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Modern Technologies for Increasing Oil Recovery Surfactant Based

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Abstract:

The major share of world oil production currently accounts for deposits, production peak, which has already passed, and the reserves are classified as difficult. For further development of these fields require the introduction of new methods of enhanced oil recovery and the use of new reagents. The article reviewed the modern methods of enhanced oil recovery, as well as focusing on the use of surfactants as independent agents or in mixed solution.

Keywords: improved recovery, EOR, oil recovery factor, surfactants.

Oil occupies the main place in the fuel and energy balance of our country, as well as in all industrialized countries of the world. Despite to a high interest in alternative sources energy it will still occupy a leading place several decades. But the main ones are large the country's deposits have already entered the late development stage and are characterized by high degree of water cut and low indicators mining [1]. Against the backdrop of these events, increasingly the issue of increasing oil recovery of reservoirs. There are already many ways increasing the oil recovery factor (ORF),For example:

- thermal: insitu combustion,displacement of oil with hot water.

These methods based on artificial increase temperatures in the wellbore and near-wellbore zone. Thermal enlargement methods are used oil recovery (EOR) mainly during production highly viscous paraffinic and resinous oils. gas: air injection into the formation, impact carbon dioxide. The objects of application of this method are homogeneous layers containing oil with a viscosity of less than 15 mPa s [2].

- physical: hydraulic fracturing,horizontal wells, electromagnetic influence, etc. They are also called methods increasing the production rate of wells, since they have found their application for unprofitable wells with

low-yield or water-flooded products.

- chemical: microbiological exposure, displacement of oil by acids,polymer solutions, alkaline solutions and

aqueous solutions of surfactants substances (surfactants) [3]. Chemical methods of enlargement oil recovery is used for additional extracting oil from heavily depleted, flooded oil-bearing formations with dispersed,

irregular oil saturation. Not at all deposits may use chemicals methods. These methods have found their application mainly in low-viscosity deposits oil (no more than 10 mPa s), low permeability reservoirs, as well as with low salinity water.

Until a unique one is found enhanced oil recovery method should be used combined methods of influencing oil layers, when, starting from the stage of progressive watering of products, the main role is played by technologies using surfactants substances that allow economically justified increase oil recovery factor by 2-15% [4]. Due to this, study of surfactants as a reagent for increasing oil recovery is a hot topic, so How can increasing oil recovery factor even by 1% allow qualitatively improve the position of our country in in this area (potential increase in production to 30 million tons of oil per year).

Surfactants when flooding oil reservoirs

For the first time, the use of surfactants as an additive for oil flooding have been used in USA in the 40s of the 20th century. Undeniable the advantage of their use is the preservation reservoir properties of productive formations, and no negative impact on the processpreparation and transportation of oil [5]. Flooding with aqueous surfactant solutions used to reduce surface tension at the “oil” - “water” boundary, relief permeability and mobility of oil and increasing its displacement by water [6]. All surfactants must meet certain requirements.First In total, two properties can be distinguished: increased surface activity at the oil-water interface and oil-water when compatible with partially effective in displacing oil from heavily watered formations [7] and, preferably, low adsorption on the surface of the formation rock. Except It is important to take these requirements into account mineralogical and chemical composition of rocks reservoir, injected water, physical properties formation, namely its temperature and degree depletion of deposits. One of the modern chemical methods increasing oil recovery factor is ASP technology (AlkalineSurfactuntPolymerflood - alkali, surfactant, polymer). This method is based on the idea injection into the reservoir of a mixture consisting of anionic surfactant, soda and polymer. ASP technology belongs to the category combined methods for enhancing oil recovery layers [8-9]. The main thing in this technology is quality pumped mixed solution. Using a technique based on measuring dimensions surfactant associates in aqueous solutions using laser analyzer was searched optimal compositions of reagents for ASP technology for the study of phase states oil-water solutions of surfactants, which allowed select an analogue for an imported reagent [10]. IN as a result of replacing a foreign surfactant with a non-inogenic one Russian production was reduced the cost of the solution for ASP technology, what important in today's unstable conditions on the Russian market. If we talk about ASP technology, then we can’t help but take into account the EOR project (EnhancedOilRecovery - chemical methods enhanced oil recovery) company "Salym Petroleum Development N.V.” [eleven]. It is aimed at increase in oil recovery factor no less than, than 16% due to the use of a mixture of alkaline, surfactants and ASP polymers. The technology was developed for the West Salym field. Important questions associated with uncertainty, for deposits are well injectivity, method of operation, salt deposition, primary processing of produced fluid and fracture growth hydraulic fracturing during injection. The most important the uncertainties are the effectiveness chemical reactions, flooding coverage, formation heterogeneity and preparation of marketable oil.

Based on the results of theoretical and experimental study, it was concluded that for oil from the West Salym field, which has a low acid number but contains surfactants with high molecular weight in the form of asphaltenes and resins, surfactants with large alkyl groups are best suited chains. For West Salym crude oil there was a surfactant based on a long-chain surfactant was developed IOS family (internal olefin sulfonates), the high efficiency of which has been proven in phase tests and core filtration. Below the structure of a long-chain surfactant is presented iOS families:

During the SWCT (singlewell chemical tracer) test well) [12], performed in the West Salym deposit, positive results were obtained results that show that 90% residual oil saturation after waterflooding was mobilized using ASP flooding. This confirmed that ASP based on long-chain surfactants IOS family turned out to be chemically active in reservoir conditions. It is planned to implement the pilot in stages ASP project to optimize development deposits by reducing risks and costs[eleven]. One of the oil companies uses technology of influencing the watered formation with using sediment-forming dispersive detergents systems This technology includes two element of impact: isolation of cracks and reduction interfacial tension by injection surfactants and reagents having cleaning qualities. The method was tested on 13 injection wells, additional production amounted to 77.9 thousand tons [13].

Currently used more often in practice total combinations of different types of surfactants with each other other, or their combinations with polymers, salts, acids to achieve the required effect per layer Properties of each surfactant substances individually are already good enough have been studied, which cannot be said about mixed solutions. In this regard, an important task today is to determine how mixed solutions Surfactants will affect the temperature, pH of the medium, viscosity and other properties of the system [14]. Also during research of various methods increasing oil recovery, scientists are faced with a number of problems, not least of which occupies the deterioration of formation permeability due tobiocontamination, which depends on the species composition, number and size of microorganisms. For increasing the oil-displacing properties of solutions Surfactant with combined suppression of biocontamination the authors of [15] propose the use bactericides type LPE-11 with the addition of non-inogenic surfactants (NSAS).

After numerous tests and experiments, it was found that LPENOL (a mixture of bactericide type LPE-11 with non-inogenic surfactant, namely ethoxylated nonylphenol AF9-12) is effective and technological oil-displacing agent, is not exposed to reservoir conditions biological and chemical destruction; has low adsorbability on rock. Besides, the agent has biocidal properties and restores well injectivity, permeability of the reservoir and increases reservoir coverage by waterflooding due to bioformations and blockages, which generally leads to increased oil recovery.

Both in our country and abroad a common method of increasing oil recovery with using polymers, but these solutions have a number of disadvantages, among which we can highlight high sensitivity to salt content, which leads to a sharp decrease in viscosity. This problem can be solved using additives in the form of non-ionic surfactants substances. The authors of the article [16] during the study chosen as an additive to the base polymer

(polyox)diproxamine (D-157) and triethylene glycol alcohol (TEG). Surfactant during the experiment was added in amounts from 5% to 20%. IN As a result, the authors came to the conclusion that economically feasible for processes oil displacement is the use of polymer solution consisting of 80% polyox solution and

20% additive, which is a mixture high molecular weight alcohols and having low cost, since the use of nonionic surfactants at 5% quantity did not give good results, but although the use of a 20% solution showed positive effect, but in industrial scale, its use will be economical unprofitable.

By touching upon the economic side of the issue it is impossible not to mention that most oil producers companies today use imported expensive materials and reagents. Due to unstable economic situation in the country, and also in light of the EU and US sanctions against oil industry in Russia, acutely the question arises about import substitution, i.e. V substitution of foreign reagents or reagents, manufactured on the basis of imported raw materials, on formulations developed and produced in your country using domestic raw materials.

At the Bashkir State University [17] a comparison was made of oil laundering abilities of aqueous solutions of domestic and foreign surfactants with the possibility in the future to be used in our production domestic analogues. In the experiments there were the following reagents were used: LA 450 (mixture ethoxylated and propoxylated fatty acids alcohols C12-14, Plurafac series, manufacturer BASFGmbh, Germany) and AOS-38 (Alpha Olefin sulfonate, Polystep A-18, manufacturer StepanCompany, USA), Hamposyl 30 (Hamposyl, USA), SynperonicPE (CrodaInternationalPlc, UK), and in as domestic surfactants substances that meet the requirements For environmental safety, reagents P30 and P-44 were taken. These surfactants were specially created for oil production and oil refining industry. As a result, all solutions exhibit high oil-cleaning ability, although surfactant has the highest degree of laundering foreign production LA 450, AOS 38 and Synperonic PE, but it should also be noted that domestic surfactants manufacturer have less corrosive activity compared to foreign ones [17-18].

One of the methods for increasing oil recovery layers is the use of micellar solutions (MR) and microemulsions (ME). Given the direction is considered in [19]. Experience the use of MR and ME shows that this method provides oil displacement up to 50...95% or more [20-21]. The main components of MR and ME are surfactants,

hydrocarbon solvent, codetergent (alcohol) and water. As a surfactant for producing microemulsions amine salts of fatty acids can be used [19-22]. The formation of such salts occurs when simple mixing of fatty acids and amino alcohols or polyethylene polyamines (PEPA). Amine soaps fatty acids are surfactants substances (surfactants) of the anionic type [13] Optimal composition of hydrocarbons micellar solutions were selected according to their ability to solubilize water to form transparent, separation-resistant microemulsions, including stable and phase reversal [19-22]. The more absorbed water solutions, the more effective they were considered.

Education was considered acceptable for MR stable ME with a water content of more than 90.

As a result of all the research carried out the authors managed to select the optimal solution composition, which is a 50% solution concentrate in kerosene. For these microemulsions, some physicochemical properties at different their water content. The result of the study was development of MR and ME based on technical soaps

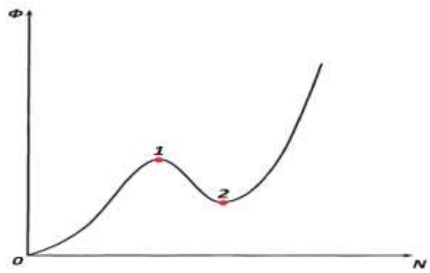
oleic acid and polyethylene polyamines in kerosene, stabilized with isopropyl alcohol. It is shown that replacement is possible distilled fatty acids for technical grade oleic acid [23]. They considered the method

micellar flooding. Since micellar solutions are complex thermodynamic systems, they have some shortcomings,

important among which is the essential decrease in the displacement properties of the solution when insignificant change in the concentration of incoming in the composition of components, as well as a narrow range geological parameters under which the impact on the reservoir will be effective. For example, this The technique can only be used for objects with a temperature not exceeding 90 ° drops with high hydrodynamic resistance. Increasing the stability of the micellar solution can be achieved by dividing the system into associates of micelles (domains) separated from each other each other with layers of solution. At concentration

Surfactant above the first critical concentration micellization (KKM1) and lower KKM2 system divided into areas of different concentrations micelles System structuring will be accompanied by a decrease in solution viscosity. Domain partitioning is thermodynamically beneficial due to the transition of the system to metastable state (a state in which stability is maintained at minor changes in external conditions).Metastable the state of the systems will correspond to the local minimum of the total thermodynamic curve potential (Fig.1).The emergence of local minimum is explained by the negative contribution surface tension, i.e. the Rebinder effect

[3].



Rice. 1 - Change in total thermodynamic system potential with increasing number micelles:

1 – unstable state of the system, 2 – metastable state of the system; N – number micelles, F – full thermodynamic system potential

A solution to the problem of surfactant adsorption is proposed in article [25]. This work also discusses enhanced oil recovery using micellar solutions. As a solution problems, it is possible to use water-repellent additives [26]. Russia already has experience production of micellar solutions with the addition water repellent. This component was highly dispersed material with a developed specific surface, which is modified silica. The component was introduced into a micellar solution in the hydrocarbon phase.

The authors of article [27] considered the possibility creating hydrophobized micellar solution different from the composition considered in article [25], adding a water repellent to the water phase under conditions of domain division of the system. IN in this case, the water repellent due to the forces hydrophilic-hydrophobic interaction will appear in the interdomain space. This the state of the system will promote adsorption water repellent for oil washing, surfactant in this case remains in the micellar solution. Theoretical study of filtration of hydrophobized micellar solutions, revealed the periodicity adsorption of hydrophobizing particles on the walls pores, which will lead to a decrease in the swelling process clay minerals without significant impact on relative permeability of oil. In the work, a positive effect was revealed hydrophobizing additive for stability micellar systems, expressed in periodic adsorption of water repellent on the surface of the reservoir rock. Stabilization of the solution will lead to increasing efficiency of oil displacement from flooded formations.

There are very few fields where the oil recovery factor would exceed 50%. At the same time quite quickly production from production wells becomes waterlogged and difficult to extract. Economically not It is profitable to continue working on these wells. The solution to this problem was found using use of a nonionic surfactant, which is already has been tested in production and shown positive results. In their work, the authors [28] conducted laboratory studies of the reagent KS-6 and composite systems based on it. The latter have shown greater efficiency in compared with a known reagent for all studied colloid-chemical and oil-displacing properties, in particular, water a solution of the composition with "GZ Distillation" allows extract up to 82.22% of residual oil[28-31].

Conclusion. Today there is no unique enhanced oil recovery method, which can be would be applicable to all fields, which differ from each other in terms of collection, physical and chemical properties of the formation, i.e. it is impossible to use any one method impact. Therefore, for each deposits are required individually select impact technology to increase oil production. Much attention should be paid for combined methods of increase oil recovery using surfactants. There are many more works that present positive and negative qualities of surfactants, their possibilities application and implementation in technology for increasing reservoir oil recovery. But it can definitely be done the conclusion is that this is a promising direction, requiring qualitative study of both the surfactants themselves, and mixed solutions with polymers, salts, acids and other components that can improve their properties.

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