Investigation of the Efficiency of Fatty Acid Amides as Atmospheric Corrosion Inhibitors

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Keywords: agricultural machinery, multifunctional corrosion inhibitors, anticorrosive protection, experimental studies, fatty acid amides, fat-containing waste.

Abstract: Protection of agricultural machinery (AM) from corrosion at all stages of operation using anticorrosive agents is an important condition for increasing its service life, reliability and reducing costs for ensuring preservation. The unsatisfactory state of anticorrosive protection of AM is caused by a number of reasons. One of which is the lack of effective multifunctional corrosion inhibitors. The shortage of domestic inhibitors remains an important problem today. This is due, first of all, to the lack of a scientifically sound concept for their creation, as well as the lack of a raw material base. The cessation of production of such a product as synthetic fatty acids has led to a reduction in the market of a number of effective corrosion inhibitors. The authors have developed a technology for obtaining fatty acid amide (FAA) from triglycerides of plant, animal origin or fat-containing waste. The aim of the research was to assess the effectiveness of fatty acid amide as an inhibitor of atmospheric corrosion. To ensure the reliability of the result, a comparative assessment of a number of currently used preservation materials was carried out using the methods specified in GOST 9.054-75.

1 INTRODUCTION

At all stages of operation, the SHT is exposed to climatic and operational factors. It is known that 70...80% of machine parts and structural elements fail due to atmospheric corrosion and mechanical loads. Of these, 20...25% are breakdowns due to loss of strength due to corrosive wear.

Protection of chemical equipment from corrosion by conservation is a necessary condition for maintaining its service life and operability. Conservation is the protection of metal surfaces of machines and equipment from the effects of climatic factors that cause electrochemical corrosion (Vigdorovich, Tsygankova, Emelyanenko, 2020).

A wide range of protective materials (PM) produced by domestic manufacturers is recommended for use in agriculture. However, the practice of using PM in preserving agricultural products has shown their low efficiency quite often and, as follows from the analysis of modern scientific literature, due to:

- there is no scientific concept for the development of protective materials;
- reduction of the raw material base for the production of polyfunctional inhibitors;
- termination of production of anti-corrosion materials by large oil refineries due to their low profitability (Gaidar, Pikina, Lapsar, Golubev, 2023; Gaidar, Pikina, Sergeeva, Lapsar ', 2024).

The production of corrosion inhibitors is related to small chemistry, as a result of which the production of these products is of great interest to small enterprises. Due to the lack of funds, products are often presented to the market without proper laboratory and natural tests and, as a result, the declared protective efficiency is a declaration.

Taking into account the above, in order to obtain a reliable result of the protective effect of the corrosion inhibitor, it is advisable to conduct

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comparative tests using the methods specified in GOST 9.054-75.

Objective of the study: To evaluate the protective the effectiveness of the corrosion inhibitor based on the results of comparative tests using the methods of GOST 9.054-75.

2 MATERIALS AND METHODS

The following samples were used as test samples:

- experimental sample – 16% solution of AFC inhibitor in mineral oil I-20 (Gaidar, Konoplev, Lapsar, Balkova, Pikina, Posunko, 2023);
- preservation oil " Avtokon LS" (TU 2389-059-27991970-00);
- preservation oil " Rosoil - 700" (TU 0253-027-06377289-2000);
- 50% solution of inhibitor " Cormin " in mineral oil (TU 38.1011159-88);
- 30% solution of inhibitor " Cormin " in mineral oil (TU 38.1011159-88).

A comparative assessment of the protective effectiveness of the prototype was determined using method 1, 3, 4, 5 of GOST 9.054-75 (Mansuraeva, Yusupova, Bulaev, 2022).

The protective properties of the compositions were studied on 50x50 mm samples made of grade St3 steel. Before testing, the samples were wiped with a clean dry cloth. The surface roughness (Ra), measured on 5 samples at 4 points, was 0.30 μm for the outer surface and 1.59 μm for the inner surface.

The samples were preserved for 3-5 minutes, after which the samples were kept in the air in an inclined position to remove excess of the applied composition. The samples were kept for 60 minutes. During the keeping, the samples were blown with warm air (~ 60 ^{o}C) from a fan.

The assessment of the protective properties of the compositions was carried out based on the time of appearance of the first source of corrosion damage and on the area of corrosion destruction during the testing period (the rate of appearance and development of corrosion) (Karelina, Dmitrevsky, Laguzin, 2018; Karelina, 2015).

The results of the study of protective properties using method 1 according to GOST 9.054 (at elevated values of relative humidity and air temperature with periodic condensation of moisture) were carried out over 45 working cycles (63 days).

When studying the protective properties using method 3 according to GOST 9.054 (under the influence of salt fog), the dispersion and water content of the salt fog were controlled according to GOST 15151-69. The water content of the salt fog was maintained at a level of 0.5-0.8 ml/hour.

The samples were tested at a temperature of 35±2 $^{\circ}$C and under the influence of salt fog created by spraying a 5% solution of potassium chloride.

When studying protective properties using method 4 according to GOST 9.054 (with constant immersion in electrolyte), samples with applied preservative compounds were placed in glasses with electrolyte and kept in it at room temperature (23-27 ^{o}C) for 24 hours.

After completion of the tests, the appearance of the solution was assessed (color of the solution, presence of a red suspension of iron hydroxide, presence of an oil film on the surface of the electrolyte); the appearance of the samples before and after removal of the lubricant (Figure 2).

When studying the protective properties using method 5 according to GOST 9.054 (under the influence of hydrobromic acid), the sample after dipping in a 0.1% solution of hydrobromic acid was treated in the studied preservative composition. Treatment in the preservative composition was carried out at an operating temperature of 60 $^{\circ}$C, since a number of compositions are characterized by high viscosity at room temperature. The protective ability was assessed after 4 hours of exposure at room temperature based on the appearance of the sample before and after removal of the preservative composition layer.

3 RESULTS AND THEIR DISCUSSION

Tests with periodic condensation of moisture were carried out in the SC 450 humidity chamber (KST) Figure 1.

Figure 1: External view of the SC 450 (KST) humidity chamber.

After 45 working cycles, the tests showed no signs of corrosion on any of the test samples.

The comparative result according to method 3 of GOST 9.054-75 is presented in Table 1.

Table 1: Results of studies of preservative compositions using method 3 (under the influence of salt fog).

Compound	In 2 hours	In 4 hours	In 6 hours
Autocon LS	No corrosion	No corrosion	Three corrosion points 2.1.2 mm (Scor less than 3%)
AJK 16%	No corrosion	No corrosion	Corrosion point 1 mm on the end face (Scor less than 1%)
Rosoil 700	2 corrosion points 1 mm	No change	Several points and spots of corrosion 1,3,5 mm (up to 5 pcs) (Scor less than 5 %)
Cormin 30%	Corrosion spots 5-10 mm on more than 50% of the surface	Increased corrosion	Continuous corrosion on 50% of the surface
Cormin 50%	No corrosion	No corrosion	Corrosion point 1 mm (Scor less than 1%)

All compositions for reducing protective properties can be arranged in the following sequence: AZHK 16%, Avtokon LS, Kormin 50%, Rosoil 700, Kormin 30%.

The results of the study of protective properties using method 4 according to GOST 9.054 (with constant immersion in electrolyte) for 24 hours at a temperature of 23-27 ^{o}C in the electrolyte showed the following results:

1. In the electrolyte at the bottom of the glass in the compositions Cormin 30% and Rosoil 700 there is a suspension of iron hydroxide, in the other samples there is no suspension.

2. In compositions based on AZhK 16%, Avtokon LS, Kormina , no oil floating is observed; in other cases, there is an oil film on the surface of the electrolyte, which contains corrosion products.

3. Swelling of the film of the compositions is not observed in any of the cases.

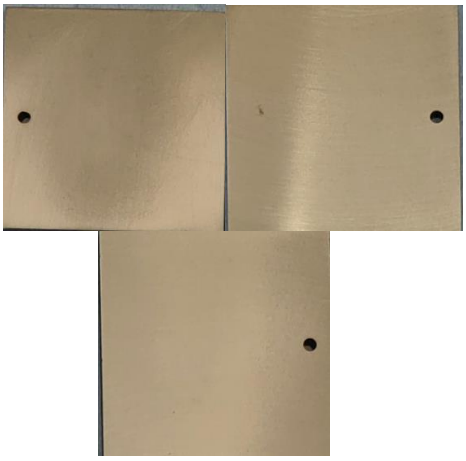
The protective capacity of the compositions decreases in the following order: AZhK 16%, Avtokon LS, Rosoil 700, Kormin 30% and Komin 50%.

Moreover, the last three samples have the same level of protective ability.

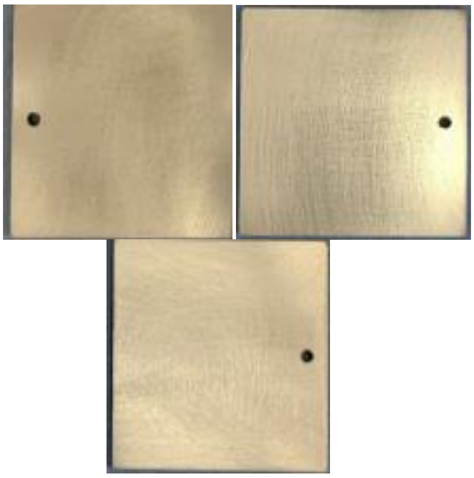
The results of the study of protective properties using method 5 according to GOST 9.054 (under the influence of hydrobromic acid) are presented in Table 2.

Table 2: Results of testing preservative compositions using method 5 (under the influence of hydrobromic acid).

Compound	Appearance of the sample before removal of grease	Appearance of the sample after removal of grease
Autocon LS	Without corrosion	Without corrosion
AJK 16%	Without corrosion	Without corrosion
Rosoil 700	Without corrosion	Without corrosion
Cormin 30 %	3 points corrosion to 1 mm	4 points corrosion to 1 mm
Cormin 50 %	Some dots corrosion 1-2 mm	Some dots corrosion 1-2 mm



Sample with anti-corrosion coating before testing (Kormin 30)



Sample with anti-corrosion coating before testing (AC)

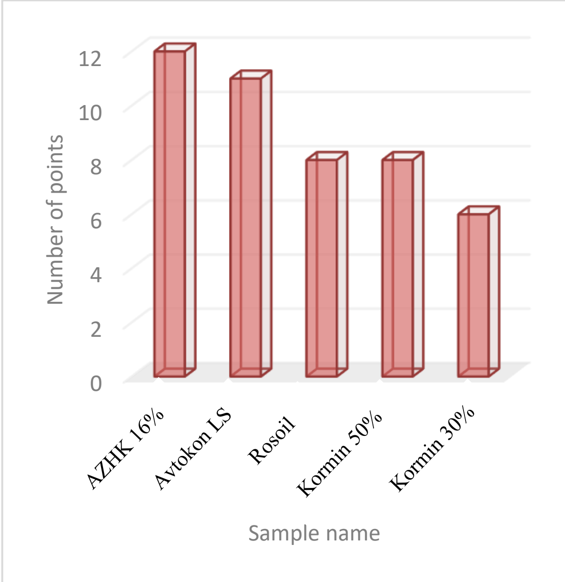
Sample with anti-corrosion coating after testing (Kormin 30)

Sample with anti-corrosion coating after testing (ACT)

Figure 2: Results of the conducted studies of the protective capacity of the compositions.

All compositions in order of decreasing protective capacity (ability to displace hydrobromic acid) can be arranged in the following sequence: AZHK 16%, Avtokon LS, Kormin 30%, Kormin 50%, Rosoil 700.

The final results of the studies of the protective properties of preservative compositions are presented in Figure 3.



*Note: The number of points is a total assessment of the protective capacity of the compositions according to GOST 9.407-2015 Unified system of protection against corrosion and aging.

Figure 3: Results of tests of the protective properties of preservative compositions, conducted according to the methods of GOST 9.054-75.

4 CONCLUSIONS

1. Experimental studies have shown that the effectiveness of preservative oils depends on the composition and amount of inhibitor, and the more severe the conditions, the stronger the effect.

2. Preservative oil made using an experimental inhibitor exceeds the protective effect of analogues by 1.1 ÷ 2.0 times.

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