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OBRTANING OF ANTICORROSION COATINGS BASED ON METHYL METHACRYLATE AND MONOETHANOLAMINE

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Abstract. In this research work, the optimal conditions of a new type of organic anti-corrosion coating based on methyl methacrylate, monoethanolamine and phosphoric acid and ED-20 epoxy resin were studied. At first, a new compound was synthesized based on methyl methacrylate, monoethanolamine and phosphoric acid, and its structure was studied by YAMR and PMR. The resulting mixture was mixed with ED-20 epoxy resin at different mass percentages of 10, 15, 20, 25 and 35%. The resulting mixture was mixed at a speed of 600 rpm and a temperature of 90 °C for 1,5 hours until a uniform mass was formed in the entire volume. The durability of the resulting coating was tested on a HUATECH scratch tester to assess hardness and scratch resistance. According to the obtained results, the coating thickness is one of the factors affecting the corrosion resistance. It was found that when the thickness of the coating is in the range of 120 μm, the level of stability is better than that of coatings of other thicknesses.

Keywords: methyl methacrylate, monoethanolamine, phosphoric acid, ED-20 epoxy resin.

Introduction.

At the same time, corrosion is causing great damage not only to industrial infrastructures, but also to cultural heritage[1]. We can say that there is no sector that does not suffer from the corrosion process, for example: energy, transport, chemical and chemical technology, food and drinking water system, oil and gas production industry, pharmaceutical, engineering, construction. did not Corrosion of metal and reinforced concrete structures, pipelines carrying hydrocarbons and water, air, land and sea transport infrastructure, bridges, piers, marine structures, chemical plants and nuclear reactors, power plants, electronic devices, body implants, cultural heritage ob causing unprecedented damage to objects, artifacts and many other structures[2,3].

If we talk about the economic damage of this process, as an example, we can cite the following figures, for example: according to the results of international research conducted by NACE (IMPACT 2016), the annual economic damage of the corrosion process worldwide is 2.5 trillion US it is concluded that it is $, if we analyze this figure in each country section, it is about 3.4% of the average gross domestic product (GDP) of each country. Searching for new types of anti-corrosion coatings with high efficiency and low cost, environmentally friendly in preventing the corrosion process remains one of the current directions of research[4].

The inhibition mechanism of anti-corrosion coatings is based on preventing or completely stopping the corrosion of the anti-corrosion coating obtained in certain concentrations by passivating the surface of metal and metal structures by various physical and chemical mechanisms [5]. In the next work[13], two layers consisting of a highly cross-linked polyethylene glycol diacrylate (PEGDA) bottom layer and a nanostructured poly(perfluorodecyl acrylate-co-ethylene glycol diacrylate) (P(PFDA-co-EGDA)) top layer were used. layered polymer coatings are synthesized with each other. Two-layer polymer coatings provide a protection mechanism as shown in Figure 1.

Functionalized montmorillonite as polymer coatings by Mo, Q. F. The main properties of this compound are fire resistance, high level of hydrophobicity, antibacterial activity and the ability to significantly improve the absorption of solar radiation, which is the reason for its use as an anti-corrosion coating. Exchanged with metal ions or metal oxides also provide improved super-hydrophobicity of the coating[6].

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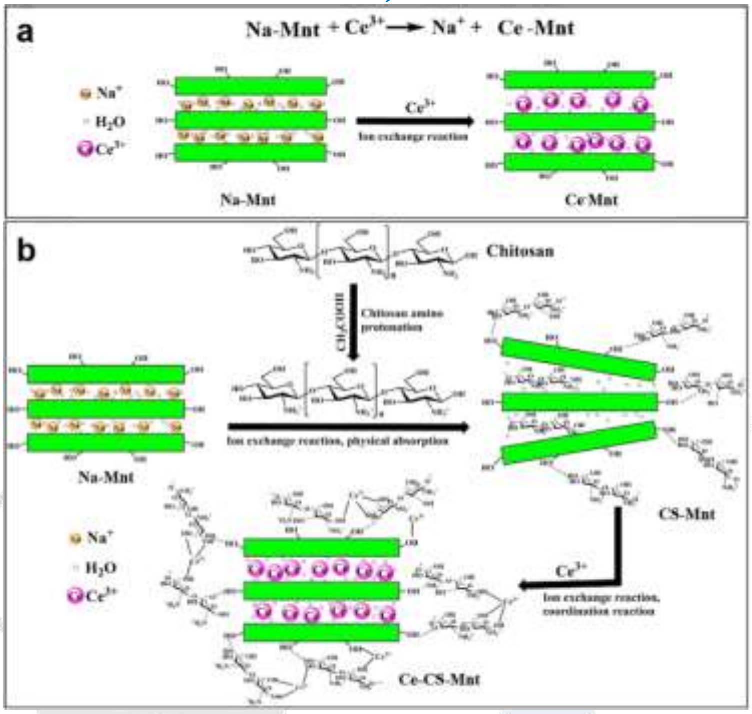

Fig. 1. Schematic presentations of the preparation steps: a Ce-Mnt and b Ce-CS-Mnt CS: chitosan; Mnt: Montmorillonite.

An electrostatic interaction can occur between Ce3+-Mnt and the aqueous polyurethane anionic matrix. Active Ce^{3+} released from Ce^{3+}-Mnt can also significantly increase the cross-linking density of polyurethane molecules with hydroxyl groups in polyurethane (Figure 1a). In addition, the surface of the polyurethane coating becomes rough due to the addition of Ce^{3+}-Mnt to its composition, which helps to increase the super-hydrophobicity of the coating. Pretreatment of Mnt with chitosan can increase the Ce^{3+} loading capacity of Mnt, and Ce^{3+}-chitosan-Mnt particles in polyurethane coatings can increase the hydrophobicity of the coatings (Figure 1b) [7-9].

Experimental part

Synthesis of anti-corrosion coating based on methyl methacrylate and monoethanolamine.

In this case, 1 mole of methyl methacrylate (102 g) and 2 moles (122 g) of monoethanolamine were placed in a round-bottomed flask with a volume of 500 cm3. In this case, the process was carried out at a temperature between 35 ^{0}C and 40 0C and a time interval of 48 hours. The reaction was cooled and the dark orange compound was obtained in 95.2% yield.

IR-spectrum of the substance obtained on the basis of methyl methacrylate and monoethanolamine.

The composition and structure of this obtained anti-corrosion coating was studied using IR-spectrometer (IK-Fure, SHIMADZU, Japan) technology in the range up to 4000 cm^{-1} area (Fig. 1).

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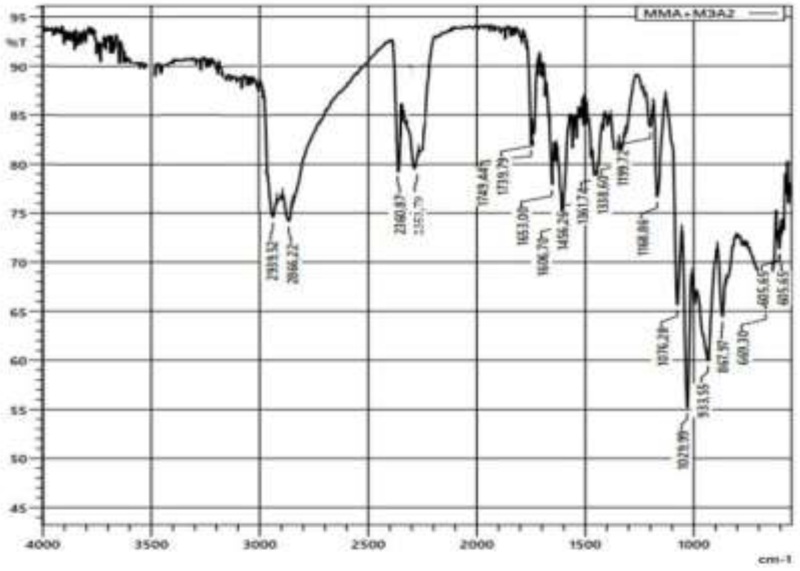
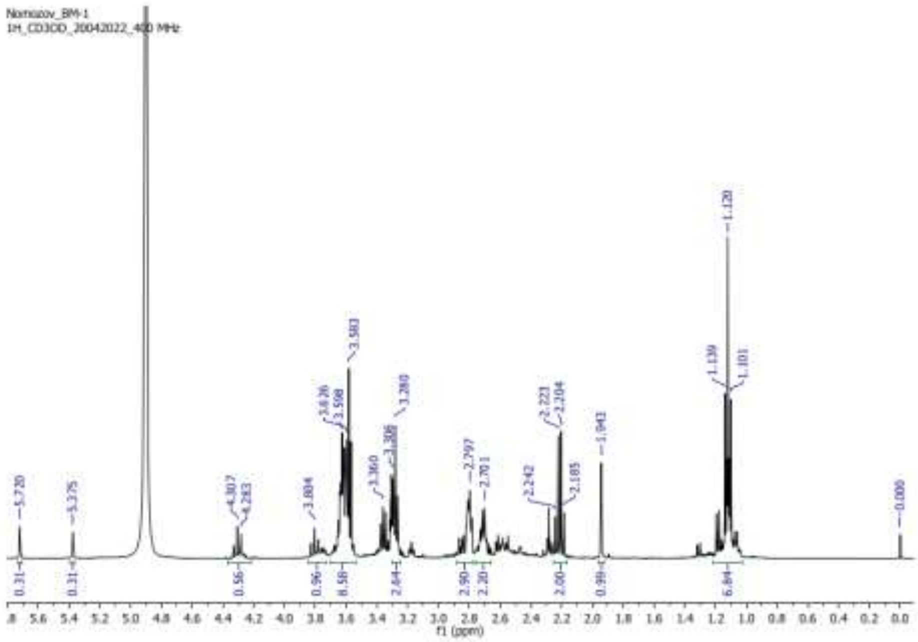


Figure 1. IR-spectrum of the substance obtained on the basis of methyl methacrylate and monoethanolamine

From the obtained IR-spectrum analysis, we can see that C-H in the methyl methacrylate monomer is in the area of 2989.66 cm^{-1}, -C=O is 1720.50 cm^{-1} for the double bond between carbon and oxygen, and 1300.02 for the carboxylate group. The valence vibrations of the cm^{-1} group were observed, the valence vibrations of the bonds for –O-CH_3 were observed in the 1637.56 cm^{-1} area, and a broad and intense absorption was observed. It can be seen here that valence fluctuations of specific bonds in the -OH or -C-N- bond were not observed in the original substance.

Analysis of results of YMR and PMR analysis. YMR and PMR analysis of oligomeric anti-corrosion coating based on methyl methacrylate and monoethanolamine was obtained and analyzed (Fig. 2).



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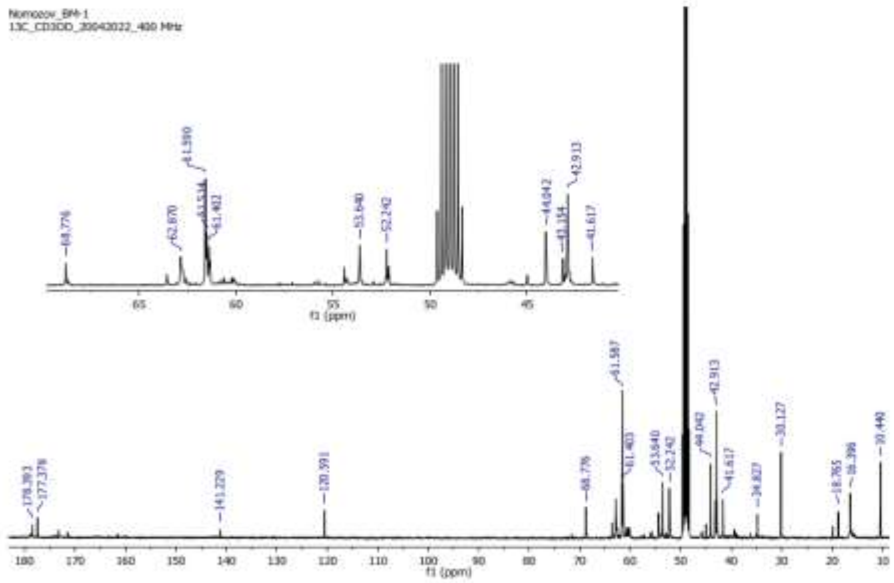
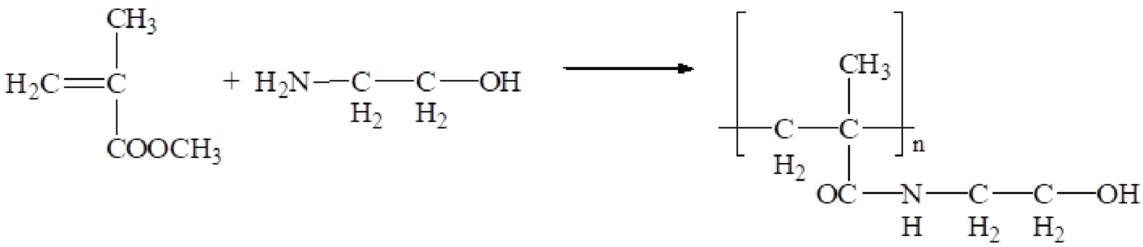


Figure 2. YaMR (A) and PMR (B) analysis of the obtained anti-corrosion coating

When analyzing the YAMR-spectrum (Fig. 2), proton signals spectrum PMR 1H (400 MGs, SD3OD, d, m.u., J/Gs) (N-5) 3.804 m.u., (N-7) 3.626-3.583 m.u., (H -8) 3,360 m.u., (N-4) 3,306-3,280 m.u., (N-6) 2,797-2,701 m.u., (N-1) 1,943 m.u. shows that Spectrum YAMR 13C (400 MGs, SD3OD, d, m.u., J/Gs) quaternary carbon (C-2) that is bonded to the NH group is 120.591 m.u., the carbon of the CH2 group bonded to the NH group (C- 6) - 42,913 m.u., carbon in the CH2 group (C-7) bonded to the OH group - 61,587 m.u., carbon in the CH3 group (C-4) bonded to O in the sample -53,640 m.u., quaternary in the substance carbon in the methylene group bonded to carbon (C-1) -30.127 m.u. shows . The obtained spectra confirm the structure of the synthesized substance.



The gravimetric method is one of the widely used and effective methods for determining the corrosion rate of metal in laboratory conditions. In this case, the metal samples being tested are determined based on the difference in mass loss in the state of coating and without coating. We also conducted practical experiments at different temperatures and concentrations to determine the corrosion rate of steel. We determined the corrosion rate of the steel sample taken for the experiment in time intervals from 24 to 240 hours. For this purpose, experimental work was carried out to determine the corrosion rate of the steel electrode at different concentrations and at certain temperatures, and the corrosion rate (K) and weight loss (X)) based on the gravimetric method.

$$K = \frac{(m_1 - m_2)\cdot 1000}{S\cdot\tau_1}[г/м^{-2}\cdot sutka] \qquad (1),$$

$$X = \frac{К_{инг}}{К_0}\cdot 100, \quad Z=100 - X, \% \qquad (2),$$

Here: m1 is the initial weight of the metal sample, g: m^2 is the weight of the metal sample after exposure, g: S is the surface area of the sample taken for the practical experiment, m^2: t1 is the exposure time, hours, days.

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Results and Discussion

Corrosion medium containing 0.5 M H2SO4+200 mg/l NaCl was used as a working solution to determine the level of corrosion protection of this obtained anti-corrosion coating. According to GOST 9.506-87 by gravimetric method and at temperature range of 30-70oC, the speed of movement of working solutions in the system was determined at 1.1 m/s.

Table 1

Corrosion rate of steel 20, g/m2•h Corrosion rate and protection levels of coated and uncoated steel samples in 0.5 M H_2SO_4+200 mg/l NaCl environment

Coating, %		Temperature, ^oC	Corrosion rate, g/m^2•h0,5 M H_2SO_4+200 mg/l NaCl	Protection level, % (Z)
MFS-1	Without Coating	30	0,0112	–
		40	0,0196	–
		50	0,0287	–
		60	0,0450	–
		70	0,0522	–
	10	30	0,0028	74,08
		40	0,0025	77,17
		50	0,0021	79,15
		60	0,0018	82,02
		70	0,0014	85,13
	15	30	0,0029	75,11
		40	0,0044	77,81
		50	0,0049	79,91
		60	0,0056	83,14
		70	0,0047	89,04
	20	30	0,0008	77,16
		40	0,0009	79,23
		50	0,0012	85,23
		60	0,0019	90,22
		70	0,0021	9237
	25	30	0,0011	91,88
		40	0,0018	92,18

		50	0,0026	93,13
		60	0,0037	94,05
		70	0,0027	94,95
	35	30	0,0010	89,12
		40	0,0016	90,15
		50	0,0025	91,08
		60	0,0035	92,17
		70	0,0027	91,85

The above table mainly shows the results of the study of the corrosion rate and protection levels of the hybrid coating in two types of corrosion (0.5 M H_2SO_4+200 mg/l NaCl) environments. According to the obtained results, it was determined that the protective efficiency of the hybrid coating in a corrosive environment is higher than that of other percentage coatings (0.5 M H_2SO_4+200 mg/l NaCl).

The analysis of the conducted experiments showed that the rate of corrosion and the degree of protection of the anti-corrosion coating depend on the concentration of the anti-corrosion coating and the ambient temperature. It can be seen that the corrosion rate of steel at a certain temperature decreases with an increase in the concentration of anti-corrosion coating.

Conclusion.

In this research work, the optimal conditions for obtaining an anti-corrosion coating based on methyl methacrylate and monoethanolamine and ED-20 resin were determined. It was found that the inhibition efficiency of this received anti-corrosion coating was 91.85% when studied by the gravimetric method. In addition, the mechanical strength of the coating was checked and studied and analyzed using the HUATECH scratch tester.

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Authors' Declaration

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are ours.
- Ethical Clearance: The project was approved by the local ethical committee at the Termez Institute of Engineering and Technology, and Tashkent Institute of Chemical Technology.

Authors' Contribution Statement

M.T.M: conducted the research, K.Kh.Kh: did the conception, design, drafting and responsible for the acquisition of data; A.R.A: did the interpretation; A.N.: participated in the conception, design, drafting and all the authors took part in revision and proofreading.

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