

Implementing Response Surface Model Approach in Validating South of Oman Geological Model

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Abstract

The objective of this study is to obtain a history match of one of South Oman simulation models in a very fast and convenient time and manner by utilizing a response surface modeling technique. This project involves using many reservoir parameters (like viscosity, critical saturations, transmissibility multiplier and injection multipliers) as variables with different ranges in order to obtain the history match. That will require a design of experiment that can generate a group of realizations that are enough to cover the boundaries of expectations. Performing these realizations in a conventional simulation manner would require extremely long simulation run times and much human effort to manage the huge outcomes expected from the experimental design. To overcome this problem, response surface modeling (RSM) is used to deliver outputs similar to those obtained by running all the scenarios, but in a much shorter timeframe.

Depending on the number of the variables and their values in any study, a Design of Experiment (DoE) will generate the possibilities of all scenarios associated with all variables. In this study, the total number of scenarios based on 20 variables would be more than a million scenarios! Running all of them is clearly an endless job and not practical at all, especially if we take in consideration that each scenario requires one hour of simulation time to run. In this study, RSM was used to do the work in only 144 hours (6 days) and obtain a history match. RSM only requires running about 144-288 simulation jobs (Runs) that are selected so as to represent the rest of the scenarios. The results of the 144-288 runs will be utilized by RSM to create an equation that links the results with variables. RSM can then easily extrapolate the needed results and will suggest the required variables to be used based on those results.

Overall, the match of the South Oman model was obtained to a certain degree of acceptance on cumulative liquid and oil production, steam injection, down-hole temperature, and bottom-hole pressure. Results were compared to the actual data from the field over period of 3 years from 2008 to 2010. During the study, CMOST, STARS and JMP software programs were used to obtain the match. Uncertainties associated with the historical data caused the match to be not quite perfect, but the overall match was good.

These uncertainties were mainly in the steam injection records and production rates. Some other sources of errors could be the bottom-hole pressure readings and down-hole temperatures, as some of them were calculated rather than measured. The geological model used in this project is "no flow boundary," unlike the reality of the field, and that caused over-pressurizing in some parts of the reservoir model. The actual wells in the field are in contact with adjacent wells, but the case is not the same in the model. These limitations could cause some deficiency in achieving the best history match.