THE EFFECT OF NS-2 CORROSION INHIBITORS ON IMPROVING THE EFFICIENCY OF OIL AND GAS PRODUCTION

[1]Sanjar Berdiev, [2]Abdulahat Djalilov
[1]PhD student, Tashkent research institute of chemical technology Tashkent, Uzbekistan
[2]DSc prof., Academician, Tashkent Scientific Research Institute of Chemical technology
https://doi.org/10.5281/zenodo.10154992

Abstract. *Experimental tests carried out with the aim of applying the corrosion inhibitors proposed in metal pipes of great importance in the production of oil and gas. According to the preliminary results obtained, the proposed NS-2 brand additives found to be stable to mechanical wear, which is form on the surface of the metal under the influence of petroleum products.*
Keywords: *corrosion; mechanism of corrosion; sources of corrosion; commercial corrosion inhibitor; green-based corrosion inhibitor.*

Introduction. In oil and gas industries, the corrosion issue has always been of great importance, with consequences similar result to those of natural disaster. Corrosion normally occurs in oil and gas pipelines. Since the pipelines play the role of transporting oil and gas from the wellheads to the processing facilities, they are expose to the continuous threat of corrosion, from the date of commissioning up to decommissioning or abandonment. According to, the rough estimation of the aggregate yearly cost of corrosion is $1.372 billion, which is the total of surface pipeline and facility costs ($589 million), down-hole tubing costs ($463 million), as well as capital expenses ($320 million) [1].

Corrosion inhibitors are one of the mediums applied to minimize corrosion in petroleum industries. For an optimum inhibition to be achieve, the inhibitors must be added above a certain minimum concentration. There are plenty of techniques, e.g., cathodic protection [2], organic coatings [3], and application of first-rate corrosion-resistant alloys [4], that can be implemented to fight against corrosion, yet film-forming inhibitors are still known to be the unrivalled method of defense for mild steel in an acidic environment [5, 6]. The film-forming inhibitors are use in industries to create a molecular layer right on the surface of the steel and aliphatic tail as a second layer in hydrocarbon to prevent the water from contacting the steel surface and causing corrosion [7].

Corrosion is observed as one of the main reasons for the failures of oil and gas infrastructure. The existence of corrosion is the consequence of chemicals such as naphthenic acid (NA) reacting with iron particles or developing a surface film, this occurs with sulfur particles (S) in the hydrocarbon industries.

As the foremost drivers of corrosion, sulfur and naphthenic acid exist as organic acids in various crude oils. However, the rate of corrosion is also dependent on the quality of the crude oil, its acidic constituents, and the environment of the transport [8]. It is crucial to study the nature of these acids and the amount of sulfur and naphthenic acid components present in the crude oil to understand the performance and the root of corrosion. Despite the defects in oil and gas infrastructure (e.g., pipelines), the nature of crude oil itself promotes corrosion due to its harmful impurities like naphthenic acid and sulfur [9].

Pipelines, as one of the common tools of the oil and gas industries, have seen an increased demand in infrastructure due to the augmentation of the Canadian oil and gas industry to create improved operational and management conditions.

It is vital to maintain the integrity of this pipeline infrastructure from being affect by the environment in ways that will have consequences of economic loss. Moreover, internal corrosion of the pipelines turns out to be a key threat to the initial stage of production. In accordance with this, more than 9000 failures due to internal corrosion reported from 1990 to 2012, which accounted for 54.8% of all spills. The United States' (US) oil and gas companies disburse 1.052 billion dollars annually to prevent internal corrosion. Considering these issues, there is an urge to come up with an effective corrosion prevention approach within the given budget of the companies [10].

Results and discussion. In the practical experiments of this study, the degree of corrosion protection of organic corrosion inhibitors of the NS-2 brand with nitrogen and sulfur in the oils of the industrial I-20A mark was investigated.

Based on melamine-cyanuric acid, sodium tetrasulfide and orthophosphoric acid, the NS-2 brand oligomer containing nitrogen and sulfur was synthesized at 90 °C for 1.5 hours. The corrosion inhibitor of this brand NS-2 was found to have a positive effect on the dissolution of oils under static and dynamic conditions.

The concentration of soluble additives in oils of the NS-2 brand, which contain nitrogen and sulfur, led to a decrease in the viscosity of the mineral oil as a result of the study of its effect on the properties of the mineral oil associated with the viscosity and the temperature of hardening. It was also experimentally determined that there was no significant effect on the hardening temperature (table 1).

Table 1

Influence of the NS-2 brand corrosion inhibitor on the properties of mineral oil I-20A

o/n	NS2 corrosion inhibitor with I-20A brand oil content, %	VZ-4 bladder discharge at a temperature of 20 ºC (s)	Temperature, ºC
1	I-20A oil	24,5	-22
2	I-20A : NS-2 (95/5)	22,6	-22
3	I-20A : NS-2 (90/10)	21,4	-22
4	I-20A : NS-2 (85/15)	20,6	-22
5	I-20A : NS-2 (80/20)	20,1	-22

The main indicators of an organic oligomer of the NS-2 brand with nitrogen and sulfur in the proposed composition were comparative analysis with its anologists (inhibitors SD-11 and akor-1). To assess the level of functional properties of organic oligomers of the NS-2 brand, tests of their corrosion protection properties were carried out at different concentrations at a temperature of 22os for 720 hours. The results are presented in the table below (table 2).

Table 2

Determination of the protective capacity of inhibitors using the gravimetric method

NS-1 grade corrosion inhibitor in I-20A oil, %	Sample surface S, m^2	Pre-test sample mass, g	Sample mass after testing, g	Mass loss in the sample, M1-M1. 2, g	V corrosion rate in a nutrient-free environ ment g/ m^2·s	V inhibitor environ ment corrosion rate in g/ m^2·s	Degree of protectio n (Z)%
I-20A oil (100)	0,006	0,3682	0,3409	0,0273	0,0063	-	-
I-20A : NS-2 (95/5)	0,006	0,3968	0,3918	0,0050	-	0,0011	82,5
I-20A : NS-2 (90/10)	0,006	0,3857	0,3838	0,0019		0,00048	92,3
I-20A : NS-2 (85/15)	0,006	0,3893	0,3873	0,0020		0,00046	93,1
I-20A : NS-2 (80/20)	0,006	0,3958	0,3937	0,0021		0,00048	92,4
Anologist AKOR-1 (10)	0,006	0,3963	0,3925	0,0038	-	0,00087	86,1

Corrosion rate. №1. I-20A: NS-2 (95/5)

M2=0,3968 g; M2.2=0,3918 g;

S=0,006 m^2; t=720 hour.

V_i= M_2- $M_{2.2}$/S·t =0,3968 - 0,3918 /0,006*720=0,0011 g/ m^2·s.

Determination of the degree of protection (Z):

Z=V-V_i /V ·100% =0,0063 -0,0011 / 0,0063 * 100%=82,5%

When the concentration of corrosion inhibitors of the NS-2 brand in the oil content of I-20A was 5%, the degree of corrosion protection (Z) was= 82.5%.

№2. I-20A: NS-2 (90/10)

M_2=0,3857 g; $M_{2.2}$=0,3838 g;

S=0,006 m^2; t=720 hour.

V_i= M_2- $M_{2.2}$/S·t =0,3857 - 0,3838 /0,006*720=0,00043 g/ m^2·s.

Determination of the degree of protection (Z):

Z=V-V_i /V ·100% =0,0063 -0,00043 / 0,0063 * 100%=93,2%

When the concentration of corrosion inhibitors of the NS-2 brand in the oil content of I-20A was 10%, the degree of corrosion protection (Z) was= 93.2%.

№3. I-20A: NS-2 (85/15)

M_2=0,3893 g; $M_{2.2}$=0,3873 g;

S=0,006 m^2; t=720 hour.

V_i= M_2- $M_{2.2}$/S·t =0,3893 - 0,3873 /0,006*720=0,000469 g/ m^2·s.

Determination of the degree of protection (Z):

Z=V-V_i /V ·100% =0,0063 -0,00046 / 0,0063 * 100%=93,1%

When the concentration of corrosion inhibitors of the NS-2 brand in the oil content of I-20A was 15%, the degree of corrosion protection (Z) was= 93.1%.

№4. I-20A: NS-2 (80/20)

M_2=0,3958 g; $M_{2.2}$=0,3937 g;

S=0,006 m^2; t=720 hour.

V_i= M_2- $M_{2.2}$/S·t =0,3958 - 0,3937 /0,006*720=0,00048 g/ m^2·s.

Determination of the degree of protection (Z):

Z=V-V_i /V ·100% =0,0063 -0,00048 / 0,0063 * 100%=92,4%

When the concentration of corrosion inhibitors of the NS-2 brand in the oil content of I-20A was 15%, the degree of corrosion protection (Z) was= 92.4%.

Conclusion

From what has been analyzed and discussed in the abovementioned argument it can be inferred that in the practical experiments of the study, experimental tests were carried out with the aim of applying the proposed corrosion inhibitors in metal pipes of great importance in the production of oil and gas. According to the preliminary results obtained, the proposed NS-2 brand additives were found to be stable to mechanical wear, which is formed on the surface of the metal under the influence of petroleum products. analysis of the results of the study showed that organic corrosion inhibitors of the NS-2 brand, which contain nitrogen and sulfur, have an efficiency of up to 93.1% in industrial I-20A mark oils.

According to these obtained results, it was scientifically proven that the use of the proposed additive ingibitor corrosion in the oil and gas production process is economical and environmentally effective.

REFERENCES

1. Sanjar Berdiev, Optimal proportions in the preparation of an oligomer preserving nitrogen and sulfur as well as the study of the properties of the resulting oligomer. Science and innovation international scientific journal volume 2 issue 10 october 2023, pp 104-107.
2. Chen, R.; Li, X.; Du, C.; Cheng, Y. Effect of cathodic protection on corrosion of pipeline steel under disbonded coating. Corros. Sci. 2009, 51, 2242–2245.
3. Yabuki, A.; Tanabe, S.; Fathona, I. Comparative studies of two benzaldehyde thiosemicarbazone derivatives as corrosion inhibitors for mild steel in 1.0 M HCl. Surf. Coat. Technol. 2018, 341, 71–77.
4. Chengduan, W.; Chuan, L.; Bin, X.; Xiaogang, G.; Dong, F.; Bin, L. Corrosion inhibition of mild steel in HCl medium by S-benzyl-O,O′-bis(2-naphthyl)dithiophosphate with ultra-long lifespan. Results Phys. 2018, 10, 558–567.
5. Zeino, A.; Abdulazeez, I.; Khaled, M.; Jawich, M.; Obot, I. Electrochemical Corrosion Performance of Aromatic Functionalized Imidazole Inhibitor Under Hydrodynamic Conditions on API X65 Carbon Steel in 1 M HCl Solution. J. Mol. Liq. 2018, 250, 50–62.
6. Umoren, S.; Eduok, U. Application of carbohydrate polymers as corrosion inhibitors for metal substrates in different media: A review. Carbohydr. Polym. 2016 y, 140, 314–341.
7. Yadav, D.; Maiti, B.; Quraishi, M. Electrochemical and quantum chemical studies of 3,4-dihydropyrimidin-2(1H)-ones as corrosion inhibitors for mild steel in hydrochloric acid solution. Corros. Sci. 2010, 52, 3586–3598.

8. Hu, K.; Zhuang, J.; Zheng, C.; Ma, Z.; Yan, L.; Gu, H.; Zeng, X.; Ding, J. Effect of novel cytosine-l-alanine derivative based corrosion inhibitor on steel surface in acidic solution. J. Mol. Liq. 2016, 222, 109–117.
9. Ramezanzadeh, B.; Vakili, H.; Amini, R. The effects of addition of poly (vinyl) alcohol (PVA) as a green corrosion inhibitor to the phosphate conversion coating on the anticorrosion and adhesion properties of the epoxy coating on the steel substrate. Appl. Surf. Sci. 2015, 327, 174–181.
10. Mohammadinejad, R.; Karimi, S.; Iravani, S.; Varma, R. Plant-derived nanostructures: Types and applications. Green Chem. 2016, 18, 20–52.