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Total Simulates Very Large and Heterogeneous SAGD Model in Hours

INTERSECT simulator runs SAGD model with 1.7 million cells, 9 well pairs, and 3 years of operating history in 3.5 hours

CHALLENGE
Simulate developments in adjacent chambers in steam-assisted gravity drainage (SAGD) cluster in a workable time frame.

SOLUTION
Implement INTERSECT* next-generation reservoir simulation software to take advantage of its improved numerical techniques and optimal parallel scalability.

RESULTS
Simulated the first 3 years of production history in a full resolution model, with 1.7 million cells and 9 well pairs, in 3.5 hours on 16 processors.

"We are very enthusiastic about the performance of INTERSECT software because it allows us to run full-field SAGD models in hours rather than in days. We are eager to deploy the commercial release once full functionality and performance are confirmed."

Lisette Quettier
Reservoir Simulation Expert
TOTAL

Total uses reservoir simulation for history matching and forecasting of thermal development projects. One of the main targets of its thermal development activities is the Canadian oil sands, where unconsolidated sand reservoirs contain very large volumes of extremely viscous bitumen (roughly 1 million cP). The favored process for producing this bitumen is SAGD.

In SAGD, steam is injected through a horizontal well, enabling the development of a steam chamber within the reservoir. Heated bitumen is produced by gravity from a parallel horizontal producer below the injector. A SAGD development requires mapping the steam chamber and bitumen release from the adjacent well pairs.

SAGD operations

At the start of SAGD operations, individual steam chambers may be modeled independently. However, SAGD chambers can quickly communicate with each other because of physical phenomena such as pressure exchanges, gas fingering, and aquifer interactions. Therefore, after a short period of operation, it is necessary to include all SAGD pairs in a single model to account for lateral interactions between SAGD chambers. Such models can be very large (several million cells). Simulating such large and complex multipair SAGD models is not practical with commercial thermal simulators.

Very large thermal simulation projects

Total participated in the industry initiative to develop the INTERSECT* next-generation reservoir simulation software, which features improved numerical techniques and optimal parallel scalability. The application runs large and heterogeneous models—simulating tens of millions of cells—very quickly.

INTERSECT software is an unstructured-grid, parallel, and fully implicit simulator that handles complex physics associated with heavy oil thermal recovery. It solves component material balance, energy balance, and mass equilibrium equations for component mole fractions, saturation, temperature, and pressure. External heat sources and sinks are included to model the energy interaction with overburden and underburden rocks.

To prove the application's capability to run large-scale SAGD models, Total partnered with Schlumberger Information Solutions to run INTERSECT simulation on a typical SAGD model (9 well pairs) in the Canadian oil sands.

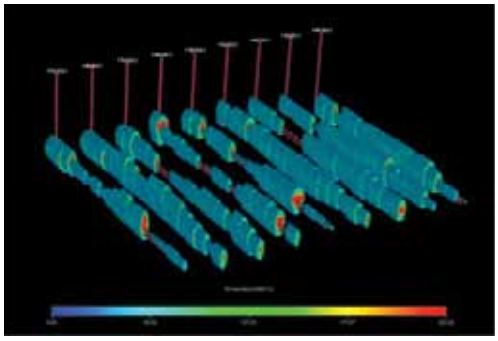
The oil was modeled using two oil pseudocomponents, one light and one heavy. The model had over 1.7 million grid blocks with heterogeneous cell properties. The producers were controlled by steam production rate, maximum liquid rate, and minimum bottomhole pressure (BHP). The injectors were controlled by maximum injection rate and maximum BHP. The injected steam quality was about 90%.

The INTERSECT simulator was used to run a model of the 3 first years of SAGD operations. To test its scalability, it was tested on different parallel platforms, varying from 4 to 16 processors. These tests proved both the ability of the application to run this very large and heterogeneous model quickly enough to support operational decisions (3.5 hours on 16 processors), and its excellent parallel scalability (4.5 times faster, from 4 to 16 processors).

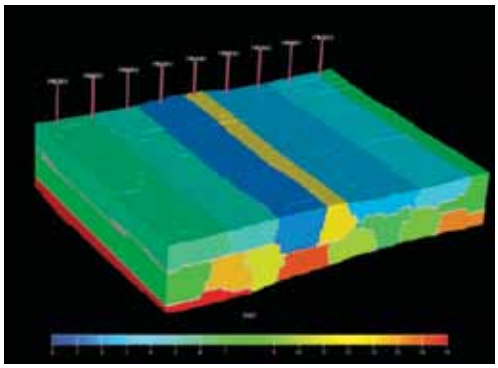
Schlumberger Information Solutions

Schlumberger Information Solutions (SIS) is an operating unit of Schlumberger that provides software, information management, IT, and related services. SIS collaborates closely with oil and gas companies to solve today's tough reservoir challenges with an open business approach and comprehensive solution deployment. Through our technologies and services, oil and gas companies empower their people to improve business performance by reducing exploration and development risk and optimizing operational efficiencies.

E-mail sisinfo@slb.com or contact your local Schlumberger representative to learn more.



Three-dimensional view of the steam chambers developed along the nine SAGD well pairs.



Processors	CPU, seconds	Speed increase (versus 4 processors)
4	55,284	
8	31,950	1.73×
12	16,635	3.32×
16	12,236	4.52×

SAGD project diagram.

www.slb.com/intersect

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