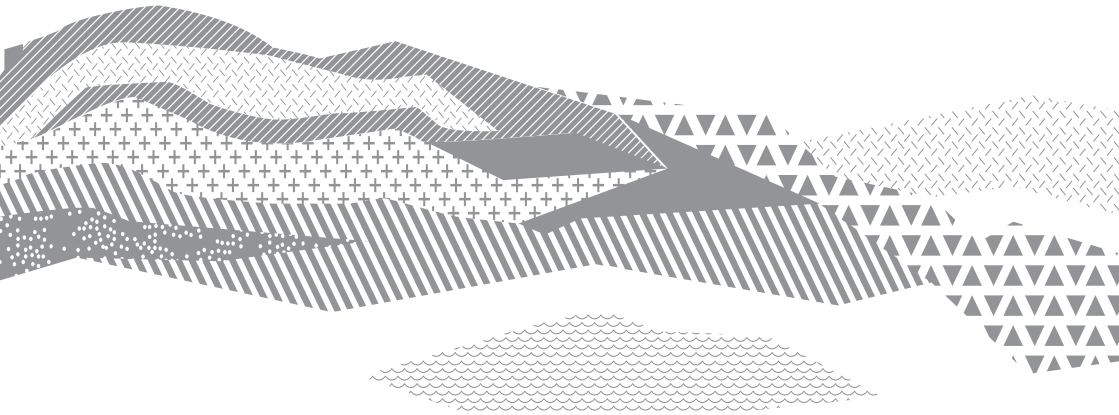
Reco

RECO surfactants

Cepsa chemicals for Enhanced Oil Recovery



CEPSA

Your world, more efficient.

Reco

RECO series is a range of anionic surfactants and precursors produced and commercialized by Cepsa and designed to achieve an ultra-low interfacial tension (IFT) in c-EOR. RECO surfactants are used in ASP and SP methods and they are accompanied by co-surfactants or co-solvents in formulations.

Cepsa Group

Cepsa is an integrated energy company operating at every stage of the oil value chain with activities in:

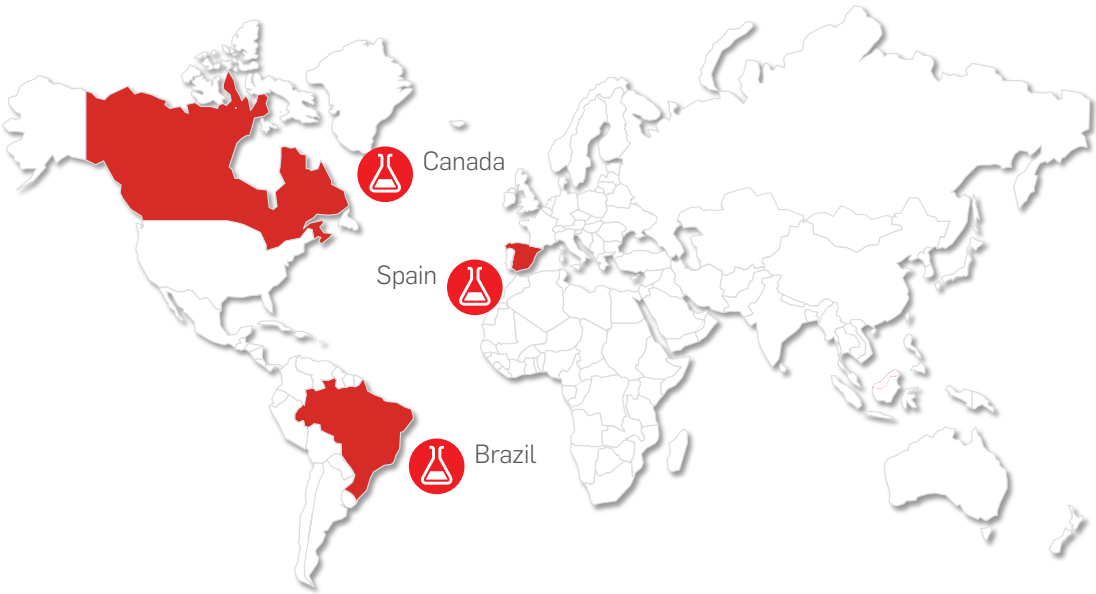
- Petroleum and gas Exploration and Production.
- Refining, distribution and sale of derivatives.
- Petrochemistry.
- Gas and Electricity.

Cepsa has been in the market for more than 80 years and, thanks to its flexibility and ability to adapt, it has become a benchmark company in the energy sector through the progressive internationalization of its activities.

Petrochemical in Cepsa

Cepsa is the global leader in the production and commercialization of alkylbenzene and alkylbenzene sulfonic acid, both raw materials in the manufacture of alkylbenzene sulfonate, the most widely used synthetic surfactant in the world.

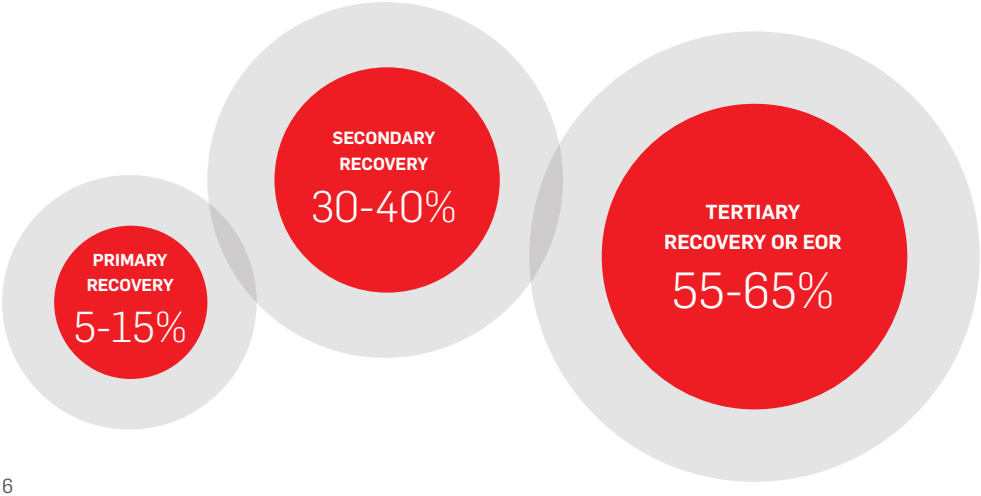
Cepsa currently has 3 plants for the manufacture of alkylbenzenes (Spain, Canada and Brazil) for the production and global supply of raw materials for surfactants.



Enhanced Oil Recovery

"Enhanced oil recovery" (EOR) or tertiary recovery encompasses several techniques to extract more crude oil from reservoirs in comparison with conventional techniques. Primary and secondary oil recoveries can usually achieve one third of the reservoir's total as long as the other two thirds remain behind. Only through the use of EOR techniques can large quantities of that remaining crude oil be recovered.

- Primary recovery: Oil extraction due to the inherent pressure gradient between the reservoir and the surface.
- Secondary recovery: Oil extraction through the injection of a driving fluid (generally water) to achieve the pressure gradient between the underground level and the surface.
- Tertiary recovery or EOR: Enhanced recovery by means of a range of techniques using the injection of steam, gas or chemicals.



Chemical EOR

Chemical EOR (c-EOR) employs the use of surfactants (S), Alkalis (A) and polymers (P) to improve:

The oil displacement efficiency by decreasing the interfacial tension (IFT) between the crude oil and injection water, almost reaching miscibility between both.

The oil sweep efficiency by decreasing the oil viscosity or increasing the water viscosity.

Surfactants and alkalis improve the displacement efficiency to encourage the flow of oil trapped in the rock through the reduction of the interfacial tension between water and oil.

The polymers improve the sweep efficiency of oil increasing the viscosity of the water. Frequently, these formulations are accompanied by other additives such as co-surfactants or solvents.

c-EOR in Cepsa

The key to success factor in the c-EOR business is the integration between Research, Chemicals and Exploration & Production capabilities to streamline the development of the most efficient solutions. Cepsa is actively present in every stage of an EOR project:

Screening and evaluation in laboratory

- Develop and define optimum surfactant and formulation compatible with fluids and reservoir conditions.
- Test and prove that formulation mobilizes and recovers the oil trapped in the reservoir sample at laboratory scale (coreflooding).

Single Well Tracer Tests (SWTT)

- Evaluate the capability of the formulation to reduce and mobilize the residual oil saturation at well scale and reservoir conditions.
- Quantify the effectiveness of the formulation.

Pilot test

- Confirm the technical success of the c-EOR process as a whole: formulation interaction with reservoir fluids and rock, injection and production behavior & profiles, etc.
- Field facilities construction and implementation at pilot scale.
- Acquire and manage monitoring data and analysis of results for the definition of the c-EOR deployment at field scale.

c-EOR field scale implementation

- Define the technical-economical viability of the c-EOR application at field scale.
- Design and implement the c-EOR development of the field.
- Reservoir monitoring and control.

Research capabilities

Through our laboratories, Cepsa offers a wide range of research services for the synthesis and development of surfactants, optimizing the performance and behavior of the surfactants and formulations employed in ASP (Alkali- Surfactant-Polymer) and SP (Surfactant-Polymer) methods.

Phase behavior studies, interfacial tension analyses, formulation stability studies, coreflooding tests, rheologic behavior, shelf life studies, etc. can be tested in Cepsa laboratories.

Oil operators, services companies and chemical companies are our customers to completely cover the c-EOR value chain.

Pilot plants and capabilities at industrial scale

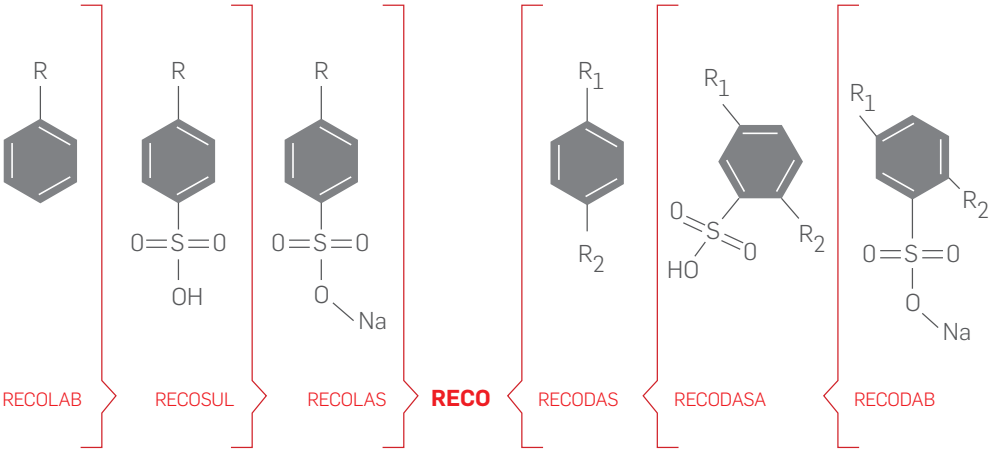
Furthermore, Cepsa has several pilot plants to develop and supply new precursors and surfactants in all steps of the production chain from kilograms to industrial scale.

The existing capacity and the availability of raw materials make c-EOR an opportunity for diversifying the Cepsa petrochemical portfolio.

Linear mono-alkylbenzene (LAB) and dialkylbenzene (DAB) are manufactured via the benzene alkylation with mono-olefins obtained from n-paraffins.

LAB and DAB, once sulfonated and neutralized, become surfactants with a different characteristic and compositions intended for a wide range of applications.

RECO precursors and surfactants



RECO surfactants portfolio

RECO series

Name	Active matter* (%)	MW**	Description	Salinity	Application temperature
RECOLAS 103	30-50	340	C10-C13 linear alkylbenzene sodium sulfonate	medium	Stable at high temperature
RECOLAS 147	30-50	389	C14-C17 linear alkylbenzene sodium sulfonate	medium/low	Stable at high temperature
RECOLAS 158	30-50	412	C15-C18 linear alkylbenzene sodium sulfonate	medium/low	Stable at high temperature
RECODAS 185	55	447	Mostly dialkylbenzene sodium sulfonate	low/very low	Stable at high temperature

Different RECO surfactants can be offered through variations in MW and alkyl chain distribution.

* Active matter may vary from the values shown in the table.
** Orientative MW.

Wide range of alkyl aryl sulfonates surfactants

Cepsa has the capability of development and manufacture of tailored surfactants to achieve the lowest interfacial tension between the oil and water at the reservoir conditions of salinity and temperature. As the leading producer of LAB, the tailored molecule is not only viable at laboratory scale but also at pilot plant and full scale implementation scale.

Staffed with engineering and chemical professionals, Cepsa provides customized solutions through our laboratories and pilot plants to any requirement related to c-EOR.

Furthermore, Cepsa facilities are readily available to supply larger volumes of surfactants demanded by our customers.

TUNING ALKYL DISTRIBUTION BY DIFFERENT CUTS OF N-PARAFFINS OR OLEFINS

ALTERING SULFONIC ACID PROPERTIES DURING SULFONATION PROCESS

MODIFYING ISOMER DISTRIBUTION DURING LAB MANUFACTURE ALKYLATION

FORMULATING SURFACTANT FOR EVERY RESERVOIR CONDITION

CHANGING THE COUNTERION DURING THE NEUTRALIZATION

QA/QC

In all EOR processes, comprehensive monitoring and surveillance programs have to be developed in advance, especially for the complex c-EOR process like SP or ASP.

Laboratory in the field for quality assurance and quality control (QA/QC) of RECO surfactants is completely necessary.

Periodical sampling and on-site analyses are scheduled but also samples delivery to Cepsa Research center for more sophisticated analyses.

These data are essential for the final performance evaluation.

HSE

RECO surfactants from Cepsa used for c-EOR activities comply with health, safety and environmental regulations with regards to the manufacture, commercialization, transport, storage and end use in the field.

RECO surfactants are registered under REACh regulation in accordance with the PPORD exemption as substances intended to be used for Product and Process Orientated Research and Development).

Our Product Stewardship department can provide our customers with any information about HSE linked to our RECO surfactants.

Distribution, handling and storage

Cepsa has a well developed logistic network deployed around the world for the production, distribution and storage of our surfactants.

RECO surfactants are pumpable and pourable at room temperature, though heating is suggested for handling and tank storage.

Alkyl aryl sulfonates are well known for their thermal stability and durability; this has been confirmed through our shelf life studies in laboratories, being stable at high temperatures and not showing any significant change in composition and behavior after a long period of time.

Contact

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RECO surfactants samples are available at variable quantities for laboratory analyses and for single well tests.

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