Application of Methods of Increasing Oil Extraction Coefficients and Intensification of Oil Production at the Fields of Yamalo-Nenets Autonomous Area

A V Sarancha¹, E D Lizunova¹, E V Baranova²

¹Tyumen Industrial University, 38, Vолодарского street, Tyumen, 625000, Russian Federation
²Saint Petersburg State university, 7-9, University Embankment, St Petersburg, 199034, Russian federation

E-mail: 89044914477@mail.ru

Abstract. The methods of impact on productive oil-saturated formations are intended to increase well productivity and increase oil recovery. In order to complete oil recovery from the formation, a coordinated application of methods of increasing oil recovery and intensification of production is required. Method of impact on formation is selected taking into account features of geological structure, filtration capacities properties, composition of formation rocks and fluids that saturate them. This article considers various promising methods of increasing oil recovery and intensification used at the fields of Yamalo-Nenets Autonomous Area of the Tyumen region.

1. Introduction
For geological and physical conditions of productive formations of the fields of the Yamalo-Nenets Autonomous Area of the Tyumen Region, the following technologies are promising: water injection to maintain the necessary reservoir pressure and oil displacement; Drilling horizontal wells, gouging of second wells; layer hydraulic fracturing; Bottom-hole zone treatment methods; Injection of acid compositions and solvents; Repair-insulation and water-insulation works; Physical and chemical methods of the increasing oil recovery (flow-blocking technologies).

2. Results and discussion
Water-flood operation. At present, water-flood operation is the most recognized and most effective method of increasing oil recovery. Its wide distribution is a due to the following advantages – availability and free water, ease of water injection, relatively high efficiency of oil displacement with water. The efficiency of water-flood operation can be questionable only in hydrophobic formations. The main problem in water-flood operation is to increase the coverage of the formations by drainage and flooding. It is solved by improving well placement, reservoir opening, water injection technology, etc. At the same time, field practice shows that the most effective conventional water-flood operation in combination with the use of treatments of individual injection wells with special chemical reagents. When pumping water into the formation, consideration should be given to the negative effects that injected water can have – colmatation of the pore space with mechanical impurities and petroleum products pumped with water; swelling of clay minerals; Salt deposition during mixing of formation
and injection waters, etc. 

*Also Sidetrack kickoff.* In some cases, opening of formations by inclined-directed wells leads to rapid watering of wells, low oil production rates, small extraction coefficient, as well as deformation and destruction of bottom-hole zone at the creation of depression above permissible when trying to increase production rates.

The second shaft opens the formation away from the drained part of the formation, where oils saturation is higher than in the bottom-hole zone of the inclined-directed well. At the same time extraction is significantly increased, new geometry of formation drainage is created, operating conditions are created, at which oil recovery of low-power formations is increased, development of low-productive and practically depleted deposits become profitable.

It should be noted that with a horizontal hole, the intensification operation may have a greater effect than in directional wells, since the length of the horizontal hole may, for example, be subjected to fracturing operations or various types of chemical reagents.

Drilling of lateral horizontal shafts will make it possible due to significant increase of area of contact of barrel with rock to significantly reduce values of depression per formation with obtaining economically acceptable flow rates in case of small capacity of formations with presence of sole water.

**Lateral drilling.** Lateral drilling should be carried out on large oil-saturated thicknesses of more than 3 meters. Horizontal holes make it possible to significantly increase production rates and accumulated oil extraction due to increase of opening intervals. Increase of opening intervals allows reducing depression, at the same time maintaining the specified flow rate without formation of the gas and water cones.

The use of horizontal holes significantly intensifies the development process, reducing the duration of the production of reserves, with virtually the same oil recovery. During lateral drilling, operating conditions are created, at which oil recovery of low-power formations is increased, and development of low productive and practically depleted formations become profitable.

Also, with a horizontal hole, the intensification work can have a greater effect than in vertical wells, since several fracturing operations can be performed along the length of the horizontal bore, selectively or sequentially, starting from the end of the horizontal hole.

The most desirable of horizontal holes is to use them for introducing plugging fluids, heat carriers and chemical reagents into the formation. Injection of plugging liquids can be used to create an impermeable barrier when isolating the gas cap from the rest of the deposits on a preselected surface.

**Hydraulic fracture.** Hydraulic fracturing is one of the most effective methods of impact on the bottom-hole zone of holes in order to increase their productivity.

The experience of the hydraulic fracturing in the fields of Yamalo-Nenets Autonomous Area shows that the hole fluid flow rate after the event increases on average by 2-15 times. Efficiency of works on application of hydraulic fracturing is largely determined by both technological and geological factors.

Working fluids for hydraulic fracturing are emulsions and fluids on hydrocarbon or water bases. Most often, the following working fluids are used in the process of hydraulic fracturing at the fields:

- Hydrocarbon-based - degassed oil, barbar oil, thickened oil, fuel oil or its mixtures with oils, kerosene or diesel fuel thickened with special reagents;
- Water-based sulfite-alcohol baid, water, hydrochloric acid solutions; water thickened with various reagents, thickened hydrochloric acid solutions.
- Emulsions - hydrophobic water oil, gidorfilny water oil, petroacid and kerosene acid.

Emulsion reaction time must be not less than 24 hours.

The sand for hydraulic fracturing is subject to the following requirements: mechanical strength (sufficient to avoid destruction under the weight of overlying rocks); absence of wide variation in fractional composition. Density of sand laying in created crack is determined by crack gap, filtration capacity of liquid-sand carrier and concentration of sand in this liquid. Sorted quartz sand of 0.5-0.8 mm fraction is most often used for hydraulic fracturing. In addition, stronger materials are used: glass and plastic balls, corundum and agglomerated bauxite.
Hydraulic fracturing is carried out with the help of special equipment for formation hydraulic fracturing production, which allows creating pressure in formation hydraulic sealing zone up to 80-100 MPa.

Hydraulic fracturing is undesirable in formation intervals bordering with water-oil contacts. The use of hydraulic fracturing is expedient in dense differences of reservoir rocks, connection of which to the development by carrying out acid treatments and re-firing, as a rule, is inefficient.

**Physicochemical method of influence.** The influence of negative factors (presence of solid particles, drilling mud filtrates and quenching liquids, water-oil emulsions) can significantly reduce productivity of production wells. The main reasons for reducing permeability of bottom-hole zone of production wells during operation include the following:

- ingress of blanking liquid (fresh or salt water) or washing liquid;
- formation water penetration in watered wells at their stops;
- swelling of particles of clay cement of terrigenic collector at its saturation with fresh water;
- formation of a water oil emulsion (emulsion blocks);
- loss, and heavy oil sediments components of oil, or salts from the passing extracted water at the change of thermobaric conditions;
- penetration into a bottom-hole zone of layer of mechanical impurity and products of corrosion of metals when muffling or washing the well.

Deterioration of collector properties of zone adjacent to injection well occurs as a result of:

- narrowing of pore channels and complete blockage of some of them due to penetration of solid particles of dispersed phase (washing liquid or contaminated pumped water);
- swelling of formation clay minerals at contact with pumped water;
- formation of insoluble sediments at the interaction of pumped water with reservoir water;
- formation of stable water-oil emulsions reducing formation fluid mobility in the contact zone;
- negative effect of capillary and surface phenomena.

The main principles of the well bottom-hole treatment technology are:

- restoration of efficiency of wells in case the efficiency is limited to a condition of a trunk of the well, punched canals and a bottom-hole zone, due to impact on the colmataging substances chemical reagents;
- increase in efficiency of wells due to impact on structure of pore space of a skeleton of breed near a bottom-hole zone of layer of production wells;
- destruction of the colmatant in physical and chemical interaction with the pumped chemical reagents;
- decrease a skin factor due to reduction of radius of the damaged zone and increase in permeability of a matrix.

In this regard, the complex of measures to process the production fund should be directed to clean the bottom-hole zone of the formation in the wells and restoring its filtration characteristics. Maximum efficiency at impact on the bottom of the formation is achieved by joint use of physicochemical methods (injection of acid compositions and solvents) and technical means ensuring removal of colmatant substances, and products of chemical reactions from the pore space of the reservoir.

Efficiency of bottom-hole zone treatments depends on many factors, such as water content of the product, initial oil saturation, oil-saturated thickness, filtration-capacitive properties of collectors, and multiplicity of treatments application.

An application of acid methods of oil production intensification is more efficient at relatively low water cut of well production. With increased watering, acid compositions in combination with surfactants, surfactant solutions and various compositions thereof are used.

Experience of application of bottom-hole zone treatments in the fields of Western Siberia shows that acid or solvent treatments combined with the use of swabbing and a device for geophysical exploration of wells allow achieving maximum result in carrying out the action. The efficiency of such works is due to the qualitative cleaning of the well face from various kinds of colmatant substances and restoration of the reservoir permeability.
Taking into account the experience of earlier works carried out, as well as the experience of works in neighboring fields, it is recommended to use clay-acid treatment, as well as complex compositions based on acids, surfactants, solvent to carry out treatment of bottomhole zone of production and injection wells.

Technology of treatment of bottomhole zone of wells in terrigenic collectors with clay acid solutions of cationic surfactants

The clay acid composition consists of 12% hydrochloric and 3% hydrofluoric acids with addition of 1% cationic surfactant.

The following materials are necessary for implementation of the technology of impact on the bottom-hole zone of the formation with clay acid compositions:

– acid hydrochloric;
– etching acid;
– cationic surfactant;
– process water.

Technology of the treatment of bottomhole zones of wells with acid microemulsions. Acid microemulsions are uniform transparent colloidal systems consisting of three or more components: surfactant, acids and co-solvents.

The technology is similar to conventional acid treatment, is implemented with standard field equipment, and is applicable to a wide range of formation temperatures, pressures, fluid composition, and rock. The technology is effective for the treatment of both production and injection wells. At 1 m of perforated capacity, it is recommended to pump 2-3 m³ of acid micro emulsion and 5-10 m³ of selling liquid.

In order to further reduction the interfacial tension of the acid micro emulsion, cationic surfactant can be presented at the boundary with the oil in the acid micro emulsion. The interfacial tension value is 0.1-0.01 mN/m.

Repair-insulation works and water shut-off. At the fields, it is recommended to carry out repair-insulation works and water shut-off using the following technologies:

polymeric grouting structures;
gel-forming structures.

An application of polymer plugging solutions is most effective in wells with low intake capacity, in sealing of casing string connecting units and repair of casing strings. The mechanism of action of polymer plugging solutions is based on reactions of polycondensation and polymerisation or crosslinking, as a result of which mobile filtering solutions are converted into elastic or jellylike systems. In order to obtain a strong insulating screen, it is effective to use a combined technology based on successive injection of a portion of viscoelastic composition and cement slurry. The solution of viscoelastic composition, having rheological properties close to water, deeply penetrates into the washed part of the bottom-hole zone of the formation or in the area of leakage, and the cement solution provides the necessary mechanical strength of the obtained insulation system.

One method of limiting the inflow of water into production wells is the technology of injecting viscoplastic gel-forming compositions based on silicate gels.

The prospect of using gel-forming compositions for insulation works is due to the processability of preparing the solution and pumping it into the formation, low cost of reagents and their non-toxicity, high strength of the formed gel, etc. When sodium silicate is reacted with acid agents, a silicic acid sol is formed, passing over time into a viscoelastic gel which can serve as a water-insulating material in washed highly permeable zones of the formation.

The insulating ability of a silicate gel is determined by its mechanical and rheological properties, depending on many factors.

The gelling composition technology is applicable to all rock species, a wide range of pressures, temperatures, etc. This technique includes simultaneous preparation and injection of gel-forming silicate solution into the well.
In order to isolate water inflow in horizontal wells, TatNIPI developed a technology based on a complex approach: joint use of a plugging composition in the form of a water-release buffer edge around the horizontal shaft with reliable screening of this edge with a profile cover. Hydrophobic water-immiscible emulsions are used as water-removing material.

Diverter technology (injection well stock). The efficiency of oil displacement with pumped water is reduced over time due to the development of system of manufactured cracks and formation of highly permeable washed intervals accompanied by breakthrough of pumped water to the bottoms of producing wells. As the water cut increases, it becomes necessary to use flow-removing compositions to redistribute the flows of draining water in the formation in order to increase the coverage of the formation by flooding both in the capacity of the formation and in the area, as well as to limit the volume of associated water entering the production wells through highly permeable interlayers.

3. Conclusion
This article was discussed the main methods of influence on productive oil-saturated formations of the fields of the Yamalo-Nenets Autonomous Area of the Tyumen Region. The following technologies are promising: water injection to maintain a necessary formation pressure and oil displacement; Drilling horizontal wells, gouging of second wells; layer hydraulic fracturing; Bottom-hole zone treatment methods; Injection of acid compositions and solvents; Repair-insulation and water-insulation works; Physical and chemical methods of the increasing oil recovery (flow-blocking technologies).

4. References
[1] Baturin Y E 2010 Bazhen without benefits so it will remain *Oil and Gas vertical* 23-24 12-16
[2] Deliya S V, Drandusov K A, Karpov V B and Mamaev D A 2015 RITEK: Prospecting experience, prospecting, reserves calculation and deposit developments of bazhen formation *Subsurface management XXI century* 1(51) 80-83
[3] Korovin K V, Pecherin T N 2016 Analysis of operating results from the bazhenov formation of deposits of the territory of KHMAO-Yugra *International research magazine* 12 (54) 91-94
[4] Nesterov I I, Brekhuntsov A M 2010 Oil bituminous clay, siliceous clayand carbonate-silic clay rocks *Vestnik CKR Rosnedra* 6 3–16
[5] Sarancha A V, Sarancha I S 2014 Analysis of the bazhen formation development at Ulyanovskoe field *Academic magazine of West Siberia* T 10 1 128-129
[6] Sarancha A V, Garina V V, Mitrofanov D A and Levitina E E 2015 Pilot Development Planning’s results of bazhenformation of Zapadno-Sakhalinskoe field *Fundamental researches* 2-14 3052-3055
[7] Sarancha A V, Mitrofanov D A, Sarancha I S and Ovezova S M 2015 Bazhen formation development of Ay-Pimskoye field *Current problems of science and education* 1-1 204-208
[8] Tolstolytkin I P 2012 Oil reserves use at the fields of KHMAO-Yugra *Science and FEC* 5.4. 26-28
[9] Shandyrin A N, Shpurov I V, Bratkova V G 2015 State and prospects of shale oil deposits development *Subsurface management XXI century* 1(51) 52-63