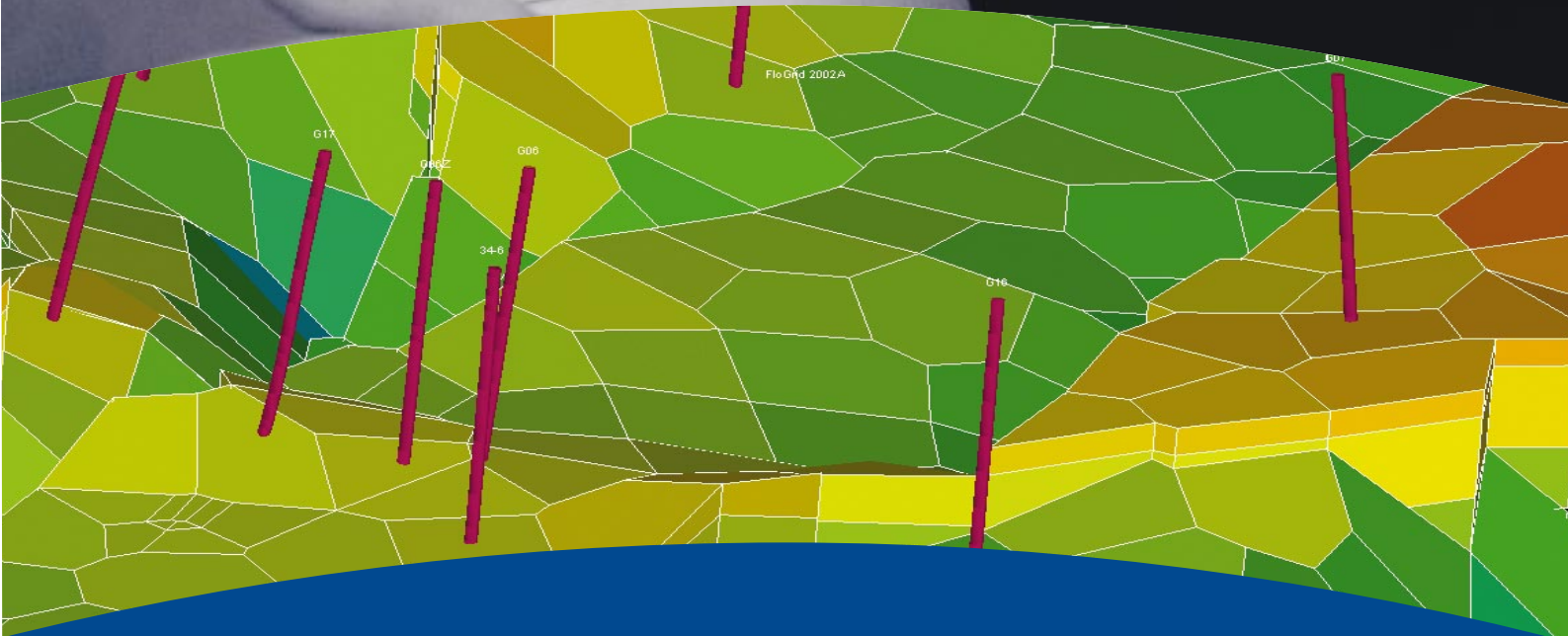


Schlumberger

ECLIPSE

Industry standard in reservoir simulation



ECLIPSE

Solution for the entire reservoir—all types of reservoirs and all degrees of complexity—to increase accuracy and accelerate speed.

Widen your spectrum of choices

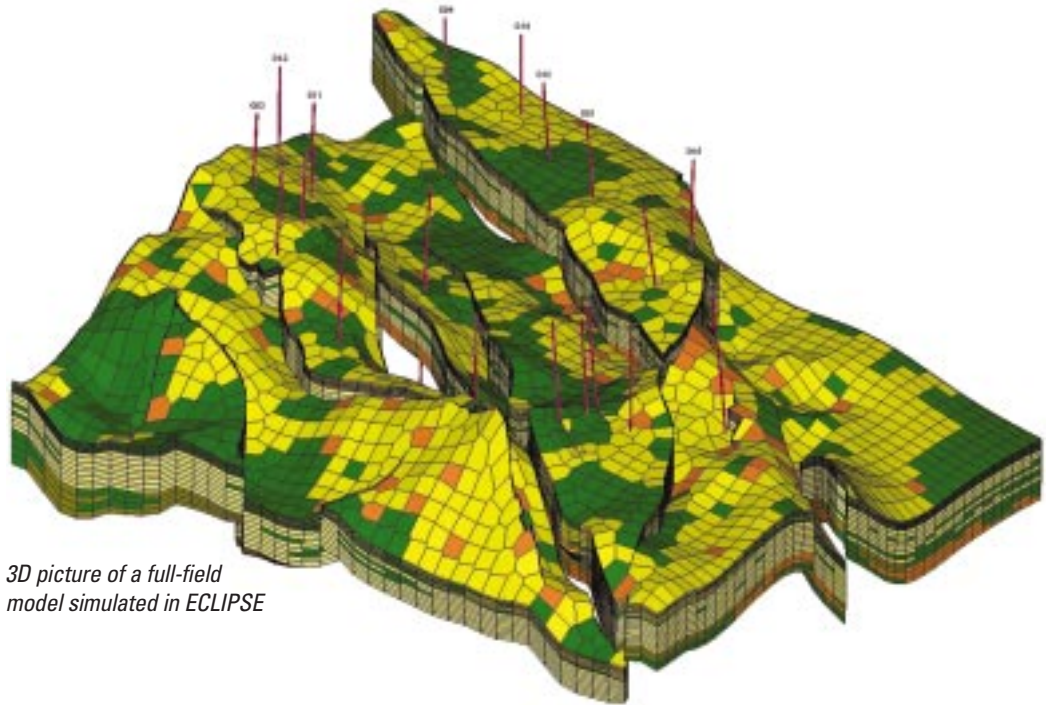
ECLIPSE® reservoir simulation software offers multiple choices of robust numerical simulation techniques for accurate and fast solutions for all kinds of reservoirs and all degrees of complexity—structure, geology, fluids and development scheme.

ECLIPSE provides solutions for the entire spectrum of reservoir simulation. The finite difference simulators are ECLIPSE Blackoil®, ECLIPSE Compositional® and ECLIPSE Thermal® reservoir simulation software. Streamline capabilities are provided by ECLIPSE FrontSim® streamline reservoir simulation software. By choosing from a wide range of add-on options—coal bed methane, gas field operations, calorific value-based controls, reservoir coupling and surface networks—ECLIPSE simulators are tailored to your needs to greatly enhance the scope of simulation studies. Complex geological features may be modeled by defining your reservoir using block-centered, corner-point or unstructured grids.

ECLIPSE gives you fully implicit and IMPES, AIM and IMPSAT solvers for the right balance of precision and speed. With ECLIPSE, you have the freedom of platforms, including UNIX[†] (SUN[‡], SGI[‡] and IBM[‡]) and PC (WIN[‡], NT[‡] and Linux[‡]). With ECLIPSE, you can implement parallel processing on multiple processor machines.

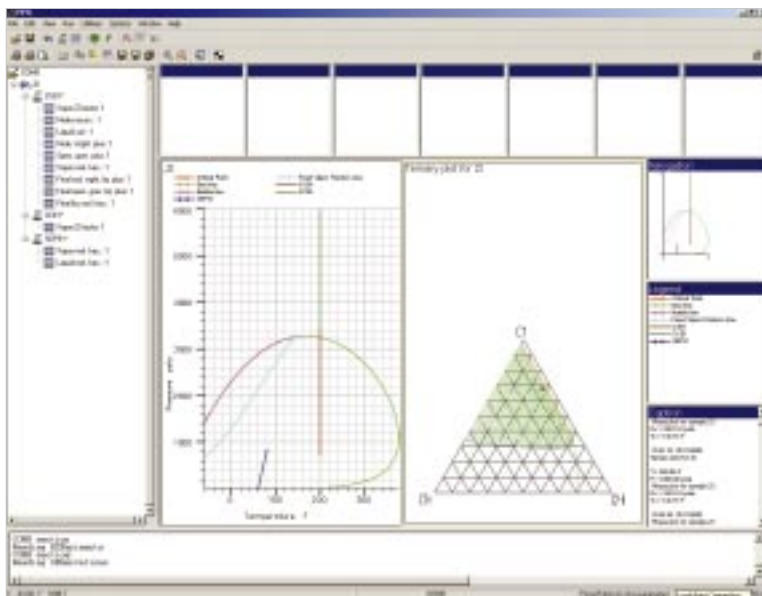
ECLIPSE Blackoil

ECLIPSE Blackoil is a fully implicit, three-phase, three-dimensional, general-purpose black oil simulator. Blackoil includes several advanced and unique features such as directional relative permeability, vertical equilibrium, dual porosity and permeability, non-neighboring connections and a three-component miscible flood model for the simulation of miscible gas injection processes. The Blackoil model assumes the reservoir fluids consist of reservoir oil, solvent gas and water. The reservoir oil and solvent gas components are assumed to be miscible in all proportions. With Blackoil, you have the benefit of modeling extensive well controls, which gives you more efficient field operations modeling.



3D picture of a full-field model simulated in ECLIPSE





Phase diagram generated in PVTi pressure-volume-temperature analysis software, a package used with ECLIPSE Compositional.*

ECLIPSE Compositional

ECLIPSE Compositional is useful when the behavior of the hydrocarbons is complex—condensate or volatile crude oil, or gas injection developments fall in this category. The ECLIPSE Compositional module extends your ECLIPSE Blackoil simulator to study problems where an equation-of-state (EOS) is required to describe the reservoir fluid phase behavior.

ECLIPSE Compositional uses an n-component compositional EOS model implemented with Martin's generalized equation for SRK, PR, RK and ZJ EOS models. The features provided with ECLIPSE Blackoil are available in the Compositional model. Many of the ECLIPSE optional features are available such as local grid refinement, gas field operations and parallel processing. The multisegment wells (MSW) option is also extended to study compositional variation where you have complex well completion.

ECLIPSE Thermal

Thermal recovery methods are typically used in heavy oil reservoirs where the oil viscosity is high at reservoir temperatures, but reduces as the temperature increases. With ECLIPSE Thermal, the Blackoil simulator may be extended to study problems such as steam injection, hot fluid or gas injection,

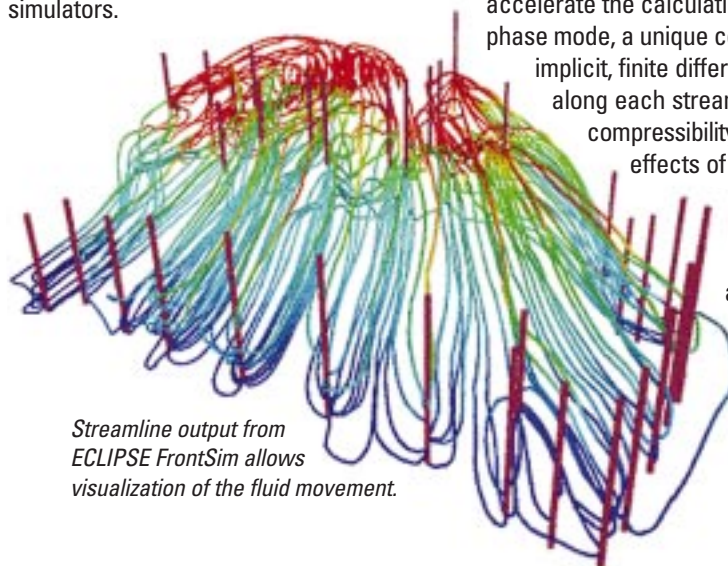
well bore heaters and simple combustion. All the features of ECLIPSE Blackoil are also offered in the Thermal model. Many of the optional features such as local grid refinements (LGRs), gas field operations and parallel processing, also operate with the Thermal model. The MSW option is further extended in thermal models to account for heat loss in complex wells, and to study steam assisted gravity drainage (SAGD).

ECLIPSE FrontSim

ECLIPSE FrontSim is a three-dimensional, three-phase streamline simulator that complements the ECLIPSE finite difference simulators.

FrontSim works with the ECLIPSE simulators to assist you in making key workflows—waterflood management, model building (multiple realization analysis) and history matching—faster, smoother and more informative.

ECLIPSE FrontSim uses an IMPES approach to solve pressure on a finite difference grid and to solve saturation along streamlines. This allows longer time steps to be taken than is possible in a finite difference scheme, which reduces run times on large models. In oil/water mode, ECLIPSE FrontSim uses a unique front tracking approach to decrease errors due to numerical dispersion, and accelerate the calculation. In the three-phase mode, a unique combination of fully-implicit, finite difference solutions, along each streamline, capture the compressibility and mass transfer effects of oil/gas systems, while preserving the speed benefits of the streamline approach.



Streamline output from ECLIPSE FrontSim allows visualization of the fluid movement.

Improve your finite difference reservoir simulation studies

ECLIPSE has an extensive range of features to optimize your finite difference reservoir simulations and provide versatility and increased accuracy to the simulation engineer.

Non-neighbor connections: Lets you connect a selected pair of non-neighboring cells so fluid flows directly from one cell of the pair to the other. This is useful when analyzing 3D radial studies, displacement faults for flow between different layers across the fault, local grid refinements and unstructured grids.

Directional relative permeabilities: You can specify relative permeability curves separately for non-isotropic flow in horizontal and vertical directions, enabling you to easily improve simulation physics. You may model both relative permeability and hysteresis.

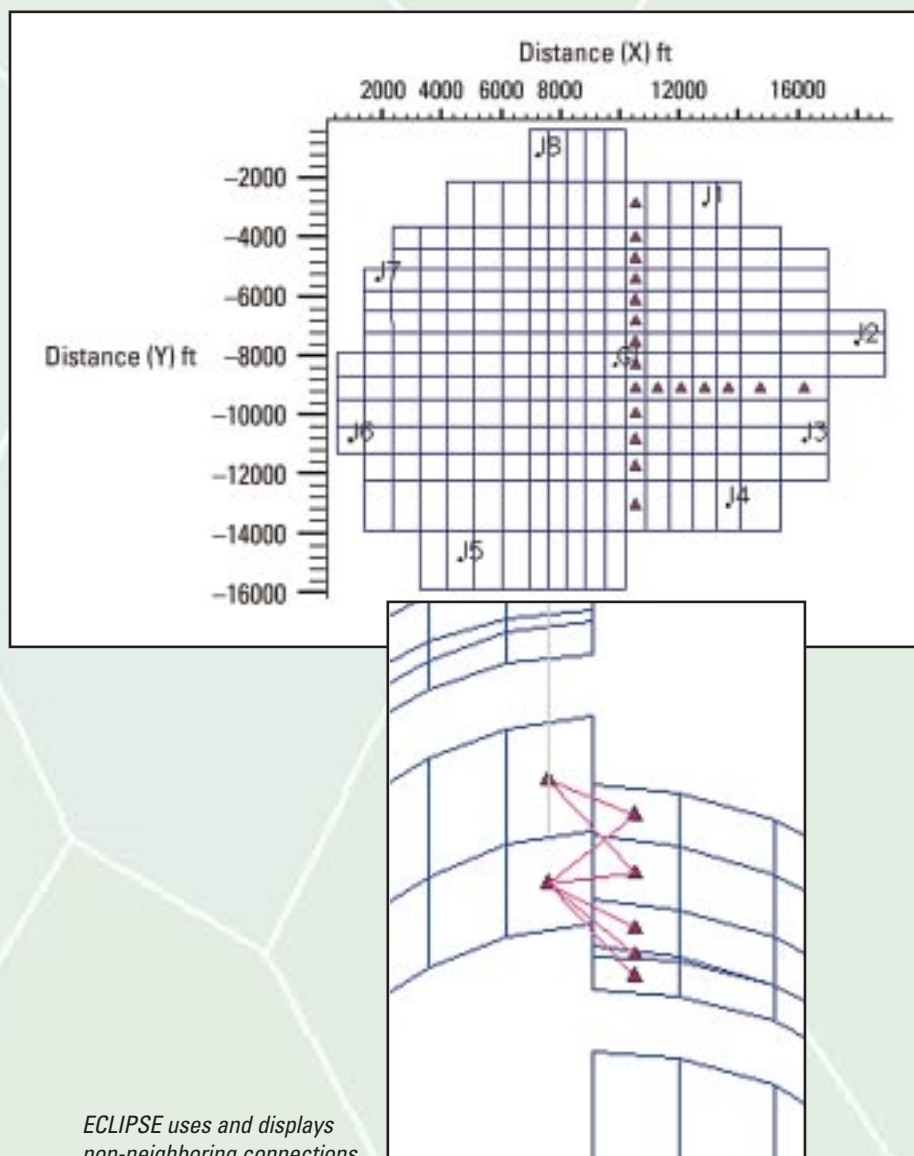
Choice of aquifer models: You are able to represent aquifer with your choice of three analytic models and a numerical model. The analytic models are Fetkovitch aquifer, the Constant Flux aquifer and the Carter-Tracy aquifer. The numerical model is a sequence of aquifer cells connected in one dimension.

Dual porosity and permeability: Simulate a fractured reservoir with the matrix and the fractures forming the two sections of every grid block. Reservoir flow occurs through the fracture cells, only or between each matrix cell and its corresponding fracture cell. A transient dual porosity approach is also available for fractured reservoirs.

MPFA: The multi point flux approximation (MPFA) scheme is a rigorous treatment of grid non-orthogonal and tensor permeability. This leads to a nine-point scheme when the grid is non-orthogonal, or the permeability tensor is not aligned with the coordinate directions. The MPFA will generally lead to a nine-point discretisation in 2D to remove the bias of grid non-orthogonal and grid orientation effects.

Rock compaction: Rock compaction models the collapse of pore channels as the fluid pressure decreases. The process is reversible, irreversible or hysteretic, as required.

API and brine tracking: Both API and brine are active tracking tools. With API tracking, you can model the mixing of different types of oil having different surface densities and PVT properties. The brine tracking option allows you to account for different water density and viscosity if the injected water has different salinity from the original reservoir water. Water properties are tabulated as a function of salt concentration.



ECLIPSE uses and displays non-neighbor connections.

Get an accurate handle on your well controls

ECLIPSE simulators give you a very comprehensive set of options for controlling individual wells. With the simulator, you can perform virtually every activity on your wells that you can in field operations. For example, to shut off the high water producing layer in a well with a high water cut.

Individual well controls: Operate your wells at specified values of oil, water, gas or reservoir fluid voidage rates; bottom hole pressures; and tubing head pressures. If you specify an operating target, the mode of the well will automatically change if a limit is going to be violated. Similar controls are possible for injection wells.

Group and field production controls: Two methods exist to control the collective behavior in groups of wells or the whole field. The overall production rate of oil, water and gas or liquid, from one or more groups, can be set to meet a specified target by one of two methods, prioritization or guide rate control. Subgroups may be created at any level, and controls and limits are applied to levels.

Group injection controls: Groups of wells and the field may be given targets and limits to control the injection rates. The targets and limits for injection are set in a number of ways.

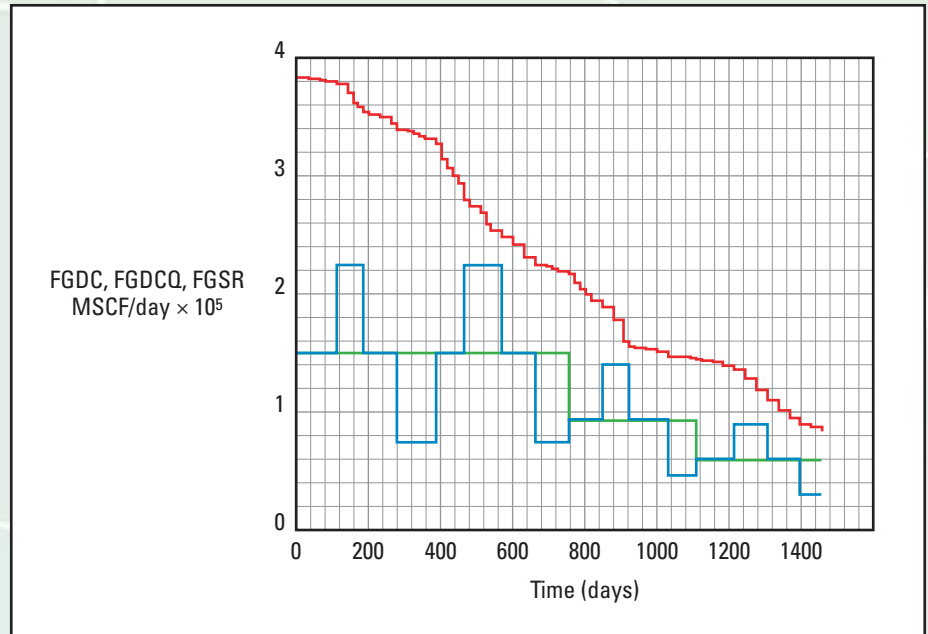
Better description for your gas reservoirs

The advanced features and options help you to better describe gas reservoir workflows.

Inflow performance for gas wells: Two facilities help you to accurately model the gas inflow. The first models the non-Darcy component of pressure—the draw down resulting from turbulence near the wellbore—by a flow dependent contribution to the skin factor.

The second model is the Russel Goodrich equation for conventional inflow performance relationship for free gas flow. This allows for variation in viscosity and density of the gas over the pressure drop between the grid blocks and the wellbore.

For condensate wells, the Fevang and Whitson pseudo-pressure model allows accurate inflow performance modeling,



Plot showing DCQ versus time for a gas field operation.

without the need for local grid refinement, to capture the effects of condensate drop out.

Gas field operations: This module is designed to model gas-field contractual production constraints and operations. Using it, you can generate the seasonality profiles for the daily contract quantity (DCQ) and set your production targets. You can also adjust the DCQ each contract year, and control and manage the output of gas production sales.

Gas lift optimization: With gas lift optimization, you can determine the right allocation of gas lift to meet the well, group and field targets. If production targets cannot be met, than this module will calculate the optimum use of available gas by preferentially allocating it to wells that will make the best use of it.

Enhance the scope of your simulation studies

Additional options to the ECLIPSE simulators allow you to greatly enhance the scope of your simulation studies. Using these options, you have the ability to simulate specialty reservoirs for coal bed methane, or apply calorific value-based controls. You may also model surface networks together with subsurface reservoir, and couple two or more reservoirs.

Coal bed methane: This option helps with modeling and simulating the coal bed methane (CBM) reservoirs, which produce methane gas that is absorbed on the coal seams surface. The CBM reservoirs are modeled as dual-porosity, dual-permeability models.

Reservoir coupling: Provides a means of coupling a number of separate ECLIPSE simulation models to allow for constraints on their overall production and injection rates.

Calorific value-based control: You can control the mean of calorific value for gas produced from the field while also managing the gas production rate.

Surface networks: Model surface networks and facilities together with the subsurface reservoir models. It calculates the well tubing head pressure (THP) limits by balancing the network flow rates and pressure losses in dynamic condition.

Simulate special reservoir conditions and scenarios

During the simulation study, sometimes you need special options to work on a part of the reservoir—refined volumes of interest and accurate calculations in horizontal wells. ECLIPSE has several optional modules.

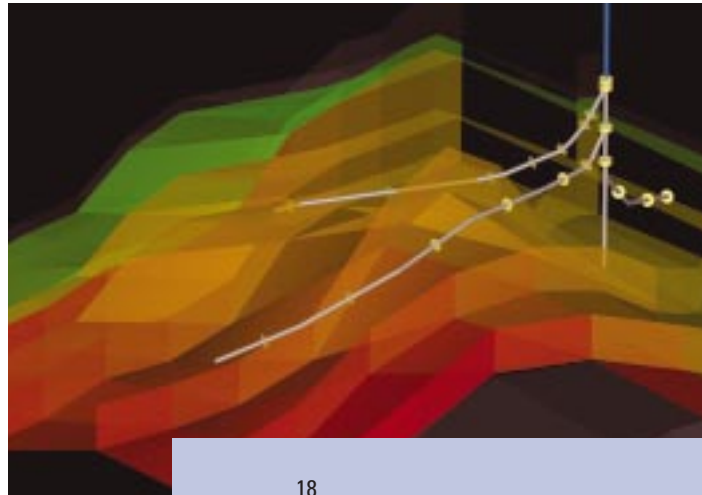
Multisegment wells (MSW): This is a unique option of ECLIPSE that is used to represent highly deviated or horizontal wells as multiple segments for improved pressure drop modeling and commingling effects. It improves overall accuracy in deviated and horizontal well-rate calculations by taking into account the frictional pressure drop calculations.

Flux boundary: Flux boundary provides for simulation runs on a small section of a field. A base run is performed for the full-field study. Time-dependent flows across the boundary of the small section are calculated. The results are written to a flux file.

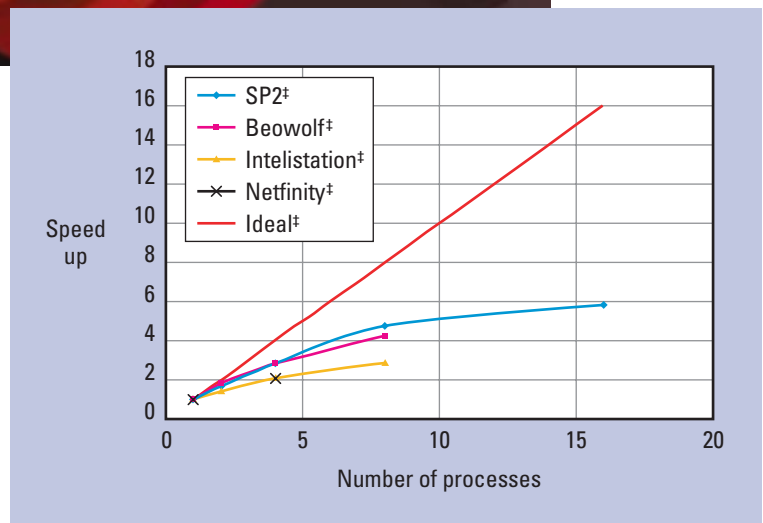
Subsequent runs for the small section are executed by reading the flux file to establish boundary conditions for consistency with the full-field model. Flux boundary is setup and run interactively and quickly using ECLIPSE NearWellbore Modeling* (NWM) refined localized simulation software.

GeoMechanics: This unique tool improves the ability to simulate compaction processes by coupling geomechanic stress calculation with fluid flow to predict subsidence and compaction.

Local grid refinement: Local models in three dimensions can be radial, unstructured or Cartesian. In two dimensions, local models may be radial or unstructured.



Schematic showing the segmentation of multilateral wells. MSW improves accuracy.

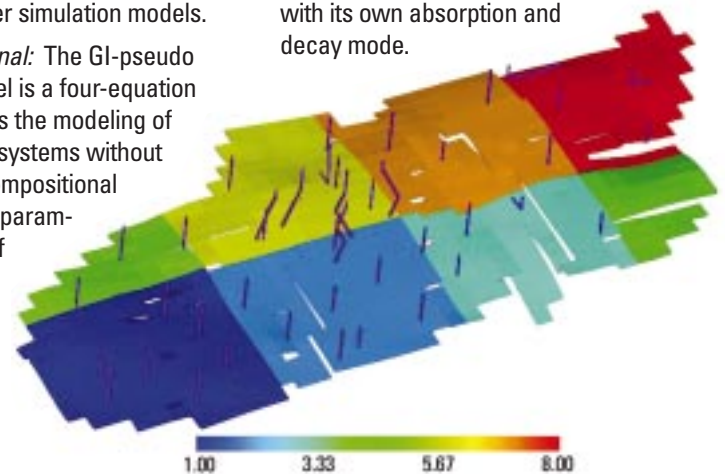


Accelerate speed as the processors increase for various machines.

Parallel: Take advantage of computers with more than one processor by splitting the simulation calculation on multiprocessors. By reducing simulation run times, you are able to handle larger simulation models.

Pseudo compositional: The GI-pseudo compositional model is a four-equation model that improves the modeling of volatile oil and gas systems without moving to a fully-compositional description. The GI parameter is a measure of the amount of dry gas that has contacted the original hydrocarbons.

Tracer: This is a general facility to follow the movement of marked fluid elements during a simulation run. Track up to 50 tracers independently, each with its own absorption and decay mode.



Domain decomposition in ECLIPSE Parallel splits the model into parts so that each model is solved on a separate processor.

Model enhanced oil recovery projects in your simulation

Older, mature oilfields often use enhanced oil recovery (EOR) techniques. With ECLIPSE, you can simulate reservoirs using several EOR scenarios.

Polymer: Use a fully-implicit, five-component model—oil/water/gas/polymer/brine—to study the detailed mechanisms involved in polymer-displacement processes. This lets you manage the absorption of the polymer to the rock surfaces, and the reduction results in aqueous phase relative permeability.

Solvent model: This is a four-component extension of the Todd and Longstaff empirical miscible flood model. You can solve four coupled equations fully implicitly for oil/water/gas/solvent. The oil/water/gas system, in the absence of the solvent component, reduces to the traditional black oil model. A solvent phase can be introduced into the model to miscibly displace the reservoir hydrocarbons.

Surfactant: This allows for the modeling of enhanced water floods where the added surfactant reduces the capillary pressure between the water and oil phases. It models the reduction in the residual saturation, and the associated modification of the relative permeability curves as a function of the capillary number.

Foam: The foam option screens fields for possible foam injection projects. The foam is modeled as a tracer in the gas phase that helps reduce gas mobility.

Build, manage and edit ECLIPSE models quickly and efficiently using ECLIPSE Office.

Prepare data deck: ECLIPSE Office is a desktop interface that allows you to quality control (QC) data—geological structures, properties and production. Data is quickly and efficiently usable with ECLIPSE simulators. In addition, the simulation runs may be submitted and managed using ECLIPSE Office.

Visualize your results: Simulation results may be quickly visualized in the result viewer of ECLIPSE Office as line plots, 2D maps and reports. 3D visualization gives you an analysis of static and dynamic properties of the reservoir.

Smoothen your ECLIPSE simulation workflow

ECLIPSE PlanOpt: ECLIPSE PlanOpt* well location optimization tool is a tool that runs from within ECLIPSE Office to help you select the best fit infill well drilling location in a given simulation model. This may be accomplished in an overnight run which would otherwise require several runs over several days. PlanOpt works by adding

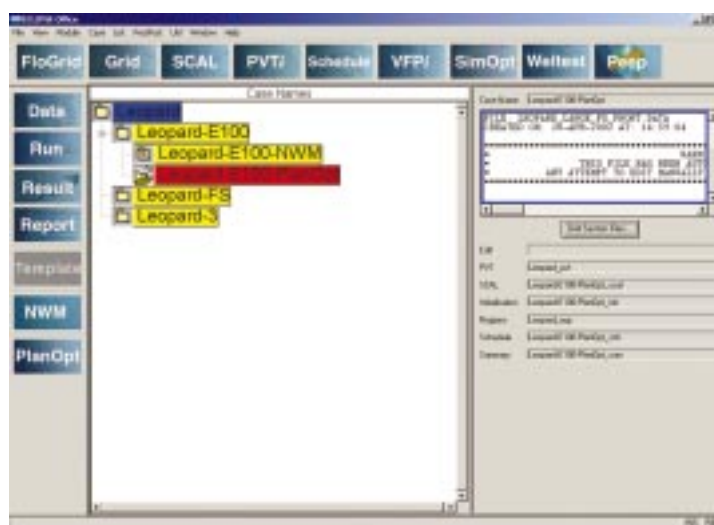
several prospective wells based on user-defined criteria in the first phase of the PlanOpt workflow. In second phase of the workflow, the least fit (productive) wells are eliminated, based on a user-defined criteria.

ECLIPSE NearWellbore Modeling (NWM): When creating a volume of interest and running quick simulation on a refined localized area, ECLIPSE NearWellbore Modeling smoothens the workflows. NWM will let you interactively digitize a refined localized area in a matter of minutes, which would otherwise take hours.

Refine interactively and run simulation on volumes of interest (VOI) very quickly. This NWM workflow helps you simulate while drilling.

Links to Merak Peep and PIPESIM: ECLIPSE simulator can be coupled dynamically with the Baker Jardine PIPESIM* total production system analysis surface network to model surface networks together with subsurface reservoir.

The simulation outputs from ECLIPSE can be directly read into Merak Peep® economic evaluation model and deline analysis software for a quick economic analysis. Peep can be launched from the ECLIPSE Office platform.



ECLIPSE Office panel showing NWM and PlanOpt. The top right shows the Merak Peep link.

ECLIPSE

Reservoir simulation software

About GeoQuest

ECLIPSE is licensed and supported by GeoQuest, the software division of Schlumberger Information Solutions (SIS), an operating unit of Schlumberger Oilfield Services. SIS is the global industry leader for the supply of integrated business solutions comprising GeoQuest software, information management services, information technology and a complete range of expert services. Schlumberger—the leading supplier of services and technology to the international E&P industry—operates offices, service locations, and research and development facilities around the world.

Contact your local SIS office or e-mail: ggmktg@geoquest.slb.com for more information about ECLIPSE.

ECLIPSE

The strength of the ECLIPSE applications give you simulation techniques for all types of reservoirs and all degrees of complexity.

ECLIPSE Simulators

- ECLIPSE Blackoil
- ECLIPSE Compositional
- ECLIPSE Thermal
- ECLIPSE FrontSim

Additional modules of ECLIPSE Simulators

- Calorific value-based control
- Coal bed methane
- Flux boundary
- Gas lift optimization
- Gas field operations
- GeoMechanics
- Local grid refinement
- Multisegment wells
- Network option
- Parallel
- Pseudo compositional option
- Reservoir coupling
- Tracers
- EOR option (includes Polymer, Solvent, Surfactant and Foam modules)
- IOR-Tracer option



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