Smith Bits’ IDEAS platform provides dynamic model to optimally design, test drill bits

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IN RESPONSE TO a drilling industry that continues to push drill bit manufacturers for bits that are application-specific, high performing and durable, Smith Technologies developed its IDEAS (Integrated Dynamic Engineering Analysis System) bit design platform.

Originally developed to optimally design roller cone bits, the advanced engineering modeling system has been applied to fixed cutter bits as well. Now, every new Smith Bits drill bit is developed and certified with the IDEAS software, which allows the precise prediction of the performance of a new bit design before the first prototype is run downhole.

IDEAS was developed as an advanced method of designing and testing application-specific bit designs. The objective was to produce improved bit designs while significantly reducing product development cycle time. Prior to the development of IDEAS, improvements in bit performance were relatively slow since they were based on traditional trial-and-error methods of designing the bit, prototype manufacturing, field testing, evaluating the results and then repeating the process until the performance objective was ultimately achieved.

With the development of IDEAS, design engineers now have the unique ability to rigorously evaluate and test changes to a bit design in a matter of hours or days rather than weeks or months.

Smith Bits engineers now better understand the effects of their design changes and how the changes relate to bit performance in a specific lithology, with a specific bottomhole assembly (BHA). Using the dynamic model of the entire IDEAS not only results in designing and producing better bits quicker, the level of risk for oil and gas companies is also reduced.

The IDEAS analysis considers all downhole components when evaluating the best bit design for the highest performance, including drill pipe, hevi-wate drill pipe, MWD/LWD tools, reamers, stabilizers and whether an operator is utilizing a push-the-bit or point-the-bit rotary steerable system. When the bit design and analysis are completed, the customer receives a specific recommendation of the optimal bit as the best solution for the objective.

After a bit has been designed in IDEAS, the same modeling technology can be used to provide a detailed applications analysis of how the bit will perform for a customer’s drilling program. The customer is given a detailed analysis of the bit or bits evaluated, a description of the drill string and its components, proposed operating parameters and the formations to be drilled, and precise performance projections. Among the data provided to the customer, in addition to the bit analysis, are graphs illustrating the specific BHA configuration modeled for the well, bit bottomhole pattern, bit center trajectory, weight on bit, lateral forces and lateral accelerations.

IDEAS’ SIX BASIC ELEMENTS

There are six basic elements to bit design and performance advantages provided by IDEAS: a comprehensive drilling system analysis; a holistic design process; application-specific performance enhancements; synergistic integration with the total drilling system; rapid solutions with reliable results; and optimized integration of advanced materials.

The comprehensive drilling system analysis examines the designed bit performance in relation to the entire drill string and individual BHA components. It also takes into account the specific operating parameters and interaction of the individual elements of the entire drilling assembly.

The holistic design process assures that IDEAS-designed bits are optimized for performance in the application-specific objective. Specific bit features previously thought to be essential to manage bit stability independently may or may not be effective depending on how they are deployed. However, with the insight to design provided by IDEAS, virtually every cone or cutter layout and configuration is designed to result in a stable bit that rotates around its center, the key to successful drilling.

One result of the drilling system analysis and holistic design process is application-specific bit enhancements. These enhancements result in bits that consistently outperform previous designs when measured against the same parameters and objectives, which include improved rate of penetration (ROP), durability, or specific bit behavior when used with a
The performance enhancements to the bit design result in better dynamic bit stability. IDEAS-designed bits are designed with the total drilling system in mind. They are consistently dynamically stable within the parameters for which they are designed, resulting in longer bit runs and less stress on the BHA.

The IDEAS solution also allows Smith Bits to develop advanced cutter material. Stronger and more durable materials work in conjunction with IDEAS’ design and simulation capabilities to deliver a bit that is more than just correcting a design for weak and high-wear areas. The result is a bit with an optimal design for high performance and abrasion and impact resistant cutters.

VIRTUAL CASE STUDIES

The IDEAS process certifies the performance capabilities of each bit design through a dynamic simulation and modeling methodology that takes into account the lithology at the rock/cutter interface, the drill string, the drive system, the BHA and the total system’s influence on the bit’s behavior.

The IDEAS process begins with bit performance data, geological information, BHA details and dull bit analysis. From these data, actual laboratory rock/cutter tests are devised and carried out. The laboratory data from IDEAS quantifies the actual cutter forces and rock removal rates, compared with other bit design tools that estimate only rock/cutter behaviors. This information is then used for the design analysis in lithologies that compare to the particular field application for which the bit is being designed.

The IDEAS design platform incorporates the quantitative understanding of rock chip generation and removal for each individual cutter into a dynamic model of the total drill string, from the BHA to the surface drive mechanism. When the actual rock/cutter data is obtained, it is integrated into a full bit design model to determine the characteristics of the bit in actual drilling conditions.

The virtual case study quantifies the effects of design changes in roller cone and PDC bit profiles, gauge lengths, cone offsets for roller cone bits and to determine bottomhole patterns and force balances. These parameters are examined in a fully dynamic simulation mode where bit influences are identical to those encountered in the actual drilling environment.

The model analyzes rock/cutter interface, BHA configuration, drill string behavior and directional response, dynamic analysis of projected bit behavior and how changes in operating parameters affect bit performance. This data set allows the design engineer to fine-tune the bit for a particular field application based on the desired objectives such as ROP, footage drilled, enhanced durability or specific behavior for use with rotary steerable systems.

The result is a drill bit that is dynamically stable within the operating and application parameters for which they are designed, contributing to longer life, faster ROP and increased reliability for downhole electronics. Optimized parameters can be maintained for faster, longer bit runs with less stress on the BHA and rig equipment.

ANALYSIS REPORT

Smith Bits provides the operator with a specific recommendation of either a roller cone or PDC drill bit that has been designed and certified by the IDEAS simulation process to be the best solution for the target application. The customer receives a comprehensive package that contains detailed analysis results of the bits evaluated. This covers the particulars of the bit, a detailed description of the drill string and all of its components, the proposed operating parameters, and the formations to be drilled. The data provided also includes graphs of:

1. The specific BHA configuration modeled for the well.
2. Bit bottomhole pattern.
3. Bit center trajectory demonstrating the relative stability of each design.
4. Torque/torsional vibration.
5. WOB/axial vibration.
7. Lateral acceleration.

With the quantitative results of the comparative bit analysis in hand, the operator can be confident that he has a sound basis for implementing the recommendations of the IDEAS analysis, and will reap the benefits of superior bit and BHA performance which is the ultimate objective of the entire process.

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