CHAPTER II

LITERATURE REVIEW

There are many studies which discuss methods to do history matching and optimization of hydrocarbon production using various strategies.

Boer et. al.[1] tried to achieve a history match using uncertainty quantification throughout the history matching process. The study presented the workflow process which consists of the following steps:

- Probabilistic multi-realizations of the reservoir model taking into account static uncertainty.
- Calculation of the impact of static uncertainties on the history match by means of reservoir simulation;
- Calculation of the impact of dynamic uncertainty on the history match using experimental designs;
- Evaluation of the relative importance of uncertain static and dynamic parameters;
- 'Hybrid' geostatistical simulations;
- Calculation of the impact of the dynamic reservoir parameters on the history match using an experimental design technique;
- Adjustment of dynamic parameters to obtain a final history match.

From this study, the results show the workflow proposed increases the chance of attain the history match.

Cullick, Johnson, and Shi[2] presented two workflows for assisted history match. One minimizes the misfit between simulated versus history data with a global optimizer, by adjusting reservoir and well unknown parameters in the simulation model. An alternative workflow is used to reduce the number of numerical simulations. The nonlinear proxy neural network is used to characterize parameter sensitivities to reservoir parameters and to generate solution sets of the parameters that match history. The study demonstrates that the neural network is an excellent proxy for the numerical simulator that yields excellent matches for well production profiles.

A new parameterization, kernel principal component analysis (kernel PCA or KPCA) has been used to automatic history matching and model permeability fields characterized by multipoint geostatistics. This work has been done by Sarma and Chen, from Chevron ETC along with Durlofsky and Aziz, from Stanford University[3]. A key feature of KPCA is that it is differentiable, implying that it can be used with gradient-based methods for history matching or other applications. It can be accomplished very efficiently using a set of realizations created by geostatistical simulation (honoring multipoint statistics). Results demonstrated that the KPCA approach was able to provide accurate history matches and also a fully automated, robust, efficient and accurate history matching procedure is required for use in closed-loop reservoir modeling, as the history matched models are used for field optimization computations.

Al-Shehri, Rabaa, and Duenas, from Saudi Aramco along with Ramanathan, from Schlumberger[4] study the development plan to extend the well's economic life of the Permian Khuff Formation. This Formation is the major non-associated gas reservoir in the prominent Ghawar Field of Saudi Aramco. It is divided into four correlative zones, namely Khuff-A, B, C, and D in downward sequence. Khuff-B and C are the two major reservoirs with distinctive hydraulic characteristics. Khuff-A and D zones mostly are either discontinuous or have poor to nonreservoir quality. The development plan has been employed by completing the Khuff-C at the initial period of the field development because of better reservoir quality with larger gas reserves. Later, the commingled production by adding the Khuff-A and B has become part of the overall strategy to offset the natural decline from Khuff-C and maximize gas production and extend the wells' life.

There has also been work done by Snider and Rindels, from Marathon Oil Company along with Folse, Hardesty and Clark, from Halliburton Energy Services[5] in which they presented perforating system selection for optimum well inflow performance. The study demonstrates that focusing perforator system performance on reservoir productivity rather than on the shaped charge, performance optimized for concrete testing can ultimately lead to significant well inflow performance. The study also provided the completions used in one of the actual fields that not only produced at optimum levels but also accelerated return on investment.

Underdown[6] investigated the effect of perforation in under-balance condition to get the optimum productivity. Results of this research indicate that the reservoir properties and perforation parameter such as penetration or net pay of perforation can result in optimum productivity. Perforations in gas-saturated, low-permeability core samples at irreducible brine may not require as high an underbalance as liquid-saturated cores to obtain zero or negative perforation skin. And the additional experimental work is required to quantify optimum under-balance requirements for obtaining zero perforation skin in gas formations.

Harms[7] presented a way to optimize solution by using cooperation of three engineering teams: reservoir engineering, production engineering, and facility engineering. IPM software was used to compare the results of various production options (i.e. well head compression or increase tubing size). The study demonstrates that IPM can provide integrated multi-discipline solutions to a gas well problems and solutions are better than typical single discipline or integrated single point in time approaches.

Wang[8] presented a methodology which uses nodal analysis, material balance, pressure transient analysis, and integrated production model (IPM) to determine reservoir boundary, original fluid in place (OFIP), and completion strategy for one of the reservoirs in West Seno field. Results of this research indicate that although reservoir size and OFIP were evaluated with various methods, the final results are very similar. It shows the successful history matching with IPM and 3D simulation models.