# RESEARCH AND PROPERTIES OF AFMD-2 BRAND CORROSION INHIBITOR FOR CORROSION PROTECTION OF OIL AND GAS WELLS

***Jamshid Khalilov***
*PhD student*
*of the Tashkent Research Institute of Chemical Technology,*
*Republic of Uzbekistan, p / o Shuro-bazaar*
*E-mail: jamshidxalilov885@gmail.com*

***Fayzulla Nurkulov***
*Head of Department,*
*Doctor of Technical Sciences, Prof.,*
*LLC "Tashkent Research Institute of Chemical Technology",*
*Republic of Uzbekistan, p / o Shuro-bazaar*

***Abdulahat Djalilov***
*Dr. chem. sciences, acad.*
*Academy of Sciences of the Republic of Uzbekistan, director*
*of LLC "Tashkent Research Institute of Chemical Technology",*
*Republic of Uzbekistan, p / o Shuro-bazaar*

# ИССЛЕДОВАНИЕ И СВОЙСТВА ИНГИБИТОРА КОРРОЗИИ МАРКИ АФМД-2 ДЛЯ ЗАЩИТЫ ОТ КОРРОЗИИ НЕФТЯНЫХ И ГАЗОВЫХ СКВАЖИН

***Халилов Джамшид Акмаль угли***
*аспирант*
*Ташкентского научно-исследовательского*
*химико-технологического института,*
*Республика Узбекистан, п/о Шуро-базар*

***Нуркулов Файзулла Нурмуминович***
*заведующий отделом, д-р техн. наук, проф.,*
*ООО «Ташкентский научно-исследовательский*
*химико-технологический институт»,*
*Республика Узбекистан, п/о Шуро-базар*

***Джалилов Абдулахат Турапович***
*д-р хим. наук, акад. АН РУз, директор*
*ООО «Ташкентский научно-исследовательский*
*химико-технологический институт»,*
*Республика Узбекистан, п/о Шуро-базар*

**ABSTRACT**

Synthesis and physicochemical characteristics of AFMD-2 brand corrosion inhibitors containing nitrogen and phosphorus for the oil and gas industry are presented. The IR spectrum and protection levels of this inhibitor at different temperatures are studied.

**АННОТАЦИЯ**

Представлены синтез и физико-химические характеристики ингибиторов коррозии марки АФМД-2, содержащих азот и фосфор, для нефтегазовой промышленности. Исследован ИК-спектр и уровни защиты этого ингибитора при различных температурах.

**Keywords:** corrosion inhibitors, nitrogen, organic compounds, fatty acids, gas-condensate well.

**Ключевые слова:** ингибиторы коррозии, азот, органические соединения, жирные кислоты, газоконденсатная скважина.

Библиографическое описание: Khalilov J.A., Nurkulov F.N., Djalilov A.T. RESEARCH AND PROPERTIES OF AFMD-2 BRAND CORROSION INHIBITOR FOR CORROSION PROTECTION OF OIL AND GAS WELLS // Universum: технические науки : электрон. научн. журн. 2023. 5(110). URL: *https://7universum.com/ru/tech/archive/item/15446*

**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 [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.

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 (Figure-1). 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.

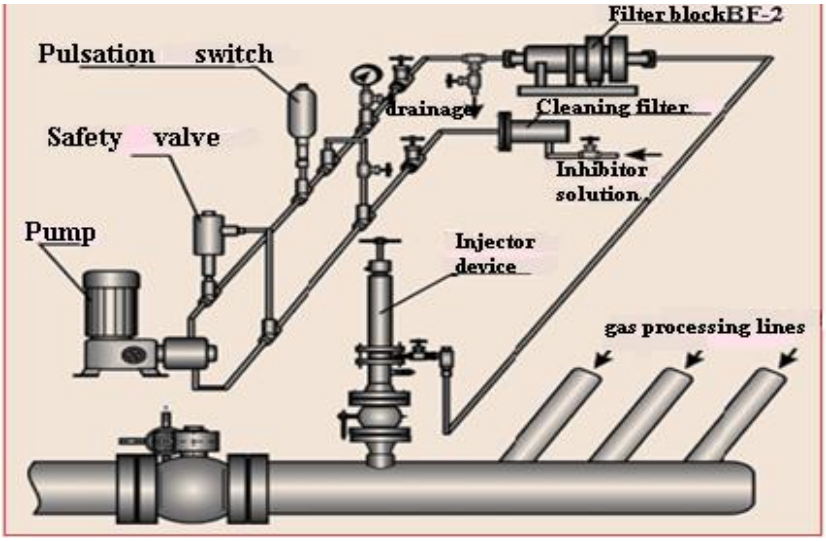



***Figure 1. Scheme of inhibitor injection in sections***

Considering the effect of chloride on downhole corrosion, Liu et al investigated the effect of chloride concentration on CO2 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 CO2 corrosion damage.

**Materials and methods.** Our researched AFMD-2 brand corrosion inhibitor was tested by gravimetric method. This method is used to determine the corrosion rate for the purpose of corrosion control 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 with 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".

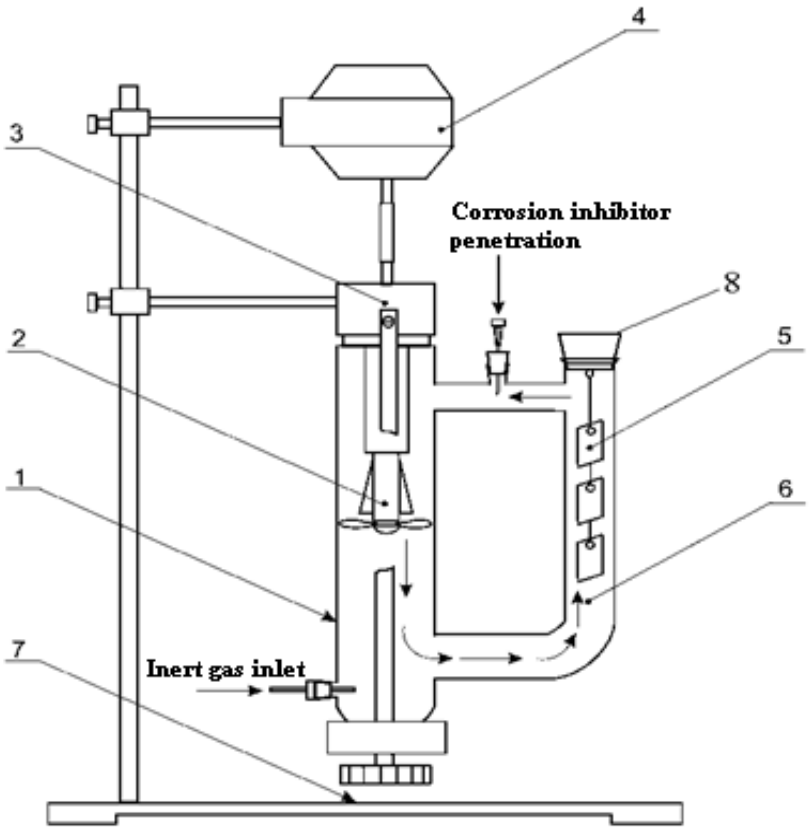
According to it, the product based on oil and alkanolamines is first placed in a three-necked flask equipped with a reflux condenser, a thermometer and a stirrer for interaction and mixed until a homogeneous mass is formed. Stirring was continued at a certain temperature for several hours. The obtained corrosion inhibitor was dissolved in 1%, 3% and 5% in gasoline, condensate and motor oil media. Later, many studies were conducted on the obtained solutions.

***Table 1.***

**Physico-chemical properties of AFMD-2 corrosion inhibitors containing nitrogen and phosphorus**

| Indexes | AFMD-2 |
|---|---|
| **1. Appearance** | Transparent, sticky |
| **2. Color** | red-brown. |
| **3. Density at 20 0C, g/cm3** | 0,3...0,6 |
| **4. Nitrogen content, % by weight** | 6...8 |
| **5.Ph environment at 20 0C** | 6,5-7 |
| **6. Level of protection against corrosion at a concentration of 150 mg/l** | 98,6 |

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.




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

***Figure 2. Device for testing at atmospheric pressure***

We studied the **IR** spectrum and analysis of the AFMD-2 corrosion inhibitor we synthesized.

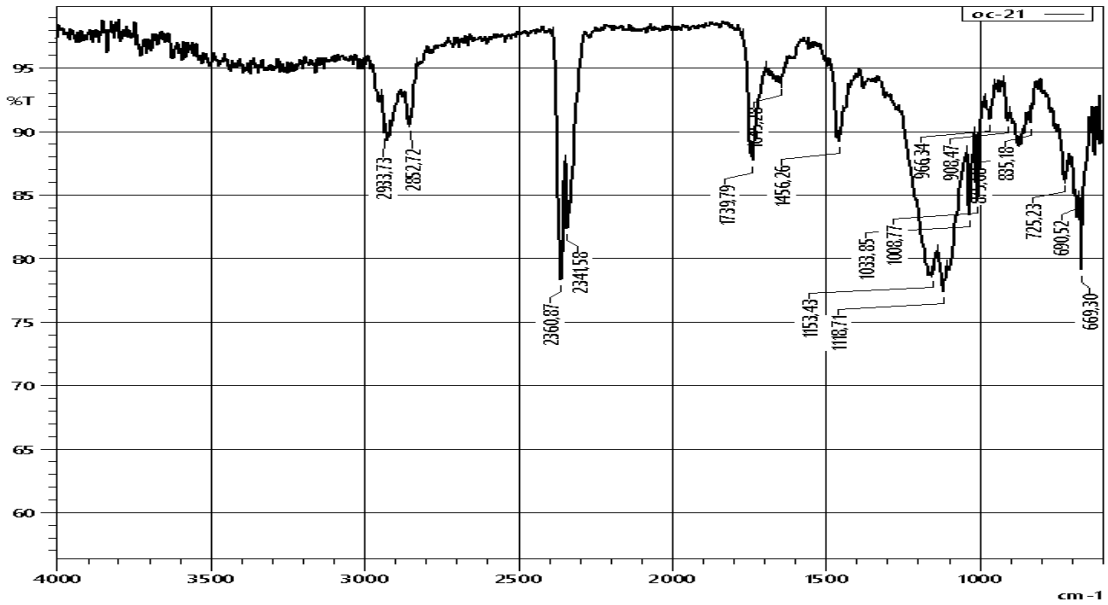



***Figure 3. IR spectrum analysis of corrosion inhibitor AFMD-2***

The composition and structure of AFMD-2 corrosion inhibitor was studied using IR-spectrometer technology (IK-Fure, SHIMADZU, Japan) in the range up to 4000 cm-1. Absorption line of IR spectroscopy of AFMD-2 inhibitor used in corrosion protection shows the spectrum of CH2 groups of bonds in the valence region at 2933.73 and 2852.72 cm-1 and in addition in the structure at 2360.87 cm-1 and 2341.58 cm-1 forms -P-H valence vibrations in valence domains. At 1739.79 cm-1 valence fields >S=O and 1456.26 cm-1 valence fields contain -SN2 valence vibrations, at 1153.43 cm-1 valence field there are absorption lines belonging to -P-O- groups.

**Results and discussion.** Results and its 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 AFMD-2 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 83.3, 90.6, 98.6 percent, respectively. With the help of the graph below, the levels of protection of our corrosion inhibitor at different temperatures are presented.

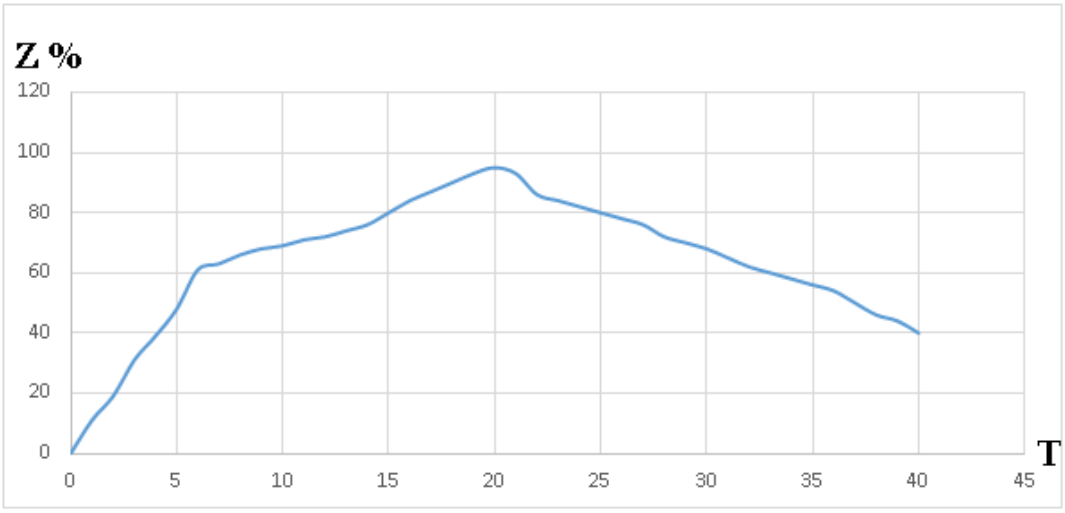



***Figure 4. Protection level as a function of temperature***

Figure 4 shows the protection level of protection against corrosion at different temperatures. From this graph, we can see that the optimum temperature for our synthesized AFMD-2 corrosion inhibitor is 20 $^0$C.

**Conclusion.** The physico-chemical properties of our AFMD-2 brand corrosion inhibitor synthesized by us and the IR spectrum analysis of the synthesized product were obtained. As a result of the analysis, it was found that this inhibitor contains nitrogen and phosphorus. This shows that it can protect against corrosion.

The concentration of AFMD-2 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 83.3, 90.6, 98.6 percent, respectively.

**References:**

1. “Downhole corrosion inhibitors for oil and gas production – a review” M. Askari, M. Aliofkhazraei. Journal “Applied Surface Science Advances” 6 2021.
2. “Амиды и соли алифатических кислот - ингибиторы коррозии черных и цветных металлов в углеводородных и водных средах” Тронова Екатерина Анатольевна.Диссертация на соискание ученой степени кандидата технических наук. Санкт-Петербург-2016.
3. История развития и методы совершенствования ингибиторной защиты в ООО «Газпром добыча Оренбург» Д.А. Кузнецов. «Территории Нефтегаз» 2014.
4. Технология маслорастворимых комплексов сулфонатов лантаноидов и Mg как ингибиторов коррозии и модификатор трения” Иванов Д.М. Диссертация на соискание ученой степени кандидата технических наук. Екатернбург-2006.