IPTC 11978

Navigating the Fog of Reservoir Uncertainties to Decision Makings with Advanced Mathematical Models in New Field Development

Tony R. Pham, Fahad A. Al-Ajmi, Mahdi A. Al-Shehab, Saudi Aramco

This paper was prepared for presentation at the International Petroleum Technology Conference held in Kuala Lumpur, Malaysia, 3–5 December 2008.

Abstract

Reservoir development, most of the time coming at the heel of an exploration effort, faces enormous challenges in terms of uncertainties in all aspects of the event, especially with respect to the reservoir parameters. A survey by Bickel and Bratvold(1), highlighted the difficulty in the industry of making the connection from the uncertainty quantifications and analyses that are probabilistic to decisions that are deterministic. The survey also highlighted the observation that the decision making process has not improved in proportion with the industry's capability pertaining to probability analyses.

This paper highlights the fit-for-purpose reservoir models and the methodology, which simplifies the link between probabilistic modeling and deterministic solutions used for decision making, as recommended by Bickel and Bratvold's survey. The examples used here, complement the current development program of an oil increment consisting of several fields and reservoirs. In addition, these examples illustrate multiple development objectives, including the *deliverability and sustainability* of oil production and the *maximizing of recovery*, which have to be optimized.

This paper discusses the linked applications of Multi-Objective Function and probabilistic modeling techniques, e.g., Experimental Design and Monte Carlo simulations, together with 3D dual porosity-permeability simulation models for practical reservoir development, management and planning.

The paper will highlight some of the main drivers used in the Multi-Objective Function model. This model allows engineers to formulate from a multitude of divergent, sometimes conflicting, economic and reservoir recovery optimization objectives, into an optimized decision that satisfies all requirements. It could be used to optimize oil off-take from different reservoirs and areas with respect to depletion rates, injection production ratio, number of well requirements for both injectors and producers, pressure support, sweep efficiency, flood front conformance and recovery in the reservoir. The Experimental Design and Monte Carlo simulations, on the other hand, are used to quantify how all the uncertainties in reservoir parameters will impact the reserves, production stream and consequently the developmental field economics. Specific examples are used, of how to use the combined outputs from different modeling techniques, encompassing all the uncertainties, to provide deterministic solutions for the decision-making process.

Introduction

As mentioned above, the Multi-Objective Function, Experimental Design, and Monte Carlo simulations are powerful techniques in helping the optimization of an oil increment development where well density is sparse, geometry is diverse, and reservoir information is few.

Although there are wide ranges of uncertainties in reservoir parameters, major decisions are solely based on deterministic solutions. These solutions are derived from analytical, simulation or "mental" (engineering