The analysis of the problem of rational use of mineral resources during development of hydrocarbon fields in the territory of Russian Federation

Aleksandr Valeryevich Maksyutin, Mikhail Konstantinovich Rogachev, Radmir Rasimovich Khusainov and Liliya Albertovna Shangaraeva

National Mineral Resources University (University of Mines), 21 line, 2, Saint-Petersburg, 199106, Russian Federation

Abstract: In the paper the analysis of the current level of oil extraction and liquid condensate on the territory of the Russian Federation are made. The results of the evaluation of the dynamics of the share of hard-to-recover reserves and current recovery indices for the last fifty years are presented. The results of experimental researches on a substantiation of innovative scientific-technical decisions directed on improvement of rheological properties of high-viscosity oil and filtration characteristics of bottom-hole formation zone in the oilfields with hard to recover reserves are presented.

[Maksyutin A.V., Rogachev M.K., Khusainov R.R., Shangaraeva L.A. **The analysis of the problem of rational use of mineral resources during development of hydrocarbon fields in the territory of Russian Federation** *Life Sci J* 2014;11(6s):280-282] (ISSN:1097-8135). http://www.lifesciencesite.com. 53

Keywords: hard to recover reserves, high-viscosity oil, rational subsoil use, oil recovery, plasma impulse effect

Introduction

According to statistical data [1], on the territory of the Russian Federation from 2007 to 2013 years has been the growth of oil extraction and liquid condensate from 488,1 to 523 million tones. This dynamics is mainly connected with the annual setting into operation of new fields. In Russia the significant hydrocarbon reserves today are to be hard to recover. Basically, hard to recover reserves of oil are concentrated in more than 650 deposits, 86 % of which are in the territories of three Russian oil and gas bearing basins of the Volga-Ural, West Siberian and Timan-Pechora [2]. The share of hard-to-recover reserves at the fields of the country is growing steadily and is close to the value of 60 % from total amount on the balance of the country, while the average oil recovery project has a downward trend (fig. 1) [3]. It is mostly connected with the economic policy of the country, directed on increase of volumes of extraction and export of oil. Due to difficult economic and political situation of the 90-ies the amount of exploration have been permanently reduced. The unstable situation on the external market and the low prices for oil and raw materials had a negative impact on the rate of growth of oil reserves.

The main part

Currently new fields are opened, however, most of these deposits are medium and small. Their profitability is known to be lower than of major fields. The structure of current reserves of oil is rapidly deteriorating because of the selective development of the best tanks. The depletion of large fields in general is 52%, and in many reaches 70-80%. Considering that the main method of deposits development of the country is flooding, and the average water cut is about 86%, the amount of residual oil reserves in flooded layers will constantly increase. Let's note, at current oil reserves of industrial categories proven reserves of 14% by heavy oil, 12% - high-sulfur, 11% - high viscosity. About 38% of oil resources fall on reservoirs with low permeability [4]. Thus, according to some experts by 2020 the Russian oilmen will develop mainly fields with hard-to-recover reserves. The urgency of using innovative and sustainable technologies, directed on additional extraction of hard-to-recover reserves, increases every year.

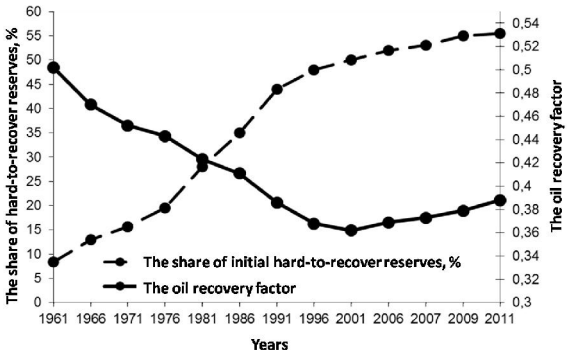

Fig. 1. Dynamics of the share of hard-to-recover reserves and the oil recovery ratio deposits of Russia

According to most experts a radical increase in average coefficient of oil recovery in the country, especially in hard-to-recover reserves, can only be achieved by a significant increase in the scale of application of the «tertiary» methods: thermal, gas and chemical (achieved production 35-70%). Enhanced oil recovery methods are much more complex processes,

compared to flooding, based on the mechanisms of additional extracting oil from porous medium. The technology of these methods require, as a preliminary careful scientific justification for specific conditions, and subsequent scientific support using the new and fundamentally new means of control and regulation. All of this requires additional costs. However, foreign and domestic experience shows that the complexity and additional costs ultimately compensated for increased efficiency.

The optimistic forecast of oil production close to the «Long-term state program of studying of bowels and reproduction of the mineral base for 2005-2010» and on prospect till 2020 is given in the table 1.

Table 1. Growth of reserves of oil in the territories and water areas at the expense of exploration works, necessary for realization of the programs of the oil extraction in Russia

The region and the water area	Rvbkkeserves increment, million tones		
	2005-2010	Coefficient	2011-2020
Western Siberia	1350,00	1,70	2295,00
Volgo-Ural (Russian Caspian sea)	120,00	2,08	250,00
The Timan-Pechora province	170,00	1,94	330,00
Eastern Siberia (including the Republic of Sakha)	400,00	1,50	600,00
Ciscaucasia	15,00	1,67	25,00
Kaliningrad region	2,00	0,50	1,00
Sakhalin oblast	4,00	1,75	7,00
Sea Russia	270,00	1,94	525,00
Overall in Russia	2331,00	1,73	4033,00

The empirical dependence identified by results of the analysis for 2005-2007 were used to forecast market capacity for the next 10 years. Obviously that the greatest interest for service companies in the next 10 years will be represented by Western Siberia, Timano - Pechersk province, Eastern Siberia and the continental shelf of Russia [5].

One of the most important problems of service companies of mineral resource complex is rational and complex use of mineral deposits. Due to this it is possible to achieve and exceed the above mentioned forecasts.

Currently mineral deposits are used in a fragmented manner: many associated components are not produced; waste is non-recyclable; water and air basins are polluted. The solution of this problem may be applying innovative technologies for complex use of mineral raw materials. This will allow: raising efficiency of production; reducing losses of mineral resources; implementing the expansion of mineral - raw-material base; increasing deductions in the Federal budget and extrabudgetary funds, as well as reducing unemployment in the region [6].

Application of vibro-wave impact on productive reservoir is not enough studied, but perspective. The results of plasma-impulse impact (PII) on intensification of well inflow during the development of hard-to-recover reserves (HRR) are presented in this paper [7]. It should be pointed out that the study of peculiarities and mechanisms of action of studied technology on the reservoir system in general have been carried out at the Mining University since 2006 till present in the laboratory of «Enhanced oil recovery». In this regard, the objectives of laboratory studies of the impact of the PII on the rheological properties of high-viscosity oil and filtration characteristics of the productive formation with the purpose of further development and validation of new effective integrated technologies of enhanced oil recovery at fields HRR are relevant in the oil and gas industry. This paper presents the results of experimental studies of the impact of technology PII on rheological and filtration properties of high-viscosity oil.

The study of rheological properties of liquid was conducted with a controlled value of the shear rate to determine the value of shear stress. The essence of this research was to study the rheological properties of high-viscosity oil (effective viscosity, the maximum shear stress, thixotropy and viscoelastic properties) before and after exposure by PII on a rotational viscometer «Rheotest Rn 4.1 of the company Messgerate Medingen GmbH (Germany). The capability of PII technology to improve the rheological properties of high-viscosity oil is established and can be helpful to increase its mobility [8, 9, 10].

Experimental bench for the impairment assessment of reservoir properties of formation damage evaluation system (FDES-645) was used to conduct filtration studies of the joint influence of plasma-impulse and physico-chemical impacts on the reservoir. The aim of the research is directed improve the rheological properties of high-viscosity oil and filtration characteristics of bottom-hole formation zone in the oilfield with hard-to-recover reserves.

FDES-645 allows filtration test with simulation of the formation at thermobaric conditions. Simulating of high-viscosity oil filtration in the bottomhole formation zone while processing plasma impulse impact with the injection of an aqueous solution of alkali and temperature change from 30 to 70ºC was carried out during the filtration studies. The results are shown in figure 2.

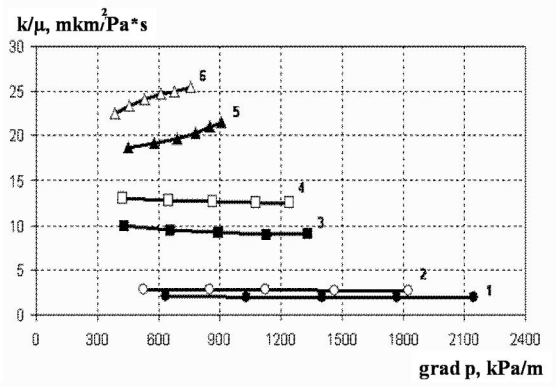

Fig. 2. Dependence of the oil mobility of the Usinsk oilfield (after the PII) vs the pressure gradient in the formation sample (sandstones, k=0,2 mkm^2) after 40ºC impulses at different temperatures:
1 - filtration of oil after the PII at T=30ºC; 2 - filtration of oil after the PII and injection of an aqueous solution of alkali at T=30ºC; 3 - filtration of oil after the PII at T=50ºC; 4 - filtration of oil after the PII and injection of an aqueous solution of alkali at T=50ºC; 5 - filtration of oil after the PII at T=70ºC; 6 - filtration of oil after the PII and injection of an aqueous solution of alkali at T=70ºC

Conclusion

It should be pointed out that the mobility of the oil increases with the temperature increasing. Injection of an aqueous solution of alkali contributes to improve filtration capacity of high-viscosity oil in the reservoir. Complex application of thermal physical and physico-chemical impact increases the mobility of abnormal (non-Newtonian) oil. Eventually, at the temperature of 30...70ºC mobility of high-viscosity oil increases by 28...39 %, 35 % in average.

The conducted research, it is a step towards creating an effective comprehensive technology of enhanced oil recovery on the basis of joint application of plasma-impulse and physico-chemical impact to increase recovery factor on the oil fields at different stages of development with different types of reservoirs.

At the present stage of development of the oil industry when the field of light oil is in the final stages of development and the share of deposits with hard to recover reserves steadily grows and necessity of development of new effective technology of enhanced oil recovery is obvious.

Research was carried out with the support of Council about grants of the President of the Russian Federation for state support of young Russian scientists - candidates of Sciences (MK-315.2014.5).

4/16/2014

Corresponding Author:
Dr.Aleksandr Valeryevich Maksyutin
National Mineral Resources University (University of Mines), 21 line, 2, Saint-Petersburg, 199106, Russian Federation

References

1. Vinogradova, O., 2009. World results 2008. Neftegazovaya vertical, 3: 18-22.
2. Yashchenko, I.G. and Yu.M. Polishchuk, 2007. Analysis of interrelation of physical-chemical properties of heavy oil and the level of heat flow on the territory of the Volga-Urals, Western Siberia and Timan-Pechora basins. Oil and gas industry, 2. Date Views 25.03.2014 www.ogbus.ru/ authors/Yashchenko/Yashchenko_1.pdf.
3. Kryanev, D.Yu. and S.A. Zhdanov, 2012. Scientific provision of new technologies for the development of oil fields with hard to recover reserves. Drilling and oil, 8. Date Views 25.03.2014 www.burneft.ru/archive/issues/2012-08/7.
4. Antoniadi, G.D. and O.V. Savenok, 2012. Stranded oil - structure and trends. Petroleum engineer, 3: 5-9.
5. Strizhnev, C.V., 2010. Repair and isolation works in wells: Theory and practice. SPb.: "Nedra".
6. Mishenko, I.T., T.B. Bravicheva and A.I. Ermolaev, 2005. Choice of a way of operation of chinks with hardly exploiting stocks. Moscow: publishing house "Oil and gas" Moscow, Russian Federation Russian State University of Oil and Gas.
7. Maksyutin, A.V. and R.R. Khusainov, 2011. Extraction and possible ways of development of deposits viscous oil in Russia. Geology, geography and global energy, 2: 97-101.
8. Maksyutin, A.V., 2009. Experimental studies of the rheological properties of heavy oil in the elastic wave action. Automation, telemetry and communications in the oil industry, 5: 4-8.
9. Maksyutin, A.V. and R.R. Khusainov, 2010. Experience and perspectives of the technology of plasma-pulse action on the fields with stranded oil. Geology, geography and global energy, 3: 231-235.
10. Burhanov, R.N. and M.T. Hannanov, 2004. Geology of natural bitumen and high-viscosity: Textbook. Almetyevsk: AGNI.