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A Review on Application of nanotechnology on Oil and Gas Industries

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Abstract

The science and technology of structures with dimensions ranging from 1 nm to 100 nm is represented by nanotechnology. Exploration and output from traditional oil and gas wells has entered a phase of decline today. To tackle this question, modern techniques have been developed. Effective production of oil at a low cost is a major problem at present. This paper reviews the uses of nanotechnology in the oil and gas production market, particularly in the fields of oil field discovery, drilling, processing and waste treatment, and their environmental concerns. In these areas, the paper discusses experiments performed by various researchers. The impact of different nanoparticles on the recovery of oil in drilling fluids and silica nanoparticles has been identified and examined. A thorough overview of the advantages of nanotechnology in oil discovery and development are represented in this article. There will be great gains from the convergence of nanotechnology and petroleum technologies. Petroleum research is very new to the mechanics and chemistry of nanoparticles and nanostructures. Nanotechnology has been reluctant to achieve mainstream adoption in the oil and gas industry because of the greater danger involved with the adaptation of emerging technologies. The existing economic dynamics, however, have been a driving force for newer innovations.

Keywords: *Drilling, Gas, Nanoparticles, Nanotechnology, Oil, Petroleum.*

I. INTRODUCTION

"There's Plenty of Room at the Bottom" in 1959, the notion of nanotechnology was first proposed by the famed scientist Richard Feynman. He presented the idea of synthesising nanoparticles by the direct processing of atoms. Nanotechnology has seen diverse uses in food, medicine, electronics, and cosmetics over the past few decades. These small particles have extraordinary properties in diverse fields that have proved to be of profound significance. Due to their exceptional physical and chemical properties on the nanometer scale, engineered nanoparticles are known to be very useful for different applications in oil and gas exploration and related industries. Structured nanoparticles may assist in enhancing structural integrity, conserving resources, and combating the technological and environmental challenges encountered during exploration and development activities. In mining, reservoir, fracking, and development operations, nanoparticles have diverse applications. Collaborations between various related fields define nanotechnology, which makes it revolutionary and more accurate than other innovations. It will lead to developing solutions that are more efficient, cost-effective and environmentally sustainable than other technologies available. Nanotechnology-enhanced

materials have strength and durability in high pressure to high temperature (HPHT) conditions to maximise drilling efficiency and boost drilling capacity. The hydrophobic or hydrophilic behaviour of substances can also be enhanced by such technologies and thereby strengthen materials for water flood applications. There is a high surface area to volume ratio in nanoparticles. Because of this, their encounters with their atmosphere are more productive and offer better outcomes than other traditional additives widely used in the oil and gas industries today[1].

II. DISCUSSION

Applications of Nanotechnology in the Oil and Gas Industries

Today, the oil industry is seeking to reap the advantages of nanotechnology, whether in the areas of mining, processing or refining. In oil and gas field implementations, nanofluids are described herein as fracking, drilling, completion, stimulation or any other fluid used in oil and gas exploration and exploitation that has at least one additive, the particle size of which ranges from 1 nm to 100 nm.

Exploration

The usage by petroleum geoscientists of nanosensors during exploration is commonly seen today. Since nanoparticles behave differently from their bulk equivalents in terms of their magnetic, optical, and electrical properties, nanoparticles can easily produce imaging contrast agents and sensors. During discovery, a special form of sensor called nano dust may be mounted in the pore space for various purposes, including fluid type identification, fluid flow control, and classification of reservoirs. Micro computerised tomography has been shown to be unable to identify the pore structure in dense formations efficiently. Therefore, nano computerised tomography could be used to obtain insight about such knowledge[2].

Production

Nanotechnology is used for hydrate recovery in the development process. Hydrate recovery can be increased if the water cage breaks down and the hydrocarbon is released (methane). This is done by the injection into the hydrate structure of nickel iron nanoparticles. High molecular weight cross-linked polymers are frequently used during relaxation, but they contain significant quantities of residue. Researchers are therefore researching the effects with surfactants of low molecular weight as fracturing fluids with nanoparticles. It is possible to perform effective stimulation operations efficiently because nanoparticles offer the fracturing fluid the desired properties. Within the production tubing, nanoparticles may build a hydrophobic surface. This helps decrease the accumulation of scales within the tubing[3].

Refinery and processing

Since nanoparticles are commonly used in manufacturing and manufacturing so they can remove hazardous gases such as sulphur dioxides, nitrogen oxides, and vapour acids. To differentiate gas streams and to extract impurities from crude, nanomembranes are being used. Utilizing nanocatalysts, the upgrading of heavy oil and bitumen can be achieved on site in order to eliminate the need to ship and treat these materials[4].

Drilling and completion

Nanoparticles increase the consistency of the base drilling fluid because they are chemically more active because of their greater surface size. Therefore, the power, electrical, and thermal properties can be enhanced. Using a mix of many industrial nanomaterials and nanostabilizers, various nano-based drilling fluids can be synthesised to create favourable rheological and filtration properties and also good mudcake consistency[5].

Advantages of Nanotechnology in the Oil and Gas Industries

A critical concern faced by the oil and gas industry is the high water production of wells. In general, polymers like polyacrylamide are used to decrease the production of water. Nevertheless, for all forms of formations, particularly shale formations, polymers are not always successful. This is because of the size of the polymers, which makes them unable to plug the formation's pore spaces. Nanoparticles may play a significant role under certain circumstances. Because of their smaller scale and expanded surface area, nanomaterials can effectively plug the pore spaces in water or gas producing areas. This, in essence, raises free energy from the surface and related structural disruptions[4].

In attempt to optimise mobility control and modify wettability, polymer-coated nanoparticles were used. In compliance with the pore throat size of the formation, the sizes of nano-polymer microspheres can be modified. Under such stresses, since the microspheres are elastic, they can deform and roll forward. They can tolerate high temperatures of up to 110 °C and high salinity levels of up to 200,000 mg/L. In seriously heterogeneous and high-temperature reservoirs, this polymer microsphere technique has become an efficient tool for profile regulation and water plugging[6].

Nanoparticles of silica have proved to be very powerful sealing agents. In the Kazhdumi shale in southwestern Iran, such nanoparticles have been used to monitor water invasion. The very poor membrane performance of Kazhdumi shale is approximately 1.8 percent and is extremely vulnerable to water invasion. This shale is, however, extremely unstable[7].

Waste Management in Oil Industries

Using nanofiltration processes, waste water generated in the oil industry can be treated. Nanofiltration is a technology for membrane separation which uses reverse osmosis and ultrafiltration to work. Using this technology, water pumped throughout secondary and tertiary recovery may be filtered and desalinated. The waste water of the processed liquid is divided by a nanomembrane into an oil-rich water phase and an oil-free phase of low salinity water. Through demulsification and dehydration, the oil-rich water layer is converted, and the oil-free low salinity water phase is prepared directly for reinjection. It is also possible to isolate compounds like polymers, surfactants, and alkalis contained in the liquid produced, lowering the cost of enhanced oil recovery.

Since they have the potential to experience redox reactions through ultraviolet light, nanoparticles can be used as a photocatalytic agent. It helps to purify toxins, organic matter, and sewage in the oilfield. TiO2 photocatalytic reaction takes place only after UV radiation excites it. The catalytic effectiveness of visible light can be improved by means of ion doping, semi-conductor compound, surface photosensitive catalytic degradation and TiO2 surface amorphization. These methods will improve the efficiency of the ultra violet rays, which would make the nanoparticles more useful for the purification process. The photocatalytic water decomposition is worthy of Graphene-like carbon nitride. Challenges can be fixed with

catalytic agent extraction and purification through TiO2 immobilisation, micrometer/nanometer structures, and immobilisation of magnetic substances. TiO2 photocatalytic technique could be extended to the reduction of trace organic matter in water in oil fields[8].

Environmental Aspects of Nanoparticles in the Oil and Gas Industries

The petroleum sector can be significantly eco - friendly by nanotechnology. Currently, emissions from these factories is an important factor that is gaining prominence worldwide. Hydrogen sulphide is an extremely corrosive and toxic gas which during drilling operations can encompass into permeable formations. In addition to maintaining the health of employees, it is very important to extract this gas from the mud, but also to mitigate environmental contamination and avoid deterioration of pipelines and drilling machinery. According to research, hydrogen sulphide can be completely separated from water-based drilling fluid by zinc oxide particles with sizes of 14-25 nm and specific surface areas of 44-56 m2 / g, whereas only 2.5% of hydrogen sulphide can be extracted by bulk zinc oxide, which was also found to take time. Silica-titania nanocomposites can be used for elementary mercury elimination from vapours such as those originating from sources of combustion. Silica improves adsorption, and titanium oxidises the elemental mercury photocatalytically into less toxic mercuric oxide[9].

III. CONCLUSION

It has been shown that the use of nanotechnology in oil discovery and development is capable of reaping great benefits. Nanoparticles have produced promising effects in every field of oil discovery and development. Due to their capacity to change the wettability of rivers, they have become a blessing in the area of enhanced oil recovery. They are a potential option for crude oil exploration and production from HPHT reservoirs. Although most HPHT additives, like polymers, tend to degrade after some time, nanoparticles have shown the ability to bear such conditions because they are extremely thermally stable relative to other additives. The key explanation for this is their high ratio of surface area to volume that makes the process of heat transfer quite effective. A smart nanofluid is produced when nanoparticles are used as an additive in drilling fluids, and has demonstrated major advantages relative to traditional drilling fluids used today in the oil industry. By reducing use and enhancing the properties of the drilling mud, the overall aim of drilling mud is to lower the cost of drilling. Utilizing nanomaterials can significantly decrease the numerous technological and environmental problems faced when drilling. In addition to the the endurance of the downhole instruments, nano-enhanced drilling mud can also have a qualitative fluid for encounters with HPHT structures. A better alternative than traditional drilling muds is offered by nano-based fluids. Approximately 1 pound (0.453kgs) of nanoparticles will substitute 10 lbs of traditional additives used in drilling mud, as per a comprehensive literature study. The high price of additives should, however, be reduced. Since they can solve multiple downhole challenges, nanoparticles have the ability to become a permanent constituent of drilling mud. Therefore, nano-based drilling mud will open the path for hydrocarbons which are not easily available to access.

IV. REFERENCES

[1] J. Yang, S. Ji, R. Li, W. Qin, and Y. Lu, “Advances of nanotechnologies in oil and gas industries,” *Energy Exploration and Exploitation*, 2015, doi: 10.1260/0144-5987.33.5.639.

[2] H. J. Huang, S. Ramaswamy, U. W. Tschirner, and B. V. Ramarao, "A review of separation technologies in current and future biorefineries," *Separation and Purification Technology*. 2008, doi: 10.1016/j.seppur.2007.12.011.

[3] D. Kumar, S. S. Chishti, A. Rai, and S. D. Patwardhan, "Scale inhibition using nano-silica particles," 2012, doi: 10.2118/149321-ms.

[4] X. Kong and M. M. Ohadi, "Applications of micro and nano technologies in the oil and gas industry-an overview of the recent progress," 2010, doi: 10.2118/138241-ms.

[5] M. Amanullah, M. K. Al-Arfaj, and Z. Al-Abdullatif, "Preliminary test results of nano-based drilling fluids for oil and gas field application," 2011, doi: 10.2118/139534-ms.

[6] A. I. El-Diasty and A. M. Salem Ragab, "Applications of nanotechnology in the Oil & Gas industry: Latest trends worldwide & future challenges in Egypt," 2013, doi: 10.2118/164716-ms.

[7] E. Kasiralvalad, "The great potential of nanomaterials in drilling & drilling fluid applications," *International Journal of Nano Dimension*, 2014.

[8] D. L. Oatley-Radcliffe, M. Walters, T. J. Ainscough, P. M. Williams, A. W. Mohammad, and N. Hilal, "Nanofiltration membranes and processes: A review of research trends over the past decade," *Journal of Water Process Engineering*. 2017, doi: 10.1016/j.jwpe.2017.07.026.

[9] M. V. Bennetzen and K. Mogensen, "Novel applications of nanoparticles for future enhanced oil recovery," 2014, doi: 10.2523/iptc-17857-ms.