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Improved Oil Recovery Through the Use of Titanium Dioxide and Silica Nanoparticles

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Abstract

By designing new materials based on their surface modifier with a variety of functional properties and applications, surface engineering of nanoparticles has helped advance nanoscience and nanotechnology. If an ionic surfactant alters their surface, dispersed nanoparticles can alter the interfacial properties of a liquid-liquid system in the aqueous phase. Ions and the nanoparticle-brine system's interfacial energy have a tendency to alter pore channel transport and enhance recovery. Some advantages of using particles suspended at Nano scales include the ability to easily counterbalance gravity's force with induced sedimentation stability. Their Nano size, nanostructure, high volume-to-surface ratio, and strong rock fluid interaction all contributed to this. Additionally, it alters the surface characteristics of surfactant and polymer within the rock in a porous medium and affects the stability of the emulsion. Due to their potential response to reduce the interfacial tension at low to ultra-low levels, wettability reversal, and improvement in formation fluid rheology, nanoscience applications have solved some of the issues with conventional EOR processes. Nanoparticles' large specific surface area, high reactivity, toughness, and other characteristics can significantly enhance oil mobility in comparison to conventional EOR. In relation to silica and titanium dioxide nanoparticles in various environments within surfactant(s), polymer(s), and polymer-surfactant EOR processes, the most recent review, experimental evidence, and reinterpretation of previous research data and applications are updated in this paper.

Key words: Nanoscience • Nanoparticle-brine • Nanotechnology

Introduction

Therefore, nanotechnology is a viable alternative to supplement the conventional EOR strategy with cutting-edge technology that has the potential to transform the oil and gas industry as a whole and significantly improve oil field industry economics. By designing new materials based on their surface modifier with a variety of functional properties and applications, surface engineering of nanoparticles has helped advance nanoscience and nanotechnology. If an ionic surfactant alters their surface, dispersed nanoparticles can alter the interfacial properties of a liquid-liquid system in the aqueous phase. Ions and the nanoparticle-brine system's interfacial energy have a tendency to alter pore channel transport and enhance recovery. Some advantages of using particles suspended at Nano scales include the ability to easily counterbalance gravity's force with induced sedimentation stability. This occurred due to their Nano size, nanostructure, high volume to surface proportion major areas of strength for and liquid association. Additionally, it alters the surface characteristics of surfactant and polymer within the rock in a porous medium and affects the stability of the emulsion. Due to their potential response to reduce the interfacial tension at low to ultra-low levels, wettability reversal, and improvement in formation fluid rheology, nanoscience applications have solved some of the issues with conventional EOR processes. Nanoparticles' large specific surface area, high reactivity, toughness, and other characteristics can significantly enhance oil mobility in comparison to conventional EOR. In relation to silica and titanium dioxide nanoparticles in various environments within surfactant(s), polymer(s), and polymer-surfactant EOR processes, the most recent review, experimental evidence, and reinterpretation of previous research data and applications are updated in this paper.

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Description

Therefore, nanotechnology is a viable alternative to supplement the conventional EOR strategy with cutting-edge technology that has the potential to transform the oil and gas industry as a whole and significantly improve oil field industry economics. The data have been plotted between the area to volume ratio and the dimension of the particles. This makes it clear that the material particles in the nanoscale range have a higher area to volume ratio than the particles in the micro and millimeter dimensions. Catalysis, imaging, medical and agricultural applications, energy-based research, and environmental applications are just a few of the commercial and domestic uses for which their utility was found to be crucial. The silica nanoparticles, for instance, are utilized as an additive in the production of rubber and plastics; as filler for concrete and other construction composites that strengthens; and as a non-toxic, stable platform for biomedical applications like drug delivery, among others. Due to their stability, low toxicity, and capability of being functionalized with a variety of molecules and polymers, the nano-silica serve as the foundation for a great deal of biomedical research [1,2].

In recent years, the oil industry has been a hotbed of research on nanoparticles, which have contributed to the growth of nanoscience and nanotechnology. Silica and titanium dioxide nanoparticles in various environments within surfactant(s), polymer(s), polymer-surfactant, and low salinity EOR processes are the subject of this paper's most recent review and current findings. The literature review also predicted that mixed formulations of silica and sodium dodecyl sulphate (SDS), an anionic surfactant, had higher recovery rates than surfactant-only formulations due to improved viscoelastic properties and foam stability in both homogeneous and heterogeneous reservoirs. It was likewise researched that hydrophilic and marginally hydrophobic silica NPs forbid the adsorption of surfactant on the stone surface and versus diminishes the IFT and impacts the rheology of arrangement liquids towards the better financial recuperation. However, titanium dioxide nanoparticles are also used extensively in the tertiary oil recovery process since the primary and secondary production stages, a decade ago. The use of an emulsion stabilizer was found to be necessary for IFT of titanium nano solution to produce reproducible results. In addition, it has been determined that the functionalized nano TiO2 solution has a faster mechanism for reversing wettability than it does for influencing IFT and viscosity [3,4].

The literature review also revealed that when screening for nano EOR applications, the chemical and engineering difficulties brought on by metallic nanoparticles should be given top priority. However, in order to ensure a smooth transportation and favourable oil recovery, it is essential to control the NPs' agglomeration and adsorption at high temperatures. As a result, nanotechnology is a viable alternative for replacing the conventional EOR strategy with cutting-edge technology that has the potential to transform the oil and gas industry as a whole and significantly improve oil field economics. Nanotechnology is a specialty of state approach and state of the art innovation which gives promising outcomes at research centre scale however no business contextual investigations is accessible. There is a significant gap in our understanding of the surfactant-NPs interaction under various conditions, which holds great promise for future research [5].

Conclusion

Silica and titanium dioxide nanoparticle adsorption and desorption at high temperatures and pressures, both with and without surfactant or polymer, remain a mystery that calls for additional research. At this time, there is no flawless Nano software model available. However, the Nano-EOR process's characteristics cannot be accurately attributed using the current colloidal model software. Consequently, in order to address the intricate flow mechanism of nanotechnology in EOR, a sophisticated Nano software model is required. However, neither human risk nor environmental constraints are discussed in the reviewed literature. This needs a coordinated examination approach in the spaces of wellbeing and security, which is a significant and urgent piece of the exploration.

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Conflict of interest

No potential conflict of interest was reported by the authors.

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