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# ECLIPSE Finite Difference Simulation

**ECLIPSE* SIMULATION FEATURES ALLOW ENGINEERS TO MODEL**

- Directional relative permeability
- Vertical or nonvertical equilibrium
- Dual porosity and permeability
- Non-neighbor connections
- Three-component miscible flood modeling
- Multiple aquifers (analytical and numerical)
- Crossflow and commingling in wells
- Chemical reactions
- Well, group, and field economic controls
- Highly deviated and horizontal wells
- Different geometry grid options, including corner point, conventional block-center, radial, Cartesian, perpendicular bisection, local grid refining, and hybrid gridding
- Multiple rock types, pressure-volume-temperature (PVT) regions, and rock compaction
- Hysteresis, tracers, and brine tracking

**Finite difference simulation is the standard technology** for obtaining accurate reservoir engineering predictions in complex field and advanced recovery processes. ECLIPSE software is the power behind the industry's leading finite difference simulator for global reservoir analysis and effective field planning.

Finite difference reservoir simulation is one of the most powerful tools for guiding reservoir management decisions. From determining oil reserves, through planning early production and designing surface facilities, to diagnosing problems with enhanced recovery techniques, ECLIPSE reservoir simulation software allows engineers to predict and manage fluid flow more efficiently, with greater insight and more accurate modeling.

ECLIPSE simulation software allows the most challenging questions that affect the economic viability of a reservoir to be answered.

- How certain are the reserve estimates? Can the uncertainties be minimized?
- How are the hydrocarbons distributed in the formation?
- How difficult will hydrocarbon recovery be and what production techniques and rates are best?
- Where should the next well be located to maximize incremental recovery per dollar of additional investment?
- How many wells are required to produce enough gas to meet the contractual delivery schedule?
- Should oil be recovered by natural depletion or by an improved recovery process?
- What is the optimal length and direction of a horizontal well in this field?
- Does a mature reservoir have bypassed oil? Where is it? How can it be produced?
- What are the best strategies for reservoir management?

## CHOOSING SIMULATION MODELS

ECLIPSE simulation offers a three-component model, referred to as the blackoil model, for reservoir situations in which oil reserves and oil recovery need to be known but the effects of fluid phase composition on flow behavior do not need to be considered.

The blackoil model assumes that the reservoir fluids consist of three components (water, oil, and gas) in a three-phase system (liquid, gas, and gas in solution) with components miscible in all proportions. Four components can also be considered for modeling reservoir recovery mechanisms when injected fluids are miscible with hydrocarbons in the reservoir.

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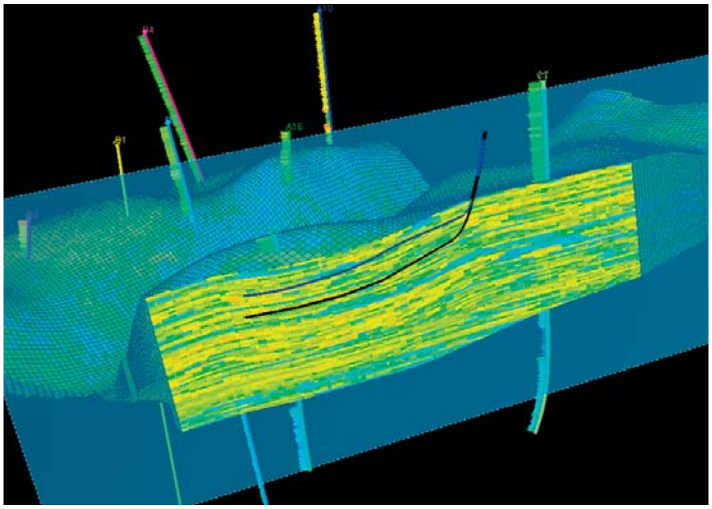


The blackoil solution can model extensive well controls, supporting efficient field operations planning including miscible-solvent gas injection, because it provides a fully implicit, three-phase, 3D simulation.

To simulate highly fractured reservoirs that require support for gravity inbibition and drainage, molecular diffusion, and displacement of viscous fluids to and from the rock matrix, the blackoil solution offers extended dual-porosity and permeability options.

## DEFINING COMPLEX RESERVOIR FLUID MECHANISMS

When oil consists of two or more hydrocarbons and those hydrocarbons exhibit distinctly different phase and composition changes relative to temperature and pressure, more complex definitions of fluid behavior are required for reservoir simulation and predictions of recovery.

Compositional simulation is useful when an equation of state is required to describe reservoir fluid phase behavior or the compositional changes associated with depth. A compositional model is the right choice for studying condensates or volatile crude oils, gas injection programs, and secondary recovery studies. Knowledge of compositional behavior is required for accurate planning and design of surface production facilities.

Compositional simulation is ideally suited for

- gas injection to increase or maintain reservoir pressure
- miscible flooding as the injection gas goes into solution with oil
- carbon dioxide flooding, with the gas soluble in both oil and water
- thick reservoirs with a compositional gradient caused by gravity
- reservoirs with fluid compositions near the bubblepoint
- high-pressure, high-temperature reservoirs
- natural-fracture reservoir modeling.

## DEALING WITH HEAVY OIL

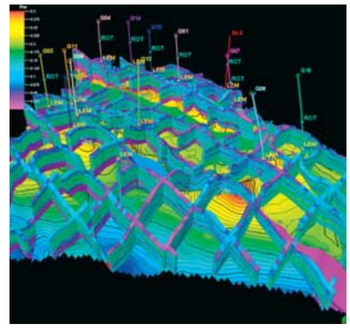
Because of high fluid densities and viscosities, as well as the complicated physics involved when massive changes take place in reservoir temperature and calorific energy, advanced thermal recovery methods are typically required for heavy oil, extra heavy oil, and bitumen reservoirs. Steam, hot fluid or gas injection, wellbore heaters, and the chemical combustion associated with heavy oil production present a whole new set of challenges compared with waterflooding or artificial lift.

Advanced thermal recovery techniques require more advanced modeling capabilities than compositional simulation, and these capabilities reside in the thermal model solution.

The thermal simulation production system uses an implicit, multilevel hierarchy to generate a crossflow well model for heightened realism. It allows analysis of oil, gas, water, and solids (useful with chemical reactions) behaviors, as well as of dead-oil or live-oil models.

This solution incorporates best-practice technologies from customers, researchers, and universities worldwide to simulate the widest variety of thermal recovery processes. It models the flow of steam and fluids, the flow of hot or cold water, in situ combustion, and virtually any other thermal phenomenon, including foamy oils.

The fundamental challenge in simulation is to create a model that predicts the state of a reservoir through time, taking into account all changes as it is produced. ECLIPSE finite difference simulation software offers multiple numerical simulation techniques and solutions for the full spectrum of reservoir simulation studies, including coning and fingering effects, near-wellbore modeling, and complex applications that require large volumes of memory and processing.



## SCHLUMBERGER INFORMATION SOLUTIONS

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07-IS-013 April 2007