Volume 7 №2 2023, 92, 98
DOI: 10.5782/2520-6133.2023.7.2.92

Application of Nanotechnology in Increasing Oil Recovery Coefficient of the Reservoir

Jamal Aliyev

SOCAR, "Oil-Gaz Scientific Research Design" İnstitute, Baku, Azerbaijan

camal.aliyev1965@mail.ru

Abstract

When the formation is injected with a nanosystem, the demulsification process takes place in the formation water; as a result, a nanoscreen against formation water and a nano-layer between the phases are formed. In this case, the surface tension on the oil and rock surface decreases and separation of oil from the reservoir occurs. As a result of the demulsation process, the conductivity of the reservoir collectors increases, thus, the filtration of oil from the reservoir to the bottomhole accelerates. One of the most promising technologies in this area is the treatment of the bottomhole zone with specially prepared solutions - nanocompositions consisting of a complex of surfactants and nanoparticles. Nanocompositions significantly increase the compaction, lubrication and solubility properties of oil under mining conditions.

Keywords: nanotechnology, nano screen, nano layer, demulsation process, conductivity coefficient, surfactant

Introduction

With the introduction of traditional methods of oil and gas fields in Azerbaijan, the latest oil ratio varies from an average of 40.3-44.2% and the bulk of the oil reserve (55.8-59.7%) remains in the subsoil, being attributed to the non-removable oil reserve.

When analyzing the positive and negative results of the methods of impacting the reservoirs being worked out for a long time, it is obvious that in most cases, obtained effects are found to be both local and short-term.

The dynamism of the water-oil-gas system is ensured by the processes arising due to the imbalance of the intralayer environment, and due to this, excess pressure is created in the reservoir. However, at the final stage of development, this system goes from a non-equilibrium state to an equilibrium state and thus, the processes taking place in the reservoir weaken and the removal of fluid from the reservoir becomes more complicated. Therefore, it was necessary to apply a more progressive and effective new technology-nanotechnology - to improve the physicochemical properties of working solutions injected into the reservoir together with water and improve the method of water injection. The nanotechnological basis for increasing the oil yield coefficient is based on the replacement of petroleum hydrocarbons by the complex action of nanoparticles of surfactants, deemulgators, acids, alkalis and hydrocarbon-oxidizing bacterial molecules. As a result of this impact , new oil-compacting reagents such as $CH4$, $CO2$, $H2$ and $N2$ are formed in reservoir (Shahbazov, 2019).

In addition Along with the increase in oil production by 2.0-2.5 times, it was possible to reduce energy costs due to the implementation of ” Nano oil "program in flooded and low-debit wells at SOCAR's oil and gas production facilities (Mirzajanzade, 2006].

During the transition of atoms and molecules from chaotic movement to orderly movement on the basis of ” minor impact and alarm effect ", there was an increase in oil production as a result of breakage of old communications and the formation of new ones.

As can be seen from Figure 1, electron paramagnetic resonance spectra are observed in NanoSystems. Transverse elongation of signals and volumetric expansion occurs in the system as the temperature increases. Surface tension falls down during volumetric expansion. During the studies carried out, the chemical properties and sizes of metal nanoparticles change as the temperature increases. As nanoparticles shrink in size, the temperature increases and the paramagnetic field arises. (Aliyev, 2020) As nanoparticles shrink in size, they move along the axis from the unit atom to the mass state and a dispersed system (dipole) arises (Matiyev, 2022).

When a reservoir is impacted by a nanosystem, a thermal and electric paramagnetic field arise. At this time, the temperature increases, the volume of the formation water expands, heat and hydrogen gas produce. The addition of nanoparticles along with surfactants to the oil-bearing reservoir improves the hydrodynamic properties of the reservoir. It lowers the viscosity of the oil, reduces its specific gravity, increases permeability, expands porosity, accelerates fluidity, and a demulsification process occurs. Due to hydrophobic and hydrophilic interactions, a strong, relatively dense thin film is formed in the system at the phase separation boundary (Aliyev, 2020).

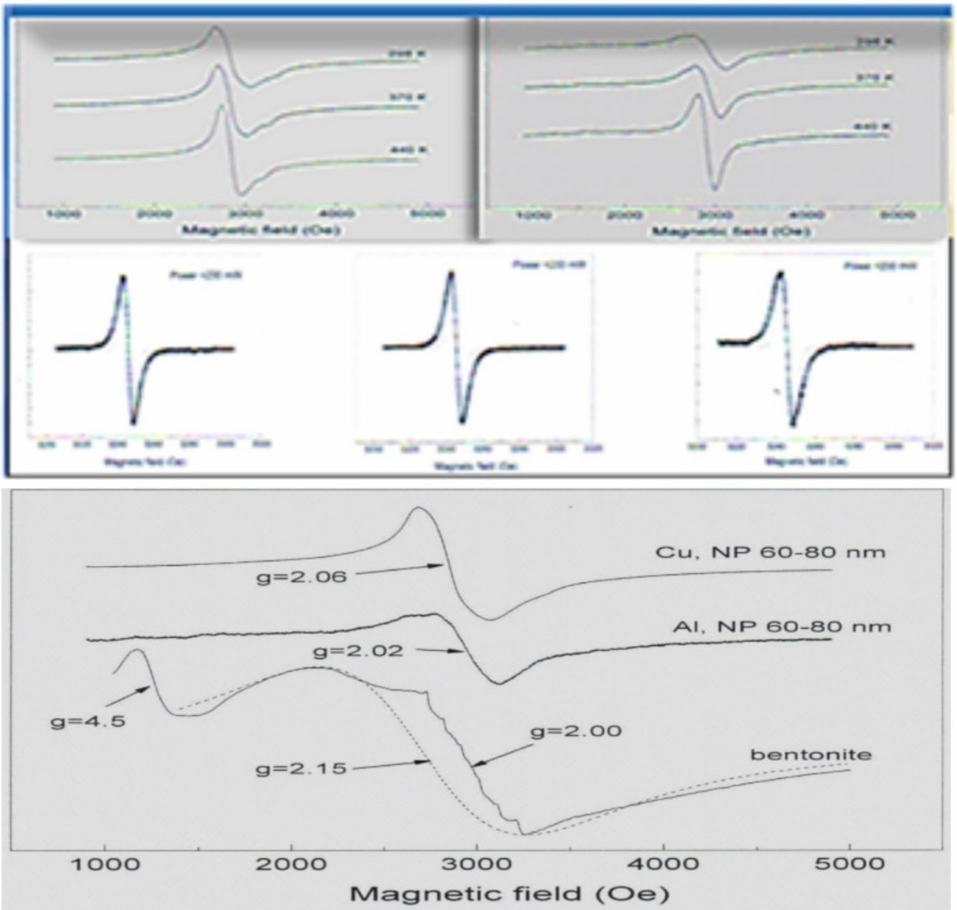

Figure 1. Electron paramagnetic resonance spectra in NanoSystems

Nanoparticle solutions enter the capillary pores, moving the oil and gas contained in the pores. It grinds the large gas bubbles in the pores and moves the oil there. It is unevenly distributed between phases. Metal nanoparticles guide the molecules of surfactants and accelerate their movement. Adsorption of a molecule of surfactants occurs, where, in the centers of nanoparticles there is a nanoparticle of metal, and around it are molecules of adsorbed surfactants directed with their polar side towards the metal, and with the non-polar hydrocarbon radical towards the water phase.

The molecules of surfactants are in a position perpendicular to the orientation of the nanoparticles. Due to the effect of nanoparticles, tens of thousands of molecules of surfactants are involved here.

As a result, the formation of mycelium-hedgehogs occurs. Hydrophobic mycelium-hedgehogs are unevenly distributed between the oil and water phases (Figure 2).

During movement, mycelium-hedgehogs acquire an ellipse-like shape. This shape is similar to the state that the jellyfish receives during its movement in water. Such a shape allows for rapid movement of mycels and the formation of a thin veil on the border of oil-water phases. Taking the form of jellyfish during the movement of the mycels makes it easier for the nanosystem to slide on the interphase boundary and provides easier separation of the oil-water phases. This is called the "jellyfish effect" because the shape that the mycels take during this movement resembles a jellyfish (Figure 3), (Aliyev, 2020-a).

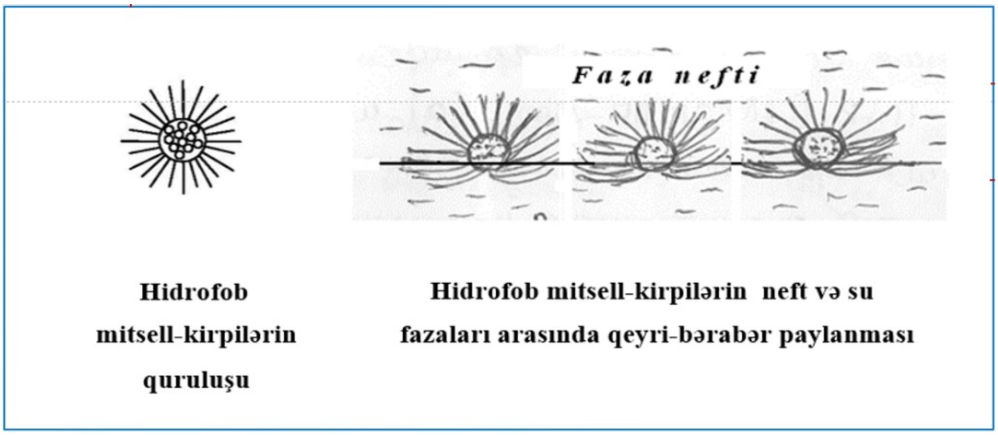

Figure 2. Uneven distribution of hydrophobic mycelium-hedgehogs between the oil and water phases

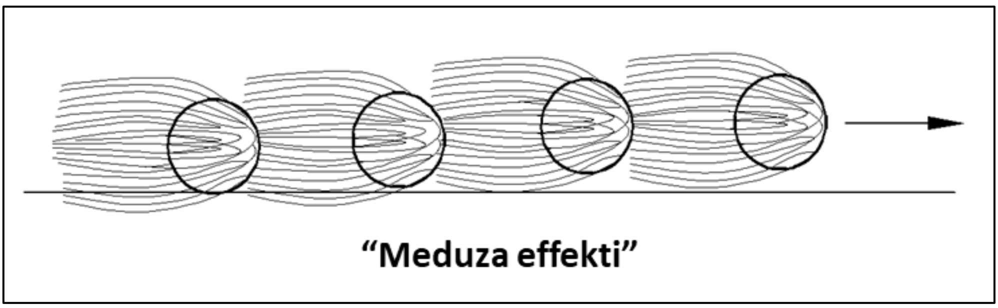

Figure 3. The state that the jellyfish effect takes during its movement in the water

When a nanosystem is injected into the formation, the demulsification process occurs in the formation water; as a result, a nanoscreen against formation water and a nanolayer between the phases are formed. At this time, the surface tension on the surface of oil and rock decreases and separation of oil from formation rocks occurs. As a result of the demulsation process, the conductivity of the reservoir collectors increases, thus, the filtration of oil from the reservoir to the bottomhole accelerates (Bagirov, 1997).

One of the most promising technologies in this area is the treatment of the well zone with specially prepared solutions - nanocompositions consisting of a complex of surfactants and nanoparticles. (Figure 4).

The addition of a small amount of nanoparticles to the surfactant solution improves its oil-compacting properties, increases the hydrophobic property of the mineral matrix (pores) of the rock, thereby providing a more complete coverage (filling) of the reservoirs with the injected liquid. In this case, more effective oil compression is achieved by using multicomponent surfactants of the NANO-SAM type of various molecular compositions. (Shahbazov, 2019).

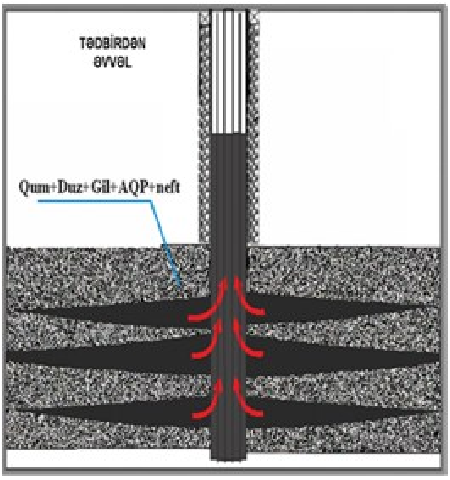

Figure 4. Treatment of the well bottom zone with nanosolution

According to the “minor impact and alarm effect" effect, the nanoparticles injected into the layer cause the formation of thermal effect and electromagnetic resonance at the boundary of phases. (Aliyev, 2020-c). Nanoparticles have magnetic properties that remain active up to a temperature of 1200C. By acting on mechanical mixtures (asphalt resin paraffin, salts, sands, etc.), the nanosystem passes into a new, "nano-nucleus" (nano-embryo) phase (Figure 5).

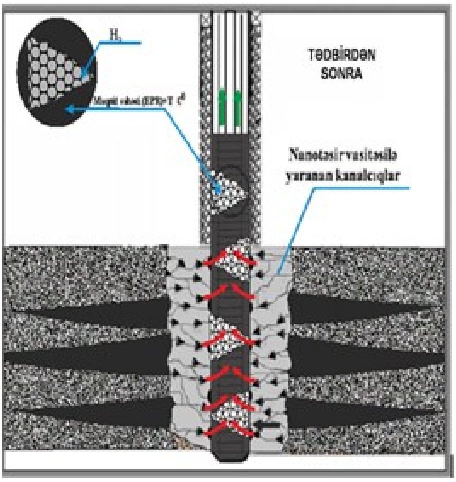

Figure 5. The effect of nanoparticles on the formation of thermal effect and electromagnetic resonance at the boundary of phases

It has been experimentally shown that by introducing iron (or aluminum) nanoparticles in bentonite nanocomposite and polyacrylamide into the clay-sand environment at low temperatures (33-360C), catalytic reactions occur, resulting in the separation of bubbles of carbon, hydrogen, ammonia and acetylene oxides.

Because of this, the pressure in the medium increases significantly, and it becomes easier to displace the oil from the porous medium (Abbasov and Aliyev, 2019).

The ability of surfactants to form a continuous adsorption layer on the metal surface is widely used, at the same time, the composition and structure of the adsorption layers depend on the structure of the surface being processed, the chemical properties of the reagents used and many other factors.

The addition of nano-substances to liquids leads to the appearance of unique properties in them. Specially developed nano-compositions significantly increase the oil compression, lubrication and solubility properties of working fluids used in mining conditions.

The introduction of nanotechnology is one of the promising directions for increasing the effectiveness of crude oil transportation in mining conditions. With their help, it is possible to significantly reduce consumption costs.

Nano-Systems help reduce surface tension in the liquid-metal contact area by creating a nano-coating on the inner walls of the reservoir and pipes, weaken hydraulic resistance, and increase their transportability by creating a nano-coating on the inner walls of oil transport collectors and pipes.

Due to the anti-corrosion effect of nano-substances, there are also economic benefits, such as saving energy and extending the service life of pipes and equipment in mines. The resulting nano-coatings weaken corrosion processes, thereby increasing the service life of pipelines and oil and gas equipment.

References

Abbasov J.S. and Aliyev C.A. (2019). Features of the effect of orography on the temperature change under the earth (Siyazan monocline). Azerbaijani geologist. Scientific bulletin of the society of oil geologists of Azerbaijan.19(23): 102-105.

Aliyev J.A. (2020-a). A nanosystem against complications in oil extraction. "Geologist of Azerbaijan" scientific bulletin of the society of oil geologists of Azerbaijan. 24: 87-90 .

Aliyev J.A. (2020-b). Application of nanotechnology against bed wetting. ANAS Council of Young Scientists and Specialists, "Young Researcher" scientific-practical journal. 6 (1): 73-79 .

Aliyev J.A. (2020-c). Increase in oil recovery of non-homogeneous layers with a new composition. Tver: Scientific and technical journal "Korotazhnik". 3:70-80.

Bagirov B.A. (1997). Azerbaijan's reserves are in hard-to-extract oil fields current state of development. Collection of scientific works of ADNA. 2: 3-7.

Matiyev K. (2022). Development of a new Flattening Inhibitor for the prevention of salt deposits. Abstracts of the Republican scientific conference "Chemistry and chemical technology".

Mirzajanzade A.Kh. (2006). Nanotechnology in oil and gas extraction: research, application and implications. In the report at the VII Azerbaijan International Scientific-Practical Conference.

Shahbazov E.Q. (2019). Application of nanotechnology in extraction and transportation of heavy oil in Bibiheybat field. News of Azerbaijan Higher Technical Schools. 21 (4): 37-4