Operations Research Seminar

Improvements in Capacitance-Resistive Modeling and Optimization of Large Scale Reservoir Systems

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Thursday, October 8, 2009
15:00-16:00 in GL-118
Refreshment 14:45-15:00 in GL-239

With the recent increase in the demand for oil and the predicted decline in available supply, the ability to obtain oil efficiently and economically has become increasingly important. Oil production strategies traditionally attempt to combine and balance complex geophysical, petrophysical, thermodynamic and economic models to determine an optimal method to recover hydrocarbons from a given reservoir. Reservoir simulators have traditionally been too large and run times too long to allow for rigorous solution in conjunction with an optimization algorithm. It has also proven very difficult to marry an optimizer with the large set of nonlinear differential equations required for reservoir simulation.

A simple capacitance-resistive model that characterizes the connectivity between injection and production wells can be used to identify an injection scheme that maximizes the value of the reservoir asset. Model parameters are identified using nonlinear regression. The model is then used together with an optimization algorithm to predict future production rates from an optimal set of injection rates. Research previously conducted has shown that this model, while simple, provides an excellent match to historic data. The optimal injection schemes yield a predicted increase in hydrocarbon recovery of up to 35% over a base case.

An advantage of using a simple model is the ability to describe large scale systems without incurring a long computation time. However, applying the model to large reservoirs with many wells presents several new challenges. Reservoirs with hundreds of wells have longer production histories that often represent a variety of different reservoir conditions. New wells are created, wells are shut in for a varying periods of time, and production wells are converted to injection wells. Additionally, history matching large reservoirs by nonlinear regression is more likely to produce parameters that are statistically insignificant, resulting in a model that is both parameter dense and may be a less accurate reflection of the physical properties of the reservoir. Several modeling techniques and heuristics are presented that provide a simple, accurate reservoir model that is then used to optimize the value of the reservoir over future time periods.

Joint work with Daniel Weber, Thomas F. Edgar, Larry W. Lake, Sami Kawas, and Morteza Sayarpour

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