Unlocking Behind Casing Potential with Holistic Machine Learning Approach in Complex Ultra Brown Oil Field

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Abstract

Objectives/Scope: The quest for extra barrel of oil have enter a challenging period where the easy located oil has been explored and extracted while potential at a more complex environment such as low resistivity contrast, tight reservoir has yet to be fully matured due to several limitations. Behind casing opportunity (BCO) is an approach where additional perforation is performed at wells that been drilled several years back. The potential at BCO was either identified by running cased-hole saturation tool (RST) with higher cost or re-evaluating the zone by using new methods or technology. Reservoirs in Malaysia Basin mostly consists of fine grains, bioturbated with brackish aquifer that further complicate the characterization process. To address and possibly overcome the issue, the function of machine learning (ML) has been put into testing at Beta Field to re-evaluate and identified pay zones that perhaps previously were considered as non-potential.

Methods, Procedures, Process: Datasets consist of raw and evaluated logs data from 5 core wells have been selected as training data. These wells were considered as reliable by comparing with routine core analysis (RCA) data and human petrophysical expert. Reservoir properties such as porosity, permeability and together with saturation and lithology were set as targets while raw well logs used as input to the target. The datasets undergone thorough pre-processing to remove any outliers that may affect the final prediction. Random forest was selected as machine learning algorithms for curve predictions. 70% from training datasets randomly selected for training while remaining 30% kept for blind test. The result at blind test showed a higher correlation between prediction and actual hence indicating the reliability of the model algorithm. The model was then deployed to another 33 wells within Beta field and the properties from machine learning prediction were compared with conventional evaluation.

Results, Observations, Conclusions: From the 33 wells deployed, 6 zones from 4 wells have been identified as potential BCO candidates where saturation from ML indicated a higher hydrocarbon saturation compare with conventional. Further analysis at the zones showed that most of the intervals are having high heterogeneity pattern with resistivity value is average at 8-9 ohm.m. The neutron density crossover was not clearly observed, with only slight changes seen. ML Porosity and ML permeability are generally following conventional trend at sand and shale interval. Hydrocarbon pore thickness (HPT) value was utilized as a comparison tool between ML and conventional evaluation.
**Novel/Additive Information:** The application of machine learning as a quick tool to analyze potential behind casing opportunities targets brings numerous advantages. It can save time by selecting zones that need to be focused, avoiding tedious and repetitive tasks performing conventional analysis at all well.