

Chemical Enhanced Oil Recovery (cEOR) Pilot Design

Chemical Enhanced Oil Recovery (cEOR) is a well-known recovery process, widely applicable for light and medium oils, with emerging applicability for heavy oils. Incremental recovery factors between 5 and 20%, increased oil production rates and lowered water cuts are field-proven features of cEOR processes.

Halliburton has developed an integrated solution offering for cEOR that enables thorough, early determination of its applicability, and this offering can provide optimized and field-ready pilot designs in a short time frame. Our methodology is focused on an accurate quantification and reduction of risk to maximize the likelihood of successful implementation of cEOR in the short and long terms.

The ultimate objective of our integrated process is to enhance the profitability of our client's field operations in a robust and timely fashion.

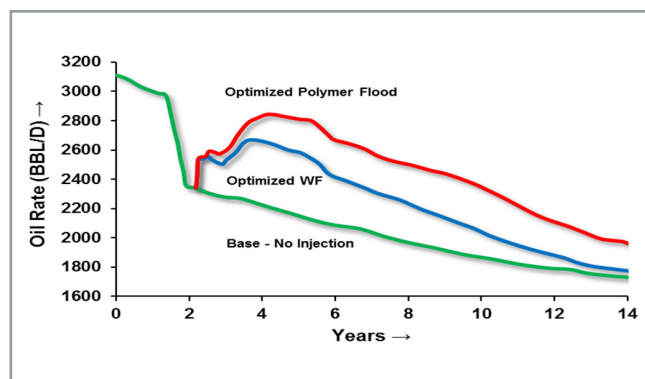
Many cEOR pilots do not meet the success criteria needed for full-field implementation. The following are some issues that cEOR pilots face and our solutions for them:

- Lack of clear results: Often caused by poor laboratory and simulation work. Our world-class laboratory offerings and rigorous modeling workflows help ensure the best possible pilot planning.
- Cost and time overruns: A result of incomplete understanding of uncertainties and risks with pilot projects. Cost overruns can be avoided with our approach of early detection and mitigation of risks. An integrated approach managed by experienced professionals also reduces the time to deployment and first oil.
- Inappropriate monitoring and operation: Poor monitoring design and poorly executed field operations that are circumvented by monitoring programs designed to evaluate pilot success criteria. The availability of the suite of Halliburton technologies helps ensure problem-free operation.
- Lack of expertise: Inadequate operator experience on cEOR projects can be overcome by utilizing our vastly experienced network of SMEs.

Case Study

A field had 80% of the hydrocarbon resource still in place, but the current pressure was 1/3 of the original and below the bubble point. There was an urgent need to increase production and also extend reservoir life.

Using our cEOR process, a Net Present Value (NPV) increase of approximately 300% over the base case was demonstrated by implementation of cEOR processes after extending the waterflood life.



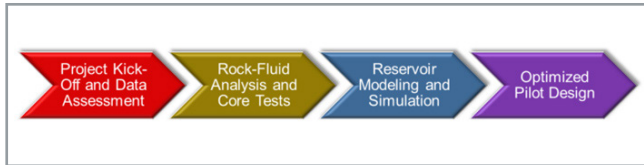
Incremental oil production forecasted through optimized waterflooding and chemical EOR.

Applications

The cEOR method is applicable in several situations not suitable to other IOR/EOR methods. For example, the method can be applied to thin reservoirs, depleted reservoirs, or reservoirs under bubble point pressure or deep viscous oil formations. cEOR can re-use waterflooding infrastructure and is often less energy and cost intensive than full-field steam or gas floods.

Chemical Enhanced Oil Recovery Pilot: The Four Phases Approach

The Halliburton four-phased process goes through initial planning, laboratory analysis, reservoir modeling and optimized subsurface and surface design. These phases enable tailored solutions at any stage of the field life.



The above phases will provide operators:

1. A comprehensive reservoir review to evaluate performance and establish the risks for cEOR.
2. Detailed laboratory studies and simulation input data to increase the pilot's probability of success.
3. Base case and optimized case forecasts for an EOR pilot, taking into account reservoir simulation, nodal analysis, and surface requirements.
4. Analysis of the impact of operational and technical uncertainties on pilot success.
5. "First-cut" economic analysis and forecasts for full field implementation using smart optimization algorithms and the support of the full-suite of applicable Halliburton technologies.

Features of the Halliburton Approach

- Widely experienced group of SMEs and professionals on cEOR
- State-of-the-art laboratory facilities in four global locations and associations with specialized third-party laboratories for the most effective chemical formulations for injection
- Integrated solution catering to all needs of the pilot planning process, from screening to field-ready pilot design

Benefits of the Halliburton Approach

- Early determination of potential effectiveness of development scenarios and associated risk through a proprietary Chance of Success (COS) methodology
- Optimized modeling solutions with quantification of surface and subsurface uncertainties and stochastic risk analyses with smart algorithms
- Access to the full suite of Halliburton technologies and Product Service Lines (PSLs) applicable to pilot and full-field implementation (for example, Multi-Chem flow assurance chemicals and remote control dosing, smart completions for injector wells, and so on)

**For more information, contact your local Halliburton representative
or visit us on the web at www.halliburton.com**