European Journal of Emerging Technology and Discoveries
ISSN (E): 2938-3617
Volume 2, Issue 5, May - 2024

OBTAINING AND TESTING RESULTS OF PF-1 BRAND CORROSION INHIBITOR OBTAINED BASED ON THE PROCESSING OF CHLORINATED ORGANIC WASTE USED IN THE OIL AND GAS INDUSTRY

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Abstract
The article examines the physical and chemical properties of corrosion inhibitors obtained on the basis of the processing of organochlorine waste for the oil and gas industry. Corrosion inhibitors of metals were obtained as a result of the synthesis and their level of protection was checked. The results of IR and NMR spectra were studied.

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

Introduction

In the global production of corrosion inhibitors composed of organic compounds, hydrocarbon-soluble inhibitors account for about 30% of the volume, the largest part of which (~70%) is used in oil refining Corrosion of these metal-based materials has a large economic impact. According to a recent study by NACE, the total economic loss to the environment due to corrosion is USD 2.5 trillion, which is equivalent to 3.4% of world GDP. [1].

In most cases, the recommended inhibitors are organic compounds of various classes containing heteroatoms: nitrogen, sulfur, oxygen, and phosphorus. The effectiveness of the inhibitory effect of substances increases in the series of heteroatoms: O ^ N ^ S ^ P. However, since the toxicity of products also increases in this series, nitrogen-containing compounds are usually chosen for industrial use. Although it is less effective than compounds containing sulfur or phosphorus, they are a less toxic compound [2].

Corrosion inhibitors are chemicals that are injected into the well in various ways to protect the casing from internal corrosion caused by the produced fluid. It should be noted that some operators further protect parts of upstream structures after the wellhead by choosing the appropriate type and dosage of inhibitors injected into the wells.

The main metal rusting properties are:

$$2Fe + 2H_2O + O_2 \rightarrow 2Fe^{2+} + 4e + H_2O \rightarrow 2Fe(OH)_2 \quad (1)$$

$$2Fe(OH)_2 + H_2O + 1/2O_2 \rightarrow 2Fe(OH)_3 \quad (2)$$

$$Fe_2O_3 + 3H_2O \rightarrow 2Fe(OH)_3 \quad (3)$$

In the Orenburg oil and gas condensate field, inhibitors were used to protect pipes from corrosion [3]. At the initial stage of development at ONGKK, Visco 904 inhibitor from Nalco (USA) was used to solve the problems of ensuring the integrity of equipment and pipes and preventing corrosion damage. The reason for this was a decrease in production. This is due to the following factors:

deterioration of fluid removal from the well; a decrease in the permeability of flow pipes due to the accumulation of liquid in the lower regions; a decrease in the quality of gas purification in GTP, which is necessary for gas transportation; reducing the throughput of separation equipment; separation of C5+ hydrocarbons above the increase in gas content. As a result of the above circumstances, the quality indicators of gas production will change.

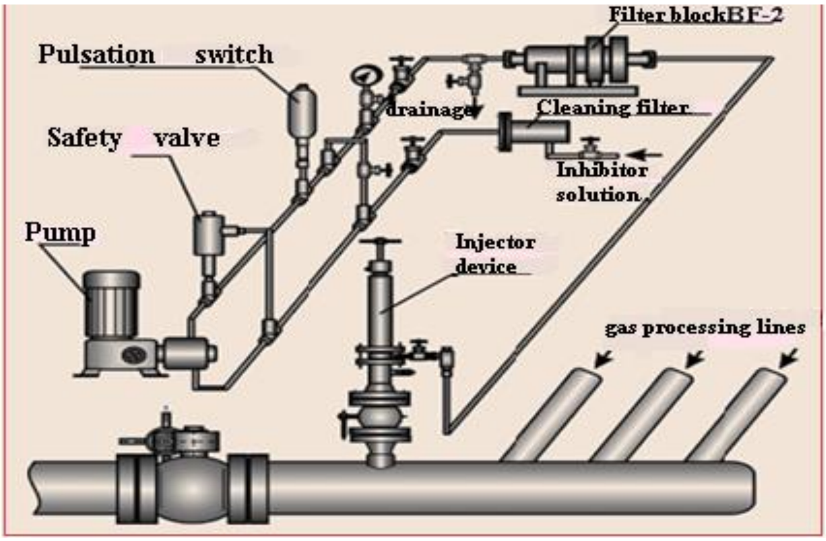

Figure-1. Scheme of inhibitor injection in sections

Considering the effect of chloride on downhole corrosion, Liu et al investigated the effect of chloride concentration on CO_2 corrosion of N80 carbon steel by immersion and electrochemical tests simulating downhole conditions. SEM observations and XRD analysis concluded that chloride ions can destroy the protective corrosion layer of the product and change its morphological characteristics. However, chloride ions do not change the chemical composition of corrosion product layers. Increasing the chloride ion concentration under constant temperature and partial pressure increases CO_2 corrosion damage.

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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".

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 1%, 3%, and 5%. 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. Physico-chemical properties of PF-1 corrosion inhibitors obtained from chlorinated organic waste processing

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

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 -

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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.

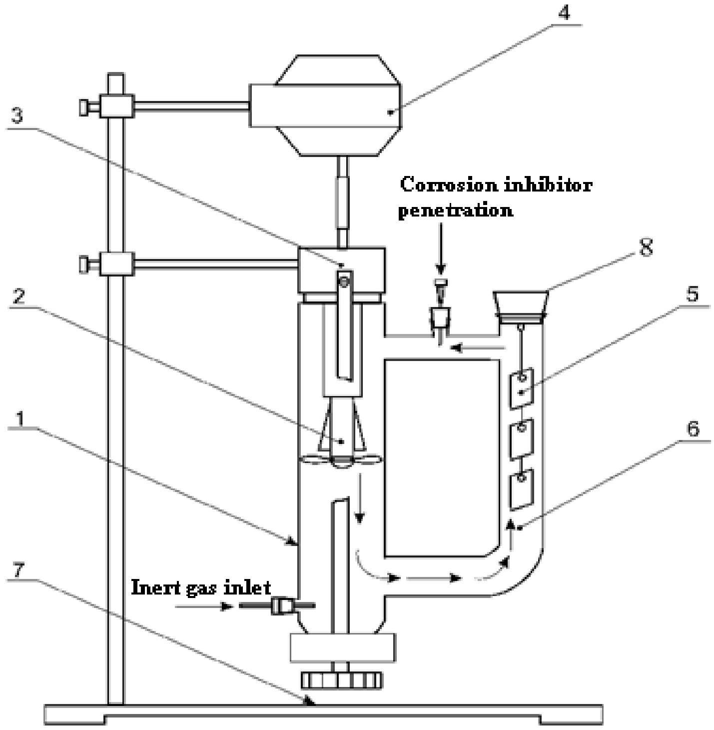


Figure-2 - Device for testing at atmospheric pressure.

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

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).

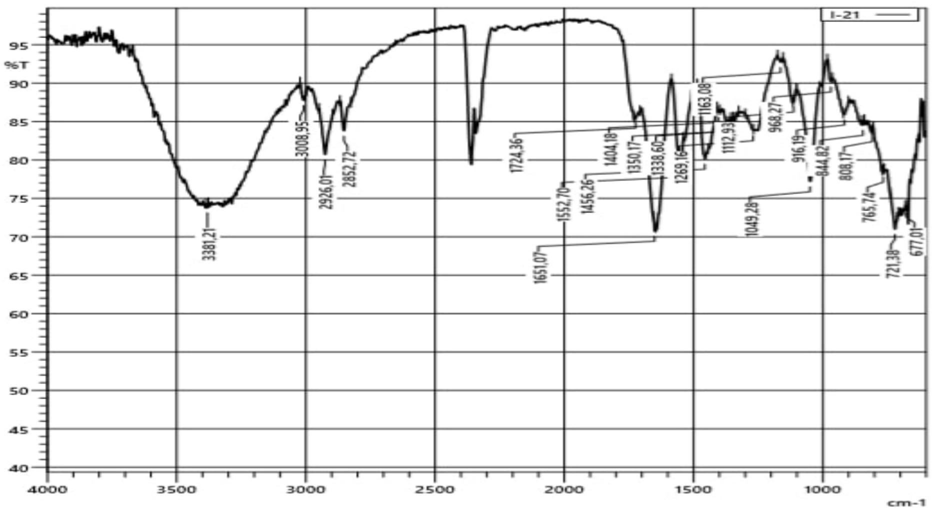


Figure-3. IR spectrum of PF-1 brand corrosion inhibitor.

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-CH_2 in 1350.17 cm-1 and valence fields 844.82 – 808.17 cm-1 contain absorption lines corresponding to -CH_2-CH_2- 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.

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.

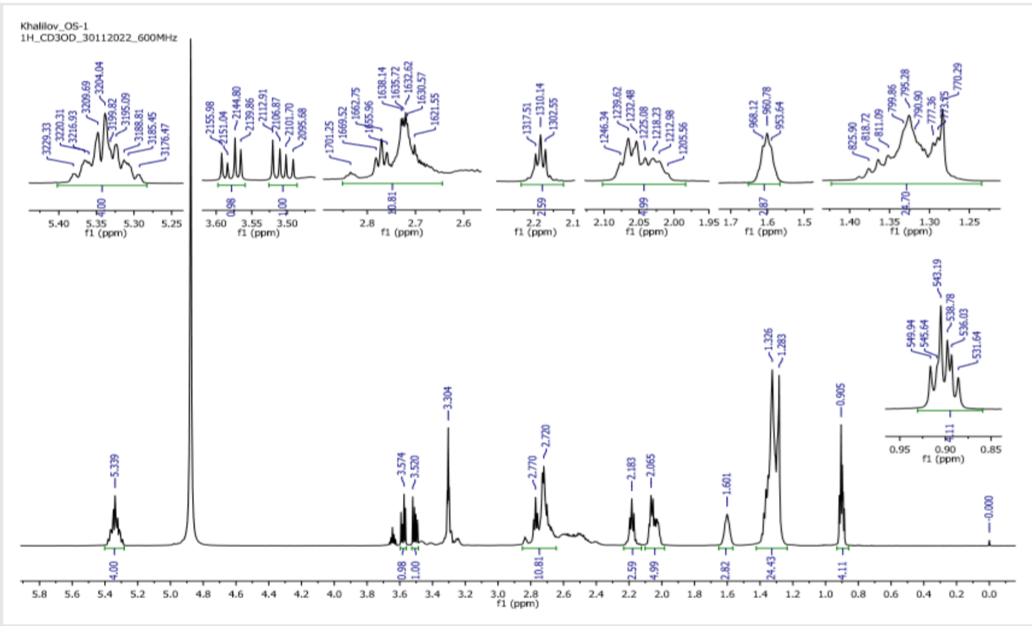


Figure-4. NMR spectrum of corrosion inhibitor PF-1.

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.

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.

The concentration of PF-1 brand corrosion inhibitor containing nitrogen and phosphorus is 1% 3% 6%; ; It was carried out in a condensate environment. As a result of the tests, the level of protection was 81.1, 89, 98.5 percent, respectively.

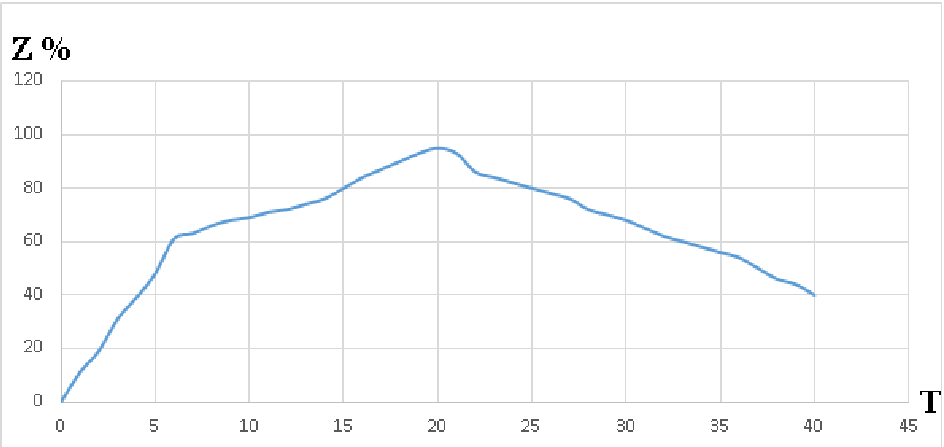
With the help of the graph below, the levels of protection of our corrosion inhibitor at different temperatures are presented.

The table below shows corrosion rates and protection levels in inhibited and uninhibited environments.

Table 2. Test results of PF-1 brand corrosion inhibitor

Model number	Sample Surface S,m^2	Mass of the sample before the test M,g	Mass of the sample after the test M,g	Sample mass loss, M_1-M_2,g	Vn.i Corrosion rate in medium without inhibitor,g/ m^2*s	Vi Corrosion rate in an inhibitory medium, g/ m^2*s	Protection level (Z)%
1	2	3	4	5	6	7	8
Without an inhibitor	0,005	0,41243	0,38412	0,02831	0,07863	-	-
1%	0,005	0,40389	0,39853	0,00536	-	0,0148	81,1
3%	0,005	0,43408	0,4312	0,00288	-	0,08	89
6%	0,005	0,41933	0,4181	0,00123	-	0,00341	98,5

From this table, we can see that the highest level of corrosion protection of the metal surface was applied at a concentration of 6%.



Graph-1. Protection level as a function of temperature.

Graph-1 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 3

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 2. 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 1%, 3%, and 6%. As a result of the tests, the level of protection was 83.3, 90.6, 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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