


SPE/IADC-173165-MS

Successful Use of Aluminum Drill Pipe with Steerable Mud Motors: Case Study in Shale Plays

S. Menand, DrillScan US Inc., Jeffry K. Lehner, Alcoa Oil & Gas, Nigel Evans, Aaron Palmer, Nabors, Arthur Metcalfe, Penn Virginia

This paper was prepared for presentation at the SPE/IADC Drilling Conference and Exhibition held in London, United Kingdom, 17–19 March 2015.

Abstract

High strength-to-weight aluminum alloy drill pipe is a powerful torque and drag reduction tool for deviated wells. The aluminum alloy drill pipe enables achieving strength to weigh ratios equivalent to 160 ksi yield strength steels and is typically 30-50% lighter than similar steel drill pipe. An operator has recently tested aluminum alloy drill pipe in a complex and highly deviated well profile.

This paper presents the key findings regarding the benefits of drilling using aluminum drill pipes in a mixed aluminum-steel string compared to a string using only steel pipes. Firstly, the innovative drill pipe design is presented, followed by lessons learned during rig operations regarding pipe handling practices, rig compatibility and pipe inspection. Then, the paper presents results of multiple advanced torque, drag and buckling simulations taking into account the rigorous mechanical characteristics of aluminum drill pipe. In the well planning phase, sensitivity analysis enabled optimisation of aluminum drill pipe placementalong the mixed aluminum-steel drill string according to the well profile and to predict anticipated torque, drag and loads on pipes while drilling. Through extensive modeling and field data interpretation, the paper presents a comparison of the overall drilling performances between steel only and aluminum-steel drill pipe strings and provides metrics in terms of torque and drag reduction. These results were then used to challenge horizontal and extended reach drilling well profiles where the utilization of only steel drill pipes has shown its limitation.

Introduction

Many industrial and research studies[1,2,3,4] have exposed the idea of using non-steel drillstrings, such as aluminum alloys, in order to reduce torque and drag loads in long deviated and/or extended reach-drilling wells. Indeed, despite continuous improvement of steel materials to increase yield strength, aluminum drill pipe has been proposed as a viable alternative to drill these extreme long wells due mainly to its light weight characteritics. **Tab. 1** compares the mechanical properties of steel and aluminum grades, in terms of density, Young modulus, yield and tensile strength, and gives the strength-to-weight ratio for a 5 inch steel drill pipe (SDP) and a 5 7/8 aluminum drill pipe (ADP). This strength-to-weight ratio represents the ultimate length of a single size drillstring that can be suspended without exceeding the yield strength of the material. Aluminum drill pipes are characterized by higher strength-to-weight ratio than steel drill pipes due to a lighter specific weight despite reduced yield strength. This characteristic allows decreased torque and drag loads while keeping a good resistance to axial, torsional and lateral loads. Lighter weight reduces the contact side force between drill pipe and borehole, thus reducing friction between the drill string and the borehole. Less friction means not only that hook load and torque at surface are lower but also expected compression while running the drill string in the hole is less than the one generated along a drill string made exclusively of steel. However, aluminum alloys are more flexible due to a reduced young modulus meaning that aluminum drill pipe buckles at a lower given compression than steel drill pipe. Nevertheless, depending on the well trajectory, coefficient of friction and application, the higher flexibility can be balanced by the reduced contact side forces with the wellbore, producing less compression along the drill string, and thus potentially extending the horizontal section further.