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Parameter Selection and Monitoring for Water-Powered Percussive Drilling in Green-Fields Mineral Exploration

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Abstract : The Deep Exploration Technologies Cooperative Research Centre (DET CRC) is researching and developing a new coiled tubing based greenfields mineral exploration drilling system utilising downhole water powered percussive drill tooling. This new drilling system is aimed at significantly reducing the costs associated with identifying mineral resource deposits beneath deep, barron cover. This system has shown superior rates of penetration in water-rich hard rock formations at depths exceeding 500 meters. Several key challenges exist regarding the deployment and use of these bottom hole assemblies for mineral exploration, and this paper discusses some of the key technical challenges. This paper presents experimental results obtained from the research program during laboratory and field testing of the prototype drilling system. A study of the morphological aspects of the cuttings generated during the percussive drilling process is presented and shows a strong power law relationship for particle size distributions. Several percussive drilling parameters such as RPM, applied fluid pressure and weight on bit have been shown to influence the particle size distributions of the cuttings generated. This has direct influence on other drilling parameters such as flow loop performance, cuttings dewatering, and solids control. Real-time, accurate knowledge of percussive system operating parameters will assist the driller in maximising the efficiency of the drilling process. The applied fluid flow, fluid pressure, and rock properties are known to influence the natural oscillating frequency of the percussive hammer, but this paper also shows that drill bit design, drill bit wear and the applied weight on bit can also influence the oscillation frequency. Due to the changing drilling conditions and therefore changing operating parameters, real-time understanding of the natural operating frequency is paramount to achieving system optimisation. Several techniques to understand the oscillating frequency have been investigated and presented. With a conventional top drive drilling rig, spectral analysis of applied fluid pressure, hydraulic feed force pressure, hold back pressure and drill string vibrations have shown the presence of the operating frequency of the bottom hole tooling. Unfortunately, however, with the implementation of a coiled tubing drilling rig, implementing a positive displacement downhole motor to provide drill bit rotation, these signals are not available for interrogation at the surface and therefore another method must be considered. The investigation and analysis of ground vibrations using geophone sensors, similar to seismic-while-drilling techniques have indicated the presence of the natural oscillating frequency of the percussive hammer. This method is shown to provide a robust technique for the determination of the downhole percussive oscillation frequency when used with a coiled tubing drill rig.

Keywords : cuttings characterization, drilling optimization, oscillation frequency, percussive drilling, spectral analysis
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