A new reservoir simulation and modeling technology that is entirely based on measured data, called Top-Down, Intelligent Reservoir Modeling for the shale formations is introduced. Examples presented for Lower Huron and Bakken Shales. Top-Down Modeling technology integrates reservoir engineering with artificial intelligence and data mining. Advantages of this new modeling technology include its flexible data requirement, short development time, and ease of analysis.

Traditional reservoir simulation and modeling is a bottom-up approach. It starts with building a geological model of the reservoir followed by adding engineering fluid flow principles to arrive at a dynamic reservoir model. The dynamic reservoir model is calibrated using the production history of multiple wells and the history matched model is used to strategize field development in order to improve recovery.

Top-Down Modeling approaches the reservoir simulation and modeling from a difference perspective by attempting to build a realization of the reservoir starting with well production behavior (history). The production history is augmented with core, log, well test and seismic data (upon availability) in order to increase the accuracy and fine tune the Top-Down model. The model is then calibrated (history matched) using the most recent wells as blind dataset.

Although not intended as a substitute for the traditional reservoir simulation of large, complex fields, this novel approach can be used as an alternative (at a fraction of the cost and time) to traditional reservoir simulation in cases where performing traditional modeling is cost prohibitive. In cases where a conventional model of a reservoir already exists, Top-Down Modeling should be considered as a complement to the traditional technique. It provides an independent look at the data coming from the reservoir/wells for optimum development strategy and recovery enhancement.

**BAKKEN SHALE**

Much attention has been focused on Bakken shale in the last decade. Recent released reports discuss the high potential of the Bakken formation coupled with advancements in horizontal drilling. Bakken formation is comprised of three layers. Middle member which is believed to be the main reservoir is mostly a limestone and the upper member is black shale. The upper member is a source and seal which has been subject to production in some parts as well.

Top-Down, Intelligent Reservoir Modeling technique was applied to a part of Bakken shale formation in Williston basin of North Dakota. The model is used to identify remaining reserves and sweet spots that can help operators identify infill locations. Furthermore, a predictive model was generated; history matched and economical analysis for some proposed new wells is performed.

**FIELD APPLICATION**

Engineering fluid flow principles are added and solved numerically to arrive at a dynamic reservoir model. The dynamic reservoir model is calibrated using the production history of multiple wells in a process called history matching and the final history matched model is used to strategize the field development in order to improve recovery.

Some of the characteristics of the traditional reservoir simulation and modeling are:

- Significantly high initial investment (time and money) to develop a geological (geo-cellular) model to serve as the foundation of the reservoir simulation model,
- Development and history matching of a reservoir simulation model (a complex process that requires extensive experience),
- A prolific asset to justify a significant initial investment required for a reservoir simulation model.

Top-Down, Intelligent Reservoir Modeling that can serve as an alternative or a complement to traditional reservoir simulation and modeling starts with well-known reservoir engineering techniques such as Decline Curve Analysis, Type Curve Matching, History Matching using single well numerical reservoir simulation, Volumetric Reserve Estimation and calculation of Recovery Factors for all the wells (individually) in the field.

Using statistical techniques multiple Production Indicators (3, 6, and 9 months cumulative production as well as 1, 3, 5, and 10 year cumulative production) are calculated. The reservoir engineering analyses along with the statistical data form the basis for a comprehensive spatio-temporal database that represents an extensive set of extremely high resolution shots of fluid flow in the shale formation. This large volume of data is processed using the state-of-the-art in artificial intelligence and data mining (neural modeling, genetic optimization and fuzzy pattern recognition) in order to generate a complete and cohesive model of the entire reservoir. This is accomplished by using a set of discrete modeling techniques to generate production related predictive models of well behavior, followed by intelligent models that integrate the discrete models into a cohesive picture that is the reservoir model, using a continuous fuzzy pattern recognition algorithms.

The Top-Down Intelligent Reservoir Model is calibrated using the most recent production history from the wells and a production from a set of new wells as blind data. Once history matched (model is then used for field development strategies to improve and enhance hydrocarbon recovery.

**LOWER HURON SHALE**

Gas production from Devonian Shale in Eastern Kentucky dates back to 1892, when the first well near Pikeville was drilled. Drilling and production just reached its peak in the second half of the 20th century when hydraulic fracturing was introduced. And that is when efficient gas production was established. The most prolific horizon of Devonian Shale in Eastern Kentucky is the Lower Huron Shale, which is Ohio Shale member. Over 80% of Devonian gas production comes from the Big Sandy Gas Field with more than 10,000 completed wells. Lower Huron is highly organically rich, dark, fine laminated, naturally fractured shale. Production data from 77 wells completed in the Lower Huron Interval of the Big Sandy field were acquired from the EQT. Well logs were downloaded from the Kentucky Geological Survey’s web site. Well logs included gamma ray, caliper, bulk density, and temperature logs.