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Static Connectivity and Heterogeneity (SCH) Analysis and Dynamic Uncertainty Estimation

Hong Tang, SPE, Chevron and Ning Liu, SPE, Chevron

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Abstract

Based on previous studies, multiple SCH parameters are used to quantify reservoir performance. Static connectivity is quantified by fraction of connected pore volume between wells. Static heterogeneity is defined by Dykstra-Parson Coefficient, Lorenz Coefficient weighted by cell volume. Two-phase streamline simulation is used to exam the dynamic performances and validate the SCH analysis.

The impact of static modeling parameters on flow responses is studied. Geological factors include net-to-gross (NTG), interbed connectivity, intrabed heterogeneity, and reservoir log cutoff. Intrabed heterogeneity is usually misrepresented due to maximum entropy assumption, stationary assumption of geostatistics and upscaling. The intrabed heterogeneity is modeled by Vdp based permeability multiplier. The flow responses of these modeling factors are examined by a D-optimal design. The study is applied to a shallow marine reservoir in the South Africa. The study indicates that SCH study is particularly useful for green field with high heterogeneity and low NTG. Probably, due to complex flow geometry and interwell connectivity, single static parameter is not good enough to be a satisfying proxy for dynamic response. However, a simple stepwise regression successfully generates a robust static proxy for cumulative oil production total. The SCH study provides a quantitative estimation of uncertainty of reservoir ultimate recovery distribution. The permeability intralayer heterogeneity is sensitive to the recovery factor. At early stage of reservoir development, the quick SCH analysis help geologists rank the reservoir models upfront and save the model cycling time. Furthermore, these methods can be used for infill drilling design and production forecasting.

Introduction

Geostatistical models are built to simulate the fluid flow and capture the uncertainty range of flow responses. Current common practice is to ranks geological models based on hydrocarbon in place (HCIP). The rank is served as a proxy of the reserve or recoverable hydrocarbon. However, studies showed the HCIP may not be a good proxy for reserve. Larue and Legarre (2004) stated the reservoir connectivity may change the recovery dramatically if the gross NTG is smaller than 30%. Results obtained demonstrate that the rank of OIP is very different from rank of recoverable oil. Jennings et al. (2007), Li and White. (2003) concluded the reservoir heterogeneity and flow baffles significantly change the flow recovery. In addition, The visually complicated geological models may not be significantly different in terms of flow responses(Jian et al. (2000)). Model and quantify the reservoir connectivity/heterogeneity upfront and select representative static models for simulation is critical for successful field development plan and better business decision.