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Combining machine learning and physics for robust optimization of completion design and well location of unconventional wells

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Summary

Various types of predictive models have been applied over the years to make quantitative decisions for unconventional development plans. These models are either very simple (e.g., type-curves) which ignore the reservoir physics or are too complex (e.g., simulation models) to be able to run for an entire field efficiently. In this paper, we propose a model for design, prediction and optimization of unconventional wells efficiently using a combination of reservoir physics with machine learning methodologies.

Theory / Method / Workflow

The proposed model is the amalgamation of the state-of-the-art in machine learning and reservoir physics into a seamless full field model. The physical model ensures that model predictions are always realistic and reliable while the machine learning algorithm allows us to utilize different types of data to make a prediction which cannot be directly integrated into the physical model. The model uses a probabilistic approach to estimate P10-P50-P90 production curves to account for uncertainty in predictions.

Results, Observations, Conclusions

The data from more than 1800 unconventional wells in a real field is used to train and test our proposed model. The input features are completion design parameters like lateral length, proppant concentration, well spacing, etc., and the output in a full time series of expected oil production from the well. The results show that our model's prediction leads to correlations of more than 0.75 for the test set which is indicative of its good predictive accuracy. The sensitivity analysis of the parameters of the model on the cumulative production shows that volume of injection fluid, length of the lateral and the proppant concentration are among the most important parameters.

Novel/Additive Information

Combining physical model and machine learning algorithms to do probabilistic predictions for unconventional wells is the novelty of the work.