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Impact of Reservoir Uncertainty on Selection of Advanced Completion Type

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Abstract

Well performance prediction is a key Petroleum Engineering task. However, large discrepancies between Petroleum Engineering models and reality still frequently occur; despite the continuous increase in the complexity and predictive quality of reservoir models. To-day's field development decisions are still made with a high level of uncertainty in the underlying data and its economic impact.

The degree of data uncertainty is greatest during the exploration stage, but decreases as the reservoir development plan is executed and production data is obtained. Standard, probabilistic workflows have been developed to quantify this uncertainty. These workflows are usually framed by the reservoir scale development plan and end prior to the well's detailed completion design. This is despite the fact that expensive, advanced completions have become common during recent years and the additional investment in such completions can only be justified if it is shown to be paid-back by improved overall project economics which is subject to a significant level of uncertainty.

This paper illustrates the quantification of the long-term benefits of advanced completions using the probabilistic approach. It will be shown how choice of the optimum advanced completion design will reduce the impact of geostatistical uncertainty on the production forecast. Geostatistical realisations of a benchmark reservoir model were generated with a suitable level of data uncertainty. The reservoir was developed by a single horizontal well in a fixed location. The well could be equipped with a variety of completions – an Open Hole with a sand control screen or a perforated pipe, Inflow Control Devices (ICDs) and Interval Control Valves (ICVs).

The probabilistic (P10, P50, P90) oil-recovery distribution was then used to identify the optimum completion design. This completion not only achieved the largest recovery, but also showed the least uncertainty in this value.

1. Introduction

Well performance prediction is one of the major tasks when preparing an oil or gas field development plan. The complexity and predictive quality of models used to support this activity have increased significantly during the last two decades, partly driven by the ever decreasing cost coupled with the increasing power of computers. However, large discrepancies between the model and reality still frequently occur. They stem from:

- The lack of data (e.g. the unknown distribution of petrophysical properties in reservoir).
- Deliberate simplifications to make the problem more tractable (e.g. upscaling, black oil PVT models, neglect of thermal effects, etc.).
- Computational (sub-grid) errors and
- An incomplete understanding of the physics and chemistry of the subsurface. Petroleum researchers still work on the more precise description of the laws governing hydrocarbon production (e.g. multiphase flow, relative permeability effects associated with gas condensate flow in porous media, effect of water salinity on oil recovery, etc.).

Many E&P development decisions are made under a high level of uncertainty. The degree of uncertainty and its impact on decision making is naturally greatest at the exploration stage of the field development process. This is one reason why a probabilistic analysis is part of reserves estimation and other standard workflows used in making early development decisions. The predictive accuracy of reservoir models should increase as the field development proceeds since the quality and the quantity of reservoir data will continually increase. Reservoir models should be continually updated by field production data, history matching, and the ever increasing number of (logged) reservoir penetrations. However, uncertainty quantification always remains an important task; even during the later, more mature phase of reservoir development.