ANTICORROSION EFFICIENCY OF A BORON-CONTAINING CORROSION INHIBITOR

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Abstract: *The anticorrosion efficiency of the inhibitor was evaluated using the gravimetric method in accordance with the requirements of GOST 9.905–82. The results showed that an increase in inhibitor concentration led to a decrease in the corrosion rate and an increase in the protection efficiency. The highest efficiency was observed at an inhibitor concentration of 1%, where the protection efficiency reached 92.12%. The obtained results indicate that the synthesized compound can be used as an effective corrosion inhibitor.*

Keywords: *corrosion, corrosion inhibitor, boric acid, glycerol, organoboron compound, FTIR spectroscopy, gravimetric method, corrosion rate, protection efficiency.*

INTRODUCTION. Sastri [1] extensively analyzed the advantages, adsorption properties, and potential practical applications of such inhibitors. According to these studies, the dense arrangement of inhibitor molecules on the metal surface leads to the formation of a protective film and a significant reduction in the corrosion rate.

Adsorption and thermodynamic approaches are of great importance in evaluating the effectiveness of organic inhibitors. Studies conducted by Bentiss et al. [2] confirm that the adsorption of organic molecules on the metal surface results in the retardation of the corrosion process. In addition, Zhang et al. [3] and Abd El Rehim et al. [4] demonstrated that heteroatom-containing organic compounds effectively suppress metal corrosion in acidic and saline media.

However, an analysis of the available literature indicates that boron-containing organic compounds, particularly organoboron inhibitors synthesized from glycerol and boric acid, as well as their structure and concentration-dependent anticorrosion efficiency, have not yet been studied systematically to a sufficient extent.

Therefore, in the present study, a new organoboron corrosion inhibitor was synthesized from boric acid and glycerol. Its structure was characterized by FTIR spectroscopy, while its inhibition efficiency was evaluated using the gravimetric method in accordance with GOST 9.905–82 and ASTM G31–12a standards [5].

RESEARCH METHODOLOGY. For the experimental study, the metal specimens were prepared in advance, and the tests were carried out in accordance with the requirements of the current GOST 9.905–82 standard. In particular, metal plates with smooth surfaces were selected for the corrosion tests.

Under inhibitor-free test conditions:

M_1 = 452.6 mg = 0.4526 g

Under test conditions with the GB-3 inhibitor at a concentration of 0.25%:

M_2 = 422.8 mg = 0.4228 g

Under test conditions with the GB-3 inhibitor at a concentration of 0.5%:

M_3 = 406.2 mg = 0.4062 g

Under test conditions with the GB-3 inhibitor at a concentration of 0.75%:

M_4 = 457.7 mg = 0.4577 g

Under test conditions with the GB-3 inhibitor at a concentration of 1%:

M_5 = 486.5 mg = 0.4865 g

The tests were conducted in an apparatus operating at atmospheric pressure for 120 hours using four different inhibitor concentrations. The test duration was measured from the moment the specimens were placed in the specified medium. The duration of the tests was determined in accordance with the requirements established by GOST 9.905–82.

To determine the optimum concentration, the inhibitor concentration was increased stepwise, and separate tests were carried out at each concentration level.

Masses of the specimens after the experiment:

Under inhibitor-free test conditions:

M_1 = 321.5 mg = 0.3215 g

Under test conditions with the GB-3 inhibitor at a concentration of 0.25%:

M_2 = 388.8 mg = 0.3888 g

Under test conditions with the GB-3 inhibitor at a concentration of 0.5%:

M_3 = 379.6 mg = 0.3796 g

Under test conditions with the GB-3 inhibitor at a concentration of 0.75%:

M_4 = 440.0 mg = 0.4400 g

Under test conditions with the GB-3 inhibitor at a concentration of 1%:

M_5 = 475.3 mg = 0.4753 g

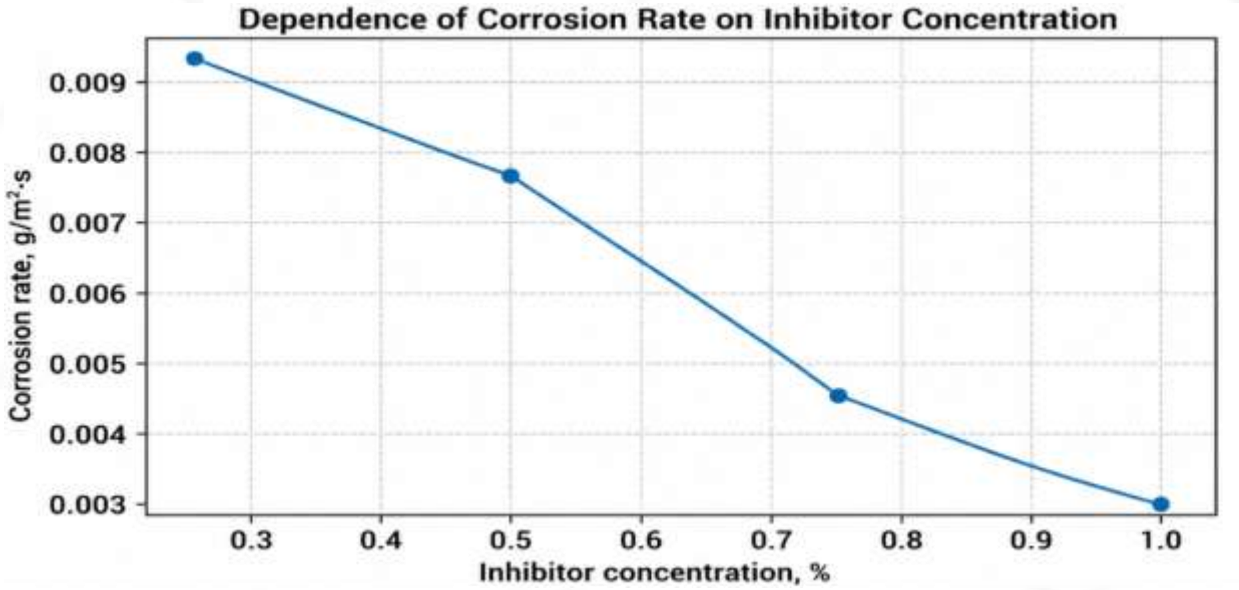
The surface area of the specimens ranged from **0.0302 to 0.0345 m²**.

Table 1. Determination of the Corrosion Rate and Protection Efficiency of the Inhibitors

Specimen number	Surface area of the specimen, S, m²	Mass of the specimen before testing, M, g	Mass of the specimen after testing, M, g	Mass loss of the specimen, M_1–M_2, g	Corrosion rate in the inhibitor-free medium, V_i, g/m²·s	Corrosion rate in the inhibitor-containing medium, V_i, g/m²·s	Protection efficiency (Z), %
Without inhibitor	0,0318	0,4526	0,3215	0,1311	0,0343	-	-
0,25%	0,0299	0,4228	0,3888	0,0340	-	0,0094	72,59
0,5%	0,0287	0,4062	0,3796	0,0266	-	0,0077	77,55
0,75%	0,0323	0,4577	0,4400	0,0177	-	0,0045	86,88
1%	0,0343	0,4865	0,4753	0,0112	-	0,0027	92,12

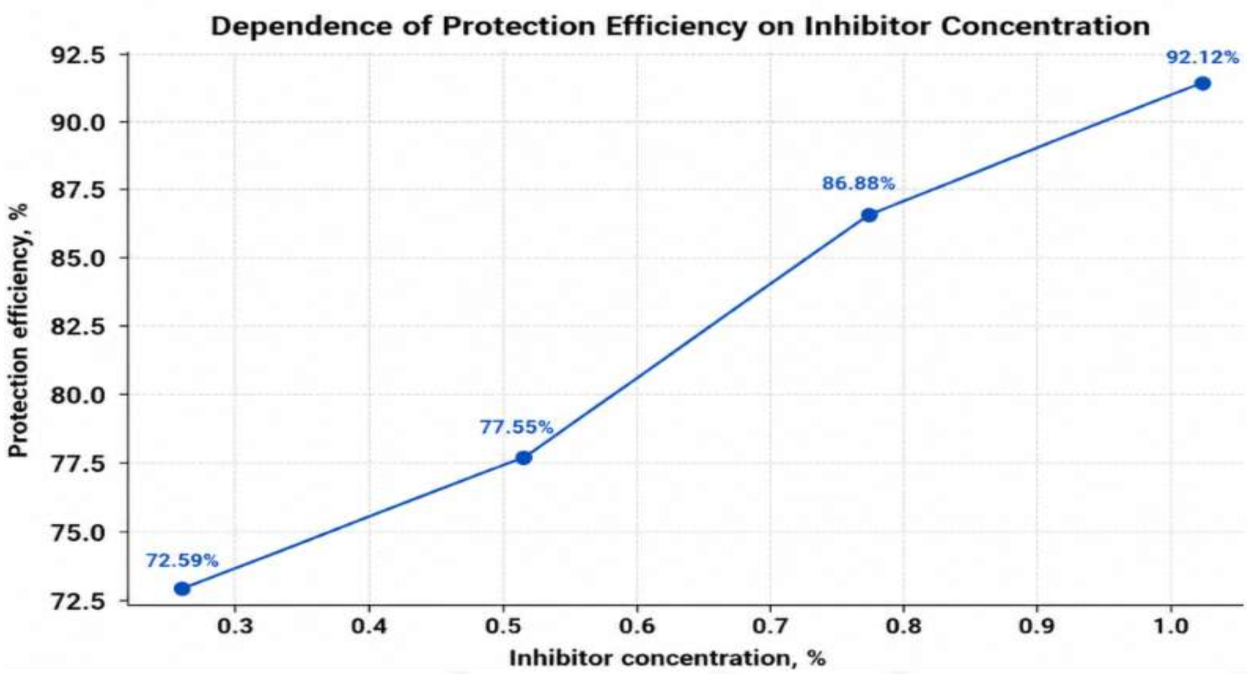
The corrosion rates and protection efficiencies of the inhibitors were determined based on the test results. In the inhibitor-containing medium, the protection efficiencies at concentrations of 0.25%, 0.5%, 0.75%, and 1.0% were 72.59%, 77.55%, 86.88%, and 92.12%, respectively.

Figure 2



As shown in the diagram presented in Figure 2, the corrosion rate decreases steadily as the inhibitor concentration increases. At a concentration of 0.25%, the corrosion rate reaches its highest value, whereas increasing the concentration to 1.0% reduces it to the lowest level. This indicates that the inhibitor is capable of forming a protective layer on the metal surface, thereby effectively reducing the impact of the aggressive environment.

Figure 3



As shown in the diagram presented in Figure 3, the degree of metal protection increases steadily with increasing inhibitor concentration. At a concentration of 0.25%, the protection efficiency is relatively low, whereas its maximum value is observed when the concentration reaches 1.0%. This behavior is attributed to the formation of a stable protective inhibitor layer on the metal surface.

CONCLUSIONS AND RECOMMENDATIONS. According to the gravimetric test results, the corrosion rate decreased as the inhibitor concentration increased, while the protection efficiency increased. The highest efficiency was observed at a concentration of 1%, at which the protection efficiency reached 92.12%. The obtained results demonstrate that the synthesized compound is an effective corrosion inhibitor.

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