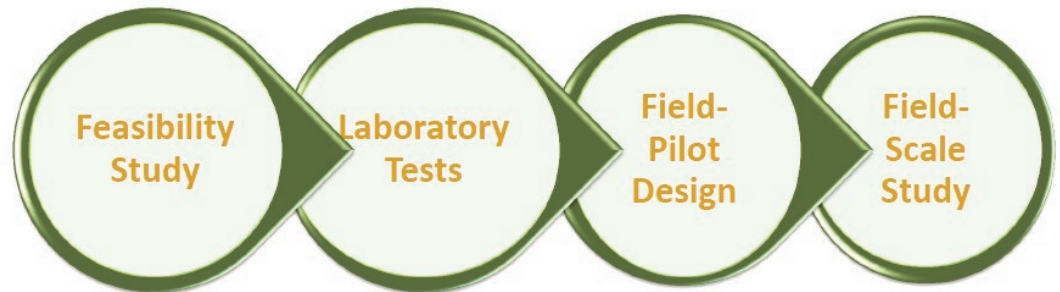


Evaluation of Enhanced Oil Recovery Potential through Integrated Field Studies



Knowledge

D&M has significant experience in designing and testing EOR strategies in mature reservoirs around the globe.

Integrity

Through training programs and engagements in major projects, the firm helps clients around the globe develop a better understanding of EOR methodologies.

Service

D&M provides guidance to help clients implement effective EOR programs and long-term EOR strategies.

Increasing Value by Enhancing Recovery

Evaluation and design of advanced EOR techniques require detailed understanding of geology, field history, and physicochemical processes involved with these techniques, which call for an integrated study that extends from pore-level analysis and detailed laboratory study to thorough field-level viability assessment. DeGolyer and MacNaughton (D&M) offers an integrated team that includes geophysicists, geologists, and engineers specialized in designing and evaluating EOR processes for the candidate fields. With solid industry experience since the inception of the firm in 1936, D&M has been a pioneer in providing accurate, reliable, and independent evaluation of hundreds of fields worldwide. D&M has performed EOR design, feasibility studies, and field implementation and optimization studies for chemical, gas, and thermal EOR methods on numerous fields.

EOR Methods

- Gas EOR
 - Hydrocarbon gas
 - Carbon dioxide
 - WAG
- Chemical EOR
 - Polymer
 - Surfactant/Polymer (SP)
 - Alkali/Surfactant/Polymer (ASP)
 - Low-salinity water
- Thermal EOR
 - Steam
 - Hot water
 - SAGD

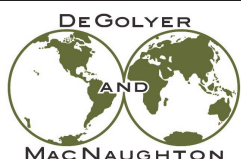
Primary and secondary recovery methods typically recover 30 to 40 percent of the oil initially in place. Capillary trapping of oil and limitations of the primary

and secondary recovery methods leave behind a substantial volume of oil in the reservoir. Advanced tertiary recovery methods, such as chemical, gas, and thermal recovery techniques, can be successfully implemented to enhance oil production from mature reservoirs.

D&M EOR Design Methodology

D&M provides consistent results for clients by following a process that promotes a comprehensive review of dynamic and geological information.

- EOR screening and feasibility study laboratory tests
 - Live oil phase behavior studies
 - Aqueous stability tests
 - Coreflood tests
 - Polymer rheology analysis
- Field-pilot design and uncertainty assessment
 - Coreflood simulation to acquire parameters for pilot design
 - Geologic characterization studies
 - Evaluation and design of pilot simulation
 - Analysis of different pattern and well configurations
 - Single-well chemical tracer test design
 - Surveillance and data collection program during pilot operation
 - Uncertainty assessment and cost analysis
- Field-scale study
 - Upscale the lab tests and pilot design to field-scale study
 - Uncertainty assessment in field-scale application
 - Detailed reservoir characterization and numerical simulation
 - Cost analysis for field-wide application



Support

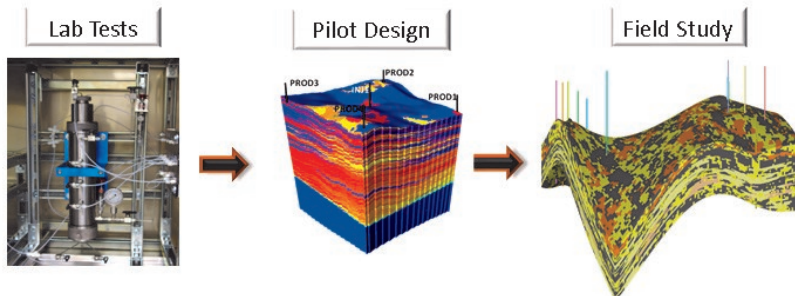
D&M's Reservoir Studies Division maintains a large full-time professional team consisting of engineers, geologists, geophysicists, and petrophysicists. These individuals are dedicated to reservoir characterization, EOR process design and application, field development evaluation, and reservoir simulation modeling.

Advanced Technology

D&M has made significant investments in computing resources and software development to deliver the answers that clients need.

Solutions

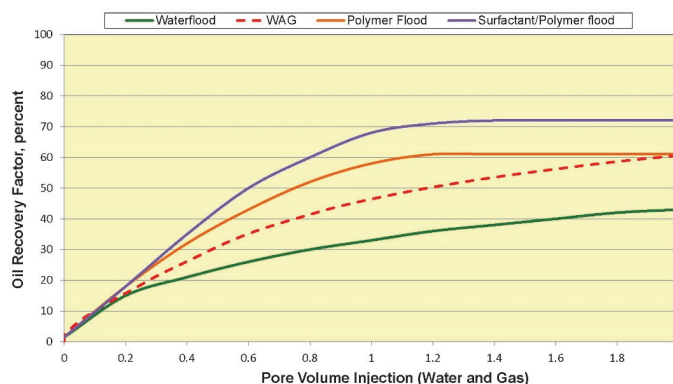
D&M offers a wide range of services to help clients evaluate EOR methodologies that will generate the most cost-effective production outcomes.



Experience

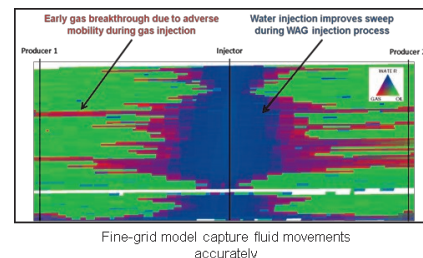
D&M's in-depth understanding of how reservoirs mature and respond to EOR techniques provides clients with greater confidence in their application of field development strategies.

- D&M performed several detailed studies of miscible gas, miscible WAG, and chemical surfactant-polymer in fields in North America.
- In 2011, D&M completed a detailed geological, petrophysical, engineering, and reservoir simulation study to design a miscible gas and chemical EOR pilot for a large carbonate field in the Middle East. Comprehensive laboratory experiments were also conducted as part of the study. The client started EOR field implementation using the D&M study.
- In 2013, D&M completed a study that involved evaluation and design of a CO₂ EOR process for a field located in the U.S. For this project, D&M estimated the potential revenue and present worth of the crude oil that could be recovered from the field through CO₂ injection.
- D&M performed simulation studies of miscible gas and WAG injection processes in several North Africa oil fields and developed a method of identifying miscibility at reservoir conditions
- D&M completed an evaluation of commercially available equation-of-state (EOS) compositional reservoir simulators to better understand their abilities to simulate miscible and near-miscible gas displacement processes, including CO₂ injection. An actual field case was used in the evaluation process.
- D&M completed detailed studies of gas EOR techniques for fields in Alaska.



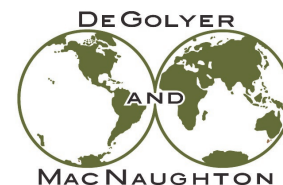
Comparison of performance of various EOR techniques on a highly heterogeneous carbonate reservoir (field test has been completed and the results have been promising).

D&M estimated the benefits of WAG injection versus continuous gas injection by evaluating the process through fine-grid simulations.



SERVICES AVAILABLE

- Chemical EOR evaluation
- Gas EOR evaluation
- Thermal EOR evaluation
- Feasibility studies
- Laboratory tests
- Field-pilot design
- Field-scale studies
- Reserves estimates



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