Brownfield Development Optimization under Uncertainty – Practical Steps

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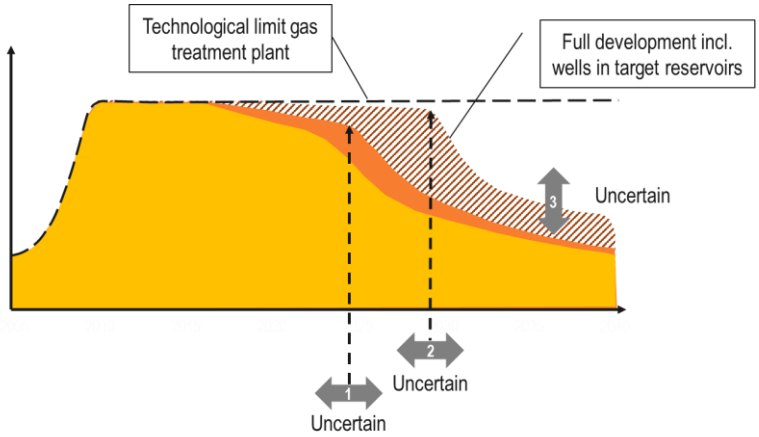
An increasing number of field development projects include rigorous uncertainty quantification workflows based on parameterized subsurface uncertainties. This work presents an integrated workflow design for a brownfield development optimization project under uncertainty. Challenges related to complex simulation models with long run times are addressed. Proxy-modeling techniques are introduced for performance improvement with application to history matching and FDP optimizing. Selection strategies of multiple history-matched prediction candidates for estimating prediction uncertainties are presented.

The scope of the presented project work was to:

- assess production profile uncertainties of a complex gas-condensate field production plan,
- get better insight into reservoir uncertainties and
- develop and implement workflow processes to optimize a field development under uncertainty

The production profile shows the expected delivery of a field development plan defined under several production constraints, e.g., the maximum delivery rate. Field development optimization efforts focus on the extension of the plateau production length under economic requirements. In this project reservoir units with different maturity are coupled and are added to the full field production at different start up times to support plateau production. The time when production drops from plateau is subject to uncertainty and defines an economic risk.



Experimental design techniques are introduced for sensitivity analysis and dimension reduction. History matching processes are built on series of parameter screening and derivative-free optimization techniques. We introduce Markov Chain Monte Carlo techniques for optimization and uncertainty quantification. FDP optimization workflows define challenges due to the nature of a high-dimensional discrete option space. We present combined usage of experimental design and proxy modeling techniques for extensively screening a multi-dimensional control parameter space. Visualization techniques are used to present a solution-frontier of optimized FDP scenarios meeting multi-objective optimization criteria; economic and production.

The structured workflow was designed and applied to an undisclosed field development optimization project. Modeling aspects of compositional flow properties are reviewed and the impact on the uncertainty quantification objective is discussed. The work motivates the benefit of experimental design and optimization techniques with application in various phases of the structured workflow from history matching to field development optimization under uncertainty. Complexities in prioritizing selection criteria of cross-disciplinary static and dynamic uncertainty parameters are discussed under practical criteria. A strong focus is given to dynamic uncertainties including multiple PVT-models which was the basis for both, history matching and estimation of forecasting uncertainty.

A full description of this work can be found under SPE187856 which was accepted for publication at the SPE Russian Petroleum Technology Conference, 16-18 October 2017, Moscow.