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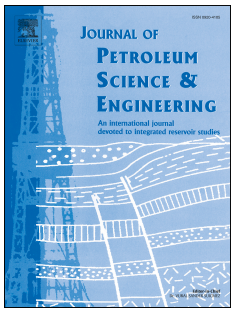

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ARTIFICIAL INTELLIGENCE TECHNIQUES AND THEIR APPLICATIONS IN DRILLING FLUID ENGINEERING: A REVIEW

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ABSTRACT

For an oil well to be said to have been successfully and conclusively drilled, the drilling fluid lies at the heart of the solution. Therefore, the guarantee to solving issues in oil well drilling is to contrive an optimal drilling fluid. However, there is usually a complex interplay of factors involved during drilling fluid formulation, property determination, its performance in the well and its relationship with other wellbore drilling parameters. This is so because drilling muds exhibit time dependent properties. This time dependency is the direct product of the synergy among the various active additives that make up the mud and the characteristic of each additive especially at downhole conditions where the effects of temperature and pressure are well pronounced. These additives are more often than not diverse in size, chemical activity, density and surface energy. Deriving knowledge from the data from these parameters in order to develop a functional relationship between them is a challenging task requiring advanced modelling techniques as well as human intuition and experience. The dependence on human intuition and on the experiential knowledge of professional mud engineers lays bare the shortcomings of traditional mud design techniques. Artificial intelligence techniques have been shown to alleviate this challenge. Exploiting the abundant literature on the various applications of artificial intelligence in oil and gas operations, several works that show how and what artificial intelligence techniques are used in the drilling fluid industry, and what have been achieved due to their use have been selected. In this paper, a review of existing artificial intelligence techniques and their applications in drilling fluid engineering is given. This paper also dug up and analyzed the strengths and pitfalls of each artificial intelligence technique. The examination of the strengths and deficiencies was done using the following virtues as the basic criteria: robustness against noise, self-organization, generalization ability, data volume requirements and the convergence speed. The artificial intelligence techniques presented in this paper include: artificial neural networks (ANNs), fuzzy logic, support vector machines (SVM), hybrid intelligent systems (HIS), genetic algorithms (GA), case based reasoning (CBR) and particle swarm algorithm (PSA). An overview of the applications of classical artificial intelligence in drilling fluid engineering is also presented. From the review, it was gathered that the ANN technique is the most widely applied in drilling fluid engineering accounting for over 54% of the papers reviewed; while lost circulation problem was the most predicted well problem related to drilling fluids accounting for over 17% of the mud problems predicted. It was also observed that a blend of AI techniques performed better than when each one of the AI techniques was used singly. Finally, judging the AI techniques on the criteria mentioned above, ANN was found to meet all the listed criteria except for its slow speed of convergence while ANN, GA, SVM and fuzzy logic were all found to be robust against noise.

Keywords: Drilling Fluid, Artificial Neural Network, Fuzzy Logic, Case Based Reasoning, Hybrid Intelligent Systems, Genetic Algorithm, Particle Swarm Algorithm