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Testing of New PDC Cutter Edge Geometry Doubles Penetration Rate and Reduces Torque

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Abstract

A new edge preparation of Polycrystalline Diamond Compact (PDC) cutters has been developed to target applications where either weight or torque is limited. This paper describes the geometry, which differs considerably from existing thermostable product.

Initial testing at atmospheric conditions in a drilling laboratory shows a 30% reduction in torque and a 100% increase in penetration rate when compared to conventional cutter geometry. Secondary testing was conducted with drill bit designs at a non-commercial test facility. In this controlled environment, designs with new cutter edge geometry were compared directly to those with conventional cutters. By using the same drill bit cutting structure and parameters, any difference in torque and penetration rate was solely dependent upon the cutter geometry. Additionally, to quantify any effects caused by torsional or lateral vibration, a downhole dynamics recorder was used to gather data at a high frequency sample rate.

Performance studies are presented for a variety of applications from around the world but focusing on applications within the US Rockies. They compare direct offset runs against conventional geometry cutter designs. Results demonstrate that the new geometry delivers footage and ROP equal or greater than the best field offsets.

The increased penetration rate and reduced torque provided by this geometry result from more efficient failure of the rock. This provides reduced Mechanical Specific Energy and improved drilling efficiency, thus reducing drilling costs for the operator. This is a significant step change in PDC cutter technology, dramatically increasing fixed cutter drill bit performance.

Introduction

For many years, PDC cutters used in drill bits for drilling oil and gas wells have employed a small chamfer to avoid having a sharp 90 degree edge presented to the formation being drilled[1]. The chamfer angle has often been 45 degrees. Conventional wisdom is that this chamfer prevents chipping of the edge of the diamond table during drilling – and, indeed, while the bit is being handled prior to drilling – but it has the detrimental effect of increasing backrake seen by the formation, thereby slowing the bit down[2].

As the cutter wears, the backrake presented to the formation reduces as the chamfer is worn away, but unfortunately this does not make the bit more aggressive due to the generation of the tungsten carbide backing “wear flat” behind the diamond layer of the PDC. This acts to rub on the formation and slow the bit down, as well as providing a source of frictional heat that accelerates wear of the cutter.

Now, enhanced PDC cutter technology has enabled the effective use of an altered edge geometry (AEG) designed for drilling efficiently by presenting a sharper edge to the formation as compared to the standard edge preparation. The geometry employed in the AEG cutters which are the subject of this paper is a 15 degree chamfer angle, measured relative to the cutting face. That is, the chamfer angle significantly reduces the backrake seen by the formation (Figure 1). This is expected to significantly increase performance but, as the cutter wears, the effect is soon lost and the cutter then behaves like any other for the rest of its life. Thus the effect of the more aggressive cutter is transitory unless a mechanism can be found to prevent, or to significantly slow down, initial wear of the PDC. Just such a mechanism was found in the form of thermostable cutters.