Reservoir Modeling Constrained to Dynamic Data and Uncertainty Quantification - New Solutions to Improve Reservoir Management

Frédéric ROGGERO[1]

[1]IFP, 1-4, avenue de Bois-Préau, 92500 Rueil-Malmaison, France
frederic.roggero@ifp.fr

1. Introduction

Building reservoir geological models that are consistent with all available information is necessary to reduce uncertainty in production forecasts. It is well known that history matching problems have generally non-unique solutions. Therefore, the integration of multiple sources of information and the quantification of uncertainty are key points to improve this inverse process. In addition to production data, time lapse seismic information[1] may be very useful to better understand the fluid movements in 3D and time. This new source of information may be advantageously used to update reservoir models and reduce uncertainty on production forecasts. To achieve this goal, the main challenge is the ability to use 4D seismic data quantitatively in the reservoir modeling workflow.

2. Key Features

This presentation proposes an integrated inversion methodology for constraining 3-D stochastic reservoir models to well test data, production history and 4D seismic information. This approach is based on the geostatistical approach, which is the most appropriate way for integrating various kinds of data ranging from geological knowledge to production history. Uncertainty quantification[2] is addressed using the experimental design technique and by considering several constrained realizations. Experimental design may be used as well to help the decision making process, through a better uncertainty assessment in the optimization of field developments.

This approach allows to history match complex reservoir models in a consistent way by updating both geological and reservoir models simultaneously. Advanced parameterization techniques are used to modify either the geostatistical model directly or the fluid flow simulation parameters in the same inversion loop. In a first step, the relevant inversion parameters are selected according to a sensitivity study based on the experimental design technique. In a second step, history matching is performed with the most significant parameters using an automated inversion procedure. In this step, the gradual deformation method[3-4] is used to constrain the geostatistical model while respecting the global model properties. This technique may be combined with other inversion methods in order to history match other deterministic parameters simultaneously.

Benefits and perspectives of this integrated approach are illustrated on field case examples. Recent results and specificities of 4D attributes history matching[5] will be addressed in this presentation.

3. Conclusions

The proposed methodology allows to update reservoir models in a consistent way to account for dynamic information at different scales. Geological, geophysical and reservoir engineering data are considered in the same history matching workflow to build more predictive models. Recent applications show the potential of this approach in terms of uncertainty reduction and improved reservoir management.

3. References and Bibliography

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Speaker's Biography

Frédéric Roggero is principal research engineer in the IFP reservoir engineering department. Graduated from the Ecole Nationale Supérieure des Arts et Métiers (ENSAM, Paris) and from the Ecole Supérieure des Techniques Aérospatiales (ESTA, Orsay), he is now in charge of the coordination of research projects on reservoir simulation and monitoring. More specifically, he has contributed in the development of methodologies focusing on reservoir modeling constrained to production and 4D seismic data and on uncertainty management.