

Case study: Haynesville shale, North America

Versa-Drive milling service proved versatility in three cases, saved rig time, costs

The **Versa-Drive™ extended-reach milling service** from Baker Hughes leverages coiled-tubing-conveyed milling solutions and extended-reach technologies to reliably remove plugs from long horizontal wellbores. Built on technologies and procedures honed in the shale formations of North America, the service offers proven capabilities for reaching total depth (TD) reliably, and is ideal for plug milling in all formations.

In most operations, the Versa-Drive service deploys in a bottomhole assembly (BHA) featuring a **Navi-Drill™ X-treme™ workover motor**, a mill dressed with **Advanced Milling Carbide (AMT)** such as **Glyphaloy®**, a **Vanguard™ plug drillout bit**, and an extended reach tool. To enhance safety, improve efficiency, and increase the certainty of success, the **CIRCA™ Real-Time (RT) modeling software** is often incorporated.

But no matter the configuration, challenge, or environment, the Versa-Drive proved itself a versatile technology, as the following case histories validate.

Haynesville shale

A customer in the Haynesville shale drilled a lateral well, completing it with 4 ½-in. casing. The lateral was horizontal at 90°, over 10,000 ft (3048 m) long, with 82 plugs deployed. A plug and perforate fracking operation was conducted. During

the subsequent plug milling, the customer encountered friction lock-up with coil tubing at 19,604 ft (5975 m). With the target depth at 23,035 ft (7021 m), 30 plugs remained in the completion. A competing oilfield service company attempted to reach the target, but failed.

The Versa-Drive service milling BHA was run in hole to the previous final depth. It then successfully continued in hole while increasing the pump rate by 0.6-bpm and staying at the same pressures seen by the previous BHA. The increased flow rate improved additional hole cleaning and lifting debris to the surface while avoiding additional wear and charges on the coil.

After exceeding the previous depth achieved by the competition, Baker Hughes continued to mill the remaining 30 plugs starting from a depth of 21,577 ft (6576 m). When the final plug was successfully cleared, the BHA continued through the uphill horizontal to a final depth of 23,035 ft (7021 m), exceeding the customer's expectations. The cuttings generated were small, and contributed to easier well cleanout.

By using the Versa-Drive plug milling service, the customer was able to complete the well 3,000 ft (914 m) deeper than another competitor, providing the customer 31 additional stages of production clear of plugs and debris.

Challenges

- Mill remaining 30 plugs in 10,000 (3048 m), 90° horizontal lateral in Haynesville Shale
- Remove 86 composite frac plugs from well in Permian Basin with MD of 22,954 ft (6996 m)
- Mill 175 composite frac plugs from 4 wells in the Niobrara formation in Colorado

Results

- Surpassed last achievable depth of the competition by 3,432-ft. in the horizontal Haynesville shale
- Milled all plugs in Permian Basin in a single trip with one BHA, saving 24 hours rig time, and reduced costs by USD \$100,000
- Saved 40 hours per well in Colorado from not conducting second trip, realizing a total savings of \$250,000
- Encountered zero HSE issues

Permian Basin

A customer in the Permian Basin had drilled and completed a well with 86 composite frac plugs in 5 ½-in., 20 lb/ft casing at a total vertical depth of 9,300 ft (2834 m). The proprietary plugs were spaced evenly throughout the wellbore, going as deep as measured depth (MD) 22,954 ft (6996 m). Using conventional technology, milling out 86 plugs—17 more than the customer's standard operation—typically required conducting a second trip to replace motor and mill. The customer sought a more streamlined operation and contacted Baker Hughes for a solution.

The Versa-Drive BHA successfully milled all 86 composite frac plugs in one run. The average milling time was 8 minutes per plug with a flow rate ranging from 4.00 to 4.25 bpm over the entire 81.25-hour operation.

By using the Baker Hughes Versa-Drive plug milling service with the Vanguard plug bit, the customer saved 24 hours of operational time, equating to approximately \$100,000 USD. The single-trip run was completed safely, experiencing zero health, safety, and environmental (HSE) issues.

Niobrara Basin

A customer in Colorado drilled and completed a pad in the Niobrara formation with four wells and 5 ½-in. casing. The laterals were 2-mile horizontals and plugged and perforated with a total of 175 composite frac plugs. The most in one well was 47 plugs. After successfully fracking, Baker Hughes was called to conduct the final drillout in an efficient and reliable manner.

The Versa-Drive BHA was deployed and all four wells were successfully milled out in single runs. The average mill times were 4 minutes with a flow rate 5.25 bpm. The entire operation

encountered only a single stall. By using the Versa-Drive plug milling service, the customer saved 40 hours per well and approximately \$250,000 USD.

With the ability of Baker Hughes to reach final depth reliably, the customer changed from dissolvable to less expensive composite plugs. Further savings were accomplished on coil charges because of the limited stalls.

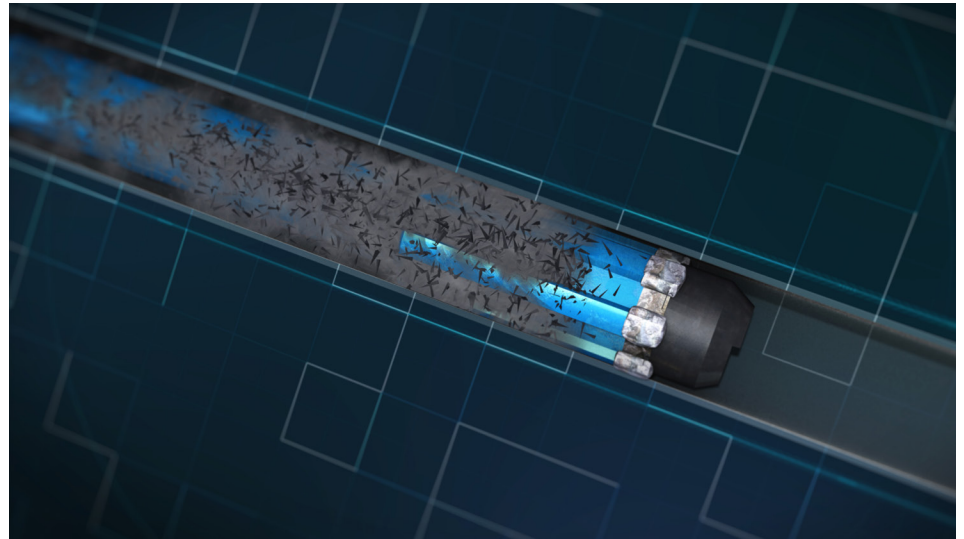
Validated technology

By selecting the Baker Hughes Versa-Drive extended-reach milling service, three operators in different environments overcame challenges where conventional technology proved insufficient.

Customer expectations were surpassed in all cases, reaching greater depths, milling more plugs, reducing rig time and associated costs, all with zero health, safety and environmental (HSE) issues.



Advanced milling technology cutters can achieve greater efficiency and longer runs with cutting and milling systems used for casing exits, wellbore intervention, and other milling applications. The durable technology increases milling penetration rates, extends effective time on the bottom in high-volume milling applications, and enables greater flexibility during the milling process.



The Baker Hughes Versa-Drive milling solution is ideal for removing frac plugs in multi-stage completions with faster mill-out times, small debris generation, and extended-life performance unrivaled in the market.

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