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Synthetic Generation of Random Permeability Fields for Heterogeneous Reservoir Simulation

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Abstract

Fields of permeability and other reservoir properties are synthetically generated using a variety of numerical algorithms. These fields are used in reservoir simulators to observe the effects of heterogeneous properties on reservoir behavior during secondary and enhanced oil recovery. They are also used to help develop pseudo-properties for simulator grid blocks that are too large to directly represent smaller scale spatial variation of properties.

Three methods for generating random property fields are reviewed and demonstrated by example: auto-regressive matrix decomposition methods (ARMD), the turning bands method (TBM) and Fast-Fourier transforms (FFT). The methods are used to generate both continuous and discrete random fields, that are either stationary or non-stationary. The methods differ in cost, versatility, flexibility, accuracy, and CPU and storage costs.

The synthetically generated fields can be conditioned on observed data in order to represent actual reservoir conditions. Where additional synthetic data is required in order to resolve numerical detail, additional data points can be infilled. In some circumstances both properties and states (e.g., pressures) can be co-generated, using cross-covariances based on the physics of flow and displacement. Examples of each of these features are given.

Applications to well field simulations demonstrate that synthetically generated properties provide a powerful means for examining the effects of property heterogeneity on reservoir behavior.

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