

Reservoir Modeling

Abstract

Describing a physical phenomenon in terms of mathematical equations, and then solving these equations, is generally referred to as modeling. These mathematical equations mainly consist of a physical law and continuity equation. In reservoir modeling, the physical law is called Darcy's law.

Depending on how Darcy's law is coupled with the continuity equation, the types of reservoir modeling approaches fall into one of two main categories. In the first approach, Darcy's law is coupled with continuity equation (material balance) in differential form for a small control volume and diffusivity equation is derived. Considering initial and boundary conditions as well as the complexity of the model, an analytical or a numerical method is utilized to solve the diffusivity equation. With the second approach, however, reservoir is assumed as a tank. Then, modified Darcy's law is coupled with the continuity equation for the whole reservoir, and analytical models such as Capacitance Model (CM) and Multiwell Productivity Index (MPI) are developed.

Based on the aforementioned approaches, we have developed several numerical and analytical models. For instance, with the first approach, we have investigated the numerical modeling of enhanced oil recovery of tight oil and shale gas, flow back analysis, and core scale simulation. In the second approach, we have studied CM- and MPI-related works such as connectivity evaluation, waterflood management, and production forecast.

The numerical models in the first approach are robust enough in terms of prediction, optimization and detailed assessments of several conventional and unconventional plays. On the other hand, second approach models do not require geological and geophysical data to generate the initial model, and they are more efficient in terms of model run time. However, they might be affected by field data noises and generate less accurate results. Therefore, they are useful more as a tool for validation or preliminary assessments.