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Synthesis of Composite Inhibitors and Their properties

Anvarova Zarina, Nazarov Sayfulla, Xolov Anvar, Baqoyeva Marjona
E-mail: s.i.nazarov@buxdu.uz, sayfullanazarov103@mail.ru
Bukhara State University, 200117, M.Ikbol str., 11, Bukhara, Uzbekistan

Abstract: This paper presents the synthesis and identification of (1,3-dioxoisoindolin-2-yl)methyl phosphoric acid and the corrosion rate and protection levels of the DIIMFK inhibitor Fon-1 in solution at various temperatures and concentrations.

Key words: Inhibitor, corrosion rate, plate, concentration, environment, degree of protection, IR spectrum, (1,3-dioxoisoindolin-2-yl) methyl phosphoric acid, temperature.

Protection of metals with corrosion inhibitors has been one of the most effective and cost-effective ways to ensure durability and long-term operation of process equipment and pipelines in aggressive environments for several decades. The most significant losses are typical of metal-intensive industries such as water supply, thermal energy, and the oil and gas industry. Water purification in industrial closed systems of energy, water and heat supply is a complex and very expensive process [1,2].

The causes of fatal situations and corrosion damage of various metal structures are hydrogen sulfide, carbon dioxide, high corrosion activity of the environment containing the organic phase.

Hydrogen sulfide has extremely aggressive properties and causes electrochemical and possibly chemical corrosion and corrosion damage to equipment as a result of hydrogen release.

Ya.R. Nachekina and his colleagues [3,4] carried out scientific research on the synthesis of new effective inhibitors that simultaneously slow down acid, hydrogen sulfide and carbon dioxide corrosion, as well as hydrogenation of steel. In such environments, the use of corrosion inhibitors, which form and maintain protective films on the surface of steel equipment and pipes, is especially effective.

Corrosion of metals in an acidic environment occurs with hydrogen depolarization, to prevent it, inhibitors are used that reduce the overvoltage of hydrogen ions and metal ionization. The addition of acid inhibitors reduces the corrosion rate in acidic environments by hundreds of times.

Various amines, ketones, aliphatic carboxylic acids and amino acids, as well as products of interaction of amino alcohols and their derivatives with sulfoacids, carboxylic acids, ethers and aldehydes are used as organic inhibitors. Amino acids such as glycine, methionine, and histidineglutamic acid are used as inhibitors of steel corrosion in sulfuric acid, aspartic acid in hydrochloric acid, and alanine chloride and sulfuric acid[5-7].

The scientific research of these scientists is based on the creation of highly effective inhibitors and the study of their mechanism of action. At present, great attention is being paid to the creation of

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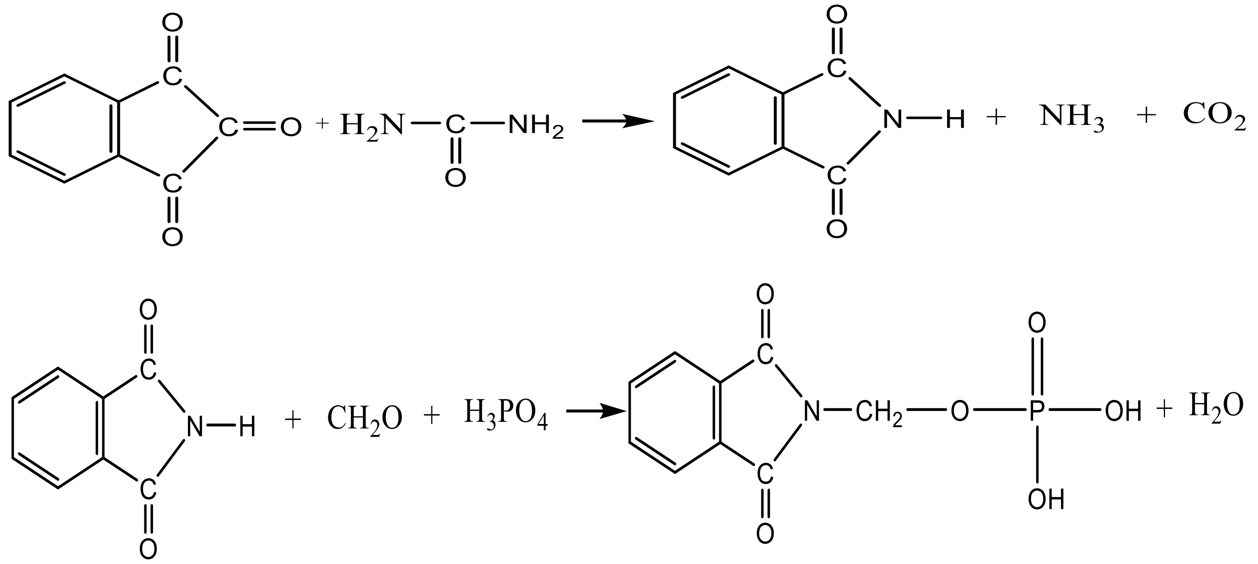
composite inhibitors based on local raw materials and secondary products, which are highly effective in existing corrosion environments in chemical industry enterprises and factories.
In particular, composite inhibitors based on phthalanhydride, formaldehyde and phosphoric acid serve to solve the above problems[7-10].
As a result of the three-component condensation of phthalanhydride with formaldehyde and phosphoric acid, (1,3-dioxoisoindolin-2-yl) methyl phosphate (DIIMFK) has been formed. Phthalanhydride and formaldehyde were mixed in a 1:1 mole ratio, 5 ml of 0.1 M hydrochloric acid and 5 ml of water have been added to the flask, and the mixture was boiled for 30 minutes. Phosphoric acid was added to the mixture and boiled for 2 hours with stirring. The resin is removed with acetone. The resulting precipitate has been filtered and dried at room temperature. The yield of (1,3-dioxoisoindolin-2-yl) methyl phosphoric acid has been 79%.



Scheme 1. Three-component condensation with phthalic anhydride, methanal and phosphoric acid.

The formed substance 1 is a yellowish crystalline substance, easily soluble in water, alcohols, acetone, dimethylformamide.

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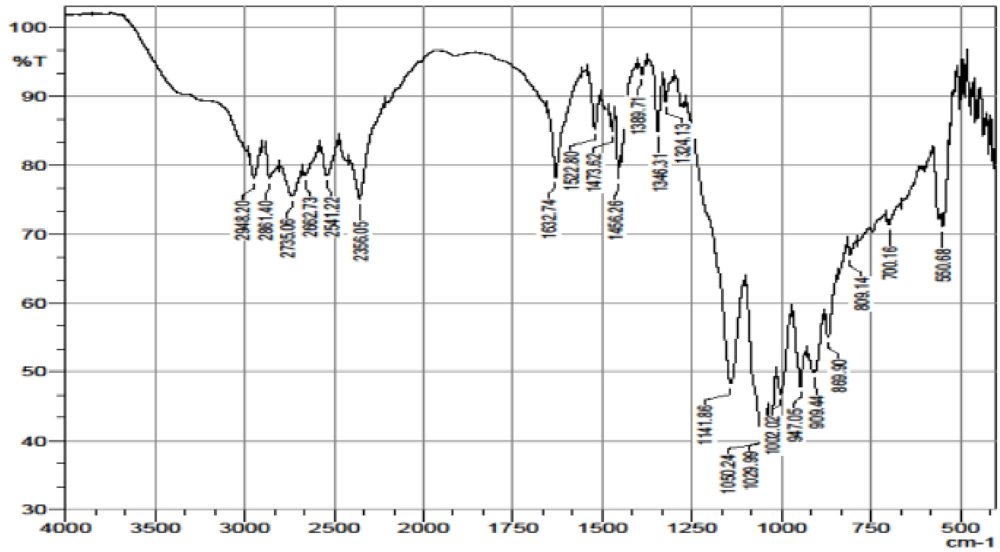

Figure 2. IR spectrum of (1,3-dioxoisoindolin-2-yl) methyl phosphoric acid.

According to the results of the IR spectrum of (1,3-dioxoisoindolin-2-yl) methyl phosphoric acid, groups corresponding to absorption maxima in the following range are listed: 2931-2819 cm^{-1} ^{V} (ON), 1458 cm^{-1} ^{V} (-O-CH_2 -), ^{V} (-N-CH_2), 1340 cm^{-1} ^{V} (R=O), 1111 cm^{-1}, 1037 cm^{-1} ^{V} (P-O-C) (Figure 2).

According to the analysis of the IR spectrum of (1,3-dioxoisoindolin-2-yl) methyl phosphoric acid, the vibrational lines of the (ON) bonded hydroxyl group appeared in the 2931-2819 cm^{-1} region, in the 1458 cm^{-1} region ^{V} (-O-CH2-), ^{V} (-N-CH2) groups, 1340 cm^{-1} ^{V} (R=O) region, phosphorus oxygen bond, 1037 cm^{-1} region, ^{V} (P-O-C) ether group was.

Studies have been conducted to determine the effectiveness of inhibitors using the method based on the difference between the masses of metal, that is, the gravimetric method. Experiments have been carried out at different temperatures and with different inhibitor concentrations in background solutions close to existing aggressive environments in industrial enterprises.

The analysis of the conducted experiments showed that the rate of corrosion and the level of protection of the inhibitor depended on the concentration of the inhibitor and the temperature of the environment. It can be seen that the corrosion rate of steel at a certain temperature decreases with an increase in inhibitor concentration. Data are presented in Table 1.

Table 1

Corrosion rate and protection levels of DIIMFK inhibitor Fon-1 in solution at different temperatures and concentrations

Inhibitor	T	$C_{ing.}$	K	ν	Z

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	(c^o)	(mg/l)	(g/m^2.milk)		(%)
DIIMFK	50	0	17.48	-	-
		10	1.18	14.65	91.7
		20	1.23	16.23	92.4
		30	1.04	19.69	93.6
	80	0	21.03	-	-
		10	1.63	14.16	91.4
		20	1.45	15.71	92.3
		30	1.20	19.07	93.6

In this table, when the concentration of DIIMFK brand inhibitor was 30 mg/l, the protection efficiency was 93.6%. In conclusion, we can see that with increasing inhibitor concentration, corrosion rates decrease and protection level increases.

The protective effect of composite inhibitors is different, each of them has its own characteristics. As a result of the formation of a thin layer of inhibitor on the surface of the metal, the resistance of the metal to aggressive environments increases. In forming layers, composite inhibitors are preferred over smaller size inhibitors in terms of volume. Tested inhibitors showed a high level of protection of steel plates in acidic and neutral environments, reducing the deterioration process.

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