

ENHANCING ONLINE CONTROL AND OPTIMIZATION OF OIL RESERVOIRS USING MACHINE LEARNING

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Abstract

Optimizing well controls is a central task in reservoir management to maximize hydrocarbon recovery, economic value, and under operational restrictions. However, standard workflows relying on high-fidelity numerical simulators are often computationally prohibitive due to the need for thousands of function evaluations, particularly in heterogeneous reservoirs. This work proposes a robust optimization framework leveraged by a novel class of hybrid neural operator surrogate models. We employ Machine Learning surrogates instead of very costly computational simulators. We apply this framework to the challenging SPE10 Model 2 benchmark, addressing a high-dimensional input space that includes stochastic geological realizations by varying permeability and porosity maps and dynamic operational parameters, specifically bottom-hole pressures (BHPs). By learning the mapping between these geological and operational inputs and the resulting flow dynamics, the surrogate model serves as a rapid, differentiable proxy for the reservoir simulator. This allows for efficient evaluation of diverse production scenarios. We demonstrate that the proposed hybrid surrogate accurately captures the multiphase flow physics required for optimization while reducing the computational cost by orders of magnitude compared to traditional finite-volume solvers.