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Intelligent Optimization Methods For Tight Oil Production Prediction Based On PINN

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Objectives/Scope: The paper aims to create optimized PINN methods that leverage intelligent optimization to achieve superior, physics-compliant predictions of tight oil production, validated on real data, addressing the core challenges of data scarcity and complex physics in this domain. Propose novel methodologies integrating Physics-Informed Neural Networks (PINNs) with advanced intelligent optimization algorithms and Conventional data-driven ML models specifically tailored for tight oil production forecasting.

Methods, Procedures, Process: The paper's core revolves around integrating Physics-Informed Neural Networks (PINNs) with intelligent optimization algorithms to predict tight oil production. By gathering historical production data and collecting relevant static & dynamic well parameters,Oil production rate are automatically generated through PINN Intelligent Optimization Integration. The core process involves iteratively using intelligent optimization to configure or guide the PINN training for superior results.A validation set form certain oil field are set to objectively guide the hyperparameter/search process performed by the intelligent optimizer

Results, Observations, Conclusions: Standard data-driven models (e.g., LSTM, XGBoost, MLP) trained only on data itself. A PINN trained without the proposed intelligent optimization, using standard optimizers (Adam/L-BFGS) and fixed, potentially suboptimal, loss hyperparameters.

The optimized PINN models consistently achieved significantly lower prediction errors (RMSE, MAE, MAPE) on the test set compared to Pure Data-Driven Models (LSTM, XGBoost, MLP) and Analytical Models with estimately 40% reduction in RMSE. It Improved Training Efficiency & Stability with Faster Convergence, Reduced Computational Cost and Increased Robustness to initial weight initialization and random seeds.

Intelligently optimized PINNs represent a significant advancement in tight oil production prediction, demonstrably overcoming limitations of existing approaches by synergistically combining data, physics, and advanced optimization. The results validate the core hypothesis and provide a practical methodology for improved reservoir forecasting.

Novel/Additive Information: The paper not just applying PINNs to a new problem. It's solving PINN's core weaknesses (via novel optimization integrations) specifically to make them viable and superior for this challenging problem. PINN are used to set validation of intelligent optimization techniques to overcome fundamental PINN training challenges, thereby enabling highly accurate, robust, and physics-compliant production forecasting in tight oil reservoirs.