

SEEING THE FOREST FOR THE *trees*

DAN DALL'ACQUA, AND BRAD KWASNYCIA, VOLANT, CANADA, REVEAL HOW CENTRALISER SELECTION AND OPTIMISED PLACEMENT CAN IMPACT COMPLETION COSTS ON EXTENDED REACH WELLS.

Longer and more challenging extended reach drilling (ERD) wells are becoming more commonplace in an industry focused on maximising reservoir production. With this focus comes an associated desire to drill and complete these wells as economically as possible.

While efficiencies and advancements in rig technology and downhole tools have enabled faster drilling, the increasing complexity and lengths of these wells has introduced additional casing running challenges, resulting in more time spent on completion activities. Finding ways to improve run-ability in these types of wells is the key to shortening run times and unlocking the significant cost savings operators are searching for.

While there are many factors that can contribute to casing string run-ability, an often-overlooked variable is the impact of centralisers in the horizontal and build sections of ERD wells. The traditional view of centralisers as a tool for providing borehole standoff, while still important, does not fully address the casing running challenge or efficiency opportunity that they may create. In extreme cases, improper centraliser implementation has been shown to cause running challenges during well construction that considerably increase non productive time (NPT) and drive up

the overall costs of completing the well. Operator adoption of practices that focus on how to avoid or mitigate these challenges by application-specific selection and placement of centralisers can counteract this effect, enabling higher confidence in reaching target depth (TD) with lower NPT and hence significantly reduced overall completion costs.

Volant has been working closely with Operator D&C teams to ground-truth and evolve an applications engineering method for its robust rigid-body centralisers that combines application specific pre- and post-run torque and drag modelling and interpretation with a centraliser placement strategy for minimising drag, particularly in high-compression situations typical of longer-reach wells. This technically founded approach is designed to help overcome common industry casing and liner running challenges and has, in some cases, significantly reduced the costs associated with completing each well.

Case study

The clearest demonstration encountered thus far of the value gained (time saved) through an appropriate application-specific centralisation strategy occurred in a challenging US onshore (Bakken) shale application. The operator was having challenges running 4 1/2 in. liner in an extended reach well, particularly in the last 2000 ft. Along with significant buckling-related running challenges, the customer was using a composite rigid centraliser that was breaking apart downhole. By replacing the composite centraliser product with a one-piece steel centraliser and coupling it with an

appropriate centraliser placement strategy, the customer was able to reduce liner running time on an offset well by more than half of the previous run: 39 hours compared to 91 hours, a 57% reduction in run time.

The supporting evidence in this case, and many others since, show that a holistic view of casing running costs should be adopted and that it is appropriate to focus on the net benefit of practices and equipment that can reduce the overall number of NPT incidents and better equip operators for subsequent wells. This means factoring reduced NPT likelihoods



Figure 1. Volant HydroFORM™ centralisers are manufactured using hydroforming technology that utilises high pressure water to precision form tubular steel into a variety of customisable shapes and profiles.

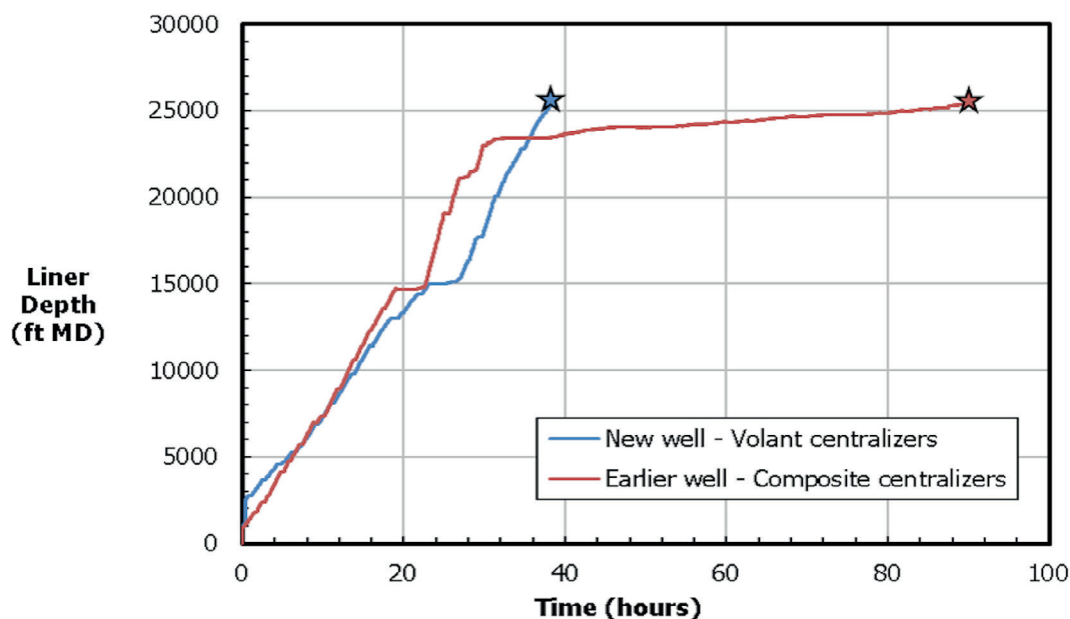


Figure 2. Liner run time saved on an ERD well after switching to the HydroFORM centraliser and using an optimised placement strategy.

into the cost equation, in addition to the original material (centraliser) costs.

Cost-benefit equation for centralisers

In a traditional standoff-based view of centraliser products, it makes sense to consider the cost of the tubular consumable product prominently in the selection process, particularly if multiple product options are available that can reliably meet the application need. However, this strategy can quickly break down if an application demands increased functionality from the product, or if a failure leads to unplanned costs that far exceed the material cost savings available.

For centralisers in extended reach wells, industry is venturing into a new area. There is an increasing need for centraliser products that will reliably enable operators to install their casing and liner strings farther than ever, and at the same time have the ability to withstand harsher running conditions. The cost-benefit equation of equipment and service options that enable successful casing and liner runs needs to be revisited with a perspective that clearly includes the factors that have changed. This requires vision, and having to quantify and work through uncertainties and challenges along the way is to be expected.

Volant's perspective is that there are four fundamental factors that must be considered as centralisers are selected and configured:

Product functional requirements

It is important to identify what is expected from the product in service, and to use the right centraliser for the right application (and at the right points in the well).

Product installation robustness

Centralisers must withstand the rigours of installation and must be intact once TD is reached to provide required standoff.

Local friction management

As the centralisers will generally be a primary contact point between the casing string and formation, friction between the centraliser and the borehole contributes to running resistance.

Global friction management

The factors that govern whether a string will reach TD smoothly are complex, and go beyond the cumulative effect of local friction at each contact point. This is the area that currently poses the largest challenge and the largest opportunity for advancement.

By considering each of these factors, the industry can more readily identify components that must be treated with care, as the frontiers of ERD casing running are pushed, and pinpoint factors that offer the most cost saving opportunity.

Product functional requirements

Centralisers are traditionally used to achieve pipe standoff from the borehole wall, and also have some performance requirements that should be considered in the selection process:

- ▶ Standoff is the most obvious parameter, and a range of product solutions (bow spring, rigid, semi-rigid) is available. Standoff should be considered in the in-situ loading condition, which demands estimates of the amount of side force being applied to the centraliser, centraliser lateral compliance, and pipe sag between centralisers.
- ▶ Coverage, contact area, and rib shape are parameters that are associated with the design of the centraliser and how it interacts with the borehole wall or casing. Interactions between the centraliser and the borehole, particularly in the open hole where cuttings beds may exist and where contact stress between



Figure 3. HydroFORM centraliser used in an extreme liner drilling application that required multiple trips. In this crimp-on application, the string had an accumulated running distance of 65 870 ft and over 41 000 revolutions, with the entire lot of installed centralisers remaining intact. Wear on the centraliser ribs measured less than ¼ in. on OD, or less than half of the original wall thickness.



Figure 4. Volant's radial tubular forming (RTF) tool used for crimping centralisers, stop collars and wear bands to casing and liner strings.

the centraliser and formation may cause indentation, can influence local friction during running.

- ▶ Open flow area around the centraliser must generally be considered to ensure the pressure losses along the annulus do not limit flow or create downhole pressures that inadvertently fracture the formation during circulation or cementing operations. Sufficient open area will also minimise the potential for cuttings to pack off in the annular space.

Product installation robustness

In ERD wells, the distances travelled by centralisers under severe side loading against competent formations can lead to significant surface wear potential. Clear examples of retrieved strings indicate there is merit in selecting wear-tolerant centralisers. Cost savings offered by less wear-resistant options should be weighed against the potential for failure and the associated implications to centraliser function and the overall cost of the casing run.

Robustness evaluations should consider:

- ▶ Wear anticipated for the overall travel distance to TD. Wear of the centraliser may compromise standoff and run-ability.
- ▶ Integrity of the centraliser as a whole during harsh running conditions. Simply put, damaged centralisers can increase local friction and cause challenges in reaching TD.
- ▶ Application factors that increase wear potential. For instance, centralisers used in casing drilling applications can be expected to undergo much more severe surface wear, and will benefit from surface treatments (such as hard-facing) that diminish wear rates.

Local friction management

Friction coefficients between centraliser contact surfaces and the borehole or surrounding pipe ID are often the focus of centraliser product literature. Since contact surfaces on centralisers are subjected to high loads, harsh conditions that lead to wear, and will tend to interact with cuttings beds and the formation in the open hole section, centraliser shape and borehole quality should also be considered. While there is merit in considering reductions in the drag force on a given centraliser by minimising surface friction coefficient, true benefits offered by 'low friction' options should be established through field evidence.

A second important consideration is the management of friction in situations where rotation is used to enable casing and liner strings to reach TD. Affixing centralisers to the outside of the string (through mechanisms such as crimping or set-screws) allows rotational motion to occur at the centraliser/borehole interface, creating a more favourable axial friction condition that enables forward progress. In the limit, a centraliser that rotates freely on the casing string may simply act as a sleeve if the string is being rotated from surface, providing no benefit to forward progress.

Global friction management

Many of the factors identified above are common to more conventional horizontal well technology, and can be considered in the same light for ERD wells. However, the largest centraliser-related opportunity for technological

advancement in these types of wells clearly rests in the management of casing string mechanics as the string is pushed towards TD from surface. Compression in the casing string, particularly in the heel section of the well as the string approaches TD, creates higher potential for sinusoidal and helical buckling than in shorter wells. Even with local friction reduction measures, this situation should be anticipated, and if possible, addressed with a buckling-tolerant design.

Traditional torque and drag (T&D) models provide a mechanism for predicting the onset of buckling and its associated implications on drag; this work is continuing in the academic community, with a focus on more accurate estimation of T&D behaviour. Volant has advanced its understanding of the impact of centraliser spacing on sinusoidal and helical buckling mechanics, specifically in the context of side loads that are generated from the buckling behaviour. Proper centraliser density, particularly in high-compression zones of the string, can mitigate buckling-related side loads and associated drag forces. Centralisers will not prevent buckling, but they can be used to limit the side load associated with a particular compressive force, reducing the overall drag. This is the foundation for the company's centraliser placement strategy.

The company considers it mission-critical to ground-truth the benefit of its placement strategy through field application, and has been actively doing so over the past three years. Volant performs T&D modelling before and after ERD runs to both calibrate its placement basis and to enable a better understanding of risk. As a result, operators have had fewer surprises, learned from challenging wells, experienced lower overall costs, and enjoyed the benefit of higher reliability in reaching TD.

Summary

Successfully reaching farther with ERD well design requires attention to all aspects of the well construction process, and designing the well with an appropriate strategy for centraliser selection and placement is no exception. Industry stories of centralisers degrading downhole and hampering casing installation are common and lead to significant amounts of NPT for operators. While it is easy to look at the cost of centralisers and elect to use the most inexpensive option as a means to cut material costs, one must be careful this is not done at the expense of additional rig time spent to overcome inadequate product performance. In most cases, very few hours of rig NPT need to be saved to offset the cost of selecting an application-appropriate centraliser solution.

Well-conditioned centralisation strategies can significantly improve the chances of successfully reaching TD in ERD casing and liner installations. In addition to improving run-ability of existing string designs, understanding the positive impact of coupling the right centraliser product with an optimised placement strategy can reduce completions costs by saving time, and may enable operators to drill farther with the confidence that they will be able to successfully complete those longer wells. ■