UNIVERSITI TEKNOLOGI MARA

MODIFIED BOURGOYNE AND YOUNG MODEL USING LOSS SEVERITY MULTIPLE REGRESSION BY INCLUSION OF CUTTINGS TRANSPORT RATIO FOR DRILLING RATE PREDICTION

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Drilling in carbonate rock is quite challenging due to the presence of a naturally fractured zone and a vug porosity system, both of which can cause lost circulation. These losses could make hole cleaning more problematic. The lack of a hole cleaning parameter in the Bourgoyne and Young (B&Y) model for drilling rate prediction, as well as multicollinearity in the regression process, causes the model to be inaccurate, especially when applied to carbonate rock drilling. Therefore, the study aims to improve ROP prediction accuracy in loss zones of carbonate formation by modifying the B&Y model based on loss severity levels by including cutting transport ratio (R_T) parameter and eliminating multicollinearity parameters. The R_T parameter was proposed from a relationship between equivalent circulating density (ECD) and drilled solid concentrations at different formations through experimental analysis and field data. The experimental analysis was conducted by taking the drilled solid samples from four formations, namely Radhuma, Tayarat, Hartha and Sadi in North Kuwait onshore field. The rheological behaviour of the drilled solids-laden mud was conducted according to API Recommended Practice 13B. As a result of the laboratory tests and actual field data, new empirical equations between drilled solid concentration and equivalent circulating density were proposed. ECD from laboratory works matched with the ECD field at an R^2 value of 0.93, proving the data's reliability. For model development, 80 drilling datasets from the North Kuwait field were used, and another 38 datasets were used for model verification. The modified model can improve the model accuracy about 29-31% and accurately predicted the ROP with a mean absolute error (MAE) of 3.21%, 4.08% and 3.50% for seepage loss, partial loss and severe loss, respectively and outperformed all the existing four ROP models. The modified model's application to other field location data resulted in model improvement about 37% using Kinabalu East-1 field data and substantial R^2 value of 0.996 using Khangiran Iranian gas field data. Finally, the modified model can be used as a tool for drilling optimization and can reduce drilling costs and time by around 7% and 19%, respectively.

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