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Enhanced Oil Recovery Nanoparticles Market Assessment, By Type [Organic Nanoparticles (Carbon-based, Lipid & Polymeric-based, Others), Inorganic Nanoparticles (Metal, Ceramic, Others), Encapsulation NP, Others], By Injection [Chemical Floodings, Thermal Floodings, Microbial Floodings, Others], By Additive [Polyacrylamide, Xanthan Gum, Sodium Dodecyl Sulfate Surfactant, Others], By Region, Opportunities and Forecast, 2016-2030F

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Abstracts

Global Enhanced Oil Recovery Nanoparticles Market size was valued at USD 104.3 million in 2022, expected to reach USD 332.6 million in 2030 with a CAGR of 15.6% for the forecast period, 2023 -2030. Primary and secondary oil recovery methods help extract conventional oil and gas. Primary and secondary methods can recover oil by 30% and 60% of oil initially in place (OIIP). The role of tertiary oil recovery techniques called enhanced oil recovery (EOR) becomes prominent for unconventional oil and gas where it can recover up to 75% of OIIP.

Nanoparticles are considered as a green alternative to conventional polymers and chemicals for enhanced oil recovery (EOR). Under the inorganic nanoparticles, nano silica particles are abundant as they have flexible properties of resembling hydrophobic and hydrophilic, as required for oil extractions. Injection of silica nanoparticles can improve microscopic displacements by altering various parameters such as reducing interfacial tension between oil and water, and desired wettability variations. Celluloses under the category of organic nanoparticles are highly effective in improving macroscopic sweep efficiency by enhancing viscosity of injected water.

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The Rising Adoption of Responsive Nanoparticles for EOR to Foster the Market Growth

High mobility of carbon dioxide occurs in ultra-low permeability reservoirs which causes severe gas channeling during carbon dioxide flooding. Mobility control becomes an important parameter to enhance oil recovery, in which there are conventional processes to reduce carbon dioxide gas channeling such as polymer injection, gas injection, etc. These methods are accompanied by certain limitations as the heterogenous appearance of reservoirs makes extraction exacerbated leading to less sweep efficiency. Responsive nanoparticles provide various functional characteristics such as surface action, wettability, and pressure reduction, among others.

Responsive nanoparticles are developed by modifying nano-silica (silica oxide) using 3-aminopropyltrimethoxysilane (KH540) through Eschweiler-Clark reaction (Methylation Process). Electrostatic interaction in the responsive nanoparticles resembles a remarkable nanoparticle dispersity control. It shows a perfect plugging capacity of around 93.3% for carbon dioxide mobility control and more than 26% for oil recovery. The excellent characteristic of developed responsive nanoparticles unveils immense potential of enhance oil recovery during flooding of carbon dioxide in ultra-low permeability reservoirs. The unique properties of nanoparticles for tertiary oil recovery can create incredible opportunities to gain experience in the oil and gas market.

Growing Technological Innovations for the Nanoparticle Encapsulation is Accelerating the Market Growth

Nanoparticles possess unique characteristics such as higher ratio of surface-to-volume, nano particle size, etc., which is gaining considerable importance in enhancing the tertiary oil recovery (EOR). These nanoparticles can be used either as additive or as nanofluid flooding where nanoparticles of single phase (solid, liquid, or gas) disperse in continuous medium of another phase. Super magnetic iron oxide nanoparticles and petroleum sulfonate surfactants are nano-encapsulated to produce a hybrid nano-surfactant in high salinity water (56,000 ppm). The novel designed nanocomponents are highly effective in enhancing the residual oil mobilization by altering rock’s wettability along with reducing the interfacial tension (IFT).

Encapsulation methods are employed to bind nanoparticles in the respective surfactants and assist in improving enhanced oil recovery (EOR). Under the internal encapsulation method (IEM), nanoparticles are encapsulated in the oil core of the nano-surfactant droplets producing significant hybrid structure. This novel hybrid technique can be

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explored across various oil reservoirs and basins to extract oil from the deep down of rocks. There are favorable parameters relevant to the technique for nanoparticles market to create more opportunities for expansion.

Impact of COVID-19

The COVID-19 pandemic has led to unprecedented consequences on the mobility, production, and exploration of oil and gas globally. The gaps have been created in the supply chain and transportation due to reduction in labor workforce and presence in the onshore and offshore oil recovery area. For instance, according to the U.S. Energy Information Administration, in 2020, the average annual per day production of crude oil in the United States was 11.3 million barrels, a decline of 8% in comparison to 12.2 million b/d per day in 2019. To counteract the impact, the governments produced certain regulations to implement cost-effective technologies in enhancing oil recovery. Nanoparticles are composed of unique properties which can be explored to enhance oil recovery in different oil reservoirs. To compensate for the loss due to the outbreak, the companies are improving their technologies to develop a new range of nanoparticles for application in enhanced oil recovery. These initiatives will create prominent opportunities for the enhanced oil recovery nanoparticles market in the coming years.

Impact of Russia-Ukraine War

The annexation of Russia on Ukraine has been developing uncertainties across various energy industries. It has disrupted oil supply chains and their distribution network. In 2020, Russia was one of the largest producers of oil and gas with an average of 10.5 million barrels of liquid fuel every day. However, the invasion led to sanctions on Russian energy by United States and European Union by cutting around two-third Russia’s oil export to other countries. With immediate ban, Western countries began investing in enhancing their oil recovery from the oil reservoirs and wells by implementing innovative EOR technologies. Thus, the adoption of innovative technologies such as nanoparticles increased in regions such as Europe and North America, which led to a surge in oil production in 2022.

For instance, according to the U.S. Energy Information Administration, in 2022, the global annual production of crude oil was 99.85 million barrels per day, representing an annual growth rate of 4.34% as compared to 95.69 million barrels per day. Therefore, prominent factors such as the shift from Russian oil imports, increasing government measures to increase crude oil production, and others due to the Russia-Ukraine war created a lucrative opportunity for the enhanced oil recovery nanoparticles market.

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Key Players Landscape and Outlook

Enhance oil recovery (EOR) nanoparticles are being continuously implemented by major large oil volume processing companies and startup companies to improve the oil recovery process. For instance, Interface Fluidics, a successful Canadian startup assist in providing reservoir fluid analysis for the oil and gas industry through its proprietary nanofluid technology, which is effective in recognizing the structure of oil and gas reservoirs. Furthermore, Aramco, a global leader in the oil industry has explicitly obtained a solution for enhancing oil recovery by implementing nanoparticles in its chemical flooding practices. They have developed hybrid nano-surfactant by encapsulating iron oxide nanoparticles and petroleum sulfonate surfactants. Likewise, there are companies who are investing in enhancing oil recovery nanoparticles via various flooding mechanism and developing multiple opportunities for the market to expand which fascinates more companies to develop in such technologies.

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