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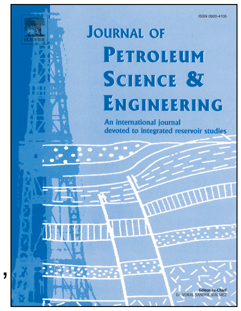

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Field Experimental Investigation of Bit Stick-out for Different Soil Strengths during Deepwater Conductor Injection

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Abstract:

The jetting method of deepwater conductor installation is the most widely applied method of underwater well construction. The degree of bit stick-out from the running conductor assembly directly affects the efficiency of the injection process and the bearing safety of the conductor after installation, a key factor in deepwater drilling design. In order to improve the efficiency and safety of conductor installation, it is necessary to determine a reasonable range of bit stick-out for soil formations with different shear strengths. In this paper, a modified model for selecting the bit stick-out is developed based on the theory of water jet ground breaking and the conservation of momentum. The key factors influencing the optimal bit stick-out, such as hydraulic parameters, formation strength, and the ratio of bit-to-conductor dimensions, are also considered. Orthogonal experiments of conductor jetting were conducted in in-situ soil strata with different soil strengths. The influence law of parameter change on bit stick-out is studied, including hydraulic parameters change, bit stick-out variation and running assembly structural change. The results indicate that the bit stick-out is a key factor affecting the efficient jetting of the conductor as well as the bearing capacity of the conductor after injection. For different soil shear strengths, the effects of bit stick-out on the jetting efficiency and bearing capacity are different. In soil strata with low shear strength, the bit stick-out from the running assembly has little influence on the jetting efficiency, but a significant influence on the bearing capacity of the conductor, and hydraulic factors dominate the jetting efficiency and conductor stability. In soil strata with relatively high shear strength, the bit stick-out has a significant influence on the installation efficiency and a relatively small influence on conductor bearing capacity. An optimal drill bit stick-out is then determined that provides the highest jetting efficiency under a given drilling fluid discharge rate. From the field experiments, the optimal bit stick-out is determined to be 147.4 mm, and the range of reasonable bit stick-out is 96.6–198.2 mm. In total, these research results provide a design basis and theoretical guidance for optimizing the bit stick-out of deepwater conductor running assemblies.

Keywords: Conductor injection; bit stick-out; field experiment; soil strength; installation efficiency; bearing capacity

1. Introduction

A deepwater conductor is the load bearing foundation of the surface casing, underwater wellhead, and underwater BOP components during the oil well construction process. Deepwater shallow formations are usually poor in rock diagenesis and low in formation strength, thus the jetting method is the most commonly applied method for conductor installation. Jetting technology provides high installation efficiency, good prevention of failures due to the weakness of shallow geological formations, and good adaptability to various soil strengths. To date, jetting has been widely used in Mexico, Brazil, West Africa, the North Sea, the South China Sea, and other major deepwater oilfield blocks around the world (Faul et al., 1998; Wang et al., 2015). In the process of injection, the design of bit stick-out is one of the key factors that affect the efficiency of jetting and the stability of the conductor when the injection is finished.

Akers, Beck, et al. performed research on the force balance relationship during the conductor injection process by applying the load bearing capacity analysis of pile foundation model. Several installation depth calculation models were obtained as well as the bearing capacity models after the conductor installation (Akers, 2006; Akers, 2009; Beck et al., 1991; King, 1993). Jeanjean proposed a method for calculating the real-time bearing capacity of a conductor after installation, taking into consideration the soil disturbance and soil stress recovery in the