geoconvention
Calgary • Canada • June 20-22 2022

An Overview of Measurement and Reduction of Drill String Vibrations

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Drill String Vibrations Measurements

The understanding of the accurate measurement of torque, torsional vibrations, tensile load (hook-load is the weight of the drill string and the BHA added together, hanging on the traveling blocks), axial vibration, pressure and lateral vibration are prerequisite to understanding the way and manner drill bit, drill strings and BHA operates in drilling operation. Measurements at the surface has been done by measurement-while-drilling mud-pulse telemetry, however, it has been dampened by inaccuracy due to calibration issues. Instrumented surface sub (ISS) having perfect and calibrated sensors, has been found to salvage this errors recorded (Lesso et al., 2011), (Ahmadi & Altintas, 2013). ISS is a surface, wireless sensor package, powered by a battery that is employed to measure and connect the real time drilling parameters to the benefit of the driller. Drilling Mechanics Module (DMM) is battery powered, recorded-mode tool employed to compliment the work of ISS by measuring parameter such as tensile load, temperature, torque, bending moment, lateral and axial vibration, axial pressure, internal pressure, annular pressure, collar RPM. This is meant to give detail understanding of the drilling environment to detect drilling issues early (Lesso et al., 2011).

Vibration Prevention Methods Typically Implemented During Drilling

The major way to prevent drilling issue such as vibration is to harness surface and downhole measurements. This will ensure quick recommendation and accurate decision for drillers in real time Then, there will be higher drilling rate of penetration and overall wellbore health (Lesso et al., 2011), (Hakimi & Moradi, 2010). The use of latest dynamic preventive maintenance on drilling equipment would prevent stick-slip and other mechanized vibration during drilling (Kessai et al., 2020). Dynamic model such as finite-element method has been developed to control sudden failure of drilling equipment. This model records gyroscopic effect, torsional-bending inertial coupling, gravity and inertia-axial stiffening (Hakimi & Moradi, 2010).

Figure 1.0 shows the possibility for stick-slip increases as the drill-bit gains stabilizations against lateral-vibration when WOB is increased. On the other hand, the increase in rotary speed has frequently helped to mitigate stick-slip with the tendency to produce more lateral-vibration. While this scenario occurs between this two-vibration phenomenon, the driller sometimes can manage the situation by finding a sweet spot but at other times, the driller may not. Therefore, when no sweet spot can be found, an advisory system is used. This helps to recommend optimum drilling parameter in real-time by monitoring drilling performance. Two of such systems are the Drilling Advisory System (DAS) and the Physics Inspired Drilling Simulator (PhiDrillSim).

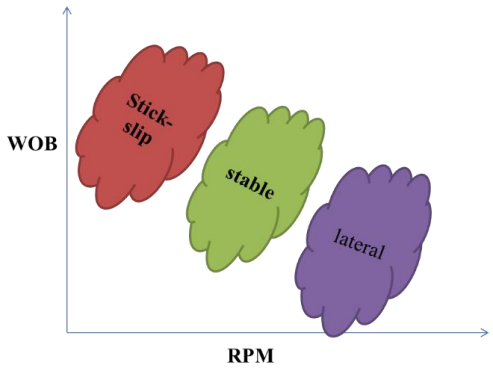

Fig 1.0: The Notional Drilling Problems Domain (Bailey et al., 2016)

References

Ahmadi, K., & Altintas, Y. (2013). International Journal of Machine Tools & Manufacture Stability of lateral , torsional and axial vibrations in drilling. *International Journal of Machine Tools and Manufacture*, *68*, 63–74. https://doi.org/10.1016/j.ijmachtools.2013.01.006

Hakimi, H., & Moradi, S. (2010). Journal of Petroleum Science and Engineering Drillstring vibration analysis using differential quadrature method. *Journal of Petroleum Science and Engineering*, *70*(3–4), 235–242. https://doi.org/10.1016/j.petrol.2009.11.016

Kessai, I., Benammar, S., Doghmane, M. Z., & Tee, K. F. (2020). applied sciences Drill Bit Deformations in Rotary Drilling Systems under Large-Amplitude Stick-Slip Vibrations, 1–17.

Lesso, B., Ignova, M., Zeineddine, F., Burks, J., Welch, B., & Varco, N. O. (2011). SPE / IADC 140347 Testing the Combination of High Frequency Surface and Downhole Drilling Mechanics and Dynamics Data under a Variety of Drilling Conditions.