

Methodology

01

DIAGNOSIS

- Identify the remaining volume of hydrocarbons
- Select candidate EOR processes
- Sources of fluids to be injected and logistics
- Economic analysis

02

ANALYSIS

- Laboratory studies (data on rock and fluid properties)
- Reservoir characterization studies (core analysis, geophysical records, seismic, fluids, production history, among others)
- Static and dynamic geological models

03

SELECTION AND VALIDATION

- Design and execution of pilot and field tests
- Data collection and interpretation
- Study of tracers
- Facility reliability and well integrity

04

PLANNING

- Large-scale design
- Updating of models
- Development plans and decline of the deposit to its economic limit
- Economic project

05

EXECUTION AND SERVICE

- Project implementation and management
- Operations and monitoring
- Monitoring and control



In sync with the priority issues in the sector, **Apollo**, in association with strategic allies, evolves its platform to collaborate in the execution of strategic investment projects, technological development, efficiency and productivity.

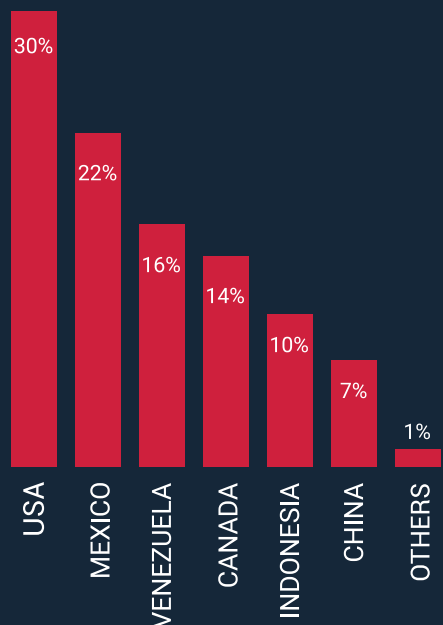
We offer the **integration of competitive** solutions and align our effort and commitment to maintain and increase your production and recovery levels, through proven **global experience**, technically and financially.

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Complete solutions that are applied throughout its value chain

Enhanced Recovery (EOR)



Graph 1. Percentage of oil production by country attributable to improved recovery methods, with respect to total world production by EOR, Thomas S., 2008

Currently 4/5 of the oil production in the country results from the exploitation of mature fields (Graph 1), a situation that demands special attention around technologies aimed at increasing recovery factors in producing areas.

In the same sense, the **remaining oil** contained in the country's oil fields represents an important opportunity for reclassification and reincorporation of reserves, since an approximate unproduced volume of 224 mmmmb is currently estimated, where just over 85% represents the potential for the application of new technologies, including **enhanced recovery** methods (EOR). According to studies and from a conservative point of view, these mechanisms could increase the recovery factor in a range of 5 to 10%.

INTEGRAL SERVICE

Apollo adds to its portfolio of solutions, complete programs for EOR that cover different technologies recognized in the market, as well as the services and infrastructure associated with their implementation, operation and monitoring.

CHEMICAL PRODUCTS

Apollo has a broad spectrum of new generation and proprietary surfactants to meet specific needs in EOR, heavy oil recovery and unconventional gas. Among its main advantages we can mention:

Low surfactant concentration during formation flooding, with successful field proven results.

Optimization of salinity is not required. Clay swelling, migration due to changes in formation salinity, polymer degradation due to high salt content, and overall project cost are reduced.

A single compound. The optimization and absence of a co-surfactant or solvent, it is translated to a simplification of the surface injection equipment, reduction of operating costs, an improved injection system and a greater return on investment.

Low adsorption. A low adsorption compound facilitates flooding with a polymeric surfactant (SP).

Furthermore, scale and polymer degradation problems associated with the use of alkaline polymeric surfactants (ASP) are eliminated.


Field proven results. These products have been used successfully in more than 20 EOR projects around the world.

Custom design. In accordance with the requirements of performance, logistics, procurement, supply, deposit conditions and customer specifications.

Continuous development. New products and processes based on changes in conditions, requirements and experience in the field.


Complementary projection. Identify the optimal surfactant according to field conditions.

TRACERS BETWEEN WELLS




WATER PHASE

Inorganic salts,
Organic compounds,
Chemical isotopes,
Dyes,
Radioactive material




OIL PHASE

Inert gases,
Inorganic compounds,
Organic compounds,
Radioactive material



GAS PHASE

Inert gases,
Inorganic compounds,
Organic compounds,
Radioactive material



OF PARTITION

Acetic and formic acid esters

LABORATORY

These studies are important to determine the properties of the producing formation, of the fluids they contain and their distribution. The tests for ROS method selection can be classified into the following four groups:

- Oil characterization
- Study of injection fluids
- Reservoir cores characterization
- Study of displacement of porous media

**Note: In the event of proposing the in situ or thermal combustion method, the geomechanical properties of the formations must be determined.*

SOFTWARE (Simulator for modeling)
The numerical simulation in an EOR project allows to determine:

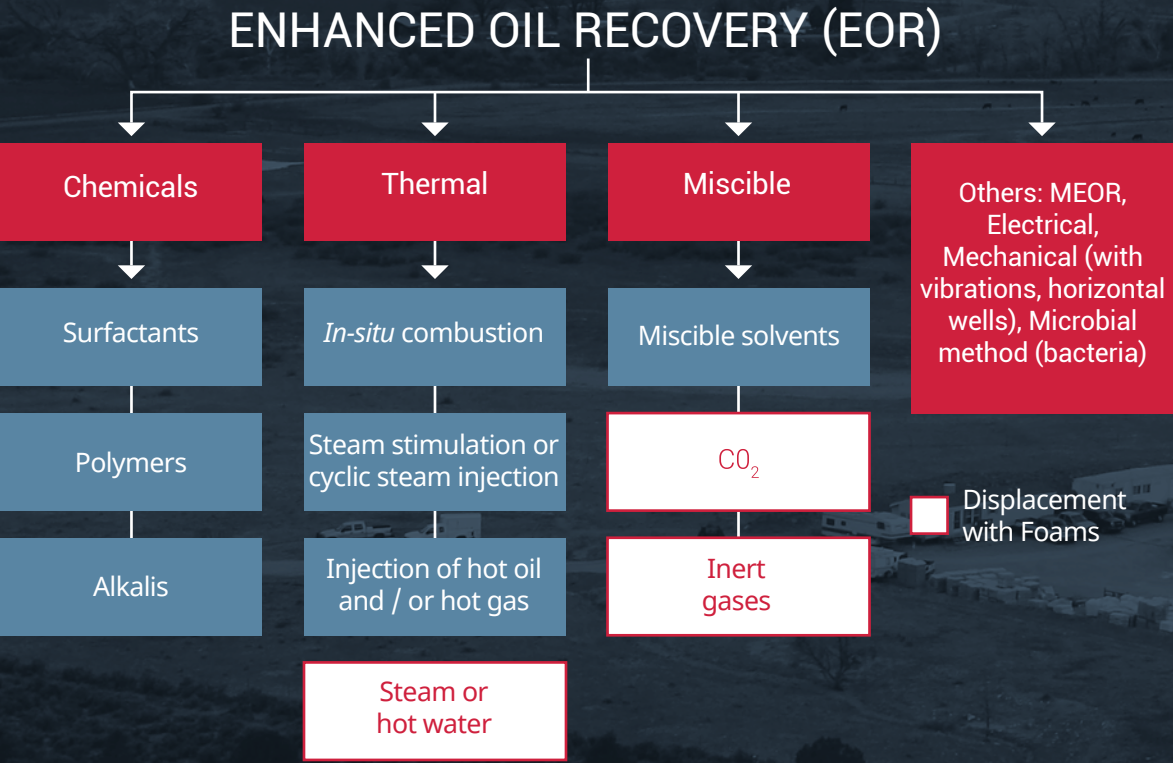
- The number of injector and producer wells to be used and that already exist in the field
- The volume of fluids to be injected
- Additional production profiles
- The economic value of the project
- Sizing the required infrastructure

INFRASTRUCTURE

- Headquarters
- Field laboratory
- Logistics, procurement and supply
- Dosing, measurement, monitoring and communications equipment
- Conditioning of access roads and locations
- Specialized staff

CONTROL, TELEMETRY AND AUTOMATION

- Instrumentation and measurement
- Adaptation and transmission of signals
- Display and storage
- Continuous monitoring of historical data storage systems
- Triggering alarms and sending messages
- Remote control and operation of the system
- Real-time monitoring



TYPE	SURFACTANTS	SUPER SURFACTANTS	GREEN SURFACTANTS ®	SMART SURFACTANTS ®
Applications EOR	ASP	SP, P	SP, ASP	Viscoelastic (low interfacial tension and viscosity)
Tolerance SDT	30, 000 ppm	> 100, 000 ppm	> 200, 000 ppm	> 200, 000 ppm
Tolerance Ca. Mg	~ 400 ppm	> 1, 000 ppm	> 2, 000 ppm	> 2, 000 ppm
Thermal stability	> 100 °C	> 100 °C	> 100 °C	90 °C
Origin	Petrochemical	Petrochemical and Biochemical	Biochemical	Biochemical
Water softening	Yes	SP - No ASP - Si	SP - No ASP - Si	No
Co-surfactants	No	No	No	No
Co-solvents	No	No	No	No
Salinity optimization	No	No	No	No
Industrial property	Patented	Patented	Patented	Patented