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Prediction of Lost Circulation Zones using Artificial Intelligence Techniques

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Drilling deep and high pressure-high temperature wells have many challenges and problems. One of the most severe, costly and time-consuming problem in the drilling operation is the loss of circulation. Loss of circulation or loss of return is known as the partially or completely loss of the drilling into the formation instead of returning back to the annulus. The drilling fluid accounts for 25-40% of the total cost of the drilling operation. Any loss of the drilling fluid will increase the total cost of the drilling operation. Uncontrolled lost circulation of the drilling fluid can result in dangerous well control problem and in some cases the loss of the well. Lost circulation is divided into four types based on its severity: seepage, partial, severe and total. It can occur in different formations such as natural fracture, induced fracture, unconsolidated zones, cavernous formations and high permeability formation.

It is very difficult to cure losses, especially in workover operations. Using conventional lost circulation material (LCM) is not successful in all cases of lost circulation due to some limitation and disadvantages. In order to avoid loss circulation, many methods were introduced to identify the zones of losses. However, some of these methods are difficult to be applied due to financial issues and lack of technology and the other methods are not accurate in the prediction of the thief zones. The objective of this paper is to provide deep literature reviews that contain the types, zones, effects and migration of circulation loss. Then, this paper will predict the lost circulation zones using five different Artificial Intelligence (AI) techniques namely Artificial Neural Networks (ANN), Radial Basis Function (RBF), Fuzzy Logic (FL), Support Vector Machine (SVM) and Functional Networks (FN). Moreover, the results obtained from all AI methods will be compared with each other to get the most accurate model based on the highest correlation coefficient (R), the lowest average absolute percentage error (RMSE) and the confusion matrix.

The obtained results showed that the five models of artificial intelligence were able to predict the zones of circulation loss with high accuracy in terms of R, RMSE and confusion matrix. Artificial neural network (ANN) was the most accurate AI model to predict the losses zones with a correlation coefficient more than 0.99 and root mean squared error less than 0.05. Moreover, all the AI models were able to predict the losses zones in two another wells that were used as a validation for the ability of the AI models with a correlation coefficient of 0.946 and root mean squared error of 0.165 for the first well and an accuracy of R = 0.952 and RMSE = 0.155 for the second well.

Biography

Abdulmalek Ahmed obtained his Bachelor and Master degree in Petroleum Engineering from King Fahd University of Petroleum & Minerals (KFUPM). Currently, he is working as a Research Assistant and pursuing his PhD degree in Petroleum Engineering at KFUPM. His research interests include drilling and Artificial Intelligence. He has published more than 11 conference and journal papers.