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Integrated approach for the optimal selection of environmentally friendly drilling systems

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Abstract

There is a pressing need in the energy industry to develop technologies capable of reducing the environmental impact during oil and gas drilling operations. However, these technologies have not been fully integrated into a decision-making system that can reflect a quantitative effort toward this goal. This paper introduces two quantitative decision methods for the selection of environmentally friendly drilling systems. One is based on a multi-attribute utility approach and the other one is based on the analysis of interventions or causal approach. To illustrate the applicability of the proposed methods and to contrast their benefits and limitations, a case study is presented using data collected from Green Lake at McFaddin, TX, USA.

Keywords: Comparative analysis, Environmentally friendly drilling, Decision-making, Multi-attribute utility, System selection, Intervention, Causal approach

Background

One of the current goals of the oil and gas industry is to minimize the environmental impact during drilling operations. This is because an effective management of the environmental impacts during drilling operation has proven to lead to a greater access of reserves in environmentally sensitive areas, particularly those classified as 'off-limits' [1-3]. As a consequence, a significant number of Environmentally Friendly Drilling (EFD) technologies continue to emerge, but these have not been integrated into a decision-making method capable of combining them to define an optimal drilling system for specific conditions on a given site. In practice, the major challenge is to select the best combination of EFD technologies based on a set of competing evaluation criteria. In this paper, a 'system' will be defined as a set of EFD technologies.

From an engineering perspective, the civil infrastructure needed to complete a drilling operation may strongly condition its success (e.g., access and maintenance of roads, power supply, water availability and management of residuals, traffic and noise control). This interaction is exacerbated when the drilling operations

expand on large areas, and at a rapid pace, threatening the sustainability of the inherent civil infrastructure.

A number of studies have introduced decision support systems for the selection of drilling well locations [4-7]. A few studies on the best practices on the use of EFD technologies are also available such as in the case of drilling waste discharge [8] and in the design of cementing [1]. However, to the best knowledge of the authors, there are few precedents on a quantitative decision-making method for the integral selection of standard drilling systems.

This work aims at introducing a decision-making evaluation protocol to find the optimal EFD system for a given drilling site and also discusses the sensitivity of the inherent input parameters with respect to the expected outcomes. A search algorithm is proposed as the basis of a multi-attribute utility model combined with an exhaustive enumeration of all available technology combinations. This work hypothesizes that optimal decision-making on EFD technology selection can be achieved by an integrated approach, which allows decision-makers to minimize the environmental impact, to maximize the expected profits, to account for the influence of public perception, and, most importantly, to guarantee the operation's safety [9,10].

To support this hypothesis, two competing methods for the selection of EFD systems are presented in this

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