Petrotechnical Services for EOR
From candidate screening to full-field implementation
Asset managers and field planners around the world are realizing the importance of working enhanced oil recovery (EOR) processes into their initial field-development plans—not just when production begins to wane. Planning for EOR from the earliest stages of field development saves money, boosts ultimate recovery, and ensures maximum return on your investment.

EOR projects are among the most complex and difficult undertakings in the upstream industry. Questions regarding technical and economical viability require answers that are bolstered by industry-spanning and localized expertise, advanced technologies, and multidomain services. Success lies in improving efficiency in every step of the EOR scheme by synchronizing diverse measurements, applying advanced technologies, and integrating knowledge across multiple domains. Schlumberger petrotechnical services for EOR include access to a global network of experienced recovery experts and senior geoscientists who complement your in-house resources to address recovery enhancement projects of every kind, identify and mitigate project-decision risks, and maximize ultimate recovery.

**Responding to your EOR needs**
Addressing today’s EOR challenges requires a broad, holistic approach with multidisciplinary integration during all stages of the project—from design through execution to evaluation. Early stages require state-of-the-art technology to shorten the cycle time from concept to pilot and full-field implementation, where reliable monitoring and control are key to ensuring long-term economic success.

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START WITH THE END IN MIND TO MAXIMIZE RECOVERY
Planning for EOR from the earliest stages of field development could save money, boost ultimate recovery, and ensure maximum return on your investment.

Experienced Schlumberger petrotechnical EOR specialists bring multidisciplinary expertise and worldwide and local EOR experience to solve your most complex operational challenges. Through our network of multidomain experts, Schlumberger delivers long-term solutions, innovative technologies and workflows, and integrated services for all your EOR operations.

Delivering end-to-end solutions
Our petrotechnical teams have a long history of consulting and creating integrated solutions for full-field review and field-development planning at locations around the world. They deliver a full-cycle solution to EOR development, starting with high-quality reservoir construction through screening, pilot design, and evaluation.

UNIQUE ADVANTAGES OF SCHLUMBERGER PETROTECHNICAL SERVICES FOR EOR

- Collaboration between a global network of EOR experts and local knowledge at every stage of the E&P life cycle
- Continuous use of state-of-the-art technologies and industry-leading software
- Interpretation and comprehensive integration of all E&P data types and multidisciplinary workflows
- High-accuracy reservoir characterization at EOR-relevant scales
- Expertise and experience to provide the most appropriate EOR method to meet your specific recovery needs

Measurable benefits delivered to your EOR projects

- Acceleration of cycle time from concept to field trial
- Efficient monitoring of full-field implementation
- Prevention of reservoir damage during primary- and secondary-recovery operations with end-to-end planning
- Cost savings during finding and lifting in mature fields

FIELD IMPLEMENTATION
Full-Field EOR Development Planning and Economics Evaluation
Full-Field Expansion; Reservoir Monitoring and Control
MAXIMIZE OIL RECOVERY
MAKE EOR DECISIONS WITH GREATER CERTAINTY

Advanced reservoir characterization
Comprehensive reservoir knowledge supports more-efficient decision making at every stage of your EOR workflow—from concept selection to full-field implementation. Understanding complex reservoir systems in the detail needed to increase recovery requires integrating measurements at pore, log, interwell, and field scales.

Reservoir and flow models must not only be more detailed than ever but must also incorporate new laboratory, log, and field data as they become available.

To build multiscale reservoir models that deliver greater predictive and analytical power, Schlumberger petrotechnical experts use state-of-the-art reservoir characterization techniques and EOR proof-of-concept technologies, including:

- MicroPilot* single-well in situ EOR evaluation
- MiniPilot* medium-scale EOR evaluation
- DeepLook-EM* crosswell electromagnetic imaging service
- EORt* enhanced oil recovery method evaluation and screening tool
- Petrel* E&P software platform
- ECLIPSE* reservoir simulation software.

Starting with reservoir characterization, Schlumberger petrotechnical specialists work with you to identify and implement the EOR methods that can help you reliably meet your goals.
Schlumberger petrotechnical experts use MicroPilot evaluation to perform quick screening of EOR processes, providing fast evaluation of dynamic petrophysical properties.

The 4D saturation monitoring from Schlumberger DeepLook-EM service is used to image multiphase saturation distribution, enabling more robust dynamic evaluation of chemical flooding.

Tools and measurements used to evaluate formations for EOR projects in the field, laboratory, or office span a wide range of scales with various resolutions. The Schlumberger crosswell measurement methodology comprises microscopic and macroscopic data, enabling evaluation of a variety of datasets for more-informed decision making.
EORt evaluation and screening tool
Understanding the reservoir at different levels and scales is critical for a robust EOR screening, which is where reservoir heterogeneity and displacement-force balance determines the ultimate benefit of an EOR process. To better serve our customers’ in-house teams, Schlumberger developed the EORt enhanced oil recovery method evaluation and screening tool. This process-based, interactively guided tool exceeds conventional screening approaches by incorporating a comprehensive analysis of the reservoir architecture and up-to-date fluid flow. The output is actionable data that can optimize EOR process selection and help find the best method to address your specific reservoir challenges.

Schlumberger engineers can perform a rapid yet robust assessment of the EOR potential for any reservoir, identify relevant data gaps in reservoir characterization, develop risk-mitigation strategies, and quantify the technical potential of different applicable EOR techniques to find the one that best fits your objectives.

Laboratory testing support
Working together with laboratory professionals, our EOR experts ensure that laboratory investigation properly addresses the challenges identified during the preliminary screening and design phase. We provide technical support during interpretation of preliminary laboratory results and help translate these results onto the models used to further evaluate EOR strategies.

Pilot design and risk evaluation
The accurate translation of EOR laboratory and field measurements is paramount for a successful, accurate reservoir model and subsequent pilot planning. This measurement translation helps to preserve the predictive power of static and numerical modeling during upgrades and ensure that all measurements are translated at the proper scale to the numerical model. With the Schlumberger model, preliminary screening results are validated and modified (if required) to suit updated reservoir conditions.

Our proof-of-concept alternatives range from traditional large-scale pilots to small-scale and single-well operations. With a portfolio that includes technical support and guidance for the design of all pilot alternatives, we help identify the best zones for the pilot test, recommend completion designs, identify injection and production requirements, and determine the optimal number and placement of observation wells. We work with you to bring the latest EOR acquisition technologies to the job and mitigate uncertainties during pilot execution.

Successful, reliable reservoir modeling and pilot planning requires translating EOR laboratory and field measurements into actionable information.
Reservoir Analysis
- Evaluates fluid type, rock distribution, current reservoir conditions, and recovery mechanisms prior to EOR selection
- Identifies reservoir description limitations
- Provides user guidance through the validation process

EORt Screening Tool

Qualitative Screening
- Compares industry experience with individual reservoir characteristics to substantiate EOR method selection
- Estimates local displacement efficiency based on analytical and numerical methods for single- and dual-porosity reservoirs
- Uses reservoir architecture and current fluid distribution to guide EOR method selection
- Provides analog fields from an industry-wide database

Quantitative Screening
- Systematically uses your reservoir model to identify appropriate sectors for EOR studies
- Uses numerical simulation to quantify recovery and rank the best EOR alternatives
- Provides forecasts of all streams for economic screening

The EORt tool can evaluate existing EOR methods at current field conditions. EOR solutions are screened with a two-stage approach. First, methods are ranked based on compatibility, geology, and recovery improvement—decisions which are validated against the EORt tool database of 2,700 historical projects. Secondly, realistic reservoir models are built and optimized using ECLIPSE reservoir simulation software to quantify recovery and economical efficiency.
Reservoir geomechanics for EOR
Understanding and modeling a reservoir for an EOR project involves predicting changes in the rock structure and mechanical properties caused by injection and production cycles. A reliable geomechanical model can simulate different scenarios in advance and help determine the optimal injection pressure. Without geomechanical modeling, forecasting recovery would require assuming that reservoir pressures and associated pore volumes remain unchanged during EOR—which is rarely the case.

Together, our teams work to build a full-field mechanical earth model that can couple with a flow model rendered in ECLIPSE software to provide an integrated EOR solution. The result is more accurate determination of how much EOR fluid to inject, where to inject it and at what pressure, and how much oil and gas production can be expected.

Pilot operation surveillance
During pilot operations, our integrated multidisciplinary teams interpret and validate field observations, evaluate results, and assess existing reservoir understanding and the model’s predictive power. Constant monitoring of the results and validation of the static and dynamic assumptions are paramount for the success of the pilot operation.

Gain a better understanding of fluid distribution and movement for successful reservoir management.

Until recently, well logging measured only within the borehole and near-well environment, and vital characterization information farther into the reservoir remained a mystery. Challenging this convention is crosswell electromagnetic imaging, which expands the scale investigated by resistivity logging. This enhanced measurement acquisition system gives a fuller picture for monitoring fluid distribution and movement at reservoir scale—an essential part of any EOR reservoir management process.

The 2D or 3D inversion of the data acquired by interwell electromagnetic surveillance provides high-quality data for use in a workflow that integrates existing reservoir information from the Petrel platform to create a field model of possible fluid-movement scenarios. Simulation based on these scenarios ensures the application of the appropriate measurement sensitivity.

Following the survey, interwell resistivity distributions are exported back to the field model. From there, experts begin data integration and interpretation to provide greater insight for water and stream tracking, reservoir characterization, and bypassed pay detection.

Integrating crosswell electromagnetic imaging survey data with reservoir history matching leads to improved reservoir modeling by reducing the uncertainty of fluid saturation between wells. This leads to more reliable predictions and, in turn, more accurate economical modeling and decisions for EOR field-development planning and exploitation.

INTERWELL IMAGING REVEALS
THE BIGGER PICTURE

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Schlumberger petrotechnical experts can provide real-time support during pilot operations to validate model assumptions and to suggest changes to the operation (as required) during new data interpretation.

**Pilot evaluation and field scaleup**

When pilot operations near completion, the reservoir model requires validation and updating with the pilot results prior to full-field EOR development planning. With strong reservoir characterization, reliable history matching, and a team of EOR specialists, Schlumberger can help you translate pilot results onto the numerical model to update the reservoir description when needed and fluid-rock interaction assumptions in preparation for full-field development of EOR operations.

Integrating Schlumberger technologies addresses different scale measurement challenges, including reconciling displacement efficiencies, identifying EOR agent requirements, updating residence time, and reevaluating and ranking uncertainty before full-field development feasibility and planning.

Schlumberger experts use the DeepLook-EM service (above) to interpret and history match your data, recalibrate models, and recommend refinements to your EOR strategy based on high-quality interwell imaging results. Following the workflow developed for use with the DeepLook-EM service helps reduce uncertainty, resulting in better-informed decisions and more reliable economical modeling during field-development planning.

Integrating crosswell electromagnetic imaging data to history matching (left) provides accurate understanding of multiphase saturation distribution for reservoirs undergoing EOR-agent flooding.
A PROVEN PLAN TO EXTEND PRODUCTIVE LIFE

Schlumberger has performed full-field EOR evaluations and development planning around the world, including in clastic, carbonate, and dual-porosity naturally fractured reservoirs. Our enhanced field-development design incorporates monitoring and control systems for better sweep efficiency—and better understanding of your reservoir's behavior.

Efficient EOR decision making
Feedback loops to improve design are implemented rapidly

Additional Recovery

Success of EOR operations
Optimizing the EOR project continues throughout its life

Starting operations with the end in mind can initiate accurate reservoir characterization early enough to reduce uncertainties, avoid reservoir damage during primary and secondary recovery, shorten EOR cycle time, and achieve maximum return on investment over the life of the field.
## OUR EOR PORTFOLIO

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**Schlumberger petrotechnical services**

The Schlumberger portfolio of petrotechnical services offers a unique combination of multidomain expertise, proprietary technologies and software, and expert support to transform your well, field, and reservoir data into better-informed business decisions at every stage of the E&P life cycle.