Success probability of oil production on KhMAD-Yugra oil fields

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Abstract. Oil in KhMAD-Yugra fields has been produced for more than five decades. More than 470 fields of hydrocarbon raw materials have been discovered on the territory (more than 240 – have been developed). Flow charts of oil and liquid production, water injection, rate of withdrawals of initially extracted reserves and water cut have been constructed for all discovered fields. These diagrams have been used for the definition of the development stage on considered fields and the distribution of current recoverable reserves by these stages. It has allowed defining the structure of reserves alternatively. First, it became known what amount of residual reserves is attributable to the share of fields of the first, second, third and the fourth stage of development that indirectly indicates, for example, the growth potential of fields of the first stage or decrease potential of the third stage fields. Secondly, authors determined the distribution of annual production by the fields being at different stages of development that indirectly indicates the possible decrease or growth of the general dynamics of oil production in the future. In general the carried-out analysis has allowed predicting further dynamics of oil production in KhMAD-Yugra.

1. Introduction

Oil in KhMAD-Yugra has been produced for more than five decades. More than 470 fields of hydrocarbon raw materials are discovered on the territory (more than 240 are developed). In February 2016, 11 billion tons of oil are extracted in Khanty-Mansiysk Autonomous District.

KhMAD contributes significantly to the Russian oil production, 45% of Russian oil and about 6% of world oil are extracted in the district. It should be noted that this region provided more than a half of annual oil production in the country over the period of three decades.

Thus the cumulative oil production made 11 billion tons. It was required to drill about 400 million meters of rocks, to construct and complete more than 170 thousand wells, to extract more than 45 billion tons of fluid and to inject more than 55 billion cubic meters of fluid. Average current Oil Recovery Index on the developed fields makes 0.22. The reserve recovery of ABC_1+C_2 makes 48% that means that about 11 billion tons of oil still remains in the interior of the earth. It is important to note that the frequency rate of residual recoverable reserves (ABC_1+C_2) at the current recovery rates is only 43 years. Taking into account the production decline, it will be possible to produce oil for about hundred years. But will it be able to satisfy the growing needs of mankind.

2. Results and Discussion

The authors paid attention to the dynamics of oil production in the district. In 2017 oil production in

KhMAD made 235.3 million tons that is less by 3.9 million tons than in 2016. Thus, decline of oil production on the district has been continuing for ten straight years. A decline of oil production from 2009 to 2012 slowed down from 7 million tons (2009) up to 2.6 million tons (2012) that gave occasion to optimism, but in 2013, 2014 and 2015 the decline of oil production increased up to 4.8, 4.7 and 7.2 million tons, respectively, that caused high anxiety about the prospects of oil production in Yugra. Besides the valuation of oil in the world commodity markets falling to 40 dollars per barrel these years has not inspired optimism at all.

One more anxious moment is watercut of produced oil which in 2017 made 90%, in reserve recovery development - only 60%.

Oil production maintenance at reached levels requires constant carrying out the large number of geological and technical actions (GTA). Analyzing dynamics of a gain of production from GTA in the period of 2008-2013, it is possible to define the descending tendency, both by a total gain of oil production and by specifics of one borehole operation. And though the oil production, gain in 2013 has made more than for the previous two years, but considering this indicator specifically, it becomes clear that the efficiency of GTA held steadily decreases. Decline in a specific gain of production is observed on such technologies as drilling of horizontal wells, sidetracking, hydraulic fracturing of layer.

Considering an oil production gain by separate actions, it should be noted that the greatest contribution is carried out from layer hydraulic fracturing, but the specific efficiency of this technology is lower than drilling of horizontal or sidetracking. Based on specific indicators, it is possible to draw a conclusion that drilling of a side track is three times more effective than hydraulic fracturing, and a horizontal track-for five times.

It is possible to draw a conclusion that traditional technologies of development including the GTA standard set exhausted all possibilities for a change of the descending tendency. The necessity for creation of new technologies of oil production which are based on more deep basic investigations, but for the developed economic conditions, it seemed problematic.

Generally many papers and publications analyzing the current state of KhMAD-Yugra fields' development are published. They contain enough material allowing estimating the current state and problems of development. The authors of this paper present the current state from a position of stages of fields' development.

The authors defined that 16% of reserves accounted for the fields at the first research stage, 25% - for fields at the second research stage, for the third stage - 21% and for the fourth - 38%. One selected 20% of approved recoverable reserves, the second - 24%, the third - 54% and the fourth - 74% by depletion of reserves.

Separately it is necessary to state the group of undeveloped fields with prepared reserves of industrial category C1, which share in total amount is inconsiderable and makes 2.3%. It confirms conclusions that it is not worthy paying much attention to discovery of new fields for satisfaction of growing needs of world economy. It is better to focus on rational development of producing fields, as much as possible using the potential of new technologies.

25% of annual production in 2010 belongs to fields of the 4^{th} stage and though it is not the maximum indicator (35%), but represent greatest concern as fields of this group most intensively decrease in production by 10 – 20% annually being the share of group of the fields which are at the 3rd stage. If fields of the 1 stage with 16% of CRR and 18% of annual production do not compensate decrease in production of fields of the 3rd stage, then annual oil production in KhMAD will continue the further decline begun in 2008. This scenario is also most probable because 20% of CRR and 18% of annual production in 2017 are the share of fields of the 2^{nd} stage, which already on the way to the third stage as practice of KhMAD fields' development shows that duration of the 2^{nd} stage usually is no more than 2-3 years, then an intensive decrease in production starts. Thus, a further decrease in annual oil production on KhMAD fields from the position of development stages is inevitable.

The greatest volume of residual reserves accounts for the 4^{th} stage of development and at the same time they are developed only by 74%.

It is necessary to remind that the fourth stage of development is implemented in the conditions of high water content of production (more than 80%) and the low level of rates of oil production (less than 2% from the IRR). From the development position this stage is the most difficult and long-lasting period during which, problems of designed systems of development are especially critically shown and also there is a natural aging and wear out of wells and oil-field constructions. But problems of more than 80 fields of Yugra which are at a late stage of development do not come to an end. A serious problem that additional recovery of residual approved reserves will stay deep beneath the earth of KhMAD without geological and technical actions (GTA), i.e. considerable financial investments.

The carried-out assessment presented that the volume of reserves brought into development at the existing systems of development and the realized technologies - 76% on fields of the fourth stage and 24% of residual reserves of industrial category C1 are not brought into development. It concerns fields where the design well stock is almost completely realized. It is also necessary to note that more than a half (53%) of not drained stocks of more than 80 fields is the share of only five of them. These fields are unique and large-scale deposits - Talinskaya Square of Krasnoleninsky, Fedorovsky, Vatinsky, Southern Surgut and Mamontovsky.

It is necessary to note that oil reserves of fields on the 4th stage of development as drained and in particular not drained, are not just hardly recoverable, but "superhardly recoverable". Their production is complicated by the previous technological processes, and they represent:

- not depleted reserves because of the low forcing-out ability of the injected working substance or as a result of decrease in oil mobility;
- residual reserves in zones which are not affected by waterflooding;
- reserves in cross-borehole sites of the development object, the filtrations which are not affected by filtration owing to the insufficient density and unevenness of well network;
- reserves of the peripheral undrilled parts of water-oil zones of an object with low oil-filled thickness;
- reserves of interlayers with the low permeability which development lag is caused by multispeed filtration and the advance waterflooding of the most high-permeable layers;
- reserves of low-permeable uppermost and bottom parts of the developed object;
- the residual reserves caused by other geological and technological reasons.

To bring non-draining reserves into development and also increase the deposits' coverage by processes of desaturation and efficiency increase of these processes, subsurface users have to concentrate the attention on such actions as drilling of additional injection and production wells, isolation of flushed intervals, well-drilling of designer wells, application of GRP special technologies, application of hydrodynamic, physical and chemical, physical, water gas, gas and thermogas methods of increase in oil recovery, disaggregation of existing development objects, the organization of a separate system of influence for a more dense grid of wells for hardly removable reserves and also the continuation of search and development of essentially new technologies in relation to the concrete structure of residual reserves.

It is also worth understanding that the application by subsurface users of large-scale studies to increase oil recovery is impossible without state support, i.e. tax remissions. For example, it is offered to initiate zeroing of MET on oil extracted from wells working with an output on oil less than 5 tons per day or water content of more than 95%. Responsibility for this situation is not only carried by subsurface users, but the state as the owner of mineral resources. The government has to monitor the current situation and react, for example, by stimulation for the rational use of reserves or the imposition of economic sanctions for gross violations of design solutions.

3. Conclusion

Traditional technologies of development including the GTA standard set have exhausted the opportunities for a change of the descending tendency. The necessity for invention of new technologies of oil production which are based on deeper basic researches and the realization of those seem very doubtful in modern economic conditions.

Decline in annual oil production in KhMAD started in 2008 will continue further because now more than 25% of annual oil production in 2017 and more than 20% of residual reserves of industrial category C1 are concentrated on fields in a phase of intensive decline in production, and also about 15 fields, which are in the third stage of development (20% of current recoverable reserves CRR and 18% of annual production).

The greatest number of approved residual recoverable oil reserves of C1 is concentrated on fields which are at the fourth (finishing) stage of development and at the same time they are developed only for 75%.

The assessment presented that about 24% of approved recoverable reserves of fields at the 4th stage of development are not subjected by processes of drainage on fields where the design well stock is almost completely realized.

To remedy the situation, it is necessary to start large-scale actions on enhanced oil recovery on fields of the 4th stage of development that demands considerable financial and material expenses, but it is estimated economically inefficient by subsurface users.

It is necessary to regulate barrelage tax payments first of all for fields which are at the 4th stage of development for the purpose of subsurface users' stimulation, introducing modern methods to enhance oil recovery that will allow one not only to reduce the decreasing rates of production, but also to enhance and, as a result, to increase oil recovery, to reduce development terms and to prevent the decline in annual production in KhMAD.

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-silica-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.* **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