Novel technologies for fine scale dynamic modeling in Lundin Norway

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Lundin Norway AS is the most rapidly growing operating company in Norway. With recent discoveries in the North Sea it currently holds the position of the second largest oil company in the country.

Reservoir engineers in Lundin implement multiple innovations in order to optimize development of the fields operated by the company. One of the current projects is to investigate opportunities to enhance oil recovery from the Johan Sverdrup field by polymer injections. It is believed that this option will help improve the reservoir performance significantly.

One of the most important and challenging parts of the project is related to numerical modeling. An accurate description of the polymer flooding effects requires high-resolution dynamic models. Reservoir engineers often adopt sector models for such studies to make the simulation time more feasible. However, in this case this approach cannot be applied directly as the common network facilities have to be taken into account. So, a dynamic model of the giant field with high grid resolution is considered for the study. Combined with polymer modeling options, it makes the simulation time very challenging. As the field is at the early development stage and the information is very limited, a thorough uncertainty study with hundreds of simulations is required to draw reliable conclusions of the polymer flooding effects.

Preliminary tests of the dynamic model revealed that the simulation time required for one run is far too long for a detailed study with conventional simulators. That is why Lundin decided to try tNavigator® developed by Rock Flow Dynamics, which is quickly being recognized around the world for its simulation performance.

Rock Flow Dynamics started as an independent software vendor in 2005. tNavigator® is the flagship product developed by the company. This is a full-fledged black oil and compositional reservoir simulator implemented from the beginning to run parallel. The key feature of the simulator is the scalable solver which is optimized for modern multi-core computers. Recent studies of parallel computation methods implemented in tNavigator® show that the model simulation time can be reduced almost boundlessly as the number of simulation cores grows. The parallel hybrid algorithm mixing MPI and system threads was applied to a number of real models and demonstrated a record parallel acceleration.

The simulation performance tests on the model of Johan Sverdrup field show that **the total run time can be reduced from 9 hours to 45 min** even on a regular workstation. That will significantly reduce the length of the project and make a detailed uncertainty study realistic.

The project team would be happy to present the results to the SPE Oslo section when the work is complete.

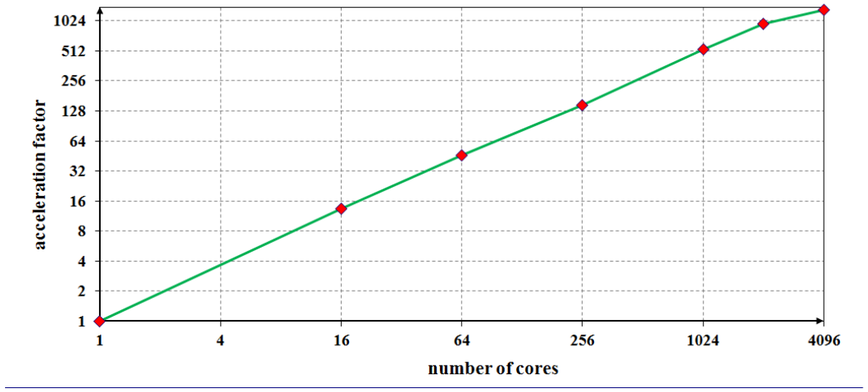


Fig.1. Speed-up for a 21.8 million active grid block model on a cluster (with respect to one core calculation time) (SPE 163090)

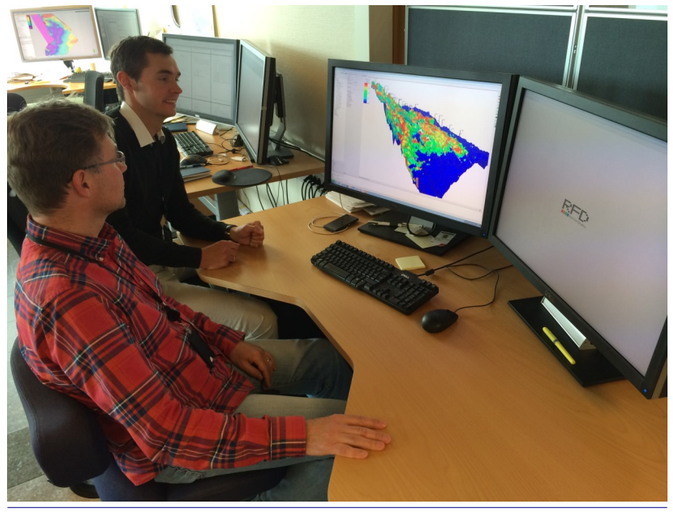
INTERVIEW WITH LUNDIN NORWAY

Jens-Petter Nørgård & Geir–Magnus Sæternes

-As operator of the PL501 license, where we made the Avaldsnes discovery, we of course have high focus on the Johan Sverdrup field. Polymer was early identified as a potential EOR method by the partnership of Johan Sverdrup. Lundin therefore initiated a research project with TIORCO (Houston) to identify the best suitable polymer for this reservoir and describe its characteristics to be used in dynamic simulation. In this regard the need for a faster simulator in order to evaluate polymer injection became obvious. At this time we were given a presentation of tNavigator. The speed and ease of use was really impressive! The only drawback was the lack of support for polymer injection, Jens-Petter Nørgård explains. *-However, we liked the product and saw the potential for our project so we suggested doing a project with RFD to develop polymer functionality and with the same simulation speed. RFD was positive to the idea so we initiated a project.*

Lundin specified the functionality requirements and RDF was left with the challenge to implement accurate polymer simulation at the same impressive simulation speed. A couple of months later RFD came back with a beta version for the Lundin engineers to test. The time was come to test and see if they had succeeded the challenge...

-The polymer functionality worked fine and the speed was amazing. We reported a few minor bugs that RFD fixed immediately, Geir–Magnus Sæternes says. *–I've used the tNavigator for a while now for our polymer study, but also other simulations since it's so fast and it fits nicely into our Petrel workflow. It's so intuitive that none of us had to attend any training course.*



Geir Magnus Sæternes and Paul Tijink on the photo using tNavigator

-Well, we do have extremely bright engineers too, Jens-Petter Nørgård says with a smile. *-However, we simulated all our polymer cases within the project deadline and tNavigator was an important tool,* he continues. *–Both simulation speed and the fact that our engineers could start using it without any training saved us a lot of time.*