Investigation of Water Diversion by a Novel Polymer Gel System for Enhancing Oil Recovery

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Introduction

Excess water production is a major problem leading to early well abandonment and unrecoverable hydrocarbons for mature wells.

HyGreGel: Hybrid nanogels - A new class of "cost-effective and green" gel systems for water diversion.

The gel system will be based on novel multifunctional hybrid polymers prepared at SINTEF Materials and Chemistry (FunzinoNano)\textsuperscript{3} and polyelectrolyte complexes (PEC) developed at Kansas University and Texas A&M. Non-blocked functionalities on the nanoparticles react quickly with polymer and are used as Active component to be encapsulated in PEC (polyelectrolyte complexes) Nanoparticles.

Numerical Simulation Study

The transport of the new gel system through porous medium and the mechanisms of permeability reduction and crossflow are investigated.

Conservation equation:

\[ \frac{\partial}{\partial t} \left( \frac{1}{\mu} \frac{\partial P}{\partial x} \right) - \frac{1}{\mu} \frac{\partial}{\partial x} \left( \frac{1}{\mu} \frac{\partial P}{\partial x} \right) + k_{eff} \frac{\partial}{\partial x} \left( \frac{1}{\mu} \frac{\partial P}{\partial x} \right) = f(x) \]

Permeability reduction is modelled by interaction of the gelants or gel with the rock in the form of adsorption.

\[ k_{eff} = k_{o} + (1-R) k_{o} \]

The controlled release of the crosslinkers is modelled.

Results and Discussion

A good reservoir candidate for successful gel application can be considered as a layered formation with high permeability contrast between layers and low degree of crossflow. Refer to paper SPE 180190 for more details.

Crossflow

The transport of the new gel system through porous medium and the mechanisms of permeability reduction and crossflow are investigated.

Permeability Contrast

In real cases, crossflow and permeability contrast between layers are beyond control and injection conditions should be optimized when designing a treatment. Increased injection concentration, time or improved blockage properties will enhance the recovery, but economic analysis seems necessary when selecting the best possible treatment technique.

Injection Time

Gelation Rate

Layer Resaturation

Efficient Diversion

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References:

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