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Application of Optimized Proxy Algorithm for History Matching Using Response Surface and Genetic Algorithm, a Case Study: in One of the Big Oil Reservoirs

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Abstract

One of the most important sections in fulfilled study (FFS) and master development plan is history matching which plays an important role in production scenarios and future production plan of reservoir. It would be a challenge for reservoir engineering due to lots of parameters and uncertainties during reservoir study which need lots of simulation runs to reach good match for responses in conventional mechanism of history matching. However, for accelerating history matching part, new methods which called as assisted or automated history matching (AHM) have been established. In this paper, an approach for automated history matching (AHM) was applied in a real brown field with 14 wells with multiple responses located in south of Iran. The main important features of the proposed algorithm were defining a proxy model which was a response surface method in which 21 model parameters were incorporated based on cubic centered face method. Response surface method (RSM) has been employed to create the proxy model. The optimization algorithms utilized in this research were genetic algorithm (GA) and particle swarm optimization (PSO). Proxy model was successfully constructed using 256 samples leading into R^2 of 0.9 on dataset with good results on GA.

Keywords: Assisted History Matching, Proxy Model, Optimization Algorithm, Genetic Algorithm.

Introduction

One of the most important sections in fulfilled study (FFS) and master development plan is history matching which plays an important role in production scenarios and future production plan of reservoir. It would be a challenge for reservoir engineering due to lots of parameters and uncertainties during reservoir study, which need many simulation runs to reach good match for responses in conventional mechanism of history matching. However, for accelerating history matching part, new methods which called as assisted or automated history matching (AHM) have been established.

Methodology

In this paper an approach for automated history matching was applied in a real brown field with 14 wells with multiple responses located in south of Iran. The main important features of the proposed algorithm were defining a proxy model, which is response surface method in which 21 model parameters were incorporated based on cubic centered face method. Response surface method (RSM) has been employed to create proxy model. The optimization algorithms utilized in this research were genetic algorithm (GA) and particle swarm optimization (PSO). Proxy model was successfully constructed using 256 samples leading into R^2 of 0.9 on dataset with good results on GA.

The assisted history matching workflow used in this work has the following steps:

I. Experimental design for diagnosing the most important parameters using CCF method

II. Building the proxy model using RSM

III. Optimizing the proxy model using GA (and PSO).

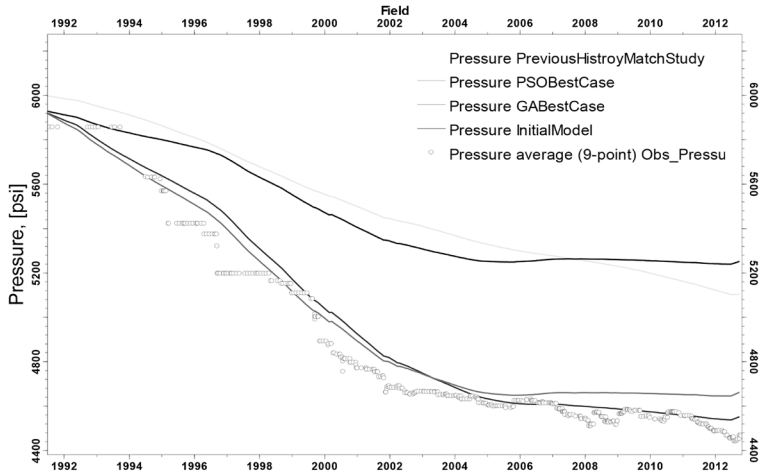
Discussion and Results

A global objective function was defined to consider the responses of all local objective functions for each well, ignoring the effect of time steps (instead of many objective functions that needs a long time to run). The objective function is a numerical parameterization of the optimization target used as a performance measure in optimization problems. In this paper, the objective value for a function defines the difference between the simulated values. In this paper, a good combination of assisted history matching, as a fast method, and increasing the accuracy and quality of reservoir properties and characteristics were presented. As a proposed solution, history matching was done in a very timesaving procedure with good matches. In this giant field with lots of well, using the proposed workflow, all uncertain and sensitive properties were checked and improved. History matching of reservoir pressure and the results for bottom hole pressure for well 11 and production for well 3 are illustrated in Figs. 1 to 3, respectively.

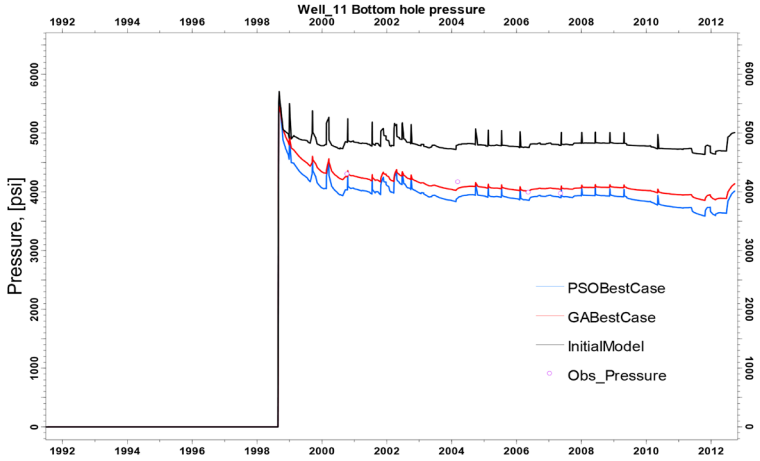
Conclusion

For the studied brown filed, the results are as follows:

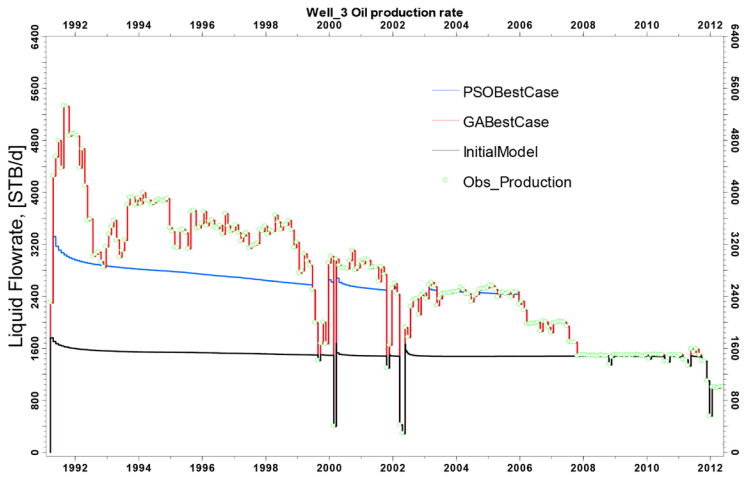
a. Although some work have been done on different algorithms for proxy modeling and optimization methods, the main important features of the proposed algorithm were defining a proxy model which is response surface method based on cubic centered face sampling method. The proxy model was then optimized by genetic algorithm. Finally, proxy model was successfully performed using 256 samples leading into R^2 of 0.91 dataset.



Figeure 1: History matching of reservoir pressure.



Figeure 2: History matching of bottom hole pressure of well 11.



Figeure 3: History matching of oil production of well 3.

b. As a result of history matching, the matches of production rate and pressure data were quite good. However, the match of water cut data is of more concern due to lack of continuous and precise measurement of actual water cut data as well as inconsistencies in the available data.

c. The workflow is easy to use and can be general for similar reservoir with about 10 to 15 wells. There is a limitation for using the presented workflow, which is not fast for reservoir more than 20 wells due to increasing the samples.

d. As recommendations are using this in-house algorithm to other super giant fields and checking other proxy model algorithms.

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