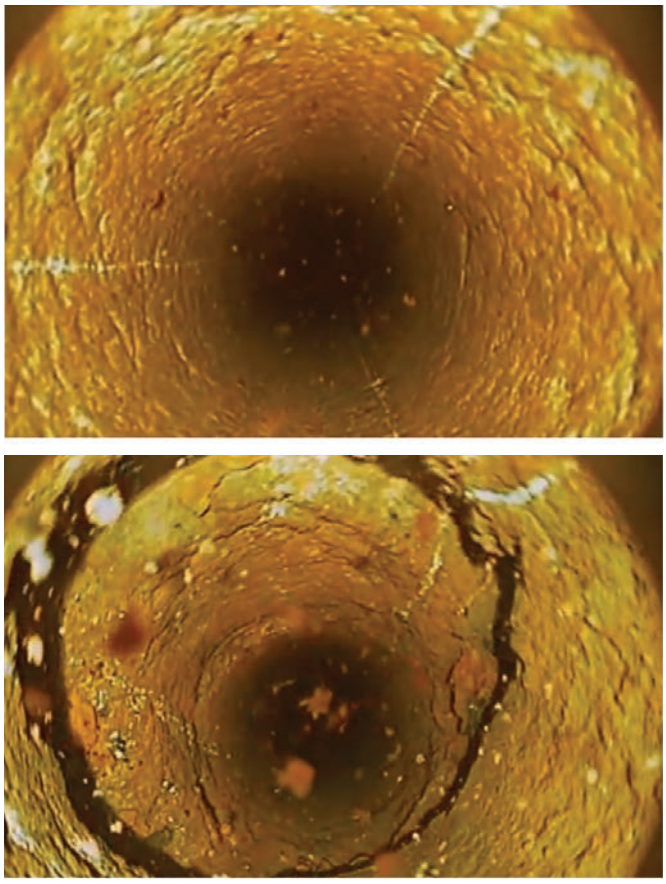

Figure 1. *Conditioned wellbore (top), common wellbore (bottom).*

Passive hole conditioning

Directional drilling assemblies, both conventional bent motor and rotary steerable system (RSS), can create a variety of these inconsistencies in the wellbore, such as ledges, spiralling, key seating, and micro doglegs. These inconsistencies will potentially increase torque and friction values, which can have a major impact on drilling performance, including decreasing the rate of penetration (ROP). In addition, ledges can potentially lead to stuck pipe events while tripping in or out of the wellbore, especially in the curve or build sections. During tripping operations, it is a common occurence after reaching total depth (TD) that the drill string will become hung up on ledges that were formed while drilling ahead, particularly around the curve section. Incorporating a passive reamer into or above the BHA provides the simplest and often most economical solution to remove many of these inconsistencies. Passive reamers, or more appropriately 'smart stabilisers', provide the same benefits of the stabilisers already in the drill string while at the same time proactively managing wellbore imperfections to create a smoother runway for drilling, tripping, and deployment operations.

The GunDRILL Reamer, a solution provided by Rubicon, is a 'smart stabiliser' design sized an ⅛ in. to ¼ in. undergauge to the wellbore (Figure 2). The bi-directional tool is designed with a combination of tungsten carbide inserts (TCIs) across each blade's gauge and PDCs that provide a passive cutting action only when engaged with wellbore inconsistencies during drilling or tripping operations. The TCIs protect the blade gauge, but also provide a continuous conditioning action of the wellbore.

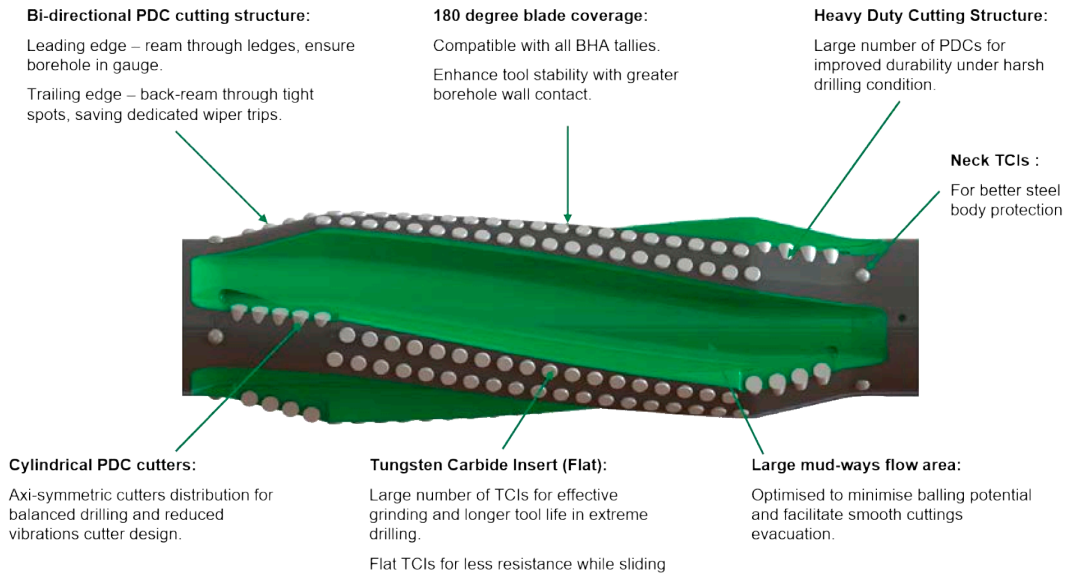

Figure 2. *GunDRILL Reamer.*

The PDCs on the leading edge of both the upper and lower blade taper, and only engage the wellbore when inconsistencies become restrictions to the drilled diameter of the hole.

Put simply, if the well being drilled has perfect wall conditions – by which to say there is no tortuosity, ledges, spiralling, key seating, etc. – the reamer acts only as a standard stabiliser. Just like a standard stabiliser, its blades provide centralisation of the BHA. In contrast to a standard stabiliser however, the reamer has TCIs on the gauge that provide the added benefit of constantly conditioning any tortuosities generated by unstable downhole conditions (Figure 3). When more aggressive wellbore conditioning is required, the PDC cutting elements on the leading and trailing edge of each blade will engage and shear the formation back to full gauge diameter. The result is a smoother wellbore condition. While there might be a slight increase in localised torque while the PDCs are engaging a ledge, the proactive removal of these larger inconsistencies results in a decrease in overall torque. In practice, this improvement in hole quality translates into a reduction in the coefficient of friction, which improves weight transfer and provides higher ROP and increased tripping/ deployment speeds.

A final consideration to be remembered in the selection of smart stabilisers is ensuring an integral blade design that maintains line of sight junk slots between blades. The importance of this feature ensures consistent flow by area across the tool for unobstructed cuttings transport to surface.

Active hole conditioning

When hole conditioning beyond passive solutions is required due to mobile, over pressured, fractured, or reactive formations, an active conditioning solution may be necessary to ensure the risk of a stuck pipe event is mitigated during drilling, tripping, or deployment operations. The challenges these formations create are often time-sensitive and while reaching planned TD may be accomplished without difficulty, merely passively conditioning the hole may not provide enough certainty to accomplish tripping and casing running operations before a restriction occurs due to formation instability. Specifically in the case of drilling BHAs and many completion systems, the larger outside diameter components in these assemblies often become the source of concern. If either the drilling BHA or completions assembly become stuck, it can lead to significant NPT and in a worst-case scenario the potential for lost equipment downhole.

For applications requiring minimal enlargement of the wellbore, the running of an eccentric style reamer is the most economical solution to actively enlarge a wellbore by 1/16 in. up to a full ¼ in. The Eccentric GunDRILL Reamer (EGDR) provides the same PDC and TCI features on the company's smart stabiliser design, with two key alterations. The first is an offset blade design that allows for enlargement of the wellbore while ensuring the tool can still drift through the upper casing string. The second is the PDCs are not limited to the leading and trailing edge of the offset blade profile as they now trace the entire leading profile of the blade.

Conditioned wellbores can still be a bumpy ride

When drilling through inter-bedded formations or environments laced with hard stringers, the priority often becomes introducing a vibration mitigation solution that is more focused on stabilising the BHA than on conditioning the wellbore. Sealed bearing roller reamers can significantly improve operations where torque management difficulties cause increased downhole vibration, stick slip, or bit bounce. The three evenly spaced cartridges maintain consistent contact with the wellbore to mitigate these issues. This is accomplished by centralising the BHA through using the three evenly spaced cartridges. This is critical in controlling unplanned trips and equipment replacement costs due to damaged downhole electronics or drill bits damaged beyond repair. It is important to focus on the word 'sealed', as best practice now recommends the use of sealed bearing roller reamers and not open bearing designs. Because of the costly implications of losing a roller reamer cartridge in the wellbore, several providers in the industry have developed

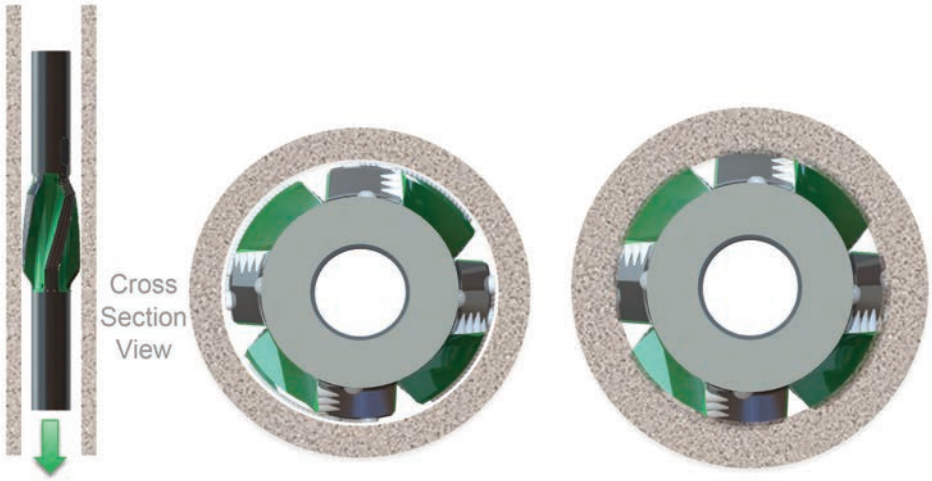

Figure 3. *Cutting structure engagement.*

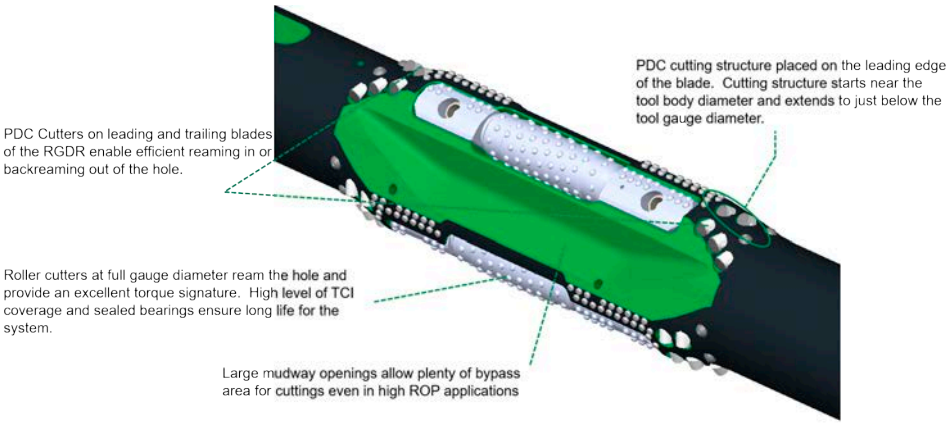

Figure 4. *Roller GunDRILL Reamer.*

redundant retention mechanisms to ensure roller cartridges cannot fall out of the tool unintentionally. With the application of these sealed bearing designs, the occurrence of a lost cartridge has become incredibly rare. For example, Rubicon's sealed bearing roller reamer, the TorqAVENGER, has sealed bearing cartridges with a triple redundancy retention system.

High vibration high torque – wellbore conditioning solutions

For applications where high vibrations, stick slip, or high torque fluctuations are an issue in conjunction with significant wellbore imperfections, the industry has developed proven sealed bearing roller reamer technology with the passive reaming features of a smart stabiliser to properly condition the wellbore. One such tool is Rubicon's Roller GunDRILL Reamer, which offers the vibration, stick slip, and torque mitigation benefits that a sealed bearing roller reamer provides while incorporating the PDC cutting structure (Figure 4).

The PDC cutters on the leading and trailing shoulder work in the same manner as the PDCs on passive and active fixed blade reamer designs to remove wellbore inconsistencies. The difference is the integral blades with TCIs on the gauge have been replaced with three sealed bearing cartridges that maintain consistent contact with the wellbore. Above and below the cartridges the tool integrates a passive PDC cutting structure that provides the heavy lifting when cutting action is required for large ledges.

Placement

When adding a reamer to a slick BHA or replacing stabilisers in a packed assembly, ensuring placement is optimised is as critical as selecting the right solution. Removing uncertainty regarding tool placement, and so ensuring it does not detrimentally impact the operation, can be attained by using the latest application engineering modelling software. One of several areas to focus on is modelling the bending moment of the BHA to confirm the tools' mechanical limits will not be exceeded.

When choosing a hole conditioning solution it is also important to compare the build/turn rate tendencies vs the previous BHA to ensure the directional control is not significantly altered.

The latest modelling software options available to the industry come preloaded with baseline behaviour of the BHA in static conditions, which then allows the inputting of several of the external variables listed below that are acting on the BHA. While modelling can provide insight into the anticipated real-world environment, the closer the downhole inputs are to the actual downhole conditions, the closer the modelling will be to accurately predicting downhole performance. The following is a list of what should be considered the minimum parameters to make modelling a worthwhile exercise:

- Inclination angle – which section of the wellbore is of most concern for modelling.
- Weight on bit (WOB) – both on surface and estimated actual on bottom.
- Mud weight and type.
- Friction factor (this can be determined from friction factor calibrations done from offset wells using torque and drag modelling).
- Bit steerability and bit walk (bit and formation characteristics are expressed using these two parameters).
- Hole gauge – at gauge, over or under (based on previous data, caliper logs, offset wells etc.).

A final consideration regarding placement is that the wellbore conditioning solution selected will likely take on the brunt of back reaming operations. The benefits of having a bi-directional tool capable of back reaming in the string far outweigh any of the drawbacks it introduces; however, the entire drilling team must be cognisant that most of the stress during back reaming is now higher up the BHA and localised on the hole conditioning tool. Exceeding safe revolution per minute (RPM) speeds during back reaming operations creates a high risk of backing off a connection at the reamer. To mitigate this, a prudent practice is to request back reaming ROP guidelines, which the tool provider should be able to provide based on modelling. Figure 5 depicts one such example of very simple to understand safe vs unsafe RPM guidelines while back reaming, which could be easily printed to be displayed by the drillers' console.

Conclusion

Although not as visually impactful as seeing a fighter jet take off from an aircraft carrier, extended reach drilling (ERD) wells are a modern engineering marvel that require a balanced approach of seeking out the latest technology while never forgetting the importance of basic drilling fundamentals. By remembering to always be excellent at the basics, such as wellbore conditioning, the likelihood of repeatable success is maximised. Working with a technology partner, such as Rubicon Oilfield International, that provides operators with a holistic 'fundamentals first' approach to downhole products ensures money is not wasted chasing 'silver bullet' solutions. After all, what benefit comes from buying stronger landing gear if there is still no proper runway?

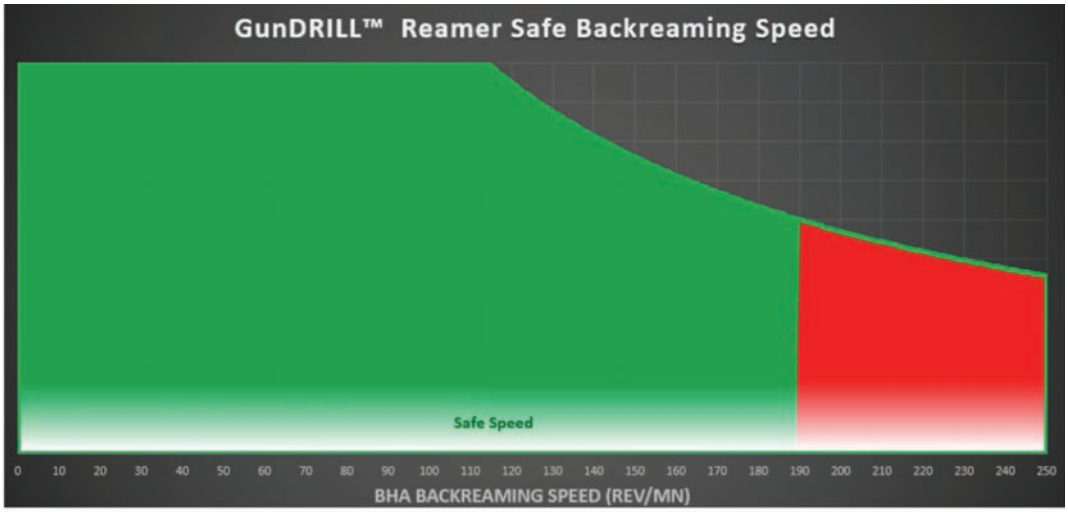

Figure 5. *Backreaming RPM guidelines.*