Improving Drilling Performance in East Texas Haynesville Shale

A fit-for-basin bit design improves ROP by 69%, reducing rig time and associated costs.

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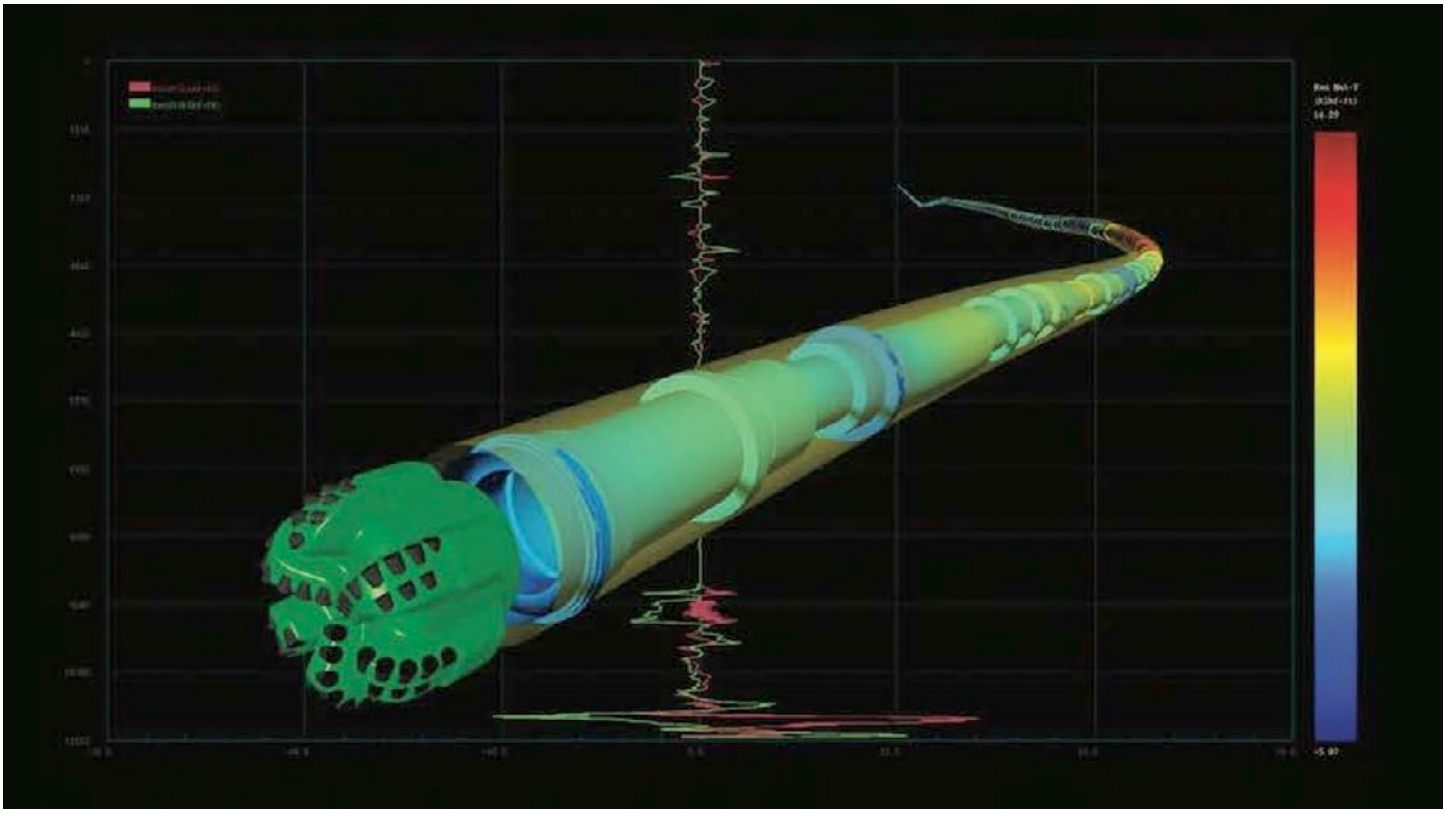

A virtual bit design is depicted in the integrated dynamic design and analysis platform. *(Source: Schlumberger)*

The Haynesville Shale offers great potential, but there are also many challenges both on the drilling and completions side. With respect to drilling, the impact-prone formation characteristics of the play, comprising interbedded limestone, anhydrite, shales and sandstone, significantly affect ROP, thus increasing time on hole.

Even with recent technological advancements, horizontal wells in the Haynesville Shale can cost anywhere between $7 million and $12 million, depending on lateral length, rig costs and several other factors. While many strides have been made on the completions side to drive costs down and improve well performance and economics, drilling advancements that significantly increase ROP and reduce rig time have remained relatively stagnant for the better part of the last decade.

Challenging drilling application

Rockcliff Energy is an independent operator focused on developing the East Texas Haynesville Shale. In

the Carthage Field, Rockcliff was encountering several challenges when drilling their 9 7/8-inch sections. The application required drilling through 14 distinct formations with varying lithologies, unconfirmed compressive strength (UCS) ranges, impact and abrasion. The Travis Peak Formation, just over halfway through the section, was the most difficult portion due to higher UCS values, heavily abrasive sandstones and high impact levels from interbedded formations, which caused heavy cutting structure damage and high lateral vibrations.

Rockcliff wanted to reduce well days through faster ROP and considers the bit a primary factor. Smith Bits, a Schlumberger company, worked with the Rockcliff team to develop a fit-for-basin bit design that would address the challenging formation characteristics and in turn improve drilling performance.

Elements of an optimal bit design

Many variables must be taken into consideration when designing a bit, including the cutter type and downhole shock and vibration.

To develop an optimal bit design, downhole measurement data are critical. For many years the industry has taken downhole measurements in the bottomhole assembly (BHA), but these data cannot inform on true bit-to-rock interactions.

Measurements in the BHA are helpful for understanding the drillstring drilling dynamics, but they do not provide useful information at the source of the energy—the bit. Recently, at-bit data acquisition technology was introduced to validate the interactions between the rock and the bit at various intervals of a formation, thus informing a more optimal bit design.

Gathering the data

The first step was to establish baseline drilling performance with a given bit design. This was necessary to determine which factors needed to be improved upon.

Rockcliff provided the Smith Bits team with various data inputs, including surface data and formation tops, which were used for the performance analysis. The Smith Bits team worked with Rockcliff to define the performance requirements, which were to increase ROP and drilled footage per bit run.

Smith Bits recommended deploying in-bit data acquisition using Schlumberger's Synapse performance insights and optimization service on two offset wells to help understand the drilling assembly dynamics. Analyzing drilling assembly dynamics through varying formations is a critical factor in optimizing drilling performance. One of the primary goals of the analysis was to reduce harmful downhole shock and vibrations, which can lead to increased equipment life, increased ROP, improved hole condition and directional control, and decreased overall drilling cost.

The downhole data, surface data and formation tops were uploaded to the cloud, where a proprietary algorithm merged and synced the inputs into a single report. Initial findings, which showed ROP increases correlating with reduced shock and vibration, were shared with Rockcliff, and an optimization plan for the bit design was developed.

Optimizing the bit design

The offset wells were close in proximity, which enabled the Smith Bits team to properly understand performance through each formation layer. The data gathered at each interval were used to create 4D simulations of the drillstring and wellbore geometry using Schlumberger's IDEAS integrated dynamic design and analysis platform.

Over the course of the two offset well runs, at-bit data were continuously fed into the platform to recalibrate the simulation, providing instant insights on bit design parameters. Using this dynamic modeling system, the interactions of the bit and the rock were quantified and validated in a virtual environment to customize material and design.

When compared to conventional methods, this virtually designed bit reduced the number of design iterations required to improve performance. In addition, there was less risk from multiple trips due to bit failure and additional costs incurred from improper designs, which often results in damaged-beyond-repair (DBR) bits.

Selecting the cutting elements

Using learnings captured through the performance insights

and optimization service at each interval of the formation, a fit-for-basin bit design was created using conical diamond and concave diamond cutting elements. Concave diamond elements have a tapered ridge with a thicker diamond table that significantly resists impact damage, and the distinctive concave feature decreases the effective cutter back-rake angle to cut deeper into rock. Conical diamond elements have a conical shape, enabling the cutter to have a highly concentrated point load on the formation than a polycrystalline diamond compact cutter for a given weight on bit.

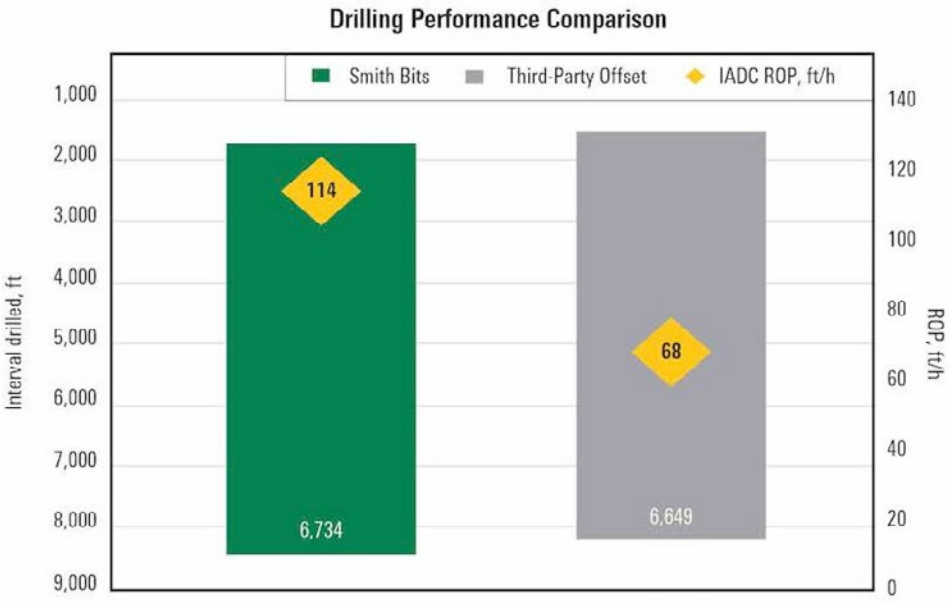

FIGURE 1. Results are shown from the deployment of a fit-for-basin bit in one of Rockcliff Energy's wells in the Carthage Field in East Texas' Haynesville Shale basin. *(Source: Schlumberger)*

Measurable drilling performance gains

On one well, the bit designed specifically for Rockcliff's Carthage Field acreage drilled 69% faster compared with the closest offset (within 2 miles), drilling 6,734 ft at 114 ft/hr (Figure 1). A third-party bit used in the offset drilled less footage at an ROP of only 68 ft/hr. The service saved Rockcliff nearly 40 hours of drilling time and set a new ROP record. This performance gain demonstrated there was no longer a lag in shallow-hole ROP and also validated that there was a 55% reduction in vibrations compared with the baseline design.

Breaking through the drilling performance plateau

After nearly a decade of relatively stagnant drilling performance in the Haynesville Shale, fit-for-basin bit technologies are helping break through the plateau. With less design iterations, operators can get measurable ROP gains that reduce time on hole and deploy more optimal bit designs on future wells faster. This ultimately has a net positive effect on strained capex budgets and overall well economics.

With the industry facing significant pressure to be more capitally disciplined, every performance gain that results in a reduction of rig time and associated costs is an important part of an overall drilling and development strategy.