Synthesis of Corrosion Inhibitor IKPK-1 and its Application for Corrosion Protection of Steel ST20 in 1M HCL

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ABSTRACT

In this paper, the synthesis of IKPK-1 corrosion inhibitor based on p-phenylenediamine and crotonaldehyde was studied. When the initial feed was taken in a ratio of 1: 2, it yielded higher yields than those obtained in other ratios. The IR spectra of the obtained corrosion inhibitor were studied. The obtained corrosion inhibitor is a gravimetric method with different concentrations (100 mg / l to 400 mg / l) and inhibition efficiency at different temperatures (298, 313 and 323 K) and the braking coefficient (γ), the surface temperature (θ), the degree of protection (η) values were determined.

Keywords: p-phenylenediamine, crotonaldehyde, IR spectrum, IKPK-1, gravimetric method.

1.Introduction

Today, metal corrosion is one of the processes that prevent us from maintaining metal and metal-based devices in stable conditions. As a result, not only is humanity suffering morally, but it is also witnessing enormous economic losses. As an example of the economic damage of this process alone, we can cite the following figures: For example, an international study conducted by NACE (IMPACT 2016) concluded that the annual economic damage of the corrosion process in the world is $ 2.5 trillion. If we analyze this figure by country, it is about 3.4% of the average gross domestic product (GDP) of each country[1]. Various corrosion inhibitors have been proposed to prevent this process, but amino acid-based corrosion inhibitors are somewhat more effective than other corrosion inhibitors. The inhibitory effects of oligomers derived from a number of amine compounds, based on 2-propenylphenol on the basis of maleic anhydride, copolymers modified with diethylamine and diethanolamine, were tested for water-salt systems for St.3 steel[2]. lso, N, N, N ′, N ″, N ″ - pentamethyl diethylamine-N, N ″ -di- [tetraethylammonium bromide] 14-2-N (CH_3) -2-14 from oligomer steel materials from environmental corrosion used to protect[3], research on the synthesis of dodecandiamine (DDA) based monomer, N, N-diallyl-N-propargyl- (12-N'-formilamino) -1-dodecyl

ammonium chloride, homo- and copolymers, and the use of the synthesized chemical compound as a corrosion inhibitor carried out.

One of the allyl groups is copolymerized with propargyl or another allyl group in a 4: 1 ratio with a higher yield than the other ratios. The inhibitory effect of the obtained copolymer on steel by gravimetric and electrochemical methods in acidic and saline environments at a temperature of 60 ° C was determined.

Inhibitor concentration was obtained at 200 mg / l at different concentrations of hydrochloric acid; 81-99% in 1 M HCl, 97-98% in 4 M HCl, 87-93% in 7.7 M HCl, 68%, and 91% in 0.5 M H_2SO_4, 84% in 3.5% NaCl -92% inhibition efficiency[4]. The inhibitory properties of N, N-dipropinoxy methyl amine trimethylphosphonate were studied using potentiometric polarization curves and electrochemical methods. In this case, the temperature was studied at concentrations ranging from 298 K, 40 mg / l to 320 mg / l, which was classified as an inhibitor of the mixed type of inhibitor. It has a mixed inhibitory mechanism and is subject to the Frumkin adsorption isotherm[5]. The mechanism of inhibition of oligomer-type corrosion inhibitors has been studied not only for acidic media but also for solutions containing sodium chloride from 5 to 200 g / l. An oligomer based on epichlorohydrin and urea was used. According to the study, the pH of the acidic medium ranged from 3 to 6 because the H_2S was stored at 50 ± 0.50 g / l and the experiment was carried out at 20 ± 3 ° C for 24 h. visited Integration efficiency was studied using gravimetric and polarization methods [6,7].

2.Experimental Part

2.1. Synthesis of IKPK-1 brand corrosion inhibitor.

One of the most important parameters of this reaction is the temperature, which is maintained between 0 and 10 0C. The crotonaldehyde is first cooled for a few minutes and then slowly carried out while mixing with p-phenylenediamine. In this reaction, the most alternative commodity ratio is 1: 2, the yield is slightly higher and the purity of the resulting product is up to 89.45%.

The general chemical equation for this reaction is:

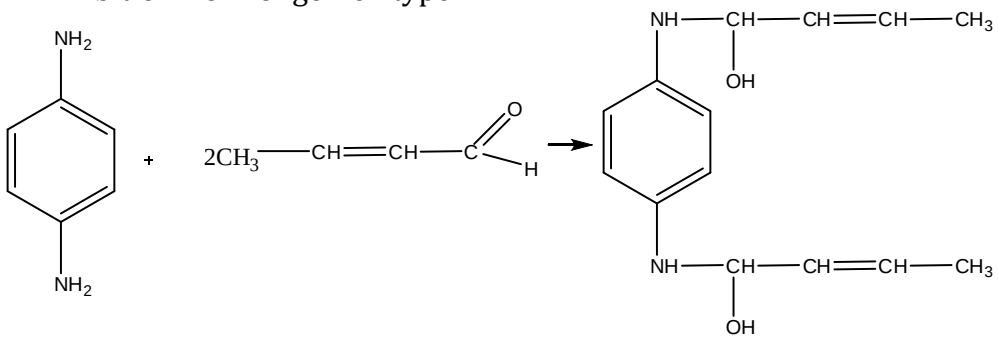

Table-2.1.

The yield of a product depends on the temperature and the proportion of initial substances

Crotonaldehyde + p-phenylenediamine ratio	Temperature ^{0}C	Yield %	Temperature ^{0}C	Yield %
1:1	0÷10	65.67	10≤t	45.35
1:2		89.45		80.36
2:1		78.15		61.26
1:3		55.62		32.56
3:1		69.43		42.25

As can be seen from the table, the highest yield was obtained when the temperature was in the range of 0 ÷ 10 ^{0}C and the molecular weight of the starting materials was 1: 2. With an increase in temperature to 10 ^{0}C, product yield also decreased significantly. In

conclusion, one of the important factors here after the temperature is, of course, the mole ratio of the initial substances.

2.2. Gravimetric method

The gravimetric method is one of the most widely used and effective methods for determining the rate of corrosion of metal under laboratory conditions. In this case, the test metal is determined by the difference between the mass loss in the solution with and without the addition of an inhibitor. We also conducted practical experiments at different temperatures and different concentrations to determine the corrosion rate of steel. We determined the corrosion rate of the steel sample taken for the experiment over a period of 24 to 240 hours. To this end, experiments were performed to determine the corrosion rate of a steel electrode at different concentrations and known temperatures, and the experimentally related corrosion rate (K) and weight loss (X) in inhibitory and non-inhibitory solutions were determined. based on the gravimetric method.

$$K = \frac{(m_1 - m_2)\cdot 1000}{S\cdot \tau_1} [г/м^2 \cdot \text{a day}] \quad (2.1),$$

$$X = \frac{K_{инг}}{K_0} \cdot 100, \quad Z=100 - X, \% \quad (2.2),$$

Where: m_1 is the initial weight of the metal sample, g: m_2 is the subsequent weight of the metal sample at exposure, g: S is the surface area of the sample taken for practical experiments, m_2: τ_1 is the exposure time, hours, days.

2.3. Determination of braking coefficient and level of protection

The values of the corrosion current thus found in different media and in solutions containing inhibitors were evaluated for the effectiveness of inhibitor film-forming and passivation; on the basis of formulas (2.2 and 2.3) the values of the braking coefficient g were found and the degree of protection was calculated Z%.

Braking coefficient $\gamma = \frac{i_c}{i_c^0}$ (2.2);

Degree of protection $Z = \frac{i_c - i_c^0}{i_c} 100\%$ (2.3)

We can see it here: i_c and i^0_c - corrosion currents in the environment with and without inhibitors.

2.4. Adsorption isotherm.

The process of adsorption is understood as the process of desorption of water molecules by inhibitor molecules adsorbed on the metal surface, as well as the process of exchange. From this we can see that the inhibitor adsorbs on the metal surface and covers the surface (θ) As the inhibitor concentration increases, the surface is also covered to a higher degree and the efficiency increases. θ is basically a magnitude indicating the effectiveness of the inhibitor, assumed to be up to 100. The adsorption isotherm was calculated based on the Langmuir and Temkin isotherms. The Langmuir adsorption isotherm is represented by the following mathematical equation (2.4).

$$\frac{C}{\theta} = \frac{1}{k_{ads}} + C \quad 2.4$$

Where C is the inhibitor concentration, θ is the surface coverage level, and k_{ads} is the equilibrium constant of adsorption. Mass loss and electrochemical results are measured by the adsorption characteristics of the process. The Temkin isotherm is represented by Equation (2.5).

$$\theta = \frac{-lnk_{ads}}{2a} - \frac{lnC}{2a} \quad 2.5$$

In the above equation, the adsorption equilibrium constant of the k_{ads} and the parameters acting on *a*.

3. Result and Its Discussion

3.1. IR spectroscopy analysis of corrosion inhibitor IKPK-1 based on crotonaldehyde and p-phenylenediamine

P-phenylenediamine is the primary raw material obtained for the synthesis of the IKPK-1 brand corrosion inhibitor. For this reason, IR-spectroscopic analysis of this substance was obtained, the purpose of which is to determine its structure by analyzing the composition of

the product obtained by reaction with croton aldehyde with high accuracy.

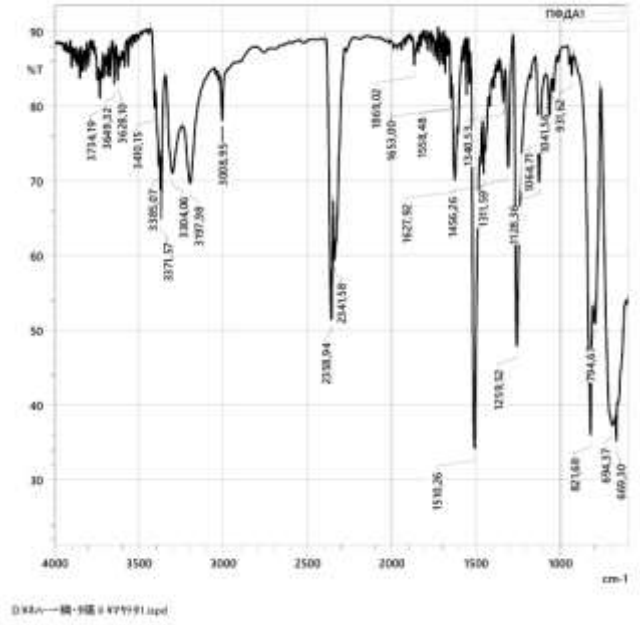

Figure 3.1. IR spectrum of p-phenylenediamine

In the IR spectral analysis, symmetrical and asymmetric valence oscillations of the N-H bonds of two amine groups are observed in the fields 3197, 3304, 3371, 3385, 3410 cm^{-1}. In the 794 cm^{-1} region, deformation oscillations of the amine group are observed. In addition, the deformation oscillation of the C-N-H bond is observed in the area 1627 cm^{-1}. We can observe the valence oscillations of the C-H bonds in the aromatic ring in the range of 3008 cm^{-1}. Deformation oscillations of C-H bonds in the plane of the ring are observed in the area 1128, 1064 cm^{-1}, off-plane vibrations are observed in the area 694 cm^{-1}.

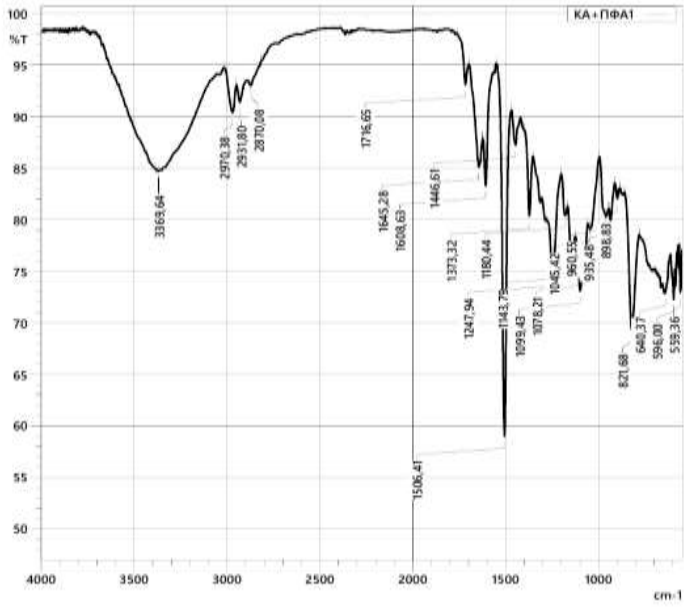

Figure 3.2. IR spectrum of corrosion inhibitor IKPK-1

The composition and structure of the obtained product were studied using IR-spectrometer (IK-Fure, SHIMADZU, Japan) technology in the range of 4000cm^{-1} -reverse field. In the analysis of the IR spectrum of this substance, valence oscillations are observed in

the field of wide and intensive absorption due to the oscillation of the O-H group (H bond formation) in the range of 3369.64 cm^{-1}. In addition, valence oscillations of the C-C bond are observed in the areas 1645,28-1608,63cm-1. We can observe the valence oscillations of the C-H bonds in the aromatic ring in the range of 3008 cm^{-1}. Deformation oscillations of C-H bonds in the ring plane are observed in the area of 1128, 1064 cm^{-1}, and off-plane vibrations are observed in the area of 694 cm^{-1}. Valence oscillations of the C-C bonds in the aromatic ring are observed in 1456, 1510 cm^{-1} areas, due to the distribution in the para-state the deformation oscillations of the 2 peaks in the 1667-2000cm^{-1} area and the ring in the 821cm^{-1} area. Valent oscillations are observed in the area of 1340 cm^{-1}, and deformation oscillations are observed in the area of 1259 cm^{-1}. Analysis of the IR spectrum shows that new carbon and nitrogen bonds have formed in the product.

3.2. Determining the inhibitory efficiency of a corrosion inhibitor

Table 3.1

The values of the braking coefficient (γ), the degree of complete surface coverage (θ), and the degree of protection (η) of the corrosion inhibitor IKPK-1 were determined by gravimetric method for 120 hours for 1M HCl medium at different concentrations and temperatures

inhibitor	**T,** (K)	**C,** (mg/l)	***W,*** gr/(sm^2·hour)	**γ**	**η,** (%)	**θ**
IKPK-1	**298**	-	**1.56**	-	-	-
		100	0.3896	6,86	75,56	0,7556
		200	0.3231	8,26	81.66	0,8166
		300	0.2012	10,14	85,53	0,8553
		400	0.1041	13,25	90,78	0,9078
	313	-	**1,68**	-	-	-
		100	0,4011	7,05	77,56	0,7756
		200	0,3232	8,36	82,46	0,8246
		300	0,2531	10,24	89,14	0,9214
		400	0,101	14,16	91,28	0,9128
	323	-	**1,79**	-	-	-
		100	0,5121	8,45	80,24	0,8024
		200	0,3562	11,46	84,52	0,8452
		300	0,2502	13,81	91,96	0,9196
		400	0,2234	14,16	93,22	0,9322

As can be seen from Table 3.1, the interaction efficiency increases with the increasing concentration of IKPK-1 corrosion inhibitor in a 1M HCl medium. The maximum inhibitory efficiency for the IKPK-1 brand corrosion inhibitor was at a concentration of 323 K and 0.4 g / l and was 93.22%.

IV.Conclusion

The synthesized IKPK-1 brand corrosion inhibitor was synthesized on the basis of local raw materials. The inhibitory efficiency of this corrosion inhibitor obtained was 93.22% at a concentration of 0.4 g / l.

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