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Efficiency of Application Complex-action Reagents in Systems for Collecting, Preparing Oil and Maintaining Reservoir pressure (MRP)

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ABSTRACT: The results of scientifically based technological developments are presented, which make it possible to comprehensively solve the problems of oil production, preparation and transportation through the creation and implementation of technologies using composite reagents of complex action.

KEY WORDS: complex action reagents, multifunctional chemical reagents, modeling optimization, selection of inhibitors, demulsifiers and biocides.

I.INTRODUCTION

Currently, it is relevant to use chemical reagents during the operation of oil fields to inhibit oil pipelines, field oil treatment and disposal of produced formation waters with simultaneous biocidal treatment of equipment and formation, which necessitates the development of the scientific foundations of technologies for complex intensification of oil production, treatment and transportation processes using composite compositions surfactant based (CSB).

II. SIGNIFICANCE OF THE SYSTEM

In this aspect, the most effective and perfect is the use of polyfunctional compounds, which include quaternary ammonium salts. Due to their operational properties, they simultaneously provide inhibitory protection, demulsification, and bactericidal treatment of well plumes, oil treatment and a water pipeline system with a manifold, which leads to an increase in the comprehensive efficiency and profitability of inhibition technologies, bactericidal treatment of field equipment and demulsification during the operation of the collection system and oil preparation.

III. LITERATURE SURVEY

When transporting oil, the metal of oil pipelines is exposed to the corrosive effects of aggressive environments - highly mineralized formation water and hydrogen sulfide. For internal protection of pipes, special reagents are used - corrosion inhibitors, which, due to their surface-active properties, form a protective layer on the metal surface.
Next, the oil is sent for primary treatment to oil treatment plants, where demulsifiers are used, due to their surface-active properties, providing a high degree of oil dehydration.

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The formation water separated from the oil is fed back into the formation to maintain reservoir pressure. The development of oil fields by flooding oil reservoirs leads to their contamination with microorganisms, including the most dangerous in terms of corrosion, sulfate-reducing bacteria. Hydrogen sulfide, formed as a result of the activity of sulfate-reducing bacteria (sulfate reduction), causes corrosion of oil field equipment, deteriorates the quality of oil and gas, reduces the reservoir permeability of formation rocks up to the complete isolation of individual oil-bearing horizons.

Water separated from oil and then used in the system for maintaining reservoir pressure in fields contains active cells of sulfate-reducing bacteria in an amount of up to 109 cells/ml, which under favorable conditions are capable of producing up to 400 mg/l of hydrogen sulfide, which causes the formation of local corrosion lesions in in the form of pittings, ulcers, grooves. Moreover, if surfactants with biocidal properties are introduced into the water, the growth of anaerobic bacteria in the formation is suppressed, the removal of colonies of which makes it possible to increase oil production from the formation by 5-8%.

The disadvantage of this scheme is that for each of the processes, reagents of different class and structure are used. This, in turn, requires their strict dosage, ensuring their absence in the next stage of the process, as well as in the commercial oil entering the refinery [1-4].

IV. METHODOLOGY

Developed [5] “Method of operating an oil collection and treatment system” for operating a system of transportation, oil treatment and waterflooding according to the following scheme (Figure 1):

- when transporting oil, a complex multifunctional chemical reagent was used for internal protection of pipes - a complex action reagent as a corrosion inhibitor (position No. 2), which, due to its surface-active properties, forms a protective layer on the metal surface and simultaneously determines the process of in-pipe demulsification and bactericidal treatment all field equipment;
- for oil treatment plants (position No. 4), where quaternary ammonium salts are used as demulsifies (position No. 5), due to their surface-active properties, providing a high degree of oil dehydration, as well as at the same time inhibitory protection of tanks and related installation equipment for oil preparation. Separators at the inlet and outlet of the oil treatment unit (item 3) separate free formation water and its residues, respectively;
- separated from the oil at the oil treatment plant, bound formation water is fed back into the formation to maintain formation pressure (position No. 7). The development of oil fields by flooding oil reservoirs leads to their contamination with microorganisms, including the most corrosive sulfate-reducing bacteria. Make-up water from open reservoirs (item 8) also contains an active biocenosis, which negatively affects the corrosion situation in water pipelines and other field equipment. Hydrogen sulfide, formed as a result of the activity of sulfate-reducing bacteria (sulfate reduction), causes corrosion of oil field equipment, deteriorates the quality of oil and gas, reduces the reservoir permeability of formation rocks up to the complete isolation of individual oil-bearing horizons. The introduction of quaternary ammonium salts into the installation for maintaining reservoir pressure as a corrosion inhibitor and bactericide (item 9) protects the equipment from hydrogen sulfide and biocorrosion (item 10).

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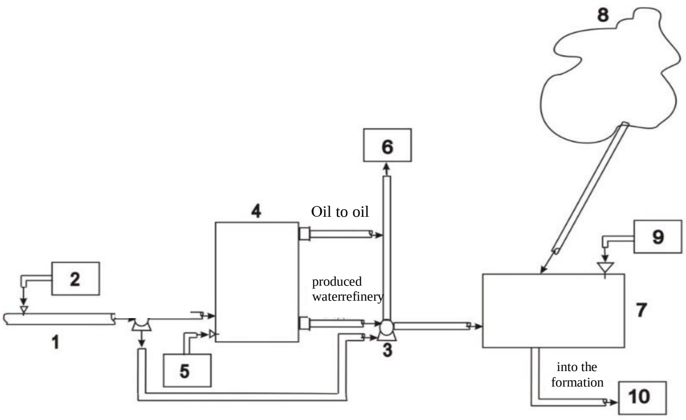

1-oil pipeline; 2-container with a complex reagent; 3- separators; 4.5 - oil treatment installations; 7 – reservoir to maintain reservoir pressure; 8-recharge reservoir; 9 – supply of quaternary ammonium salts; 10 – injection into the formation to maintain reservoir pressure

Fig 1: Scheme of operation of the oil collection and treatment system using a complex reagent

The technological advantages of using RKD as a complex reagent are [5]:
- the processes of oil transportation, demulsification and flooding are accompanied by simultaneous inhibition and bactericidal treatment throughout the entire production line, which leads to an increase in the time of trouble-free operation of the line by 23-25% as a result of protecting the metal and suppressing the growth of sulfate-reducing and other bacteria;
- the presence of demulsifying properties of quaternary ammonium salts determines the refusal to use oil trap tanks and settling ponds, because demulsification occurs throughout the entire production line, reducing oil and water losses by 35-40%;
- as a result of reducing demulsification time, the loss of light oil fractions is reduced by 25-28%;
- there is no need to select inhibitors, demulsifiers and biocides based on compatibility;
- the possibility of oil contamination with a demulsifier or inhibitor due to the unlimited solubility of quaternary ammonium salts in formation waters is eliminated;
- the time required for demulsification is reduced, because this process begins already in the pipeline during oil transportation with the introduction of quaternary ammonium salts as an inhibitor;
- the process of suppressing the growth of biocenosis is accelerated, because The composition of formation waters supplied to maintain reservoir pressure contains, to one degree or another, a quaternary ammonium salt.

In order to optimize the introduction of a complex-action reagent into the field oil transportation and treatment system, a Program Document [6] “Calculation of the dosage of multifunctional reagents based on quaternary ammonium salts in the field oil transportation and treatment system” was developed. Tables 5 and 6 present calculations of the dosage of multifunctional reagents of complex action based on quaternary ammonium salts in the field oil transportation and treatment system (programming language - Delphi XE3, operating environment - Windows 7, volume - 2664960 bytes).

V. EXPERIMENTAL RESULTS

This task is achieved by using a complex of aqueous or alcoholic solutions of quaternary ammonium salts, alkyldimethylbenzylammonium chloride of the general formula $[R\,(CH_3)_2(CH_2C_6H_5)\,N]^+Cl^-$, where R is a mixture of n-alkyl radicals $C_{10}H_{21}$-$C_{14}H_{29}$ (or individual radicals) with average molecular weight 310-368 g/mol. during oil transportation processes (as an inhibitor of all field equipment and a demulsifier), demulsification in oil treatment plants (as a demulsifier, inhibitor and bactericide) and bactericidal treatment (as an inhibitor of all field equipment and a bactericide).

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The main physicochemical chara cteristics of the complex of quaternary ammonium salts, which is a single reagent with complex action, are presented in Table 1.

Table 1

Indicator name	Meaning
Density, g/cm^3	0,98
Viscosity, cSt	107
Flash point, ºC	more than 100
Water and alcohol compatibility	Unlimited solubility
Compatibility with petroleum products	Emulsion

Results and discussion

Chemical reagents of quaternary ammonium salts, which constitute a complex reagent, due to the presence of a quaternary nitrogen atom in the structure, as well as high molecular weight, have effective surface-active and biocidal properties. As a model, a natural hydrogen sulfide-containing water-oil emulsion of the Kokdumalak field in the Kashkadarya region of the Republic of Uzbekistan was chosen with the content of formation water - 26%, hydrogen sulfide - up to 5.5 mg/l, salts - more than 24357 mg/l.

The inhibitory ability of a complex reagent depending on the concentration and aggressiveness of the medium, determined by the gravimetric method in accordance with GOST 9.509-89 “Methods for determining protective ability” and GOST 9.905-82 “Methods of corrosion tests”, is presented in Table 2.

Table 2

Reagent	Concentration, mg/l	Degree of protection against hydrogen sulfide corrosion, Z,%	Aftereffect period, hour
complex action reagent (CAR)	10 25 50	95,0 99,0 99,5	10,5

As can be seen from the data in Table 2, the proposed reagent has a high protective effect even at a content of 10 ml/g, as well as an aftereffect of more than 10 hours. In addition, it is a water-soluble, fire and explosion-proof, low-toxic (Class III) compound.

The biocidal ability of the complex action reagent, determined according to action reagent (AR) 39-3-973-83 “Methods for monitoring microbiological contamination of oil field waters and assessing the protective and bactericidal effects of reagents,” in relation to sulfate-reducing bacteria in an amount of 106 cells/ml, is presented in Table 3.

As can be seen from the data in Table 3, the proposed complex action reagent is an active bactericide. In addition, it completely suppresses the growth of adherent forms of SRB within 14-5 hours at a dosage of 200-400 mg/l.
The results of the study of the demulsifying ability of the tested reagent are presented in Table 4.

As can be seen from the data in Table 4, the proposed complex reagent is a demulsifier, effectively breaking the water-oil emulsion, separating water from oil without changing the time and temperature of the technological regime, and also actively removing salts from the oil.

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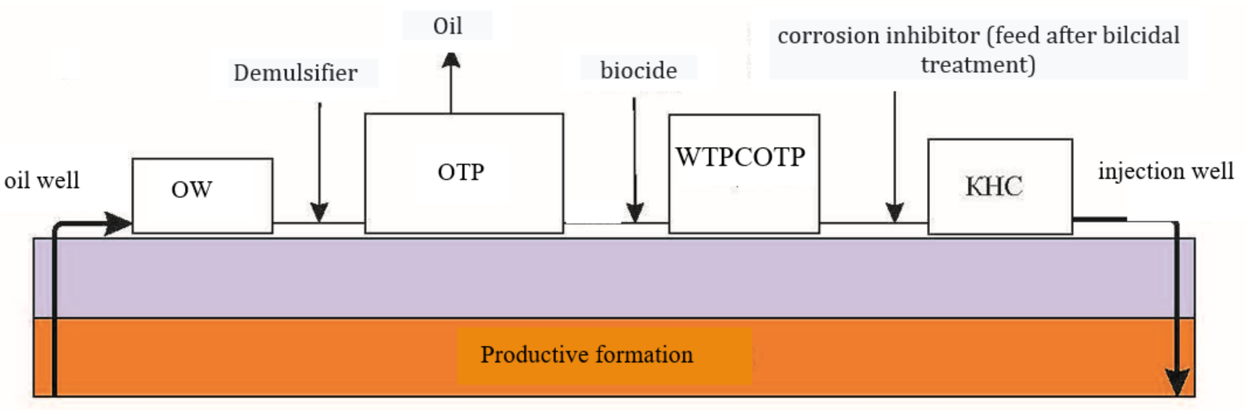
Table 3

Reagent	Concentration, mg/l	Degree of inhibition of growth of planktonic form of sulfate-reducing bacteria,%	Suppression degree adhered forms of sulfate-reducing bacteria,%
complex reagent	15	70,0	
	25	85,7	
	50	93,8	
	75	100,0	
	200		82
	300		95
	400		100

Table 4

Reagent	Specific consumption, mg/l	Temperature, ° C		Time			Residual content	
		Mixing, min	Waste	Mixing, min	Waste, h	stood out, mg/l	Water, %	Chlorine salts, mg/l
Original water-oil emulsion	-	-	55	-	2	8,0	25,0	24357,0
complex reagent	15	45	55	5	2	22	0,15	442,2
	30	45	55	5	2	24	0,05	227,4
	50	45	55	5	2	24	0,00	174,4

Analysis of the data in tables 2-4 shows that the proposed complex reagent is an effective biocide and inhibitor of hydrogen sulfide corrosion, at the same time it has high demulsifying abilities.



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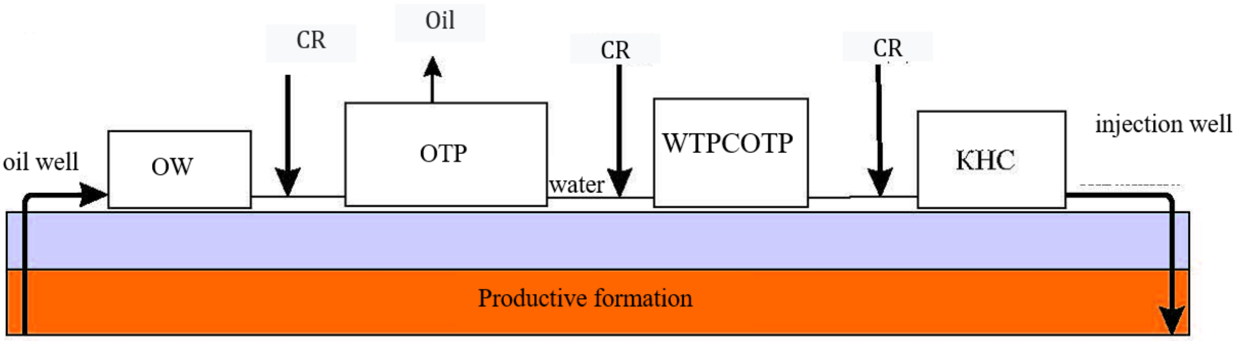


b

OW – oil well, OTP – oil treatment plants, WTPCOTP – wastewater treatment plants central oil treatment point, CR – complex reagent

Figure 2 – Schemes for introducing chemical reagents (a) according to existing technology and a complex reagent (b)

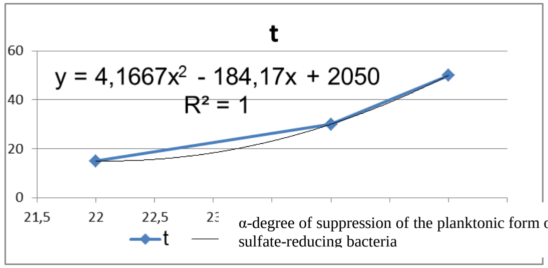
Table – 5

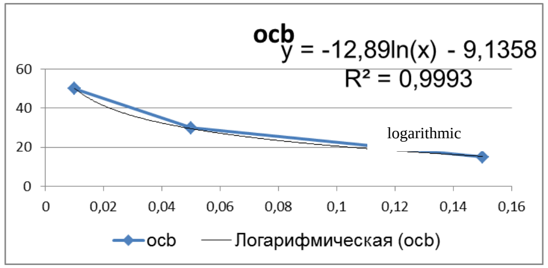
Demulsifying ability of the reagent

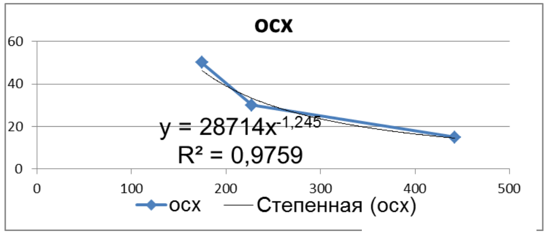
β	t	ocb	ocx
15	22	0,15	442,2
30	24	0,05	227,4
50	25	0,01	174,4

Calculation using the demulsification formula			
15,389	22,0	0,15	442,2
19,676	22,5	0,12	300,0
23,441	23,0	0,10	250,0
27,286	23,5	0,08	227,4
32,023	24,0	0,06	210,0
39,680	24,5	0,03	190,0
49,709	25,0	logarithmic	

range



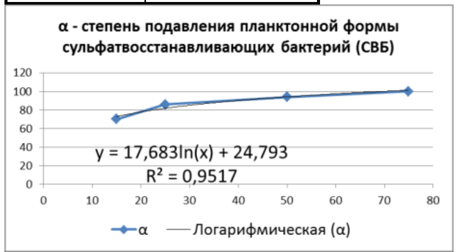




logarithmic

Biocidal ability of the reagent

α	K, mg/l
70	15
85,7	25
93,8	50
100	75



β	K, mg/l
82	200
95	300
100	400

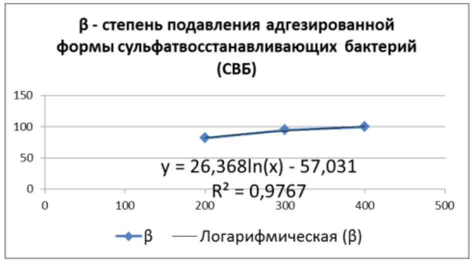
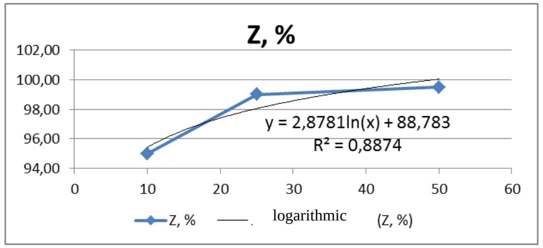


Table 6

Corrosion inhibitor		Formulas used for calculations
Recommended inhibitor consumption per 1 ton of oil-water emulsion , г/т	30	**Demulsifier calculation** $f(X)=1{,}39*X1*X1-61{,}4*X1-4{,}3*LN(X2)+9571{,}3*$ Degree $(X3,-1{,}24)+680{,}255$ correlation coefficient R2=0,9917
Daily well production , м3/сут	20	**Calculation of the degree of suppression of the planktonic form of sulfate-reducing bacteria** $(Y1)=17{,}683*LN(Y1)+24{,}793$ correlation coefficient R2=0,9517
Concentration of inhibitor working solution, %	10	**Calculation of the degree of suppression of the adherent form of sulfate-reducing bacteria** $(Y2)=26{,}368*LN(Y2)-57{,}031$ correlation coefficient R2=0,9767
Daily consumption of inhibitor solution , kg	0,06	**Calculation of pipeline inhibitor protection** M=C*Q/n/1000 where M is the daily consumption of inhibitor solution C - recommended inhibitor consumption per 1 ton of water-oil emulsion , g/t Q - daily well flow rate, m^3/day n - concentration of inhibitor working solution ,%

M=C*Q/n/1000
где M - суточный расход раствора ингибитора
C - рекомендуемый расход ингибитора на 1 т ВНЭ, г/т
Q - суточный дебит скважины, $м^3$/сут
n - концентрация рабочего раствора ингибитора,%

Z, %	N, mg/l
95,00	10
99,00	25
99,50	50



Capabilities of a quaternary ammonium salt based chemical							
Demulsifier		Biocide (calculation of the degree of inhibition of the growth of planktonic form of sulfate-reducing bacteria)		Biocide (calculation of the degree of growth inhibition of the adherent form of sulfate-reducing bacteria)		Inhibitor	
Allocation time	22	Reagent concentration, mg/l	40	Концентрация реагента, мг/л	100	Рекомендуемый расход ингибитора на 1 тонну водонефтяной эмульсии, г/т	15
Residual chlorine content , %	0,15	The degree of suppression of planktonic growth of sulfate-reducing bacte	90,02	The degree of growth inhibition of the adhered form of sulfate-reducing bacteria ,%	64,40	Daily well flow rate, m^3/day	200
Residual water content, %	442,2	After correcting the data, click this button После корректировки данных нажмите эту кнопку				Концентрация рабочего раствора ингибитора, %	35
SPECIFIC CONSUMPTION, mg/l	15,39					Суточный расход раствора ингибитора, кг	0,09

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VI. CONCLUSION AND FUTURE WORK

Based on theoretical and experimental studies, a process has been developed for oil transportation, demulsification and flooding to maintain reservoir pressure, accompanied by simultaneous inhibition and bactericidal treatment throughout the entire production line, which leads to an increase in the time of trouble-free operation of the line by 23-25% as a result of metal protection and growth suppression sulfate-reducing and other bacteria with original complex-action reagents.

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