TPE-XGBoost Breakdown Pressure Prediction Study Based on Physical Constraints

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Abstract

Horizontal drilling fracturing is a highly successful method for enhancing production in gas reservoirs with tight sandstone. Accurately predicting the pressure at which the formation will break is crucial for designing fractures and improving the effectiveness of the fracturing process. This paper presents a fusion-driven method for predicting breakdown pressure in horizontal drilling. The method combines data mining and mechanism modelling to overcome the computational challenges of traditional models and the limitations of pure data-driven models. It uses the solution results of the mechanism model to physically constrain the machine learning algorithm. The study findings indicate that the sample data produced by the mechanistic model successfully meet the limitations of the machine learning algorithm. The greatest accuracy in model predictions is attained when the fusion ratio of field data and mechanistic model data is 1:1.5. The TPE-XGBoost fusion model, optimized using the TPE algorithm, demonstrates superior generalization ability and robustness in predicting breakdown pressure compared to the single-mechanism model and the purely data-driven model. It achieves an average percentage prediction error of 7.45%. Evidence demonstrates that the fusion model can effectively and precisely predict breakdown pressure in casing-completed horizontal drillings. Furthermore, it enhances the success rate of horizontal drilling fracturing construction and facilitates the subsequent high-efficiency development of the target gas reservoir, leading to long-term stable production.

Keywords

Tight Sandstone, Breakdown Pressure, Mechanistic Modeling, Data Mining