Reservoir Performance Forecasting – How Well Are We Really Doing?

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SUMMARY

Reservoir forecasts tend to be optimistic. Forecasts for IOR/EOR projects tend to be particularly optimistic. Sources of the optimism can be divided into several broad categories including: Data – quantity, quality, sampling bias; Static Modeling – model complexity, particularly for permeability contrasts; Model parameter/algorithms choice; and, Dynamic Modeling – model detail/complexity, up-scaling, well location optimization. In addition, human factors also tend to drive projects towards optimistic forecasts. Based studies of a number of reservoirs representing a variety of lithology types and depositional environments with data densities ranging from low (greenfield) to extremely high (multi-pattern pilots) observations on modeling and forecast accuracy can be made relative to IOR/EOR forecast results, in particular. Among the most critical modeling parameters are the areal grid size and the semivariogram range parameter. Optimistic estimates of the in place hydrocarbon volume is also one of the most significant sources of optimistic forecasts. Some of this latter bias is due to sampling, particularly for green-field developments, and some due to inappropriate use of analogs. This bias can be reduced with uncertainty-based analyses and workflows and an appropriate suite of analogs. Well location optimization based on stochastic models is an under-appreciated source of forecast optimism.
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Abstract

Reservoir forecasts tend to be optimistic, sometimes considerably so. Forecasts for IOR/EOR projects tend to be particularly optimistic. Sources of the optimism can be divided into several broad categories including: (1) Data – quantity, quality, appropriateness, sample bias; (2) Static Modeling – model detail/complexity, particularly for permeability contrasts (barriers and baffles to flow), model parameter and algorithms choices; and, (3) Dynamic Modeling – model detail/complexity (e.g. grid size), upscaling, well location optimization. In addition, difficult to quantify human factors also tend to drive projects towards optimistic forecasts.

Based on a number studies of a number of reservoirs representing a variety of lithology types and depositional environments with data densities ranging from low (typical greenfield project), to moderate/high (mature fields), to extremely high (multi-pattern IOR/EOR pilots) a number of observations on modeling and forecast accuracy can be relative to IOR/EOR forecast results, in particular. Among the most critical modeling parameters in general is the areal grid size, particularly for dynamic models. Models with a small number of grid cells (e.g. less than 5-10) between producer and injector wells tend to optimistic compared to models with many grid cells (e.g. more than 10-15) between producer and injector wells. Comparison of forecasts derived from models generated using semivariograms developed from high density pilot project data (average well spacing <20 m) as compared to semivariograms developed from moderate density full field data (average well spacing 400-500 m) show that models constructed with semivariogram ranges that are “too large” tend to be optimistic compared to models constructed using smaller semivariogram ranges. Steamflood forecasts are relatively insensitive to the semivariogram range parameter.

Optimistic estimates of the in place hydrocarbon volume is one of the most significant sources of optimistic forecasts. Some of this bias is due to sampling, particularly for green-field developments, and some is due to inappropriate use of analogs. This bias can often be reduced by use of uncertainty-based analyses and workflows and an appropriate suite of analogs. Manual or automated well location optimization based on stochastic models is an under-appreciated source of potentially significant forecast optimism.