GeoConvention 2015
GEOSCIENCE
new horizons
Telus Convention Centre • 4-8 May 2015 • Calgary, AB Canada

Keeping it real: deterministic geomodel of the Little Bow Upper Mannville I Pool: simulating layered behavior in a valley fill sequence to optimize ASP flood design

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Summary

The Little Bow Upper Mannville I Pool is a mature oil reservoir producing from the Glauconite Formation. The I pool reservoir sandstone is approximately 6.4 kilometres long and half a kilometre wide, with maximum sand thickness of 43 metres. It is interpreted to be a valley fill, deposited in fluvial to estuarine conditions. The pool was discovered in 1974, has been waterflooded since 1983, and by 2012 was producing at a 98% water cut. Zargon Oil and Gas Ltd. wanted to better forecast incremental production expected from a proposed ASP (Alkali Surfactant Polymer) flood, and to optimize the design of the flood. A simple three-dimensional geological model of the Little Bow Upper Mannville I pool and P pools was constructed using CMG's Builder software. The model was based on the integration of a detailed geological study with a 3-D seismic interpretation. The model was run through a black oil simulator and history matched prior to being used to forecast and optimize the ASP flood, which is now underway.

Introduction

A good history match is critical to forecasting performance and optimizing flood design for any tertiary recovery project. If the reservoir architecture is accurately represented in the model, and if changes to the model through the history matching process are geologically acceptable, then the history match will be more credible, increasing confidence in the resulting forecast .

Theory and/or Method

Six layers were correlated throughout the project area. Isopach and average porosity maps were created for each layer, and imported into CMG's Builder software. The model was hung on structure on the top of the valley fill, as interpreted from well logs and the 3D seismic volume. Spill points were constructed to contain the distinct fluid contacts observed in 10 identified regions. Based on log characteristics, core study, thin sections, core analysis and special core analysis, three rock types were defined. Relative permeability curves were then assigned to each of the rock types. Gas volumes in the model were adjusted to meet free gas required by region, as calculated from production history. Low permeability surfaces were built on the top of each valley fill cycle based on presence or absence of a surface and interpreted strength of that surface from well logs. The strength and extent of these surfaces were locally tuned through the history matching process to match the layered behaviour observed throughout the production history of the reservoir.

Results

At the field scale, excellent history matches for oil rate, gas rate, and water cut were achieved. Individual well matches were also predominantly excellent. The history matched model was used to forecast and optimize Zargon's ASP flood, which was implemented in March 2014. Initial incremental oil recovery is currently being obtained, and the model is being revised and improved based upon ongoing field observations. This model will also be used to optimize the design of the forthcoming phase 2 of the ASP flood.

Conclusions

This presentation demonstrates the value of accurate representation of reservoir geology in order to construct a realistic fluid flow model and achieve a credible history match in a reservoir simulator. The simplest model should be constructed, and geologically acceptable modifications applied as required to improve the production history match. Collaboration of engineers, geologists and geophysicists is recommended for optimal results.

Acknowledgements

The author would like to acknowledge and thank Zargon Oil and Gas Ltd. for their permission to display this data in the public domain, and for allowing the time and providing the support needed to prepare the presentation. Thanks to the team at Zargon for collaboration, brainstorming, and contributions to the model.