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Implementation of Ensemble-Based Reservoir Modelling on the Ærfugl Field

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Abstract

An ensemble-based modelling method has been implemented and utilized in reservoir management of the Ærfugl field. Ærfugl is a 60-km long, 3-km wide gas condensate accumulation in a Cretaceous deep marine deposited reservoir with high net-to-gross. The field has a 6-year long production history from one test producer. A key objective of the modelling effort was to take an uncertainty-centric approach that could integrate all available data. The methodology of this approach is presented, and its benefits and challenges are discussed. The quality of the automated history matching is shown, and the resulting uncertainty ranges are discussed. Practical use of the ensemble for forecasting and decision making is also presented.

A set of 100 reservoir models was created with Monte Carlo sampling. All uncertain parameters that were deemed important were varied, such as geological input surfaces, geostatistical parameters, petrophysical parameters, relative permeability curves, etc. All models were then conditioned to dynamic pressure and production data using an ensemble Kalman based method. The updates made by data conditioning apply to all uncertain parameters as defined in the generation of the initial ensemble, including facies and structural modelling.

The data conditioning arguably produced an adequate history match for the entire model ensemble. The posterior uncertainty range (after integrating dynamic data) remained high for most variables, but uncertainty related to in-place volumes was shown to be highly constrained by the dynamic data. Production forecasts were generated, and probabilistic production profiles were extracted. Four deterministic cases that were representative of the range of important parameters were extracted from the ensemble for use in certain applications where probabilistic modelling is not appropriate, or time constraints impose limitations. The model ensemble and associated production profiles were used as input to project economics, for a value-of-information study, and for well planning.

In addition to going through the work process and results, this paper aims to shed light on the method's practical effectiveness, the potential impact on the way we do reservoir management, and to highlight some specific issues that arise in practical application. The overall set-up is effective at eliminating waste by enabling rapid model updates as new data comes in and making use of existing data that would otherwise be under-utilized.

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