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Significant Cost Savings Achieved Through the Use of PDC Bits in Compressed Air / Foam Applications

Bryan George, Sandridge Energy, Inc.; Eric Grayson, Artex Oil Co.; and Roger E. Lays, Floyd Felderhoff, Mike Doster, and Matt Holmes, Baker Hughers Incorporated

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Abstract

Polycrystalline diamond compact (PDC) bits are widely regarded as an excellent means to improve penetration rates throughout the world in many fluid drilling applications. However, although attempts to apply PDC technology in air and foam drilling environments have been made in the past, the practice has been largely deemed uneconomical due to excessive damage to the cutting elements. Since the need for significant performance gains persists, an improvement in bit performance can benefit the industry by increasing penetration rates and operating efficiency, thus reducing drilling costs.

Initiatives have been undertaken in a joint effort between an operator and a service company to test modern PDC bit designs in the dry air, nitrogen, and foam drilling applications of the Appalachian Basin in the Eastern United States and of the Permian Basin in West Texas. These are widely drilled basins with well-known lithology and geological properties. The initiatives included identifying target applications and establishing operating practices while determining the economic viability of applying modern PDC bits in these environments. These efforts were determined to achieve drilling cost savings while reducing or eliminating down-hole complications. Careful bit selection, differences in operating parameters, bit performance and dull condition, and impact on borehole quality were monitored. Performance data was accumulated from dozens of bit runs over the life of the projects. This data has indicated that successful PDC bit performance has increased ROP by 300% with a 30% reduction of days-on-well on one application. The second application averaged 40% more hours on bit with reliable results while drilling 30% more distance, saving a trip and one bit. These results demonstrate the tremendous potential to reduce drilling costs with the conversion from roller cone to PDC bits in air-related applications.

This paper details methods, results, and lessons learned from the testing completed and translates those findings into practical techniques. Case study examples are included, with performance data and drilling conditions to support the findings.

Introduction

The introduction of the PDC drill bit in the early 1970s and the improvement in technology ever since has enabled drillers to push PDC bits into harder and more difficult applications. One of these has been in the drilling application using dry air, air mist, or foam as the primary drilling fluid. The use of air, air mist or foam as the primary drilling fluid has offered the advantage of increased penetration rates over water or other fluid-based drilling fluid systems with established technologies. It has been known for some time that penetration rates tend to decrease with the increasing fluid density, viscosity and solids content. The use of an air-based drilling fluid eliminates these issues and allows the penetration rates to be maximized as the overbalanced pressure nears zero. The situation in which the limited influx of formation fluids allows the use of the air-based drilling fluids can dramatically increase the overall penetration and reduce the number of days on the well. [3,4]

Formations typically drilled in air are known to be competent, stable, and often very hard and abrasive. Consequently, operating parameters involved in air drilling include combinations of higher weights and slower rotary speeds. Further, limited formation and circulating fluid eliminates any meaningful cooling benefit. These conditions, in connection with historical limitations of PDC cutters, have discouraged the widespread use of PDC bits in air applications. In the past, the use of PDC bits was limited by the breakage seen by the diamond cutters during normal drilling. Distance drilled was limited even with any increases seen in the penetration rates.