Innovative Drillbit Design Increases Average On-Bottom ROP by 39% and Saves PDC Energy 7.5 Rig Hours

Three-blade StingBlade bit with utility gauge pads improves ROP, steerability, and toolface control in Niobrara Shale vertical and curve drilling application

**CHALLENGE**

Improve ROP in a vertical and curve section drilled in soft sandstone while maintaining toolface control and buildup rate (BUR).

**SOLUTION**

Deploy a three-blade StingBlade* conical diamond element bit with utility gauge pads to improve drilling and hydraulic efficiency as well as stabilization.

**RESULTS**

- Increased overall on-bottom ROP by 39.2%.
- Decreased average footage required to slide by 30.6% per well.
- Demonstrated enhanced BUR capability and toolface controllability compared with the baseline drill bit.
- Saved PDC Energy 7.5 drilling hours.

**Enhance vertical and curve drilling in soft formation**

Like most operators in the Denver-Julesburg basin of northeastern Colorado, PDC Energy is drilling horizontal wells targeting the Niobrara Shale. The formation above this target comprises sandstone and shale with unconfined compressive strength of less than 6,000 psi [41.4 MPa]. In the soft environment, instantaneous ROP can climb higher than 1,000 ft/h [305 m/h], and bit balling is a common performance limiter.

In previous wells drilled in the area, PDC Energy and other operators used bits with five blades and 19-mm PDC cutters. Regardless of the drillbit vendor, five-blade bits delivered suboptimal ROP because the design’s high quantity of cutters limited the depth of cut and its limited open-face volume and junk-slot area decreased formation evacuation efficiency.

The plan for PDC Energy’s well included a 12¾-in surface section, 8¾-in intermediate vertical and curve section, and 6¼-in lateral. The intermediate interval was drilled in a single run with a steerable positive displacement motor (PDM). For the intermediate interval, PDC Energy sought a new drillbit solution that would increase drilling efficiency and overall ROP potential while maintaining durability to complete the interval and achieve the 8°/100-ft curve.

**Customize a new StingBlade bit design with enhanced features**

Smith Bits engineers recognized that StingBlade bits, which feature 3D-geometry Stinger* conical diamond elements across the bit face, would help PDC Energy enhance bit durability without decreasing ROP in the soft formation. To meet PDC Energy’s ROP objectives—and to push the boundaries of StingBlade bit performance—the engineers designed the bit with three blades instead of five, the standard for conventional PDC bits commonly used in the area.

This design would increase ROP in two ways. Fewer blades means fewer PDC cutters, which would increase the depth of cut for a given WOB. Additionally, the three-blade design increased the face volume and junk-slot area for mitigating the ball-up tendencies occurring with five-blade designs at high ROP.
Successfully drilling the section with a three-blade PDC bit would not have been feasible because PDC cutters lack the durability required to drill the section footage in one run. Stinger elements, however, enhance bit durability by enacting an ultrahigh-concentrated point load to fracture the formation more efficiently compared with conventional PDC cutters. The elements also feature a thicker diamond layer, enhancing impact strength and wear resistance.

Two utility gauge pads were added to the StingBlade bit design to enable sustained steerability and drillbit control. This engineered bit design would deliver the durability, stabilization, and hole-wall contact advantages of a bit with five blades while achieving the ROP of a three-blade bit.

**Achieve toolface and BUR capabilities while improving ROP**

The three-blade StingBlade bit with utility gauge pads has been run by PDC Energy on 21 wells to date. Compared with the baseline conventional five-blade PDC bit runs, the new bit has reduced interval drilling time by 10 hours on average, a 24% decrease. The new bit has also decreased bit-related drilling failures and increased TD rate by 11.3%.

Two wells drilled on the same pad with the same BHA and steerable PDM design were more closely analyzed to quantify the performance differential in both rotating and sliding modes.

Overall on-bottom ROP of the second well drilled with the new bit increased by 39.2%. Average on-bottom ROP while rotating increased by 22.6%, more than the finite-element-analysis-based cutter-rock interaction model predicted, because of bit-balling mitigation. Additionally, sliding footage required per well decreased by 30.6% (275.3 ft), and average on-bottom ROP while sliding increased to 21.4 ft/h, or 23.9%.

These metrics indicate that the BUR and toolface capabilities of the new three-blade StingBlade bit with utility gauge pads are improved compared with the baseline conventional five-blade PDC bit.