Use of Static and Dynamic Data in Geological Modelling and Numerical Simulation for Optimal Placement and Selection of SAGD Well-Pairs for AOSC's MacKay River Commercial Project

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Accurate well placement and selection of best well-pairs is essential for initial commercial development of SAGD. Selection of the optimal well-pairs and drilling order can be a challenging and uncertain process. This is especially true when methods are limited to qualitative and visual selection methods. AOSC has conducted a detailed geological and reservoir simulation study using a unique combination of static and dynamic modelling tools to locate and rank the initial SAGD well-pairs to support the first phase of commercial development of the MacKay River Commercial Project (MRCP).

AOSC's MRCP is located in Township 90, Ranges 13 and 14 West of the 4th Meridian. The main reservoir is the upper member of McMurray Formation which was deposited in a tide-dominated deltaic environment. A comprehensive geo-model has been generated by integration of petrophysical data, core analysis, core description, palynology and seismic data in Petrel. The geo-model has been used for future well planning, development purposes and volumetric determination as well as for reservoir characterization. The geo-model comprises facies, water saturation, porosity, vertical and horizontal permeability and fluid models. The upper McMurray reservoir consists of 6 reservoir facies which have been mapped and integrated into a 3-D Petrel geo-model. The construction of the water saturation model was a challenge due to spatial complexity of fluid saturation in the reservoir. Vertical and horizontal permeability models were constructed from Phi-K relationships generated from core porosity and core permeability.

SAGD performance of a single well-pair can be predicted by running a detailed numerical reservoir simulation using a static geo-model as a base guide. However, 3-D numerical simulation is time consuming and might be impractical to simulate every single well-pair for the initial planning stage of a commercial project. Therefore, AOSC used an alternative method to rank and predict well performance by using a combination of reservoir connectivity, thickness and initial oil saturation. Results were then validated via numerical simulation of selected well-pairs using Computer Modeling Group's thermal simulator STARS. In order to calculate reservoir connectivity within each well-pair recovery factor region, CMG's SPI (SAGD Performance Index) tool was used. The SPI calculation was expanded to include average thickness and initial oil saturation for more accurate SAGD performance ranking. Numerical simulation results validated the process and overall matched AOSC's ranking procedure. The results indicated that by combining reservoir connectivity, average thickness, and average oil saturation per well-pair AOSC was able to predict peak oil rates obtained from numerical simulation. This method was used to select and successfully place 46 initial well-pairs for the first phase of MRCP.

The above workflow can be applied to any reservoir to evaluate initial SAGD performance and assist in well placement and selection prior to running detailed numerical simulation models.