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PEMEX Achieves Faster, More Detailed Simulations

INTERSECT software enables powerful visualization for mature carbonate fields

CHALLENGE

- Improve simulation speed for large, detailed models to better characterize complex subsurface features.
- Accurately model fluid-contacts movement and near-wellbore effects including sudden breakthroughs.
- Leverage detailed simulations in field development planning.
- Understand fluid behavior in horizontal and multilateral wells.

SOLUTION

- Evaluate INTERSECT† simulator using PEMEX field data.
- Multimillion-cell models built.
- Local grid refinements added and tested.

RESULTS

- Simulation times up to 17x faster.
- Scalability for coarse and fine models.
- Detailed modeling of near-well phenomena to address surrounding gas and water breakthrough in mature carbonate fields.
- Improved field-development planning through more frequent characterization of near-wellbore fluids.
- Close interaction between PEMEX and Schlumberger to migrate ECLIPSE models to INTERSECT software.

"Unstructured grids around the wells powered by INTERSECT, coupled with higher computational efficiency, helped us predict near-well flows more accurately. This enabled us to overcome key challenges surrounding gas and water breakthrough, and fluid contact advanced modeling, in our mature carbonate fields."

Ricardo Ortega Galindo
Reservoir Engineering Team Lead
PEMEX Field Development Group.

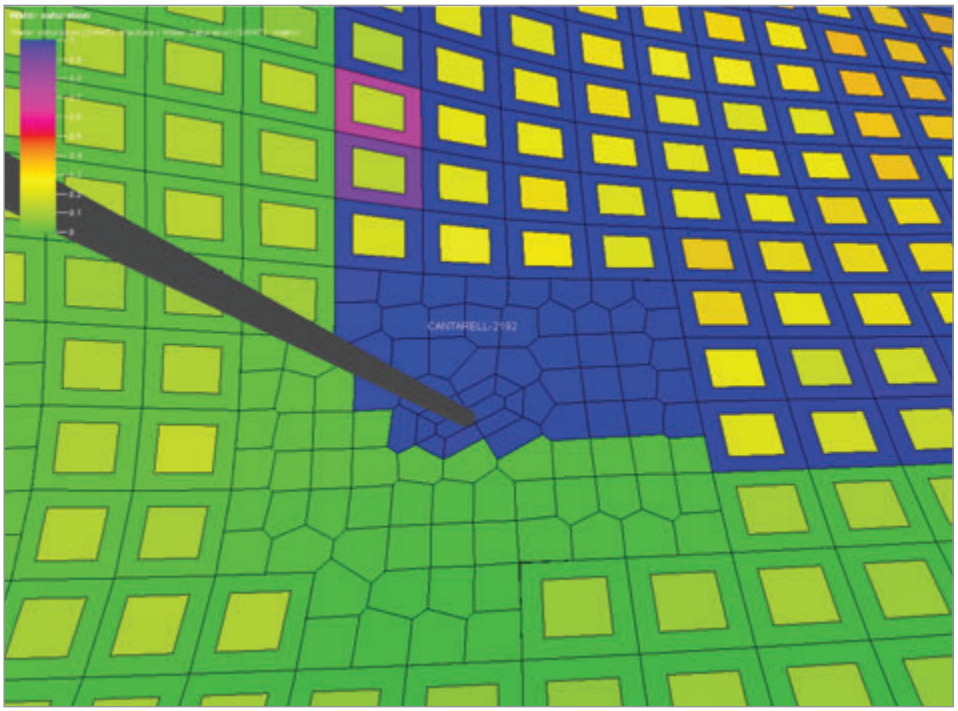
PEMEX faced significant reservoir simulation challenges when attempting to gather crucial insights for field-development planning around each of its strategic investment projects. The complexity of its fields (high heterogeneity, complex structures, and naturally fractured), along with understanding fluid behavior in horizontal and multilateral wells, placed extra emphasis on accurately evaluating viable operation schemes to maximize recovery.

PEMEX required the capability to simulate detailed models—with millions of active cells—in practical timeframes. Accurately representing fluid-contact movement and near-wellbore effects, including the sudden breakthrough of gas and water, was also essential. An additional challenge was that, in general, the performance of conventional commercial reservoir simulators degrades considerably with model size.

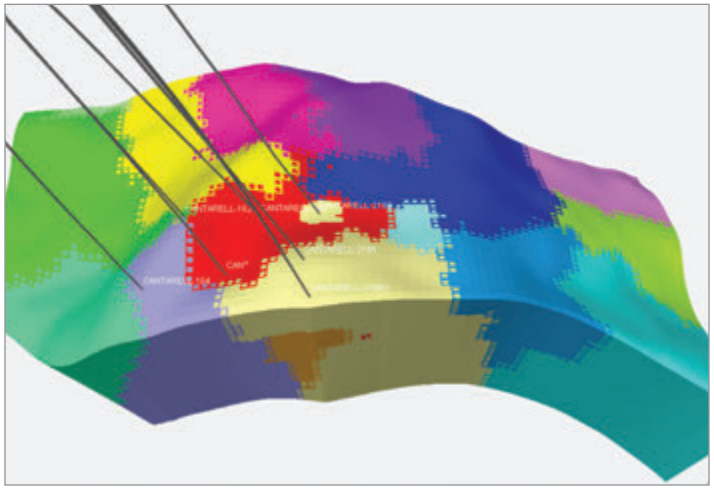
Evaluation

After enlisting Schlumberger to help provide a solution, an evaluation program was scheduled at the Abingdon Technology Center in the UK. This was designed to allow PEMEX representatives to test a proposed solution—using INTERSECT next-generation reservoir simulator—on its own field data. The PEMEX Marine region project management team selected the Chac field as the study subject: a carbonate field located in the Gulf of Mexico and part of the Cantarell complex. An existing coarse simulation model with 400,000 active cells was used as a benchmark.

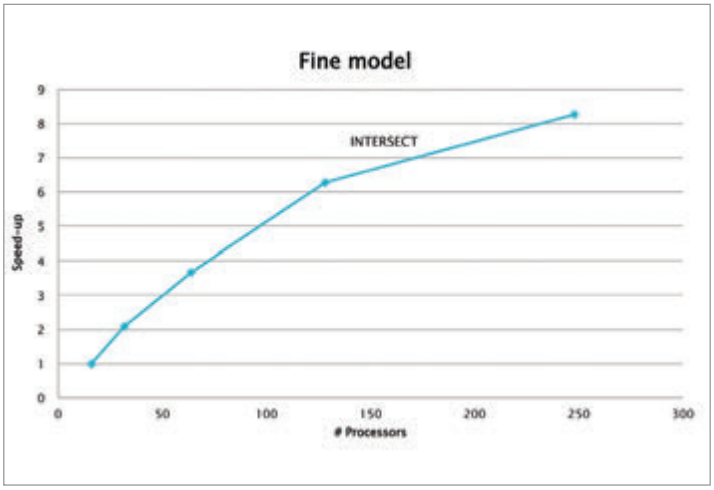
INTERSECT software enables simulation of detailed high-resolution models with millions of cells in practical computational timeframes. The Abingdon evaluation program introduced a number of workflows designed to generate INTERSECT models. From the original coarse source model, equivalent black oil and compositional coarse test models were created, as well a 13-million-cell refined model.



Unstructured local grid refinements allowed better representation of water breakthrough.



Smart domain partitions allowed faster processing.



Scalability up to 256 processors.

Local grid refinements (LGRs) were then added to the Chac coarse model to demonstrate how the INTERSECT simulator more accurately represents near-wellbore effects. Different LGRs were added, from a simple Cartesian LGR to more complex unstructured LGRs.

More speed, more detail

The test runs proved to be significantly faster than those conducted using PEMEX's existing software. They demonstrated how the INTERSECT simulator can manage parallel runs with more processors, using its innovative partitioning algorithm.

The INTERSECT solution proved to be three times faster for the Chac coarse model (400,000 cells), and at least 17 times faster for the Chac high-resolution model (13-million cells). INTERSECT software also showed scalability for both coarse and fine models—with speed-up values of up to eight times for the maximum number of processors evaluated (16 versus 256).

Based on these results, PEMEX and Schlumberger agreed to collaborate to adjust and optimize the solution on an ongoing basis, allowing PEMEX to fully model naturally fractured reservoirs.

Confident modeling

A key area of the evaluation for PEMEX was the LGR testing, due to the original challenges the company faced in accurately modeling near-wellbore phenomena. Critically, INTERSECT software was able to do this with the necessary detail to more reliably model fluid behavior, without significantly affecting computation times. Results from conversion from black oil to compositional fluid models showed INTERSECT software delivered speed increases of three times.

The swift, highly detailed simulation of near-well phenomena provided by INTERSECT software improved PEMEX's field-development planning confidence through better—and more frequent—characterization of near-wellbore fluids, in reasonable computing times. Based on the evaluation, PEMEX decided to continue exploring the benefits of the INTERSECT simulator.

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