CMG COMPUTER MODELLING GROUP LTD.

IMEX

Optimizing Well Spacing and Well Performance in the Piceance Basin Niobrara Formation

Benefits

- Numerical simulation used to make important decisions on completions and well spacing.
- Simulation optimization showed significant impact and improvement on project economics.

Why Implement?

Wells drilled too close together have a negative impact on performance. Wells drilled too far apart leave hydrocarbons behind in the reservoir.

Why Simulate?

Run multiple well placement and completion design optimization scenarios.

Results

Achieved significant improvement in Estimated Ultimate Recovery (EUR), Rate of Return (ROR) and Net Present Value (NPV) over the base case development scenario.

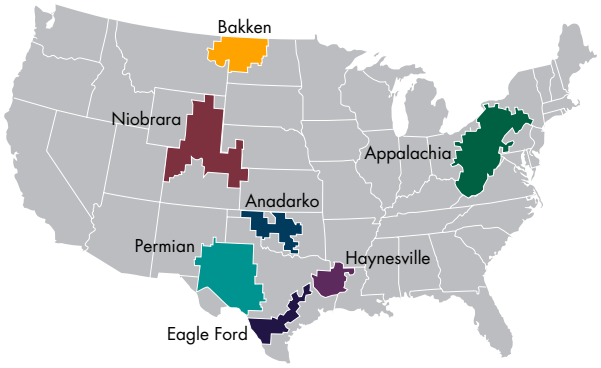
Appropriate completions design and well spacing development strategies are vital to the success of unconventional assets. The Niobrara, which covers parts of Colorado, Wyoming, Nebraska and Kansas, is a prime example of a tight formation where different well and completions strategies have been used with varying success.

Workflow

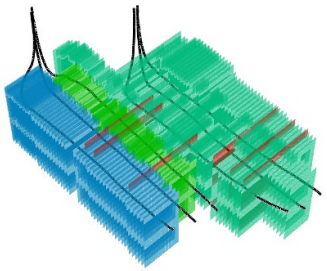
A six well operation within the dry gas zone of the Niobrara formation was selected for a well spacing simulation study. The wells currently drilled in the field were spaced 1350-2000 ft apart and drilled in the same landing zone.

The construction of the simulation model leveraged the extensive data available including micro-seismic data for the input of the size of the planar fractures. Once the model was constructed, a history match to production data was performed. This yielded fracture half-lengths of 1000 ft, a 30% cluster efficiency and the identification of 11 high conductivity fracture planes which promoted the interaction between the wells.

Learnings from the history match of the exiting six well pad were applied to a new greenfield development. A sensitivity analysis was performed where well spacing, well placement, fracture half-length, fracture conductivity, and cluster efficiency were varied and analyzed in terms of EUR, NPV and ROR.



*Unconventional formations in the USA**

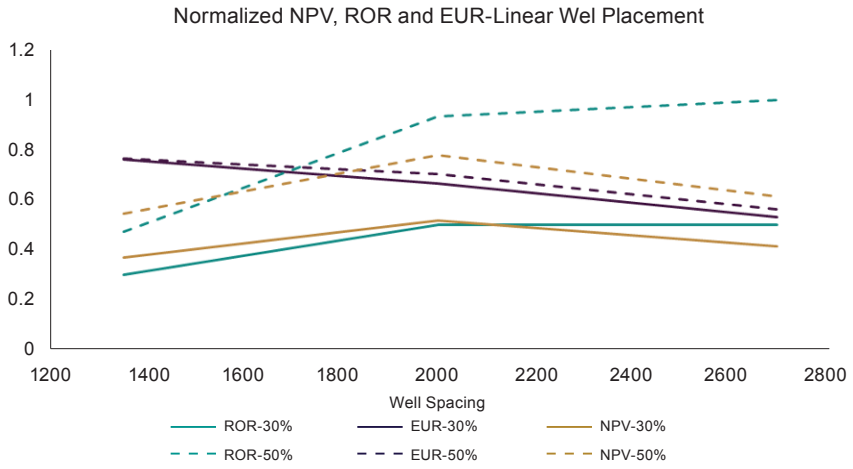


Hydraulic fractures and high conductivity fracture planes

Results

From the simulations, hydraulic fracture conductivity (within the limits tested in the study) was found to be insensitive due to the low matrix permeability of the formation. When the cluster efficiency was increased from 30% to 50%, the EUR increased by 13% and the NPV increased by 95%. This is attributed to the improved early time production which contributes heavily in the NPV formula. Staggering the landing depths as opposed to drilling all of the wells at the same depth, resulted in a 15% increase in EUR and 33% increase in NPV.

Assuming all of the wells are drilled at the same depth, the simulation shows that doubling the well spacing that was originally used would increase the NPV, despite a lower recovery. This is because of the negative effects associated with drilling wells too close together. Comparing a case with larger well spacing to a case with staggered drilling, larger well spacing has lower oil recovery and NPV, but a higher ROR. This is because of the lower capital cost and lower risk associated with drilling wells further apart.



Normalized ROR, EUR and NPV versus well spacing

From the study, the operator pursued technologies to improve cluster efficiency due to the large impact on performance. For future development projects, multiple simulations will be performed on well spacing and placement to find the optimal conditions for both ROR and NPV.

This case study is based upon SPE 184848 "Optimizing Well Spacing and Well Performance in the Piceance Basin Niobrara" (Li et al, 2017).

**Image adapted from https://www.eia.gov/*

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