ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 10, Issue 8, August 2023

Improving the proactive management of energy security in the development of oil and gas fields

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ABSTRACT: The trouble-free operational reliability of field pipelines and equipment of systems for collecting, preparing fluids and maintaining reservoir pressure (RPM) to a large extent determines the industrial safety of oil producing enterprise operation, which necessitates proactive measures to ensure inhibitory, process field equipment biocidal protection and effective demulsification during preparation oil emulsions in field conditions.

KEY WORDS: demulsifiers, CAR (complex action reagent), CI (corrosion inhibitor), RPM (reservoir pressure maintaining)

I. INTRODUCTION

This study was carried out in accordance with the Uzbekistan Republic science and technology development priority direction: No. II "Energy, energy and resource saving" and Decree of the President of the Republic of Uzbekistan No. UP-60 dated January 28, 2022 "the Strategy of development for New Uzbekistan for 2022 - 2026" and Decree of the President of the Republic of Uzbekistan No. PP-4388 dated July 9, 2019 "On measures for Stable Provision of the Economy and Population with Energy Sources, Financial Recovery and Improvement of the Management System of the Oil and Gas Industry".

II. LITERATURE SURVEY

Effective progressive activity as inhibitors and increased activity as demulsifiers of polyquaternary food additives that change the mechanisms of inhibition and demulsification: they are absorbed with inhibitor molecules on the cathodic areas of the body surface, slowing down its corrosion, and groups of demulsifiers interact more actively with oil globules, leading to their accelerated fusion , causes the effect of synergy in the processes of inhibition of sulfate and biocorrosion, as well as demulsification during the collection of polyfunctional reagents.

The task set in the conducted research is solved by developing the fundamentals of managing the energy safety of oilfield equipment operation through the integrated use of polyfunctional compounds based on quaternary ammonium salts in terms of modern technologies to improve the efficiency of oilfield equipment.

In this aspect, it was of interest to develop a complex action reagent (CAR) based on existing corrosion inhibitors and demulsifiers with a higher efficiency, capable of simultaneously not only destroying water-oil emulsions, but also preventing acid and biological corrosion of equipment metal.

III. EXPERIMENTAL RESULTS

The object of the study were commercial forms of polyfunctional reagents "Кватрамин-1001", "Кватрамин-1002", "SCIMOL WS-2651" having quaternary ammonium salt - condensation product of alkyldimethylamine and benzyl chloride - alkyldimethylbenzylammonium chloride (Ts 26873808-01:2017, Ts 26873808-03:2017)

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
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With increasing CAR concentration the area of maximum adsorption shifts slightly to a more negative potential. This is evidently due to the orientation of the CAR molecules with the amino group towards the metal surface. The same pattern is observed with the introduction of 50 mg/l H2S in the medium, and the presence of the latter contributes to the deepening of the adsorption minimum. The obtained dependence indicates that the adsorption of CI CAR proceeds in accordance with the isotherm Temkin for a uniformly heterogeneous metal surface

$$\gamma = \frac{1}{f}\lg(a_o C), \quad (1)$$

Where f is the Temkin parameter, a_o is the adsorption constant on a uniformly heterogeneous surface.

The inhibition of the corrosion process, in first approximation, is mainly due to the blocking and energetic (or Ψ_1) effects. Accordingly, the corrosion inhibition coefficient γ is determined by the expression, where the first term defines the blocking effect and the second term defines the energy effect caused by the introduction of PE:

$$\ln\gamma = \ln\frac{1}{1-\Theta} + K\Delta\Psi_1, \quad (2)$$

Where: $\gamma = i_{корр} / i^1_{корр}$ ($i_{корр}$ и $i^1_{корр}$ are respectively the corrosion rates in the background and inhibited solutions); $\Delta\Psi1$ is the change in the value of Ψ1 - potential during CI adsorption.

Taking $\Delta\Psi1 = K1 - \Theta$, equation (2) will be

$$\ln\gamma = \ln\frac{1}{1-\Theta} + K_1\Theta \quad (3)$$

Given that the protective capacity is calculated using the formula:

$$Z = (\text{iкорр} - \text{i1 корр}) / \text{iкорр} \quad (4)$$

By comparing formulae (3) and (4) we obtain the dependence

$$Z = 1 - \frac{1}{\gamma} \quad (5)$$

If corrosion inhibition is defined solely by the surface locking effect, then :

$$\gamma = \frac{1}{1-\theta}, \text{ which causes } Z = 0 \quad (6)$$

The graphical verification of the mentioned dependencies showed that the tested CI PS is characterized by energy action both in purely hydrochloric acid medium and in medium containing hydrogen sulphide. It, obviously, is caused by the fact that CAR is protonated in acidic environments and at adsorption arises Ψ_1 - potential of positive sign creating an energy barrier for output of ions Fe2+ into a solution from a surface of a steel sample under the influence of the aggressive environment.

Thus, it is established that the mechanism of inhibition of the corrosion process of steel in hydrogen sulfide-containing media with the introduction of CI synthesized on the basis of PS is caused by the creation of energy barrier for the escape of iron ions into the solution by adsorbed molecules.

Earlier it has been established that chemical reagents on the basis of quaternary ammonium salts, adsorbing and forming a protective layer on a steel sample surface, effectively inhibit the processes of hydrogen sulphide corrosion. It is expressed in significant reduction of quantity of oxide and sulphate phases, and also in complete disappearance in an X-ray film of tested metal of lines $y\text{-}F_2 0_3 \cdot H_2 0$

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International Journal of AdvancedResearch in Science, Engineering and Technology
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Table 1. Inhibitory properties of complex action reagent (CAR)

C, mg/l	Gas condensate, saturated 2,5 g/l H_2S:H_2O (1:3), Z, %	Saline solution, saturated 1,3 g/l H_2S+5 ml and 50 ml oil, Z, %		Water, saturated 1,3 g/l H_2S and 5 mg/l O_2, Z, %		Saline solution, saturated 1,3 g/l H_2S, Z, %
		5 ml	50 ml	H_2S	O_2	
Кватрамин -1001						
25	75,0	87,9	88,0	81,2	85,7	86,3
30	87,9	91,8	90,5	85,3	87,3	88,0
35	91,0	92,3	93,1	92,0	90,1	90,8
Кватрамин - 1002						
20	81,8	88,0	87,1	85,8	90,7	85,2
25	87,3	90,2	90,8	90,3	91,5	87,4
30	91,2	92,0	92,8	92,0	93,3	92,2
CAR (Кватрамин – 1002 + SCIMOL WS-2651)						
15	83.0	88.5	85,8	86,5	87,5	88.7
20	85.2	92.6	93,0	94,3	94,8	90.5
25	93.6	94.6	95,3	96,1	97,1	94.8

Table 2. Results of the CAR-based PKD CI pilot study in the Y. Kemachi municipality (medium temperature from 35 ^oC to 40 ^oC, background corrosion rate of 1.85 mm/y)

CI type	Water-oil ratio of the media	Concentration of IR in the test medium, mg/dm3	Test time, h	Average corrosion rate when injected with IR, mm/y	Corrosion rate reduction factor with incorporation of IR	Protective capacity (Z,%) in the bottom layer
1	2	3	4	5	6	7
СНПХ-6418	50 : 50	100	1656	0.8096	5.24	80.9
Кватрамин-1001	65 : 35	32,9	1488	0.2300	5.86	82.9
Кватрамин-1002	40 : 60	25,6	1536	0.0471	10.6	90.5
Scimol WS-2651	40 : 60	25,6	1536	0.0461	10.6	90.5
РКД Кватрамин-1002 + Scimol WS-2651	40 : 60	22,5	1536	0,012	13,2	97,5

As can be seen from the data in Tables 1,2 the CIs tested showed a fairly high degree of protection, but CAR showed the best result with a relatively low content.

Evaluation of bactericidal action of the reagent was carried out according to РД 39-3-973 and other sources. In the experiments functionality of the reagent was carried out on samples from different positions of RPM system in field "Kokdumalak".

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International Journal of AdvancedResearch in Science, Engineering and Technology
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Table 3. Effect of the chemicals «Кватрамин-1001» and «Кватрамин-1002» on the degree of suppression of SFB

Sample №	SFB amount	«Кватрамин-1001», g /m3	Degree of suppression, %	«Кватрамин 1002», g /m^3	Degree of suppression, %
1	1,3· 10^2 (adhesive form)	25 50 50 75 100 150 200	5.6 28.5 35.1/80.9 67.4 / 95.7 87.3/100.0 100.0	25 50 50 75 100 150 180	6.6 32.5 37,1/80.9 75.4 / 95.7 93,3/100.0 100.0
2	2,2 ·10^1	15 25 50 75	70.0 85.7/95.8 93.8/100.0 100.0	15 25 50 75	75.0 90.7/95.8 95,1/100.0 100.0
3	4,9 ·103	15 25 50 75	63.0 76.9/94.9 97.5/100.0 100.0	15 25 50 75	68.0 80.9/94.9 99.5/100.0 100.0
4	5,4 ·103	15 25 50 75	41.8 76.8 93.7/100.0 100.0	15 25 50 75	70.8 81.8 96.7/100.0 100.0
5	4,8 ·102	15 25 50 75 100	50.8 67.9 87.9/100.0 98.7 100.0	15 25 50 75 100	60.8 67.9 90.9/100.0 99.1 100.0
6	5.2 ·102	15 25 50 75 100	60.1 75.8/95.9 87.9/100.0 98.9 100.0	15 25 50 75 100	65.1 78.8/95.9 91.9/100.0 99.1 100.0
7	5,5 ·102 (adhesive form)	50 75 100 150 200 250 300 400 500	18.9 25.8 35.6 50.6/78.5 68.9/85.7 75.3/95.6 89.0/100.0 97.3/100.0 100.0	50 75 100 150 200 250 300 400 500	25,1 30,2 40.6 55.6/78.5 70.9/85.7 78.3/95.6 95,0/100.0 99.3/100.0 100.0
8	5,6 ·102	15 25 50 75	58.9/75.0 75.9/87.0 89.9/97.5 100.0/100.0	15 25 50 75	60,0/75.0 81.9/87.0 90.9/97.5 95.0/100.0
9	5,7 ·102	15 25 50 75	57.8/75.9 78.9/85.7 86.9/99.1 100.0/100.0	15 25 50 75	59,3/75.9 84.9/85.7 90@9/99.1 100.0/100.0

The denominator shows data for the reagent «Альтосан»

Taking into account peculiarities of structure of quaternary salts it was of interest to consider demulsifying ability of tested reagents in comparison with known K-1. Table 3 presents the results of the experiment (sampling location "Kokdumalak", settling temperature + 60 0C, initial water content in emulsion - 59%).

Results of investigations (ГОСТ 21534, ГОСТ 2477, ГОСТ 6370) show that the tested reagents are active demulsifiers effectively breaking water-oil emulsion and separating water from oil without changing conditions (time and temperature) of technological mode (Table 4).

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International Journal of AdvancedResearch in Science, Engineering and Technology
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The expected effect of the dosage of the chemicals «К-1», «Кватрамин-1001» и «Кватрамин-1002» as demulsifiers is shown in Table 5.

Table 4. Oil degree indicators according to TSh 39.0-176:1999

Name of indicators	Norm for group IA	Indicator after «Кватрамин - 1001» exposure	Indicator after «Кватрамин - 1002» exposure	Indicator after К-1exposure	CAR with Scimol WS-2651
Concentration of chloride salts, mg/dm^3	50	36	30	63	20
Mass fraction of water, %	0,5	0	0	0	0
Mass fraction of mechanical impurities, %	0,05	0,01	0,01	0,03	0,01

Table 5. Results of of oil emulsion demulsification comparison with the reagents К-1, SCIMOL WS-2651», «Кватрамин-1001», «Кватрамин-1002» and CAR

Place of sampling	Reagent brand	Reagent consumption		The water released over time (ml)					Remaining water, %
		g/t н.э.	g/t т.н.	1h	2 h	4 h	6h	8h	
Field «Кокдумалак»	«Кватрамин-1001»	65	160	7	10	27	30	22	4,0
		80	178	8	15	31	35	11	0
	«SCIMOL WS-2651»	70	170	3	10	22	32	49	10
		80	195	8	17	30	52	55	0,4
		90	219	12	33	38	56	-	0
	К-1	80	195	4	23	34	43	53	4,5
		90	219	10	29	42	57	-	0
	«Кватрамин-1002»	65	163	10	20	35	35	-	0
		80	180	12	31	41	1,6	-	0
		85	183	12	35	46	1,4	-	0
	CAR	70	169	13	17	41	45		0
		75	170	13	18	45	47		0
		80	175	15	18	47	52		0

The data analysis in tables 3-5 shows the admissibility of considering the tested reagents as explicitly polyfunctional, which is apparently due to the peculiarities of the structure of the main component of the reagent - the presence of active quaternized nitrogen. At the same time the prepared oil meets the requirements of ГОСТ 9965, and the reagent CAR based on «Кватрамин-1002» can be effective both as an inhibitor and as a demulsifier for heavy oil.

In order to determine a possible option of joint introduction with other chemical reagents of "SCIMOL WS-2651" their compatibility in dosages (Table 6) used in oil preparation processes has been determined.

It is established that mixtures of chemical reagents with tested chemical reagent in solutions form stable system, without stratification.

Table 6. Synergistic effect of the SCIMOL WS-2651 CAR on the performance of chemicals performance of chemicals

Reagent name	«SCIMOL WS-2651» consumption	Reagent consumption, g/t	Depth of crude oil dehydration, % (resid. Flooding)	Abrasion DARP, %	Decrease corrosion aggressiveness, Z %
К-1	25	50	2,5	-	85
Dissolvan 4411	50	50	1,8	-	-
Altosan	25	25	3,0	70	98
SCIMOL WS-2651	25	15	2,5	70	98

ISSN: 2350-0328

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Taking into account peculiarities of structure of quaternary salts it was of interest to consider demulsifying ability of tested reagents in comparison with known K-1. Table 3 presents the results of the experiment (sampling location "Kokdumalak", settling temperature + 60 0C, initial water content in emulsion - 59%).

Table 7. Results of of oil emulsion demulsification comparison with the reagents К-1, SCIMOL WS-2651», «Кватрамин-1001», «Кватрамин-1002» and CAR.

Sampling site	Reagent brand	Reagent consumption		Segregate water during the time (ml)					Residue water, %
		g/t o.e.	g/t o.e.	1h	2 h	4 h	6h	8h	
Field «Кокдумалак»	«Кватрамин-1001»	65	160	7	10	27	30	22	4,0
		80	178	8	15	31	35	11	0
	«SCIMOL WS-2651»	70	170	3	10	22	32	49	10
		80	195	8	17	30	52	55	0,4
		90	219	12	33	38	56	-	0
	К-1	80	195	4	23	34	43	53	4,5
		90	219	10	29	42	57	-	0
	«Кватрамин-1002»	65	163	10	20	35	35	-	0
		80	180	12	31	41	1,6	-	0
		85	183	12	35	46	1,4	-	0
	CAR	70	169	13	17	41	45		0
		75	170	13	18	45	47		0
		80	175	15	18	47	52		0

The data Analysis in Tables 4 -7 shows that the combined use of SCIMOL WS-2651 as the active reagent of the CAR, causes a synergistic effect:

- the demulsifier K-1 increases its inhibiting capacity by 14%;
- the demulsifying capacity by 45%;
- Disolvan 4411-increases the demulsifying capacity by more than 50%;
- with the corrosion inhibitor brand "Altosan" - improving its inhibiting ability by almost 10%, as well as by 40% flushing capacity for ARPD and 50% demulsifying ability;
- with "Кватрамин 1002", by minimum reagent injection, provides improved dewatering and desalting performance as well as increased reagent protective capacity.

The results of this research show that the tested reagents can be considered as clearly polyfunctional, which is apparently due to the peculiarities of the structure of the main component of the reagent - the presence of active quaternized nitrogen. At the same time the prepared oil meets the requirements of ГОСТ 9965, and the reagent CAR based on "Кватрамин -1002" can be effective both as an inhibitor and as a demulsifier for heavy oil.

Table 8. Adherent and planktonic forms suppression degree of SFB (infestation 105 kl/ml) of CARs «Кватрамин 1001» and «Кватрамин 1002»

Reagent name	Dosage of the drug, mg/l	Degree of suppression of planktonic forms of SFB, %	Degree of suppression of adherent forms of SFB, %
Кватрамин 1001 based CAR	80 – 120	100	-
	450 – 500	-	100
Кватрамин 1002 based CAR	50 – 100	100	-
	350-400		100

The results analysis of conducted research shows that application of tested CARs allows complex use of CARs based on quaternary ammonium salts (QAS) in oil transportation processes (as inhibitor), demulsification at oil treatment units (as demulsifier) and biocide treatment of strata (as biocide) within reservoir pressure maintenance (RPM) is relevant. Figure 1 shows a schematic of an oil gathering and treatment system using CARs.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
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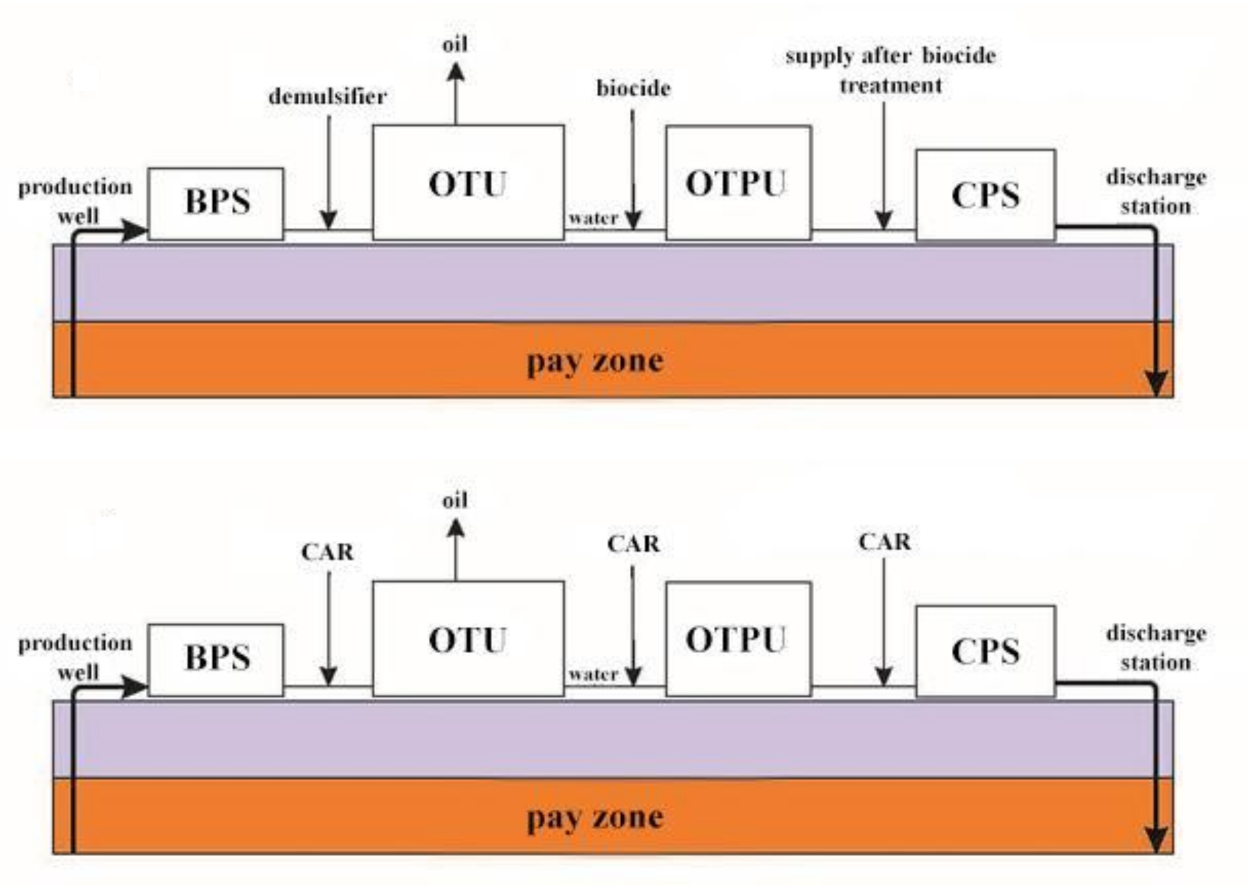

Figure 1 - Schematic diagram of an oil gathering and treatment system using the CAR

IV. CONCLUSION AND FUTURE WORK

It is obvious that consideration of oil gathering and treatment system operation peculiarities with the use of CAR is relevant, because in oil field operation processes it allows using the same reagent for three technological stages, which determines the following advantages:

- no selection of inhibitors, biocides and demulsifiers by compatibility;
- eliminating the possibility of oil contamination by the demulsifier or inhibitor due to the unrestricted solubility of RCPs in formation water;
- demulsification time is shortened because the process starts already in the pipeline during oil transportation when CARs are introduced as inhibitors.

Economic efficiency from the use of CAR is due to the preservation of metal stock from the effects of aggressive media, low reagent consumption in any of the stages of oil treatment, no negative impact on refined products, and the possibility of their wholesale purchase and storage in warehouses, which will ensure the continuity of oil treatment.

REFERENCES

[1] Bregman J.I. Corrosion Inhibitors. Chemistry, page 310, 1966.
[2] Krivosheyev V.F. Technological properties of corrosion inhibitors. w. Corrosion and protection of pipelines, wells, gas production and processing equipment, pages 19-27, 1980.
[3] Salidzhanova N.S. Muhamedov A.A. Study the inhibitory properties of quaternary ammonium salts. w. Composite materials, page 10, 2005.
[4] РД 39-9-973 Methodology for monitoring microbiological contamination of oilfield water and assessment of the protected and bactericidal effect of reagents.
[5] Salidzhanova N.S., Kerbalayeva A.A., Xakberdiyev D.M. Qualitative and quantitative identification of the biocenosis in the reservoir pressure maintenance system. w. Uzbek Journal of Oil and Gas, page 44, 2006.

[6] Salidzhanova N.S., Kerbalayeva A.A., Xakberdiyev D.M. Selection and study of biocides effect on suppressing SFB growth in the RPM system. w. Uzbek Journal of Oil and Gas, page 42, 2007.
[7] Salidzhanova N.S. et al. patent RU № IAR 20070180. A method of operating oil gathering and treatment system.
[8] Ragulin V.V., Daminov A.A., Mamleyeva L.A. Pilot testing of corrosion protection technology for equipment and pipelines of the RPM system under biocontamination conditions. w. Environmental protection in the oil and gas sector, pages 21-24, 2001.
[9] Daminov A.A., Ragulin V.V., Mamleyeva L.A. Biocorrosion of oilfield equipment and technology for its suppression. w. ЮКОС Scientific and Technical Bulletin, pages 48-51, 2003.

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