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Nanoparticles for Formation Fines Fixation and Improving Performance of Surfactant Structure Fluids

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Abstract

The migration of formation fines during hydrocarbon production has been a major problem to resolve in our industry. In many reservoirs fines migrate to the near wellbore region where they concentrate and choke hydrocarbon production. To prevent this problem, migratable fines should be kept or fixated as far away from near wellbore region as possible.

This paper will introduce the use of nanoparticle treated fracture proppant as a mechanism to fixate and distribute migrated formation fines. The nanoparticles employed in this method have significantly high surface forces, including van der Waals force and electrostatic force, and readily attach to the surface of proppant particles during the proppant stages of fracturing treatments. During production when formation fines move through the nanoparticle-treated proppant bed, the surface forces of the nanoparticles capture and prevent the fines from moving to the near wellbore region. Laboratory testing of proppant beds and sand packs treated with low concentrations of nanoparticles demonstrates that the nanoparticles are capable of fixating formation fines such as colloidal silica, charged and non-charged particles, expandable and non-expandable clays.

Previous studies have shown that select nanoparticles significantly increase the thermal stability and fluid loss control properties for viscoelastic surfactant fluids in fracturing and frac-packing applications. Recent research with advanced rheological methods was shown that with less than 0.1% of nanoparticle weight concentration, the viscosity of viscoelastic surfactant fluid was tremendously increased at low shear rates. The improved fluid rheology is based on the nanoparticle's ability to pseudo-crosslink the elongated surfactant micelles into unique network structures. Lab tests demonstrate how the nanoparticle induced network structures dramatically increase the capacity of the surfactant fluid to suspend and transport well treatment solids like ceramic proppants.

Introduction

From literature, formation fines are defined as loose or unconfined solid particles present in the pore spaces of sandstone formations, and the particles are smaller than 37 microns, which means the particles are small enough to pass through a 400 U.S. mesh screen.[1~3] Formation fines include clay and non-clay particles, and charged and non-charged particles. These particles are easy to migrate along with any fluids that flow in the sandstone formations. As a well produces, hydrocarbons (oil and/or gas) and/or formation water carrying those fines in the porous media move to the small near wellbore region from far away regions of the reservoir in all directions. As well production continues a large quantity of the formation fines may concentrate in the near wellbore region. These small particles in high concentrations can interact to form larger particles that plug pores in the near wellbore region or plug sand control screens or proppant packs, which result in rapid production decline. When formation fines pass through a sand control screen, local erosion of the screen can be another concern, and production pumps are also susceptible to damage by the formation fines.

Many studies have been conducted in the industry to find ways to control migration of formation fines and to remove the concentrated formation fines in the near wellbore region. Several organic and inorganic clay control agents had been used to minimize fines migration in high-water-cut oil wells.[4] Different acid systems were developed to remove the formation fines that plugged pores in the near wellbore region, gravel packs, and sand control screens for different downhole conditions.[5~8] Some completion methods like sand-exclusion method have been used to reduce fine producing from sandface in high fines content gas zones.[9]