



# POLYMER WELL TECHNOLOGY

*Tailor-made solutions*



EOR, WSO, Conformance, Sand Control

**POWELTEC**

An Independent Service Company

# POWELSAND

## Sand Control by polymers

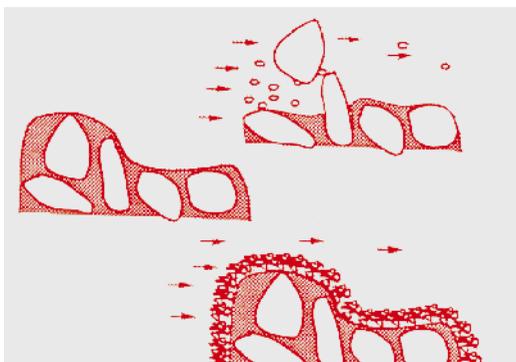


### Scope

In sandstone reservoirs, operators often face sand production problems due to the degradation of reservoir rock around the wellbore under high-velocity fluid flow. In many cases, the sand consists of fines which are not retained by stand-alone screens or gravel packs. The production of sand induces several problems such as the degradation of surface facilities (valves, pipe, pumping unit,...) and the accumulation of sand in the wellbore. The operators often choke the well and limit its production rate, which, in addition to frequent sand cleaning jobs, affects operational costs.

The degradation process starts with the erosion of the cement of the rock, with a production of fines. When the erosion of the rock is advanced, a production of large quantities of sand occurs together with sand accumulation in the wellbore.

The principle of the polymer sand control technology consists of the formation of a polymeric film on pore walls, which stabilizes the rock around the wellbore and thus stop the erosion process. Such a film has to be strong enough to resist wash out by production fluids under high-velocity flow.



Principle of polymer Sand Control

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## POWELTEC sand control technology

The technology is based on the adsorption of an «environmentally friendly» water-based polymeric film onto the pore walls, which can efficiently prevent the erosion of the cement of the rock under high flow rates.

POWELSAND™: polymeric products are specifically designed to stick onto the pore walls and prevent the erosion of the rock with almost no impact on oil or gas flow.

During the past 10 years, remarkable results have been obtained in the treatment of Underground Gas Storage wells. Treatment efficiency lasts at least 4 years, saving the cost of regular well interventions such as coil tubing sand cleaning jobs. Re-treatments have also been performed successfully.

Combined Water Shut-Off & Sand Control treatments can be designed on request.

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## Treatment mechanism

On the contrary of resin-based sand control treatments which consist of the formation of rigid material in the rock over 1-2 feet, POWELTEC technology is based on the formation of a soft polymeric film deeper in the formation (about 3 to 6 meters).

POWELSAND™ products can be bullheaded into the whole open interval of the well, without specific tools for placement. The risk of well impairment is minimized by the use of Relative Permeability Modifiers.



## Laboratory test – flocculation

without polymer



with polymer

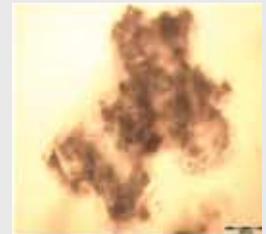


## Laboratory test – flocculation

produced sand



after polymer adhesion



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## Treatment design

Treatment design consists of laboratory flocculation tests to screen the polymer having the highest adsorption on produced sand. Coreflood experiments are then carried out to evaluate polymer injectivity, dynamic adsorption, mobility reduction and oil/gas return permeability.

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## Product delivery and field assistance

POWELTEC delivers the products and send a technical team to support the operation manager, supervise the chemicals preparation and check the quality of the solutions prepared on site.

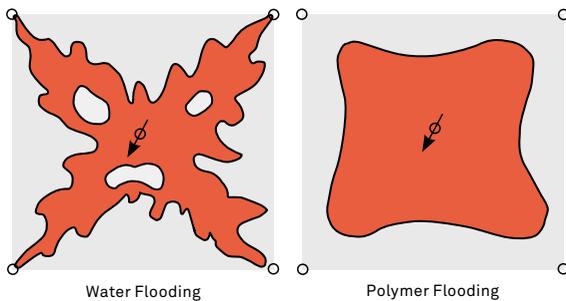
POWELTEC can also assist the operator in post-treatment monitoring.

# POLYMER FLOODING AND CHEMICAL EOR

## Study & design



### Scope



**Principles of Polymer Flooding**

Currently, about 60% of the reservoirs are submitted to water injection to sustain reservoir pressure and improve the sweep efficiency. However, due to reservoir heterogeneity and viscosity contrast between oil and water, water has a natural tendency to travel through preferential pathways thus leaving significant amounts of unswept oil behind. According the International Energy Agency 2009 report, an increase of 1% of the oil recovery factor could generate two or three years of additional oil resources. Thus, improving reservoir sweep efficiency appears as a major challenge for the oil industry.

Different EOR technologies can be implemented to reach this goal. Among them, polymer flooding consists in increasing the viscosity of injected water to correct the mobility ratio between oil and water and improve significantly reservoir sweep efficiency. Compared to other EOR technologies, polymer flooding can be implemented with relatively low assets investment.

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## POWELTEC background

POWELTEC personnel has been involved in all the major breakthroughs realized in polymer EOR during the last decades, i.e., design of the first polymer flood pilot in Daqing (largest polymer flood project worldwide), Pelican Lake (first heavy-oil horizontal well polymer flood), Dalia (first deep offshore polymer flood). POWELTEC participates to R&D programs in cooperation with universities, research centers, chemical manufacturers and field operators. The most recent POWELTEC outcomes concern the development of EOR polymers for high temperature reservoirs (up to 120°C).

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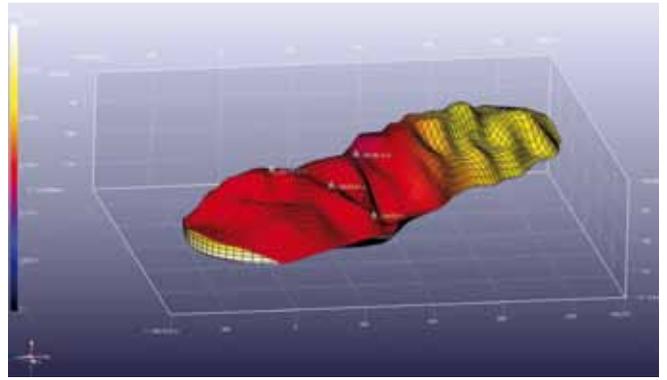
## POWELTEC integrated services

POWELTEC proposes integrated services including laboratory studies, reservoir simulations, surface facilities design, field support for pilot launching, and pilot survey.

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## Laboratory study

POWELTEC offers more than 5000 square feet of laboratory facilities including six coreflood units and 2 deoxygenation ramps for long term stability tests according to API standards. The main goals of the laboratory study are to screen out the best-dedicated polymer to fit the reservoir conditions and determine polymer performances in reservoir rock types. Coreflood data are used as polymer input for reservoir simulations.



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## Reservoir simulations

Reservoir simulation studies are performed using PumaFlow™ software which includes a pertinent polymer module. The simulation program includes the following steps:

- Building of reservoir model with the pilot pattern
- History matching and model adjustments
- Simulation of injection scenarios, sensitivity study to polymer concentration, slug size and injection rate
- Definition of the best scenario with performance and economic forecasts

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## Surface facility design and pilot assistance

POWELTEC experts assist the operator in surface facilities design. POWELTEC team usually participates to the launching of the pilot, performing QC measurements on site. Pilot monitoring is achieved via the update of the reservoir model.

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## SP and ASP

As independent expert, POWELTEC evaluates the performances of SP and ASP formulations proposed by service companies and chemical manufacturers.

# LABORATORY STUDIES



## POWELTEC lab capabilities

POWELTEC has 5000 square feet of laboratory facilities including:

- 6 Coreflood rigs (for 1.5" cores and 1" cores)
- 1 Formation Damage rig
- 2 Deoxygenation ramps (API standard)
- 2 Rheometers and 2 viscometers
- 1 Filtration unit (API standard)
- 1 Mechanical degradation unit (API standard)
- Different Analyzers (Carbon analyzers, UV and light scattering spectrophotometers)





## POWELTEC laboratory services

EOR Studies	EOR Polymer Independent Evaluation	WSO/Conformance & Sand Control	SCAL Services
Independent polymer/chemical expertise		Own dedicated product line	Initial saturation Gas/liquid permeability Porosity Pore volume compressibility Relative permeability curves Amott wettability tests Capillary displacement pressure Static formation damage studies Scale inhibitor squeeze studies
Brine compatibility tests Bulk screening Filtration tests Long-term stability test in reservoir conditions Mechanical stability test Hydrodynamic properties in reservoir rocks (injectivity, Mobility & Permeability Reductions, dynamic adsorption, set of relative permeability curves before and after polymer injection) Data set for reservoir simulations		Flocculation test Gel kinetics Gel strength	
	Field expertise		

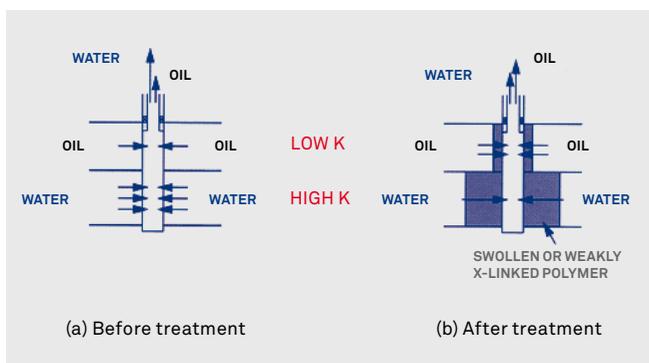
# WATER SHUT OFF & CONFORMANCE CONTROL



## Scope

Reducing water production from mature oil & gas fields represents a major challenge. Excessive water induces additional costs of lifting, separation, fluid treatments and disposal, as well as problems such as scales, corrosion, emulsion, bacteria development and sand production. Furthermore, water overtakes oil production in heterogeneous reservoirs. Water control becomes thus a major issue for the operators.

POWELTEC WSO/Conformance processes have been successfully applied in more than 100 field cases worldwide, i.e., gas wells, multi-layer water-flooded wells, heavy-oil horizontal wells, fractured reservoirs, sandstone and carbonate reservoirs.



**Principles of Water Shut-Off by polymers**



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## POWELTEC WSO/Conformance technology

Different families of products with low environmental impact have been designed for both Water Shut-Off & Conformance Control:

- POWELGEL™: Delayed gel tailored to fit a broad range of reservoir conditions. Gel consistency can be adjusted from RPM (weak) gel to sealant (strong) gel.
- POWELSMART™: Size-controlled microgel specifically designed to penetrate deeply in the reservoir and selectively reduce water relative permeability vs oil or gas relative permeability (RPM products). Microgels withstand high salinity, severe shearing, high temperature and aggressive compounds (H<sub>2</sub>S).
- POWELTHERM™: Bio-sourced thermo-thickening polymers designed to gel at a given temperature. Sealant gel for zone isolation and in-depth conformance control.

The products are environmentally friendly. They can be used up to 180°C and 260 g/L TDS salinity. For further details, refer to technical sheets.



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## Treatment design

Although the products can be used as sealant components for zonal isolation (with high consistency), a particular emphasis has been put on RPM systems (Relative Permeability Modifiers). In their RPM option, the products behave as weak gels and can strongly reduce the relative permeability to water without affecting the relative permeability to oil or to gas. They can thus be bullheaded into the whole open interval without requiring placement tools.

Treatment design combines laboratory study and near-wellbore reservoir simulations.

The laboratory study consists in product screening, (viscosity and stability tests) and core flooding. Coreflood experiments aim at measuring the polymer data set to be used in reservoir simulations (injectivity, dynamic adsorption, mobility and permeability reductions, RPM behavior and gel strength).

The reservoir simulation study consists in:

- building a representative model of the treated well or pattern constrained by history matching;
- evaluating different treatment scenarios;
- sizing the treatment and;
- predicting the benefits to be expected.

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## Product delivery and field assistance

POWELTEC defines the surface handling facilities and the operational program.

POWELTEC can deliver the products and send a technical team to assist the operation manager, supervise the chemicals preparation and perform Quality Control measurements on site.

After treatment, POWELTEC can provide post-treatment monitoring.

