UNCONVENTIONALS

CASE STUDY

Cerebro Force™ In-Bit Sensing Identifies and Addresses Drill Bit Dysfunction in Hard Abrasive Shale

RAPID ANALYSIS AND RECOMMENDATIONS SIGNIFICANTLY PROLONG BIT LIFE AND IMPROVE DRILLING PERFORMANCE

THE WOODFORD SHALE

CHALLENGE

- Address downhole failure and determine origin of bit damage and suspected dysfunction in hard, extremely abrasive shale

SOLUTION

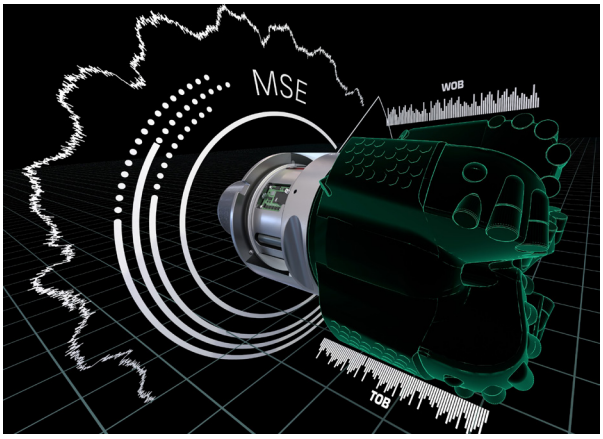
- Deploy Cerebro Force™ in-bit sensing technology for multiple runs across multiple wells to provide direct in-bit measurements of weight, torque, bending, vibration, and rotational speed
- Combine high-frequency downhole and surface data with forensic bit and BHA images to identify and rectify causes of damage and dysfunction
- Implement team-based continuous improvement process to evaluate root cause of downhole dysfunction and recommend bit/BHA design and operating procedural changes to operator

RESULT

- Three major problems identified and resolved—drillstring buckling, ROP loss caused by rotating head contact and weight on bit and differential pressure tare inconsistencies
- Bit life significantly prolonged and drilling performance improved by rapid analysis and joint recommendation process

OVERVIEW

After experiencing premature polycrystalline diamond cutter (PDC) bit failure while drilling hard, extremely abrasive shale, which were requiring 35+ runs per lateral section, an operator sought Halliburton Drill Bits and Services assistance addressing downhole tool failures and determining the origin of the bit damage and suspected dysfunction.



CHALLENGE

It was hypothesized that the primary cause of PDC bit failure was smooth wear and thermal damage. The wear flats were attributed to abrasion and mechanical chipping that rapidly progressed to thermal damage. Higher weights were ineffective and buckling was observed, causing insufficient weight transfer and increased lateral vibration.

SOLUTION

To investigate and address these issues, Halliburton selected to deploy Cerebro Force™ in-bit sensing technology for multiple runs across multiple wells in the formation. The strategy involved combining high-frequency downhole and surface data with forensic bit and BHA images to identify and rectify detected problems. Cerebro Force in-bit sensors were run in hole (RIH) a total of four runs to measure weight, torque, revolutions per minute, and lateral, axial, and torsional vibration in order to evaluate the weight transfer issues and dysfunction. Following the runs, root causes of dysfunction and potential operational changes were assessed.

RESULTS

In total, three major problems were identified and resolved—drillstring buckling, rate of penetration (ROP) loss caused by rotating head contact with drill pipe joints, as well as weight on bit (WOB) and differential pressure tare inconsistencies. During early runs, drillstring buckling resulted in the downhole WOB being significantly less than surface indicated WOB. To correct this, heavy weight drill pipe (HWDP) was run across the buckling zone. Subsequent runs revealed significant improvement to downhole WOB, reduced lateral bit vibration, and improved performance and dull condition.

Significantly decreased downhole WOB, differential pressure, and ROP were noted when running drill pipe joints through the rotating head on the BOP stack. During these events, in-bit accelerometers showed increased lateral vibration resulting from ROP loss, which continued long after recovering the ROP.

Downhole WOB and downhole torque on bit (TOB) were often much higher than surface weight and expected motor output from differential pressure indicated. Plots of rig hookload and stand pipe pressure tare values were used as indicators of inconsistent tares. Although premature motor failure was not observed during these runs, premature PDC cutter failure was observed.

Upon completion of each run, a team-based continuous improvement process was implemented to evaluate the root cause of the downhole dysfunction and recommend bit/BHA design and operating procedural changes to the operator. This rapid analysis and joint recommendation process significantly prolonged bit life and improved drilling performance in the application.

Significant wear flat and thumbnail crack (tangential overload) that has mechanically propagated and partially failed.

HALLIBURTON