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Analysis Of Encapsulated Polymer System Technology Application Methods And Other Diverter Technologies In Order To Increase Oil Recovery

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Abstract-The use of flow diverter technologies (FDT) is presented by the injection of limited amounts of special reagents into the injection wells designed to reduce the high permeability of an interlayer. The use of flow diverter technologies is aimed at injection profile leveling in respect of injection wells and the redistribution of filter flows in heterogeneous by permeability and highly watered interlayers of productive layers. In literature devoted to the methods of enhanced oil recovery (MEOR), a significant place is given to the discussion of flow deflection technologies aimed to improve the development of stock highly productive horizons. On the basis of various production data this article analyzes the application of methods increasing the oil recovery factor (ORF), namely the flow deflection technologies in various RF fields, including the technologies of encapsulated polymer systems (EPS). The paper concluded that the technology of encapsulated polymer systems in the wells of various RF deposits enabled to increase the oil recovery of layers and the blocking of water flow into high permeability areas. Also, the use of technologies with the application of encapsulated polymer systems allows to improve significantly the performance in terms of additional oil production growth and also to increase the oil recovery factor.

Keywords: encapsulated polymer system, flow deviating technology, oil recovery factor, polymer flooding.

1. INTRODUCTION

At the present stage of oil production a lot of attention is paid to the impact methods on a layer in order to increase oil recovery and, therefore, the physical and chemical characteristics of oil, including high-viscosity one [1-2].

Among many existing MEOR technologies the flow diverting technologies (FDT) are used currently, without which neither large deposits are developed. FDT role is increased especially for the improvement of highly productive facility development at its late stage. Tens of thousands of well treatments with the use of flow deflection technologies are performed in Russia.

A Considerable importance is given to increase the oil recovery factor and oil production [3]. In this REGARD it is necessary to analyze the effectiveness of various methods to improve oil recovery ratio, and the specific analysis of encapsulated polymer system (EPS) technology.

2. MATERIALS AND METHODS

Muslimov R.H. [2], analyzing, flow diverting technologies, pointed out that they account for the bulk of incremental oil production. Thus, during the period of 1999-2003 38.9 million tons of oil was recovered additionally on the fields of "Surgutneftegas", the oil recovery factor increased by 0.97%. At that the highly efficient use was presented by the technologies on the basis of polymers, the injection of which is performed in a well and also into the wells through the cluster pumping station (CPS). As the result of new technology introduction, a specific technological efficiency of RT was increased from 1.95 thousand tonnes to 2.95 thousand tonnes.

After RT introduction study the technical and economic assessment proved its high cost-effectiveness: the costs of work are paid off during the first months.

The analysis of flow deflection technologies showed the injection effectiveness of small volumes of polymer solutions aimed at the the layer coverage increase by flooding. An increased volume of polymer solution injection 2 times increases the total cumulative oil production on the average of 6% [4].

Polymer flooding is a technologically simple and highly effective method of layer enhanced oil recovery (EOR) based on the addition of small amounts of water-soluble polymers to water at conventional waterflooding of oil reservoirs. RT allow to regulate flooding, level the profile of injection, to eliminate the breakouts of water in production wells, to block the washed zones, to prevent the withdrawal of the injected water into the adjacent layers, to limit the performance of wells. The used reagents increase the filtration resistances of flooded areas, at that different plugs are formed in a flushed zone. In order to reject the stream injected into the water layer a highly watered interbed creates a waterproofing screen from polymers, emulsions and alumogels [5].

The technologies of polymeric impact are used on the fields of the Samara region, Bashkortostan, Tatarstan and Western Siberia. The pumping of polymer solutions is carried out at the facilities located in various oil and gas provinces, presented by terrigenous and carbonate rocks of different permeability, viscosity and temperature. In Tatarstan this polymer flooding is used since 1973, polymer solutions are injected into a layer in

the form of rims with the size of 0.05-0.15 from pore volume, the maximum concentration makes 0.2% [3].

During the injection of a polymer into a reservoir, the main drawback is its destruction, as well as the creation of salt resistant surfactants. The mechanical, thermal and biological degradation is revealed. The requirements to the dissolution of polymer solution mode are applied. Biological degradation reduces the duration of gel existence in a layer. Another drawback is the lack of polymer binding completeness guarantee in a porous space. In this regard, the technology on the basis of PAA was proposed, providing the formation of gel microparticles during the injection of dispersion into a reservoir - an encapsulated polymer system (EPS) [6], which is currently one of the most effective flow diverting technologies. At the interaction of aluminum and polyacrylamide (PAA) binder the binding of polymer macromolecules takes place with the formation of polymeric capsules wherein the polymer macromolecules are interconnected by aluminum ions. Aluminum sulfate, aluminum polyoxychloride, potassium alum are used as aluminum salts [7]. Currently, EPS technology is successfully implemented on the fields of Tatarstan, an extra production made over 1,900 tons of oil per well operation [8].

During the injection process of EPS, a sequence of various regents injection is used: the saturation with the waste water, the pumping of EPS using PAA reagents and the polymer of SKA grade. Further the overflush with waste water and the start of a well for injection is performed. Depending on the sequence and the liquid used in a particular well the effectiveness of a performed action may be different (the reception of an additional extraction) [9].

3. DISCUSSION

Guided by the results of EPS application in different wells, we concluded [10] that the effectiveness of EPS technology consists of two enhanced oil recovery mechanism interaction:

1. Coverage increase by displacement due to the involvement of a non-drained interlayer with a weakly changed oil.

2. The displacement efficiency increase due to additional oil displacement from a washed layer is explained by the formation of highly viscous emulsions with different structures.

The peculiarity of EPS ability is the ability of polymer particle size regulation by varying a polymer, aluminum salts, and water salinity concentration. This provides the possibilities of encapsulated polymer system optimization possibilities for different geological and physical conditions of flooding.

According to the results of data generalization concerning the use of major RT at 3543 objects using 72 technologies based on various modifications [1], EPS technology was conducted 135 times in various fields of Russia. The effectiveness of this injection is the following one: an additional production makes 135 tons, the increase in oil production makes 1.4 tons/day, the profitability makes 46%. During the period of 1991-2011 EPS technology was used at OJSC "Tatneft" at 260 sites, the effect duration made 25 months, the additional oil production per a single producing well makes 458 t [12]. Experience of EPS injection technology shows its effectiveness on small fields with high-viscosity oil [13].

In general, the numerous works [3-14] state that the efficiency of polymer flooding use depends largely on the properties of the used reagents. The main technological parameters of the solutions are: the filtration rate and permeability, the stability in a porous medium. Reagents are chosen depending on individual properties and the state of a particular field development, subdivided into specific stages of their selection. So at the first phase the injection reagents are selected depending on the physical and chemical properties, price and availability. Then the laboratory tests of the most promising polymers are carried out. The technological properties of two most suitable samples of reagents are studied during the last stage [14].

In order to evaluate the success of a certain RT application before and after an event, its preliminary analysis is necessary, that is a preliminary assessment of a prediction, the design of used RT. For this purpose it was proposed to use a rapid method that allows to evaluate the efficiency of the process, which allows to calculate the profitability [15]. During the application of MEOR it was possible to take a decision using a hydrodynamic modeling, which allows you to identify the nature of the reservoir heterogeneity and reduce risks.

During the consideration of MEOR effectiveness, the issues on research, monitoring media and regulation appear. There are several problems that must be resolved to increase the volume of MEOR application [16]:

- the regulation of chemical reagent rims promotion along a layer;
- the reduction of chemical adsorption on a porous media;
- the decrease of oil viscosity in a layer by chemicals.

Let's recall that the assessment of MEOR technological efficiency is performed by the comparison of impact object performance values resulting from the application of MEOR, with estimated values, which would have been obtained without the application of MEOR, and the specific technological efficiency is the ratio of 1 ton of additional oil production by 1 ton of injected reagent (polymer).

As noted above, the actual problem in RT application is the selection of a desired composition for the injection into a specific hole. An algorithm for candidate well selection is proposed to perform flow deflection compositions using the example of Lyantorsky field [17]. The method is based on the development of repression dependencies, with which you may choose the most diverting composition for any injection well (IW). 20 parameters were examined for this, which makes the most significant effect on the additional oil extraction determined by a PS: geological

and petrophysical parameters of a layer, perforated thickness, oil saturation ratio, permeability, porosity and layer opening ratio.

During the RT impact the limitations of their use are possible, conditioned by the following factors that can not completely cover the entire area of the reservoir under influence:

- the dilapidation of mining and injection wells;
- the absence of reacting MW at the forefront due to technical and economic reasons;
- PS absence in selection areas;
- the absence of development system balance at large facilities [18].

Currently, in NGDU "Almetyevneft" the flow deflecting technologies are applied effectively among MEOR. These technologies are being implemented since the mid 90-ies of the last century. In recent years, the number of wells, where RT was used reached 65 [19].

OJSC "Surgutneftegas" also applies RT due to the predominance of residual oil reserves. 3-5% of OER increase was the result of their application for 15-20 years compared to the conventional flooding. The unit TSA-320 is used for reagent pumping [20].

The technological effectiveness of flow deflection technologies is also established considering the nonuniformity of oil composition and properties extracted from different layer parts with varying degrees of depletion in the following cases [21]:

- If recoverable oils have lower density and viscosity;
- If the composition and the properties of recoverable oils deteriorate;
- At the absence of effect the mean values of oil parameters are the same.

At that there is the need for the re-application of polymer systems at their destruction over time.

At the development of oil fields in Western Siberia, a significant role is played by chemical methods, but due to their limited use in Jurassic deposits due to the geological and physical conditions the gelling polymer systems based on the known PAA are applied, including the Jurassic objects of LLC "LUKOIL-West Siberia" fields (2009-2010) [22-23].

Numerous experiments on the filtration of EPS compositions on physical models of porous formation at the permeability of 0.5-4 millidarcyevidence that the residual resistance factor (the ratio of the initial water mobility to the mobility of water after the addition of the polymer) increases in certain examples from 5.2 to 26, 4. This means the reduction in permeability of interlayers with high permeability or the layer zones that allow to regulate the filtration flows during flooding. Encapsulated polymer systems are obtained in waters of varying salinity in a wide temperature range. The fact that EPS has a low dynamic viscosity under normal conditions and is easily pumped through tubes is an important one [24].

4. CONCLUSIONS

Thus, the technology of enhanced oil recovery using EPS is designed to provide the development regulation process in heterogeneous reservoirs and multilayer collectors, to enhance oil recovery and reduce the development period of impact objects with the obtaining of the planned oil recovery factor.

The essence of technology is presented by unique polymer solutions limiting the water filtering in the areas washed from oil due to the increase of the residual resistance factor.

After the analysis of various sources, the articles about the effectiveness of flow deflection technologies in general as well as about the experience of EPS pumping the following conclusions may be made:

The technology provides an increased oil recovery by blocking water flow in highly permeable areas and as the result, the alignment of displacement front and layer coverage increase by displacement;

1. The formation of gel microparticles during the dispersion feeding into a reservoir enables EPS to solve the problem of polymer system destruction in reservoir conditions;

2. The use of EPS may significantly increase the values concerning the increase of additional oil production and oil recovery factor;

3. For a proper technology application it is necessary to correct the selection of candidate wells effectively, depending on geological and technical factors.

5. SUMMARY

EPS technology on the wells of different RF deposits allowed to increase the oil recovery of layers and block water flows in high permeability areas. Also, EPS use may significantly increase the performance of an additional increase in oil production and oil recovery factor.

CONFLICT OF INTEREST

The author confirms that the presented data do not contain any conflict of interest..

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