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SELECTIVE CONTROL OF FIELD DEVELOPMENT INTENSIFICATION

The state of the art of development of the majority of oil-fields of Russia is characterized by growth of almost unrecoverable of residual reserves in headers of a composite constitution at a high water cutting of well production. The raise of performance of digging with almost unrecoverable reserves requires special scientific studies.

We esteem a system of selective control of intensification of process of development including hierarchical approach to learning a plant, statistical simulation of processes of development on various instants, estimation of potential possibilities of a plant on efficiency and blow-down recovery, optimization of methods of a bottom-hole zone treatment and a plant as a whole with the purpose of meliorating performance oil recovery and new methods of check by the dynamics of oil saturation of a bench during development. All this allows to forecast and to drive the process of development. The methodology, considered by us, is resulted on an example of large oil producing region encompassing northwest of Bashkortostan.

The majority of oil fields of a Northwest part of Bashkortostan are on late development stages tracking with a constant decline of oil production. The expertise of development of these fields demonstrates, that the production decline of oil is conditioned, both natural magnification of water cutting of well production, and drop of mining possibilities of wells during their exploitation. Reasons of drop of efficiency of wells are foregone impairment of filtration characteristics of formations - headers in a bottom-hole formation zone (B-HFZ) as a result of drilling, exploitation and repair of wells. Thus, the looking up of paths of stabilising or magnification of crude oil production from each well is the actual scientific and manufacturing task.

Analysis spent in JSC "Bashneft" in 90 years geological and technical measures (GTM) on a well stimulation of oil has revealed the following tendencies:

- the padding crude oil production for the score of GTM and performance of the majority of methods steadily drops in time;
- the performance of the same methods of intensification varies in a broad band even at identical operation and technological arguments of objects of affecting and differs in 2... 20 times.

The main reasons of an unsatisfactory state GTM, on our view, are:

- not the registration in full bulk of differences of geological-physical, petrography properties of rocks, physicochemical properties of oil and water of concrete objects of influence;
- series drop of performance of influence of GTM at repeated conducting of single treatments on the same wells.

For reaching a high efficiency of GTM on a well stimulation of oil, it is necessary scientifically validly and differentiatedly to select the objects of affecting with allowance of heterogeneity of a productive strata, geological and physical

properties of the reservoir rocks and physicochemical properties of the formation fluids.

Our studies were devoted to a solution of the given research-and-production problems. They were contained in the following:

1) petrography studies of terrigenous and carbonate rocks of productive strata and their classification on structural and texture properties and mineralogical structure;

2) conducting of laboratory studies of investigation of affecting different compositions of chemical agents on formation samples with allowance for structural – textural properties and mineralogical structure on filtration installation with a maximum simulation of formation conditions and technological parameters of bottom-hole treatments;

3) choice of the most effective compositions of chemical agents for concrete structural – textural groups of formations and suggestion of the recommendations on their field application.

The all-up petrographical characteristics defining first of all reservoir properties of formations are trusted to in a basis of petrography studies. Such characteristics are referred: structure, texture and mineral composition. Mineral and microscopic examinations of terrigenous rocks have shown their essential difference on all petrography parameters. It has allowed dedicating six main genetic groups ranked in accordance with magnification of their geologic micro-heterogeneity and the applicable drop of a productivity factor. Learning of efficiency of oil-and-gas-bearing formations in connection with their structural - textural peculiarities were conducted on 2000 transparent petrography micro-sections of a "Terrigenous Rock Mass of Lower Carbonic Period" (TRMLCP) of oil fields of northwest of Bashkortostan. Six structural-textural types of terrigenous reservoir rocks are selected. Each of the type with allowance for a mineralogical structure allows logically substantiating variability of specific productivity.

The first type of the reservoirs is introduced with medium-grained quartz sandstones. Cement is quartz with interlayer of clay. Structure is fine-psamitic, with a good sand sizing grains of crystal on dimension from 0,25 to 0,05 millimeters. Texture is a massive.

The second type of the reservoirs is introduced with fine-grained quartz sandstone. Cement is quartz with interlayers of clay. Structure is a fine-psamitic, with good grading of sandy grains of crystal on dimension from 0,25 up to 0,05 mm. Texture fine-grained, conditioned by a rare and level-by-level beneficating of sandstone by a clay material.

The third type of the reservoirs is introduced with fine-grained quartzes sandstones being in lithific detritus in diameter up to 5 mm. Cement in the lithific detritus is quartzes, and detritus are in a basal clay cement. The structure of such formations can be determined as grit-gravel, and the texture – as lithific.

The fourth type of the reservoirs is introduced with fine-grained quartz sandstones. Cement is quartzes and clay. Structure is an average-psamitic. Texture is a spotty.

The fifth type of the reservoirs is introduced with fine-grained quartz sandstones, less often by coarse siltstones. Structure is fine-psamitic, less often by coarst siltstones, with a level-by-level grading of sandy grains of crystal from fine-psamitic up to coarse siltstones of dimension. Texture is mesa-stratified, conditioned both a level-by-level grading of quartzes grains, and a level-by-level beneficating by a clay mineral.

The sixth type of the reservoirs is introduced with medium-grained quartz sandstones. Cement is a carbonaceous, basal. Structure is medium-psamitic, with a good

grading of sandy grains of crystal on dimension from **0,25 up to 0,5 mm. Texture is massive.**

All learnt microsections on TRMLCP introduce rather representative sampling. They are dated for various fields and various benches. The allocation of isolated structural – textural types of formations on bulk TRMLCP is introduced in table 1.

Table 1

Allocation structural - textural of types of formations on benches of a terrigene strata of the lower Carbon of northwest of Bashkiria

| Bench | Allocation of isolated structural – textural types such as formation | | | | | | Total |
|----------------|--|-------|-------|-------|-------|-------|-------|
| | I | II | III | IV | V | VI | |
| C ₁ | 0,722 | 0,000 | 0,000 | 0,111 | 0,000 | 0,167 | 1,000 |
| C ₂ | 0,494 | 0,034 | 0,112 | 0,090 | 0,090 | 0,180 | 1,000 |
| C ₃ | 1,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 1,000 |
| C ₄ | 0,756 | 0,024 | 0,000 | 0,122 | 0,024 | 0,074 | 1,000 |
| C ₅ | 0,600 | 0,000 | 0,400 | 0,000 | 0,000 | 0,000 | 1,000 |
| C ₆ | 0,679 | 0,042 | 0,000 | 0,042 | 0,012 | 0,255 | 1,000 |

The estimation of connection structural - textural properties of formations - headers with trade indices is held. Most relevant is the connection of efficiency with isolated structural - textural groups. Thus there is a natural drop of efficiency from maiden to fifth structural - textural group of headers, that is conditioned by a magnification of a geologic microinhomogeneity of formations. The least efficiency has the formations dated to the sixth structural - texture group of headers.

The sectional studies demonstrate a composite allocation of formations - headers on a cut-away TRMLCP. In the same well the multitabular plant of development TRMLCP can be introduced by various structural - texture types of formations - headers, that institutes the necessity of a selective affecting on B-HFZ with the purpose of a well stimulation of oil and the regulating of development of these fields.

For every structural – textural types such as formations - headers the statistical models permitting to forecast a potential efficiency are created. The statistical models include reservoir and petrophysical arguments [1]. The analysis of values of actual and potential efficiency allows to estimate an outlook of applications of compositions of chemical reagents for a raise and recovery of efficiency of a bench.

After a detailed petrographic study of models formations, the looking up of effective compositions of chemical reagents and the choice of optimal proportions of reagents in these compositions for various structural – textural groups of formations - headers was carried out. The laboratory studies were carried out on the specially constructed filtration installation for the express train - study and IASPO-2, construction of the Ufa oil institute permitting maximumly to model formation conditions and technological arguments GTM.

For conducting laboratory studies was utilised керновый a material from productive strata TRMLCP of oil-fields of a northwest part of Bashkortostan, the compositions of reagents for mudding off of a bench (salt of alcali metals), circulation loss devices (solutions are cooked on the basis of acetone), mud acid (solution saline and etching acid).

The analysis of outcomes of the held experiments has shown, that:
 - in all expertises, irrespective of compositions of chemical reagents, structural – textural type such as rock and its terrain clearance penetrability meliorating filtration arguments is observed;

- the greatest performance from applying compositions of chemical reagents is observed at their use in samples of rocks, on the one hand, with a smaller terrain clearance penetrability, and on the other hand - at transferring from maiden to subsequent structural – textural types of rocks on the classification, proposed by us,
- at reference technological arguments of gas cap repressuring the anticipated technological effect will make:

| Type of the reservoir rock | Maximum technological effect | Minimum technological effect |
|--------------------------------|------------------------------|------------------------------|
| I structural – texture type | 2,11 | 1,44 |
| IV, V structural-texture types | 3,00 | 1,45 |

- outcomes of experiments held on the method of application the express train - study at the choice of compositions of chemical reagents and on the installation IASPO-2, maximumly modelling the tabular and technological arguments GTM coincide. It allows to select the methods of a bed stimulation to utilize " the method of Application the express train - study with the purpose of a select of compositions of chemical reagents for various structural - textural groups of formations - headers ", practically on the order by reducing bulk and terms of conducting of experimental studies, considerably by diminishing material and labor expenditures.

Thus, the emanating and learning of singularities structural - textural types of formations - headers of a terrigene strata of the lower Carbon allows differentiaty to approach to a select of compositions and know-how of affecting. Thus the derivation of a well stimulation of oil can be carried out even in limits of one well exploiting a multitubular plant. For process control of a raise of blow-down recovery were created adapted geologo-trade models (AGTM), permitting on a fixed instant to carry out an estimation of flowing blow-down recovery and its regulating at variation of a series of technological arguments [2].

The algorithm of making AGTM includes opening-up and fundamental treating of a geologo-trade material on major group of plants in multivariate room of geologo-physical properties with the help of methods of factor analysis with emanating of rather homogeneous groups of plants of development; analysis of dynamics of the basic indices of development on isolated to groups of plants with an estimation of flowing and terminating values of blow-down recovery and oil-in-water factor by statistical methods; making for isolated of groups of plants AGTM with the use of geologo-physical and technological indices; an estimation of the formal statistical performances AGTM and magnitude of inaccuracies at the prognosis of process of development on an example of audit plants.

At making AGTM some tens geologo-physical and technological arguments will be utilized, which one can be aggregated in five factors: the factor of physicochemical properties of tabular fluids; the factor reservoir and capacity properties; the factor of the performances of geologic discontinuity; the factor of a constitution of oil-in-water bands; a technology factor.

In a general view AGTM introduces a serial of models of an aspect:

$$H(t) = b_0(t) + S_{bi}(t) * \Gamma_i(t) + S_{bj}(t) * T_j(t).$$

Since $h(t)$ - flowing blow-down recovery on a fixed instant; $b_0(t)$ - value of a free term of the linear equation on a fixed instant; $b_i(t)$ - value of coefficient at an i -ohm a geologo-physical property on time t ; $\Gamma_i(t)$ - i -й geologic argument; $T_j(t)$ - value j -ro of technological argument on time t .

Magnitude a t -fixed instant at 10, 20, 30, ..., 90, 95, 98%-s' water encroachment of commodity of plant of development, or at dimensionless time $t = 0,1; 0,2; 0,3; 0,4; \dots; 1,0; 1,5; 2,0$ etc.

In table 2 one of AGTM, created for plants of high-viscosity oil and nonuniform terrigene headers is reduced. The geologo-physical properties in model are introduced the formalized arguments Z , each of which is a symmetric function of 26 geologo-physical properties. The technological arguments are introduced values by Q -balance reserves in thousand tons, coming on one output well and proportion $q_{\text{injection}} / q_{\text{rate of production}}$ - by the ration of magnitude of injected fluid to magnitude of select fluid.

The reduced prognosis of flowing and terminating magnitude of blow-down recovery at various magnitudes Q on a well demonstrates a possible growth of blow-down recovery at applying hydrodynamic methods of a raise of blow-down recovery (compaction of a grid of wells) [3].

Use AGTM allows to estimate performance of methods of a raise of blow-down recovery at presence of dual(twin) effect, for example, compaction of a grid of wells (hydrodynamic method of magnification of blow-down recovery) and applying of physicochemical methods of blow-down recovery.

At conducting any measures on applying of methods of a raise of blow-down recovery the monitoring system by the variation of a saturation and dynamics of a flowing position of oil-in-water contact in a concrete dot of a bench (output well) is indispensable.

For a solution of this problem in UOI-USOTU are designed and tested on the Romashkin, Arlan and Samothlor fields special casing pipes permitting to carry out temporal gagings of an electrometry in a cased well [4,5].

Some types of special casing pipes are designed. In all updates conducting temporal gagings with the help of side electric exploration and contact log (low-frequency electric methods) is possible. Some types allow to carry out besides follow-up high-frequency electric methods (induction logging). The conducting of an electrometry in wells arranged with special casing pipes of a construction UOI-OSOTU allows to carry out check for flowing oil saturation of a bench with an estimation of its quantitative values. The depth of studies is higher than existing methods of a radiometry. All developments proved by the patents and outcomes of studies, have a wide novelty.

In figure 2 the unique outcome of a multiple conducting of an electrometry in a cased well 17429 on the Romashkin field and the dynamics of disbandment of flushed zone is reduced.

Thus all reviewed methodical receptions and the means designed in USOTU and tested on fields, do a substantial problem of selective control of intensification of process of development of oil-fields. The all-up applying of the reviewed methodology will allow to raise performance of digging with almost unrecoverable by reserves at a late stage.

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