RESERVOIR LINK

PROVISION OF

# Chemical Sand Consolidation

www.reservoirlink.com

# POWELGEL™ Microgel Technology
# Water Shutoff/Conformance Control/Sand Control

POWELGEL-MICROGEL™ is a new technology using microgels with different sizes, which is new proposed on the market by Reservoir Link. The main domains of applications are:

- Water Shutoff/Conformance control
- Sand control

The process uses performed water-soluble microgels, produced in the plant and delivered under liquid (emulsion) or power form. POWELGEL-MICROGEL™ have a remarkable thermal (up to 165ºC), shear and chemical stability, a narrow size distribution and environmentally friendly (some have been qualified for offshore North Sea applications).

When injected into a formation, POWELGEL-MICROGEL™ adsorb strongly on the rock, thus forming a thick continuous gel-like on pore walls, which improves rock stability and induces RPM effects (Relative Permeability Modification). Actually, POWELGEL-MICROGEL™ can strongly reduce the relative permeability to water, while affecting very little the relative permeability to oil or to gas. They can thus be bull-headed into the whole open interval surrounding the wellbore, with very little risk of well impairment.

POWELGEL-MICROGEL™ microgels are now commercially available in a broad range of size (from 0.3 to 0.2 µm), consistency and chemistry, thus covering a very large spectrum of reservoir conditions. A recent field application has shown that a combined Water Control/Sand Consolidation effect can be obtained with a single POWELGEL-MICROGEL™ treatment (Zaitoun et al. SPE 106042)

---

POWELGEL-MICROGEL™ is a new microgel process which has been designed through a 5-year R&D research program. Several papers give an overview of the technology (SPE 64988, 80203, 82228, 89390, 93254, 106042, 179765).

Different microgels are now available at a commercial scale, with different sizes and different chemistry. They cover a very broad domain of reservoir/field conditions

The main target is a high-water-cut multi-layer production wells (Fig. 1). Due to their large size, microgels invade high-permeability watered-out layer preferentially, thus inducing a strong reduction of water influx, whereas penetrating and affecting a very little low-permeability oil-bearing layers due to their RPM effect. The net result is thus a strong reduction in water cut without any loss in oil production.

Figure 2 illustrates the RPM (Relative Permeability Modification) mechanism. Microgels adsorb strongly on the surface of the rock thus forming a thick gel-like film. The presence of this film induces a strong reduction of pore cross-section (thus of permeability) for the water wetting phase, with almost no impact on oil or gas (non-wetting phase) permeability.

Figure 3 compares different types of microgels with high-molecular-weight linear polymer. Microgel species ($D_h \approx 2$ µm) are significantly larger than linear polymers ($D_h \approx 0.3$ µm). They can be produced with higher or lower chain density, thus forming a more or less rigid structure. The chain density is induced by internal crosslinks formed during the manufacturing process. Small microgels having the same size as polymers are now available. The manufacturing process enables the production of microgels having a narrow size distribution (Fig. 4).

The internal crosslinks gives POWELGEL-MICROGEL™ microgels a high thermal stability (up to 165ºC), shear stability (up to 1,000,000 sec-1) and chemical stability (microgels withstand high concentrations of $CO_2$ and $H_2S$). Under the same conditions, linear polymers are rapidly destroyed. The high shear stability simplifies surface handling procedures during the preparation and the pumping of microgel solutions.

Due to their remarkable ability to control the permeability at long distances from the wellbore without any plugging tendency, microgels are good products, not only for (production well) water shutoff treatments but also for (injection well) conformance control treatments or heterogeneous formations.

Paper SPE 179765 reports successful conformance field application of POWELGEL-MICROGEL™ microgels in heterogeneous sandstone reservoir. Offset producer response is shown in Figure 7. In the future, microgels could be used as mobility control agents in EOR applications when reservoir conditions are too severe for the use of linear polymers.

**POWELGEL-MICROGEL™** technology can be also proposed to stabilize sand in poorly consolidated formations (Fig. 5). The adsorbed microgel layer forms a film, which can prevent the erosion of the cement of the sandstone rock. A single POWELGEL-MICROGEL™ treatment has been succefully applied for the treatment of a gas storage well suffering of both excessive water and sand problems (Zaitoun et al. SPE 106042). Figure 6 shows the strong drop of water production of the treated well as compared to neighbouring ones.

**POWELGEL-MICROGEL™** technology can be applied in a broad domain of field situations, i.e, gas wells, multi layer water-flooded reservoirs, heavy-oil horizontal wells, offshore gravel-pack wells, etc.

Field treatment design includes the following steps:

- Evaluation of candidate well according to analysis of pertinent data ( a Check List is delivered on request),
- Laboratory study to optimize microgel composition (bulk tests and coreflood experiments),
- Numerical simulations with PumaFlow reservoir software using laboratory coreflood results as input data, to size up the treatment and predict performances,
- Product delivery/On-field assistance
- Post-treatment evaluation.

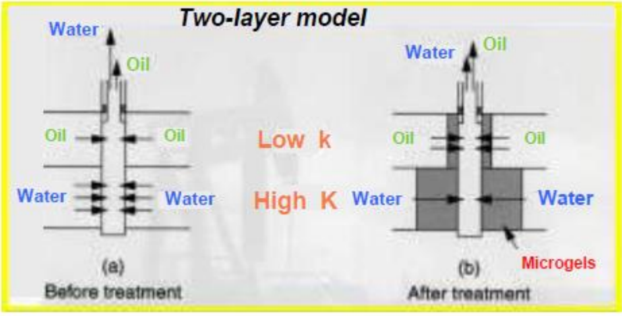


Fig. 1: Principle of production well water shut-off treatment by polymer (Zaitoun et al., SPE 56740, 1999)

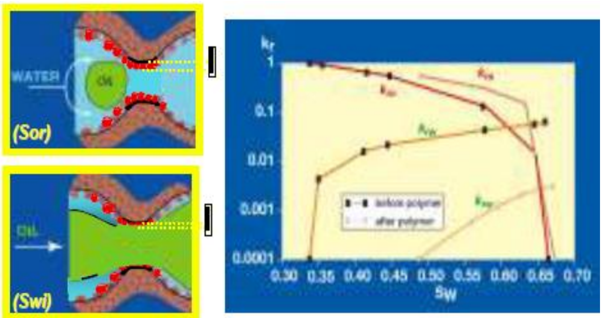


Fig. 2: RPM mechanism induced by microgel/polymer adsorption.

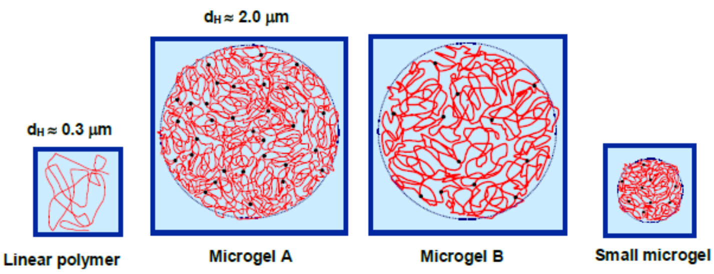


Fig. 3: Comparision of microgel species with high-molecular- weight linear polymer.

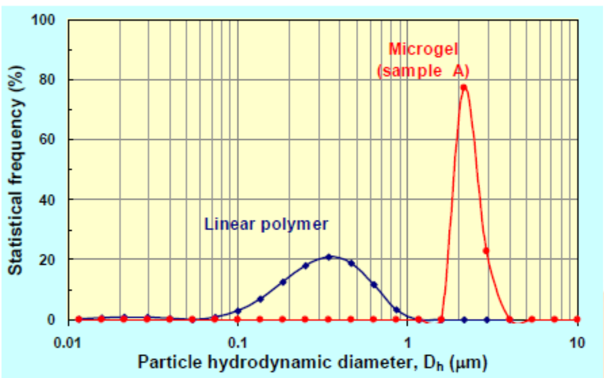


Fig. 4: Size distribution of microgel and polymer measured by Dynamic Light Scattering (PCS).

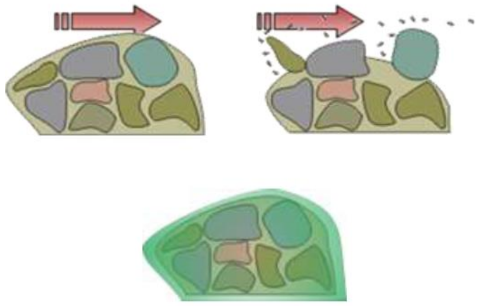

Fig. 5: Principle of sand consolidation by microgel/polymer treatment

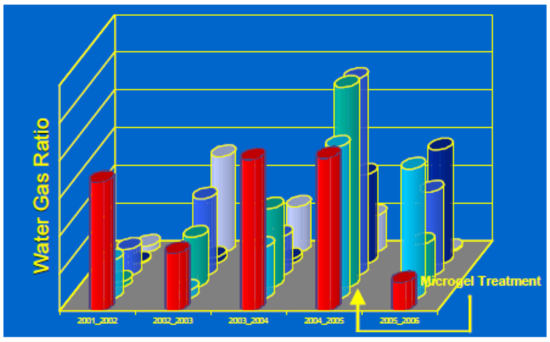


Fig. 6: Evolution of water-to-gas ratio after microgel treatment of gas storage well (Zaitoun et al., SPE 106042, 2007)

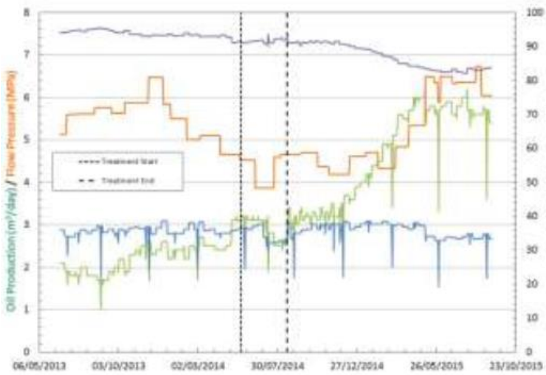

Fig. 7: Microgel Conformance treatment. Response on offset producing well (Dupuis et al., SPE 179765, 2016)