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The Conjugated Qualitative and Quantitative Approximation of Water, Salt, Sulfur, Asphaltene and mechanical Ingredients of Oil-Containing Systems interrelation.

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ABSTRACT

A wide variety of production technologies and the variability of the properties of oil-containing systemscause need for their preliminary preparation. In preparing the oils in the near future it is appropriate to give preference to a combination of new technologies with chemicals, which do not require major changes to the equipment and infrastructure of the oil production fields. A systematic approach involves simultaneous consideration of the studied object as a whole, and its constituent parts individually using the principle of differentiation and integration of the phenomena. For oil-containing systems those are the functions of interphase and intraphase of physical, physicochemical and chemical interactions: the structural and group composition, natural and forced association and dissociation of these factors, as well as the resulting viscosity, interphase tension, heat capacity, density and temperatures of phase polymorphic transformation. Initial oil is significantly different from the oil extracted in the development and exploitation of the deposit. The differences are due to injection into the oil-bearing layers a substantial quantity of water having various physicochemical and microbiological properties. As a result, the oxidative processes in the residual oil are characterized by increasing the share of polycyclic fragments and oxidative groups. From this follow differences in the quality and structure of reserved and solvation shells. To optimize the process of preparing it is appropriate to apply physical and mathematical modeling. It is suggested to usethe characteristic wave equation asthe basic modeling equation.

Keywords: oil-containing systems, the dual physical and mathematical modeling, desalting and dehydration, the characteristic wave equation.

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INTRODUCTION

The main desirable objective of the conjugate physical and mathematical modeling is a direct transition from the computer to an industrial embodiment [1, 2].

Formally, this attractive idea could be implemented. After all, as a material point in space, as well as a macro system are subject to the same forms of conservation law manifestation. First of all, they are subject to the law of matter and motion conservation. However, the impossibility of such a quantitative and not only internal energy, but alsoits changes,nullifies this principle, forcing to use a set of approximate mathematical descriptions of the various scale phenomena. For example, Grossman J.E. and coworkers [3] use 18 thousand equations and 27 thousand variables for the description of processes in the oil layer(i.e. 9 thousand information variables remain spare).

RESEARCH METHODOLOGY

Here were used the samples of oils arriving for the preparation to a number of deposits in Tatarstan (Ersubaykinsk, Sirenevsk, Berketklyuchevsk, Berezovsk, Krasnogorsk, Shegurchinsk, Ekatirinovsk, Tyugeevsk, Urganchinsk and Arkhangelsk). Development is in the later stage, which leads to high well production watering (up to 99% of water in the separate wells and 43% on average in OGPD). Oil there is generally high-sulphurous,with the high content of asphaltic substances. The physical and chemical analysis of oil was carried out by state standard and express methods.

Here was applied a dual qualitative and quantitative physical and mathematical modeling using the conjugation of physical and mathematical images and their qualitative and quantitative assessment [4-7].

At the same time, since it reflects the potency of thematerial system,which is estimated by energy, then energy changes that characterize various constituting the process phenomena, one should initially lead to the units of mass and the surface. Thus,on the basis of the principle of differentiation and integration of the phenomena, there has to be made the systemof energy inequalities, which must be analyzed, not solved. As a result, narrows the array, factor and the range of their variation andthe directions and changes are to be defined. Further the formula of a general view is used (1).

$$y=a\cdot e^{e(x)},$$

where*y* –is a target characteristic,*x* - one of the basic system's state parameters (also, it may be a function of 2 or more parameters).

The formula has been successfully applied in the calculations of viscosity, density, heat capacity, the relationship of a phase attraction with a viscosity, *Newtonian* and *non-Newtonian*field determination of oil rheological characteristics and called *the characteristic wave equation of liquid-phase systems (CWE)* [8-9].

RESEARCH RESULTS AND THEIR DISCUSSION

This paper deals with the results of applying the proposed approach to simplify and accelerate the evaluation process for oil preparation.

The most important step in the preparation of oil-containing systems is their desalting.

The specificity of the desalting process is manifested in its simultaneousness at*inter associative, intra associative* and *molecular associative levels*. All these basic levels of the desalting process and the mechanism of this procedure have common features.

The heat metric research of oil-containing systems [10] conducted by us allowed to reveal the upper bounds of their sizes under normal conditions (~ 0.9 mm), and it was found out that they are caused not mostly by their nature, but by many motion conditions (speed, temperature, pressure, etc.).

At different levels of the desalting process there are certain differences. If the first two levels are primarily determined by the interaction of a large order supramolecular formations of surface layers (~10^{10}-10^{15} and more), then,the third - is closer to the intramolecular(~ $10^{0.5}$-10^{2}). The nature and the degree of emulsion colloidality are very important for the first level, as well as the content of mechanical impurity particles. The surface layers of "aging" emulsion acquire viscosity, increasing eventually a hundred and even thousand times.

Superficial interaction between associates affects more at the second level. Besides, the nature and concentration of own dissolved in rinsing fresh water salts serves here an important function. The part of salts in the rinsing fresh water is associated, that is it can form homophase mixes (physical systems), and the other part – is dissolved (the result of chemical interaction).

As complex systems are characterized by the presence of many different parameters' extrema, there will also be quite a lot of "resonant" frequencies of absorption despite the possibility of antiphase fluctuations. Moreover, if for the process of oil productionit is desirable to define and use global resonance frequencies of force fields, then, for the oil preparation, in addition to this approach, there is another one possible: cardinal change of the wave processing functional purpose.That is, the initial objective changes to the opposite one. In this case, determination of the resonant frequency (whichis difficult) is not an obligatory condition for the process of wave processing optimality of oil-water systems.

Thus, the applied technologies used for oil extraction stimulation and its preparation, are united not only by the common functional purpose, but also by close mechanisms of action at nanolevel, despite all the external distinction (sometimes huge).

While preparing the mixture of deposit oils with similar genetic and facial-lithological conditions of formation, it is possible to take advantage of their aggregated and averaged characteristics. Especially, as in their mechanical mixing and during the preparation of oil mixture, there is an averaging of their most important physical, chemical and hence functional parameters. For a priori estimate was used the following characteristic wave equation (CWE):

$$y = e^{e^{(Ax+B)}}$$

For the solution of the objective there was identified water, chloride salts, resins, asphaltenes and sulfur concentration, as well as analyzed their relationship in oil samples coming for preparation to the facilities of NGDU "Yamashneft" (Tatarstan).

A part of the mathematical approximation characteristic results is presented in Table 1. As it comes from data comparison, there is a good convergence of required estimated and experimental indexes.The characteristic wave equation of oil-containing systems was well provenat an assessment of interrelation of sulfur, pitches, waters and asphaltenes contents.

CONCLUSION

Development and exploitation of oil fields leads to significant changes in the physical and chemical properties of the petroleum fluid. The differences are due to injection into the reservoir a significant amount of water having various physical, chemical and microbiological properties.

The choice of oil preparation technology is due to a set of factors characterizing condition and functionality of the oil-containing system. Physical and chemical properties of oils,the reservoir and pumped waters, emulsions formed are of paramount importance. The cumulative impact appears in the parameters of external and internal oil-containing systems' boundary layers.

Initial oil considerably differs from the oil extracted during the development and operation of an oil field. Differences are due to the injectionof a considerable amount ofwater having various physical and chemical and microbiological propertiesinto the oil-bearing layers. As a result of oxidizing processes in residual oil the share of polycyclic fragments and oxidizing groups increases. There from come distinctions in the quality and structure of reserving and solvent shells. To optimize the preparation process it is expedient to

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apply the physical and mathematical modeling. It is suggested to use the characteristic wave equation as a basic modeling equation.

Table 1: Experimental and calculated values of salts, sulfurs and waters concentration, interrelations of resin and mechanical impurity with each other

Sample numbers	Test Data	Calculated values		
1	2	3	4	5
	Sulphur, % mass	Sulfur containing as a function of the content		
		Sulphur=f(water)	Sulphur=f(salt)	Sulphur= f(mech.impurity)
1	1.69	1.60	1.68	1.69
2	1.68	1.60	1.69	1.68
3	1.71	1.70	1.60	1.70
4	1.71	1.60	1.71	1.71
5	1.70	1.70	1.71	1.69
6	1.72	1.70	1.71	7.69
7	1.70	1.70	1.71	1.70
	A	-0.00302	0.00012	-0.85744
	B	2.74294	2.74049	2.75222
	Mech. impurity % mass	Mech. impurity containing as a function of the content		
		Impurity= f(water)	Impurity = f(sulphur)	Impurity =f(salt)
8	0.0112	0.0111	0.0112	0.0113
9	0.0118	0.0111	0.0113	0.0113
10	0.0109	0.0112	0.0110	0.0112
11	0.0106	0.0111	0.0110	0.0110
12	0.0113	0.0112	0.0111	0.0111
13	0.0112	0.0112	0.0109	0.0110
14	0.0111	0.0112	0.0111	0.0111
	A	-0.0399	-0.0399	-0.0399
	B	2.35573	2.35573	2.35573
	Water, % vol.	Water containing as a function of the content		
		Water =f(salt)	Water = f(sulphur)	Water = f (mech. impurity)
15	0.19	0.20	0.15	0.14
26	0.14	0.16	0.15	0.15
27	0.12	0.13	0.15	0.14
28	0.10	0.13	0.13	0.14
19	0.09	0.14	0.13	0.15
20	0.15	0.14	0.12	0.15
21	0.23	0.15	0.15	0.15
	A	-0.00026	-0.00026	-0.00026
	B	2.54306	2.54306	2.54306
	Resin, %mass	Sulfur containing as a function of the content		
		Resin =f(water)	Resin = f(sulphur)	Resin = f(salt)
22	21.7	17.3	17.1	16.2
23	17.4	17.1	18.3	18.8
24	18.3	19.1	18.5	15.3
25	16.8	18.3	18.4	19.4
26	14.3	14.3	15.3	17.7
	A	-0.001487	-0.001487	-0.0000015
	B	1.089357	1.089357	1.1041374

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