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United States 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 [Nanofluid Flooding, Chemical Flooding, Thermal Flooding, Microbial Flooding, Others], By Additive [Polyacrylamide, Xanthan Gum, Sodium Dodecyl Sulfate, Others], By Region, Opportunities and Forecast, 2016-2030F

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Abstracts

United States Enhanced Oil Recovery Nanoparticles Market size was valued at USD 19.86 million in 2022 and is expected to reach USD 59.1 million in 2030 with a CAGR of 14.6% for the forecast period between 2023 and 2030. Primary and secondary oil recovery methods extract conventional oil and gas. Primary and secondary methods can recover oil by only 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 highly effective in improving oil recovery due to their promising interfacial and rheological properties. NPs dispersed in an aqueous phase can form different phase separations that reduce total interfacial energy. Phase formations effectively recover more oil by imparting significant characteristics such as change in emulsion rheology, alteration of wettability, etc. The NPs deposition in nano-flooding results in emulsion formulation for heavy oil displacement, contributing to incremental oil

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recovery. With definite properties, nanoparticles have tremendous potential in the United States market as oil-extracting companies are developing technologies to implement NPs using flooding for various types of oil extraction.

Inorganic Metallic Nanoparticles for EOR

Nanotechnology is an emerging potential tool and good in-situ agent for enhancing oil recovery in the petroleum industry. Nanoparticles alter rock wettability, substantially affecting the oil extraction from these complex rocks. Various inorganic metallic nanoparticles have specific characteristics to enhance oil recovery by changing the rheological behavior. Oxides of aluminum, nickel, magnesium, iron, zinc, silicon, zirconium, and tin have extensively been used in various practices for nanotechnology operations. Aluminum oxide (?Al?_2 O_3) nanoparticles effectively reduce oil viscosity in recovering heavy oil.

Distilled water alone is not enough for specific oil recovery, but the presence of nanoparticles provides excellent characteristics to enhance oil recovery. Aluminum oxide dispersion in brine and distilled water solution improves oil recovery. Similarly, silane-treated silicon oxide and hydrophobic silicon oxide alleviate the oil recovery in dispersion with ethanol solution. Nanoparticles are decisive for enhancing oil recovery with brine and ethanol solution dispersion. Still, while using selective nanoparticles proper care should be taken as these nanoparticles could have a negative impact on oil recovery. The prominent inorganic nanoparticles' characteristics can create significant market opportunities to expand in metallic oxides and specific solutions.

Nanoparticle Encapsulation

Nanoparticles possess unique characteristics such as a higher ratio of surface-to-volume, nanoparticle 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 very effective in enhancing the residual oil mobilization by altering rock’s wettability and reducing the interfacial tension (IFT).

Several encapsulation methods bind nanoparticles in the respective surfactants and improve enhanced oil recovery (EOR). Under the internal encapsulation method (IEM),

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nanoparticles are encapsulated in the oil core of the nano-surfactant droplets, producing a significant hybrid structure. This novel hybrid technique can be explored across various oil reservoirs and basins to extract oil from the deep down of rocks. Numerous favorable parameters are relevant to the technique for United States enhanced oil recovery nanoparticles market to create more opportunities for expansion.

Impact of COVID-19

The outbreak of COVID-19 pandemic has tremendously affected the oil recovery market in the United States which led to economic instability across every states. The imposed lockdowns and disruption in supply chains lowered the demand for oil consumption in various sectors. The advancement in technologies to implement nanoparticles in oil recovery applications is expected to derive the market growth but the prevailing circumstances have halted every such practice. Government entities incorporated certain conditions to implement cost-effective oil recovery techniques which paved the way for nanoparticles due to their promising characteristics. Companies plan to retain their revenue in the oil sector by investing in oil recovery technologies and exploring the potential of inexpensive, efficient nano-flooding techniques.

Impact of Russia-Ukraine War

The annexation of Russia and Ukraine has led to an unprecedented impact and significantly affected energy prices. The evasion forced the United States to put different sanctions on Russia. In March 2022, the United States prohibited the import of oil, various petroleum products, and coal from Russia. High oil price was the outcome of restrictions on Russian energy imports. Surging in crude oil prices over USD 100 per barrel resulted in unpredictable revenue for oil companies across the United States. These oil giants started to work more on enhancing oil recovery to create more volume in the oil market. They have put efforts to incorporate cost-effective technologies for improving oil recovery. Here, nanoparticles contribute to the extracting oil and can meet the rising demand.

Key Players Landscape and Outlook

Nanoparticle applications have frequently been explored to be implemented in enhancing oil recovery. Giant oil companies and startups are investing in circumventing the increasing tertiary oil recovery methods. Baker Hughes has discovered novel nanoparticles along with the crude oil interaction. Hydrophilic silica nanoparticles dispersed in an aqueous phase led to de-wetting, swelling, and developing adequate

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disjoining pressure of crude oil. Consequently, the mobility ratio was reduced due to oil swelling and de-wetting in a particular reservoir. Subsequently, relative permeability was modified, improving sweep efficiency and significantly increasing oil recovery by around 11%. Enhancing oil recovery (EOR) methods are being implemented via various flooding mechanisms, and exploring the potential of nanoparticles generates multiple opportunities for nanoparticles market to grow substantially.

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