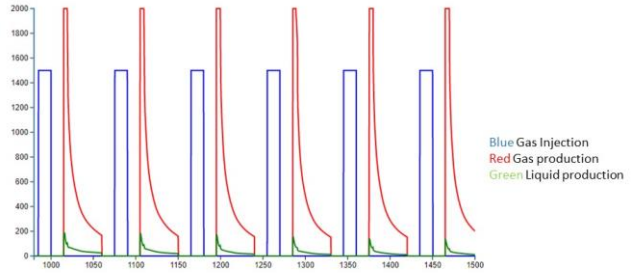
Enhanced Oil Recovery – Extract extra oil from unconventional reservoirs

Using 6X to predict recovery from an EOR cyclic gas injection campaign

The hydraulic fracturing of wells in unconventional reservoirs has resulted in high initial oil production. However the decline rates are very high with low recovery factors. Recently, Enhanced Oil Recovery (EOR) through cyclic gas injection (huff & puff) has increased recovery factors in the Eagle Ford and is being investigated for use in other shale basins.



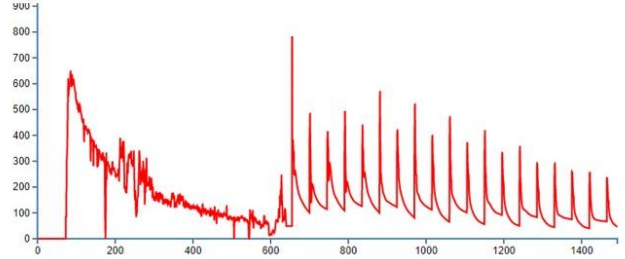
Schematic view of a number of huff and puff cycles

When planning an EOR campaign, or when analysing the early results from a well/pilot, a reservoir simulator (together with a model of the subsurface) is the only tool available to predict the production and the economics of the project.

6X has been successfully used in many EOR projects, for example see the 2021 URTeC paper: 5649 A Simulation Study to Evaluate Operational Parameter Ranges for a Successful Cyclic Gas Injection in Different Areas of Eagle Ford by M. Gaddipati, B. Basbug, T. Firincioglu of NITEC LLC.

Requirement for a tuned hydraulic fracture description

Most EOR projects follow on from a period of natural depletion. A 6X model can be tuned to both the hydraulic fracturing data (pressures and flow back) and the subsequent production. This provides a solid basis to predict the behavior of the gas injection period.



Predicted Field Production based on a real world example

Quick look prediction using a black-oil fluid description

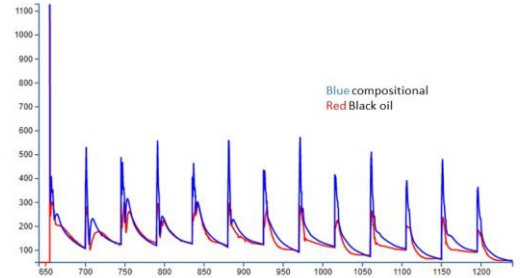
Gas injection at high pressures will typically form a super-critical fluid with the reservoir oil. Hence the simulator fluid description needs to take care of the full phase behavior. The most efficient solution is achieved by starting with an equation of state (EOS) fluid model and converting this to black-oil tables using 6X's internal converter. 6X's EOS to black-oil convertor ensures consistency and robustness.

More detailed prediction – composition fluid

Given that the huff & puff process relies on a complex set of fluid behaviors, an EOS based compositional model is more accurate and provides extra information - typically the composition of the produced fluids.

The compositional model describes the fluid using pseudo-components, typically 7-12 of them, where the black-oil model uses just 2 components. As the number of components increase so does the simulation run time. As the compositional model is only required when gas injection starts, an efficient workflow is to use the black oil model for the frac and initial production period, then to restart in compositional mode for the huff & puff phase.

In US light oils, the compositional and black-oil approaches have given broadly similar results.



Comparison between predicted production black-oil/compositional

Use 6X with a tuned hydraulic fracture description to predict the recovery from a cyclic gas injection EOR project

info@ridgewaykite.com | +44 7780 682593 | +1-713-208-8750 | ridgewaykite.com