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PREPARATION AND TESTING RESULTS OF A LIQUID HYDROCARBON SOLUBLE CORROSION INHIBITOR

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Abstract:
Abstract. In this work, the production of corrosion inhibitors through the reaction of fatty acids and the production of amines on the basis of organochlorine compounds released from JSC "Navoiyazot" was conducted. The results obtained based on the samples were IR spectrum, NMR spectrum, scanning electron studied and analyzed using microscopic and elemental analysis.

Keywords. Corrosion inhibitors, nitrogen, organic compounds, fatty acids, gas- condensate well, temperature, mass, level of protection.

Introduction

Significant recoverable reserves of oil and gas left to be discovered and produced are mainly concentrated in challenge locations, such as deep-water offshore, remote arctic locations, and difficult-to-manage reservoirs with unconsolidated sands. It is widely recognized within the oil and gas industry that effective management of corrosion will contribute toward not only cost reduction but also compliance with safety, health, and environmental policies [1].

Fatty acid triazoles have been studied for N80 downhole steels and carbon steels. Also, the side interactions of the long-chain hydrocarbons are bilateral and can lead to compact inhibitor film formation due to its dense structural network [2]. The triazole with relatively moderate efficiency includes a double internal bond, which cafuses lower inhibition efficiency compared with the triazole-3 π bond [3].

Materials and Methods

Our researched PF-1 brand corrosion inhibitor was tested by gravimetric method. This method is used to determine the corrosion rate for corrosion control purposes and to evaluate the protective ability of corrosion inhibitors. The gravimetric method is based on measuring the difference in the mass of control metal samples before and after exposure to a corrosive environment. A limitation of the use of this method is that it characterizes the average corrosion rate without taking into account the unevenness of the corrosion.

In general, when working, it is necessary to follow the current standard GOST 9.506-87 "Methods for determining the protective ability of metal corrosion inhibitors in water-oil environment".

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According to it, the product based on amino compounds and fatty acids obtained from the treatment of organochlorine waste is first put into a three-necked flask equipped with a reflux condenser, a thermometer and a stirrer for interaction, and a homogeneous mass is formed. mix until Stirring was continued at a certain temperature for several hours. The obtained corrosion inhibitor was dissolved in gasoline, condensate, and motor oil media at concentrations of 200, 400,600, and 1000 mg/l. Many studies have been conducted on the resulting solutions.

The physico-chemical properties and analysis results of our PF-1 brand corrosion inhibitor with this synthesized new composition were studied.

Physico-chemical characteristics of PF-1 brand corrosion inhibitor obtained on the basis of chlorinated organic waste processing:

Table-1.

Indexes	**PF-1**
1. Appearance	Transparent
2. Color	Pale yellow.
3. Density at 20 ^{0}C, g/cm3	1...1,3
4. Nitrogen content, % by weight	7,0...9, 5
5.Ph environment at 20 ^{0}C	6,5-7
6. Level of protection against corrosion at a concentration of 150 mg/l	98,5
7. Solubility: **- In gasoline** **- In the condensate** **- In the water** **-In the case of I- 20**	 Complete Complete 30% of weight gain Complete
8. Fluidity cCt at 20 ^{0}C	15

Table-1. Physico-chemical properties of PF-1 corrosion inhibitors obtained from chlorinated organic waste processing.

In order to simulate the real operating conditions of the equipment in two-phase systems, inhibitors are tested in laboratory facilities with intensive mixing of the medium. Figure 2 shows a typical laboratory apparatus for such experiments. In the two-chamber vessel 1 - the flow of the medium under investigation is created by means of the mixer 1 - which is driven through the water seal. Metal samples - 6 are equipped with a built-in chamber thermometer - 3 and a reflux condenser - 8.

The environment under study is saturated with oil products, and it becomes a bubble through the introduction of inert gas. The flow rate of the liquid that washes the metal samples of corrosion is determined using a tube lowered into the liquid stream.

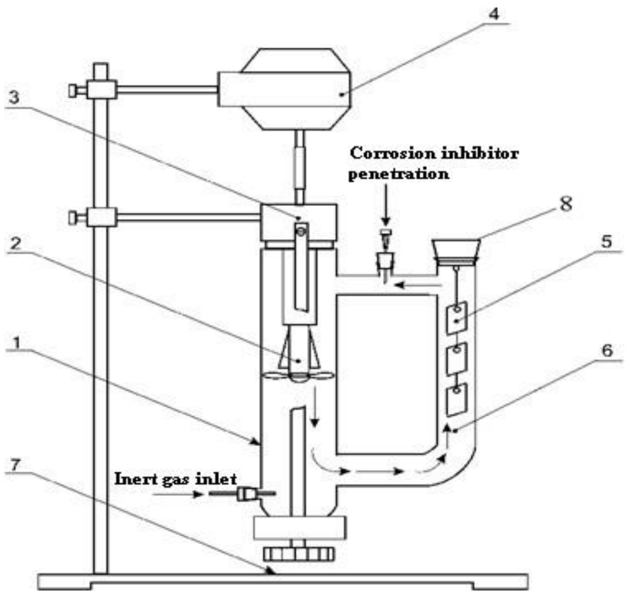
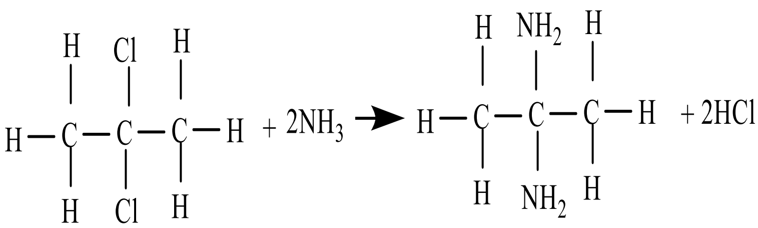
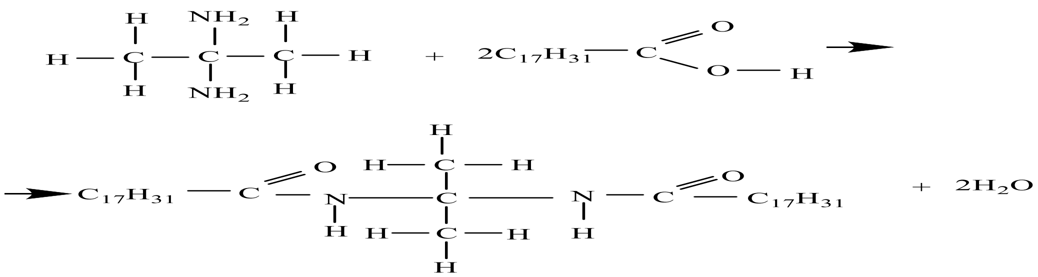


Figure-2 - Device for testing at atmospheric pressure.

1 - U-shaped device; 2 - mixer; 3 – thermometer; 4 - electric motor; 5 – metal samples; 6 - test environment; 7 – tripod, 8- reflow condenser.

1,2-dichloroethane, 2-chloropropene, 2-2-dichloropropane and 1-chlorine 1-ethyl cyclopentane were separated and used from organic chlorinated waste at boiling temperature. This raw material is based on the secondary product processing at the JSC "Navoiyazot" enterprise. Amines were obtained as a result of the reaction of the separated organochlorine mixture and ammonia. Corrosion inhibitors for gas wells were obtained by reacting the obtained amine compounds with fatty acids.





IR spectrum and analysis of PF-1 brand corrosion inhibitor. The IR-spectrum was presented to study the composition and structure of the PF-1 corrosion protection inhibitor that we synthesized and used in the test (Fig. 3).

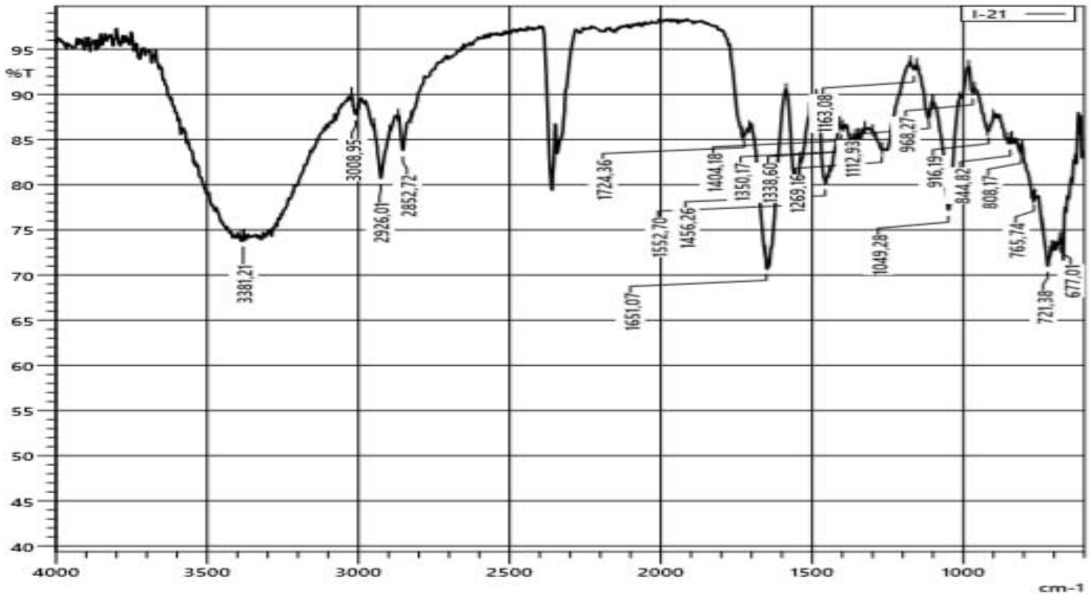


Figure-3. IR spectrum of PF-1 brand corrosion inhibitor.

The composition and structure of PF-1 corrosion inhibitor was studied using IR- spectrometer technology (IK-Fure, SHIMADZU, Japan) in the range up to 4000 cm-1. The spectrum of the –N=C< groups produces valence vibrations in the region of 1651.07 cm-1 and in addition 1552.7 cm-1 –NH2 in the structure. >N-CH2 in 1350.17 cm-1 and valence fields 844.82 – 808.17 cm-1 contain absorption lines corresponding to -CH2-CH2- groups in the aromatic ring.

According to the results of this analysis, our researched corrosion inhibitor contains nitrogen, which shows that it has anti-corrosion properties.

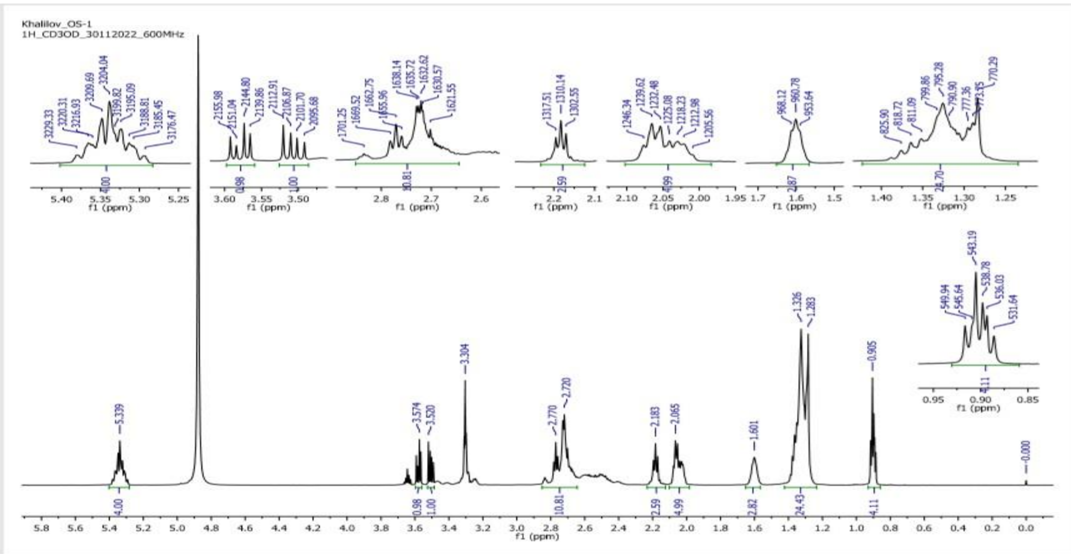


Figure-4. NMR spectrum of corrosion inhibitor PF-1.

In order to study the composition and structure of the PF-1 corrosion inhibitor used in the test, the NMR spectrum was analyzed and the analysis results were obtained.

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The NMR spectroscopy absorption line of PF-1 inhibitor, which is soluble in liquid hydrocarbons and contains nitrogen for corrosion protection, is shown.

The hydrogen molecule bonded to the 2nd carbon in the heptadiene molecule belonging to this imidazoline ring is 16.01 m.d. , the hydrogen molecule bonded to the 6th carbon is 12.83 ppm. Also, the hydrogen bonded to the 7th carbon is 2.065 m.d. The hydrogen bonded to the double bond of carbons 8 and 9 is 5.34 m.d., 10- hydrogen belonging to carbon was 2.183 m.d., hydrogen belonging to carbon 16 was 1.326 m.d., and hydrogen belonging to carbon 17 was 0.905 m.d. The hydrogen belonging to the 3rd carbon in the polyethylene polyamine molecule connected to the 3rd nitrogen atom in the imidazoline molecule is 2.770 m.d., the hydrogen belonging to the 4th carbon is 2.720 m.d., and the hydrogen belonging to the 5th atom is 3.304 m.d.

We can see that the hydrogen belonging to the 1st carbon of the imidazoline ring is 3.574 m.d., and the hydrogen belonging to the 2nd carbon is 3.520 m.d.

Elemental analysis (EDS) spectra were used to determine the percentage of oxygen and chlorine in steel samples with and without inhibitor addition. EDS analysis on the surface of the solution sample without inhibitor shows a high oxygen content (9.6 %), while the solution with PF-1 corrosion inhibitor immersed in the condensate (Citation1, Citation4, Citation7) shows a lower oxygen content (4.5 %) is determined. Corroded ST3 steel surface in the condensate solution with PF-1 corrosion inhibitor clearly shows a higher chloride concentration (6.04%) compared to the existing surface (0.12%).

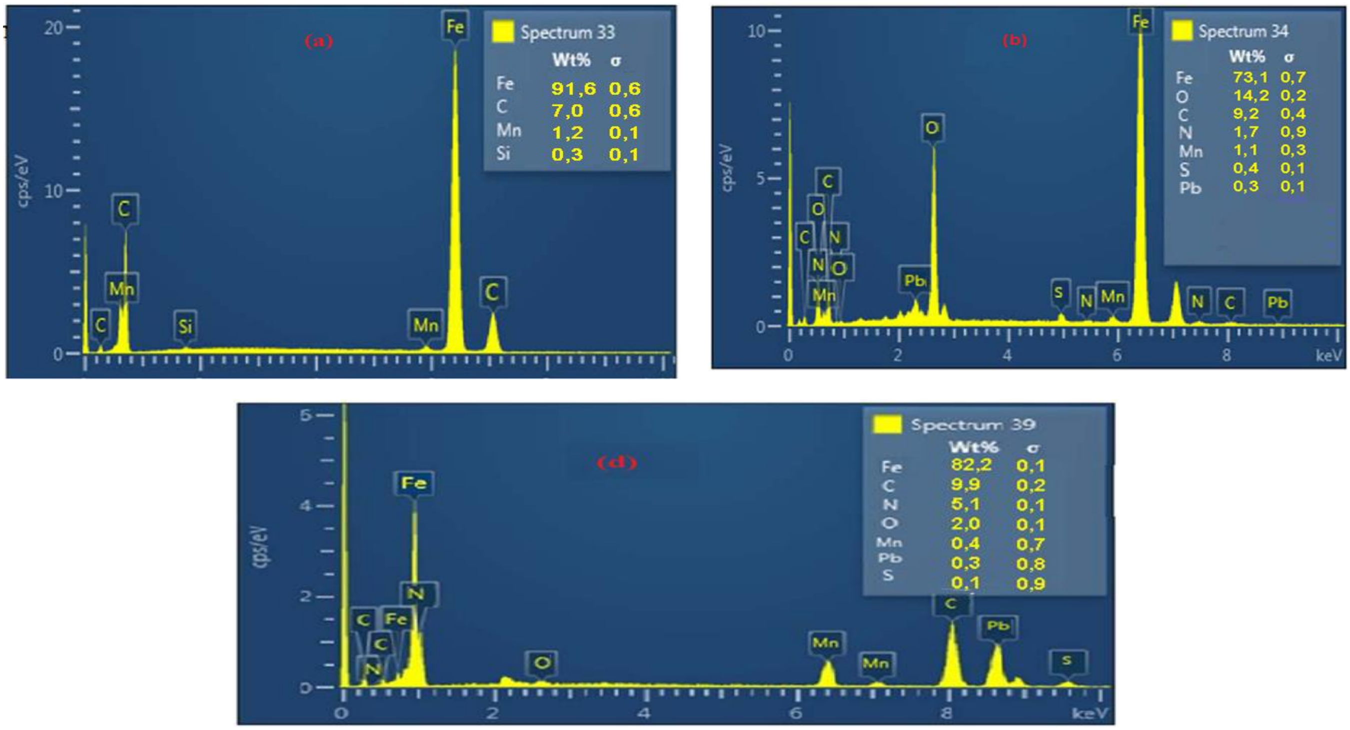

Figure-5. EDS spectra of (a) ST3 steel sample, (b) ST3 steel sample in condensate and HCl environment, and (c) ST3 steel sample in the presence of inhibitor.

From the obtained element analysis, we can see that the PF-1 brand corrosion inhibitor that we synthesized and exposed to the environment reduced the amount of chlorine (Cl) from 12.3% to 0.4%, oxygen (O) from 9% to 0.4%. We can see that it decreased from .6% to 4.5%. These values confirm the formation of a protective film with PF-1 corrosion inhibitor on the ST3 steel surface in the condensate solution. The element composition of the ST3 steel sample was studied in the presence of the inhibitor we used in the tests:

Table-2. Elemental composition of St3 steel sample with inhibitor

Element	Mass %
Fe	82,2±0.02
C	9,9±0.03
N	5,1±0.01
O	2,0±0.01
Mn	0,4±0.01
Pb	0,3±0.01
S	0,1±0.01
General	100.00

Results and Discussion

Properties of nitrogen-containing oil-soluble corrosion inhibitors were studied by the test method according to GOST 9.506-87. The molecules of these corrosion inhibitors consist of one or more functional groups that are organic substances containing a hydrocarbon radical. Tests have been conducted 3 different concentrations for 72 hours in a test rig at atmospheric pressure. The test time is calculated from the moment the samples are placed in the environment. The duration of the tests was determined according to GOST 9.905 82. Tests were conducted in gasoline and condensate environments.

Table-3 Values of inhibition coefficient (γ), complete surface coverage (*θ*), protection level (Z) of PF-1 brand corrosion inhibitor as a result of concentration and temperature

Effect of concentration of inhibitors on protection levels						
	T, K	**C, mg/l**	**CR**	**γ**	**Z, %**	***θ***
PF-1	293	-	0,07863	-	-	-
		200	0,0148	5,31	81,1	0,811
		400	0,0103	7,63	89	0,89
		600	0,00034	23,05	98,5	0,985
		1000	0,00031	68,97	98,6	0,986
	303	-	0,0861	-	-	-
		200	0,0198	4,34	75,61	0,7561
		400	0,0178	4,83	81,53	0,8153
		600	0,0073	11,86	88,21	0,8821
		1000	0,0037	23,5	91,27	0,9127

	313	-	0,124	-	-	-
		200	0,0847	1,46	71,16	0,7116
		400	0,0515	2,4	78,31	0,7831
		600	0,0236	5,25	84,67	0,8467
		1000	0,0143	8,67	89,91	0,8991
	323	-	0,313		-	-
		200	0,118	2,65	70,04	0,7004
		400	0,0961	3,25	72,46	0,7246
		600	0,0658	4,75	81,84	0,8184
		1000	0,0364	8,59	87,14	0,8714

The concentration of PF-1 brand corrosion inhibitor containing nitrogen is 200; 400; 600; 1000 mg/l It was carried out in a condensate environment. As a result of the tests, the level of protection was 81.1, 89, 98.5, 98,6 percent, respectively. With the help of the graph below, the levels of protection of our corrosion inhibitor at different temperatures are presented.

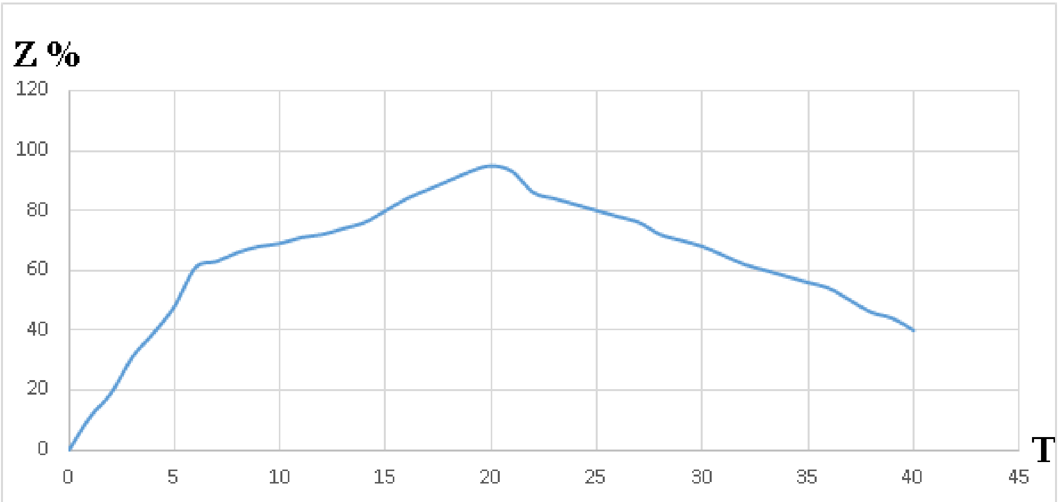

Figure-5. Protection level as a function of temperature

Figure-5. shows the protection level of protection against corrosion at different temperatures. From this graph, we can see that the optimum temperature for our synthesized PF-1 corrosion inhibitor is 20 ^{0}C.

Table-4

Mass ratios P:F	Corrosion rate	Protection level	θ
1:1	0,065	72,31	0,7231
1:2	0,08	89	0,89
1:3	0,071	78,98	0,7898
2:1	0,058	64,5	0,645
3:1	0,051	56,7	0,567

Table-4. Corrosion rates, protection levels and surface coverage coefficient values at different mass ratios of PF-1 brand corrosion inhibitor.

As a result of the test research, we can see with the help of table 1 that the best mass ratio of amine compounds and fatty acid is 1:2, and the level of protection in it is 89%.

Conclusion

The physicochemical properties of the PF-1 brand corrosion inhibitor synthesized by us and the analysis of the IR and NMR spectrum of the synthesized product were obtained. As a result of the analysis, it was found that this inhibitor contains nitrogen. These compounds have been found to be the most effective against corrosion.

Also, the obtained inhibitor was tested in different environments, at different mass ratios and temperatures. The PF-1 brand corrosion inhibitor, obtained as a result of the processing of organochlorine waste, containing nitrogen, was carried out in a condensate medium with a concentration of 200; 400; 600; 1000 mg/l. As a result of the tests, the level of protection was 83.3, 90.6, 98.5, 98.6 percent, respectively.

Our researched and tested PF-1 corrosion inhibitor can be used in various pipelines in the oil and gas industry in various aggressive environments.

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