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ADHESION OF A THERMOREACTIVE EPOXY WATERFUL EMULSION FILM FORMER ON METAL

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Abstract:

Objective. The purpose of this study is to study the adhesive properties of samples of an aqueous emulsion of an epoxy thermosetting polymer, as well as to conduct comparative analyzes of the results of tests performed on water-emulsion epoxy thermosetting film-forming materials to determine adhesive strength. The influence of the concentration of the dry residue of the emulsion system on its adhesive strength is shown.

Methods. To achieve the goal of this study, a method was used to determine the adhesive strength of samples of an aqueous emulsion of an epoxy thermosetting polymer on a computerized electromechanical universal testing machine. As an emulsifier in a water-emulsion system based on an epoxy polymer, carboxymethyl cellulose was used in amounts based on the weight of the epoxy resin. To accelerate the hardening of the water-based epoxy film former, the curing accelerator UP-606 was used in the amount of 1.2% by weight of the epoxy resin.

Results. The results of experiments on a computerized electromechanical universal testing machine to determine the adhesive properties of samples of an aqueous emulsion of an epoxy thermosetting film former showed that the highest adhesive strength of the hardened coating of an aqueous epoxy polymer emulsion on metal reaches up to 7.83 MPa at a dry residue concentration of the emulsion system of 60 percent.

Conclusion. The results obtained by the method for determining the adhesive strength of samples of an aqueous emulsion of an epoxy thermosetting film former on a computerized electromechanical universal testing machine indicate that this water-emulsion composition based on epoxy resin can be used as a film former, or as a paint and varnish matrix for metals.

Keywords. Anti-corrosion coating, water-based emulsions, epoxy resin, thermoset polymers, adhesive strength.

Introduction. In traditional paints and varnishes, about 50% by weight of the material are organic solvents, which are irretrievably lost during the production of coatings. The toxicity of most of them and the fire and explosion hazard necessitate the installation of powerful ventilation systems in paint shops and additional installations for cleaning gas emissions into the environment. One of the ways to solve the problem of excluding organic solvents from formulations of paints and varnishes is the creation of aqueous film-forming systems [1].

Water-based paints and varnishes can be divided into two groups: water-dispersion film-forming systems, which are an emulsion of the film-forming agent in water, and water-soluble film-forming systems, which are an aqueous solution of the film former. Water-based paints and varnishes of both types have a relatively high surface tension, which dictates the need for special preparation of the metal for painting to ensure uniformity of the coating and its good adhesion [2].

Reactoplast polymers form a stitched, branched polymer network as a result of cross-condensation or migration polymerization of low molecular weight resins. The resulting polymer is thermoreactive because it has a three-dimensional branched molecular structure. Therefore, in any case, in order to obtain new polymer materials that can exhibit high physical and mechanical properties, it is necessary to correctly choose the conditions of the reaction of combining oligomers with reactive active groups with each other [3]. Some literature sources explain the need to control the stoichiometric proportions of the mixture of oligomers with reactive active groups and the effect of catalysts and initiators used in the production of bicomponent polymer systems. It is very important to optimize the properties of polymer composite materials. The study of optimal stoichiometric ratios guarantees the improvement of the physico-chemical and mechanical properties of the final product [4; 5].

In recent years, the activation of the polymer industry in the fields of chemistry and technology and the need for new materials in the national economy have caused a several-fold increase in the requirements for polymer materials. In this sense, polymer materials are increasingly taking the place of traditional materials such as metal, wood, glass, etc. Plastics are materials that are light, flexible, easy to process, resistant to chemical effects, economically cheap and technologically, they can be used in many directions, and in many cases they are the death of traditional materials. can replace and even exhibit significantly better properties than theirs. The fact that all plastic mass-based materials can be used in various fields of industry, their specific thermal properties, technological parameters in processing or the ease of processing methods, the fact that the part obtained has clearly visible physical and mechanical dimensions make them in engineering technologies. is important in application [6; 7].

Reactoplast polymers are organic polymers that have a network-like molecular structure, and therefore do not soften and liquefy under the influence of temperature, or do not dissolve in any chemical substance. Their thermomechanical properties differ sharply from those of thermoplastic polymers, because at high temperatures, thermoset polymers soften like thermoplastic polymers and, instead of being diluted, go into a highly elastic state at high temperatures after the glass transition temperature. Continued increase in temperature causes further increase of elasticity property, and then destruction of the material due to temperature effect occurs [8]. Materials based on thermoreactive polymers or polymer composites are obtained with high density, solid, resistant to aggressive environments, resistant to various aggressive gases and vapors of aggressive substances. Therefore, they are very convenient to use to protect all types of surfaces. However, in terms of elasticity and impact resistance, it exhibits lower performance than most thermoplastic polymers. But the ability of thermoreactive oligomers to form polyblends with other oligomers and any organic and inorganic fibrillar materials allows to obtain new structural and industrial materials with excellent mechanical and physicochemical properties. Such properties of thermoreactive polymers further expand their field of application [9].

Researchers of the Tashkent Research Institute of Chemical Technology studied the formation of a gel fraction of an epoxy polymer, which is in the form of a dispersed phase in an aqueous medium. Studies have been carried out on the effect of the accelerator for curing epoxy polymers UP-606 on the duration of hardening of the epoxy film former of water-based paint. It was found that the formation of a coating from an aqueous emulsion of epoxy resin occurs as a result of its coagulation on a substrate. According to the conducted studies, the change in the duration of hardening of the epoxy film-forming agent on an aqueous emulsion was determined depending on the amount of curing accelerator added. The water emulsion epoxy cured at 293 degrees Kelvin. To determine the effect of the accelerator for curing epoxy polymers UP-606 on the duration of curing, the maximum degree of hardening of the epoxy film-forming agent was conditionally accepted. This cure rate was 87% of the gel fraction in the cured epoxy film former. The Soxhlet method was used to determine the content of the gel fraction in the polymer [10].

As a result of the literary analyzes and laboratory studies carried out on the basis of the Tashkent Scientific Research Institute of Chemical Technology, a method was developed for obtaining a water-emulsion-type film former based on epoxy resin. The method for obtaining an epoxy phase emulsion in an aqueous medium is based on the emulsification of epoxy oligomer molecules with carboxymethylcellulose.

Methods. To achieve the goal of this study, a method was used to determine the adhesive strength of samples of an aqueous emulsion of an epoxy thermosetting polymer on a computerized electromechanical universal testing machine. Carboxymethylcellulose was used as an emulsifier in a water-emulsion system based on an epoxy polymer. To accelerate the hardening of the water-based epoxy film former, the curing accelerator UP-606 was used in the amount of 1.2% by weight of the epoxy resin. Table 1 shows the composition of the prepared samples of aqueous emulsion of epoxy resin.

Samples of the epoxy-water emulsion system were prepared in the laboratory as follows: a 200 ml glass beaker was placed in a water bath. Epoxy resin is added to the beaker in the amount depending on the composition shown in Table 1. Next, the heating of the water bath is turned on and the thermostat is adjusted to 45 °C. After the temperature of the resin, the resin equalizes with the temperature of the water bath, the stirrer is lowered into the beaker. The stirrer speed should be in the range of 60-80 rpm.

Table 1

Composition of samples of epoxy aqueous emulsion

Sample numbers	Mass fraction of epoxy resin in the emulsion system, %	Emulsifier concentration by weight of epoxy resin, %	The concentration of the curing accelerator from the mass of epoxy resin, %
1	50	0,5	1,2
2		1,0	
3		1,5	
4		2,0	
5	60	0,5	1,2
6		1,0	
7		1,5	
8		2,0	
9	70	0,5	1,2
10		1,0	
11		1,5	
12		2,0	

Results. Polymeric materials based on organic macromolecular compounds are often used as adhesives, coatings and binding components for polymer composite materials. Based on the above data obtained from a short literature review, the task was to determine the adhesive strength of the obtained samples of a water-emulsion film former based on an epoxy polymer.

The obtained samples of epoxy emulsion, the composition of which is shown in table 1, left in closed containers for 720 hours. After that, work began on determining the adhesive strength of each sample.

Metal plates were used to test the adhesion strength of water-emulsion system samples based on epoxy polymer. The tests were carried out at room temperature after 20 hours of bonding two metal plates using an epoxy emulsion. The following table shows the adhesion strength of epoxy aqueous emulsion to metal (Table 2).

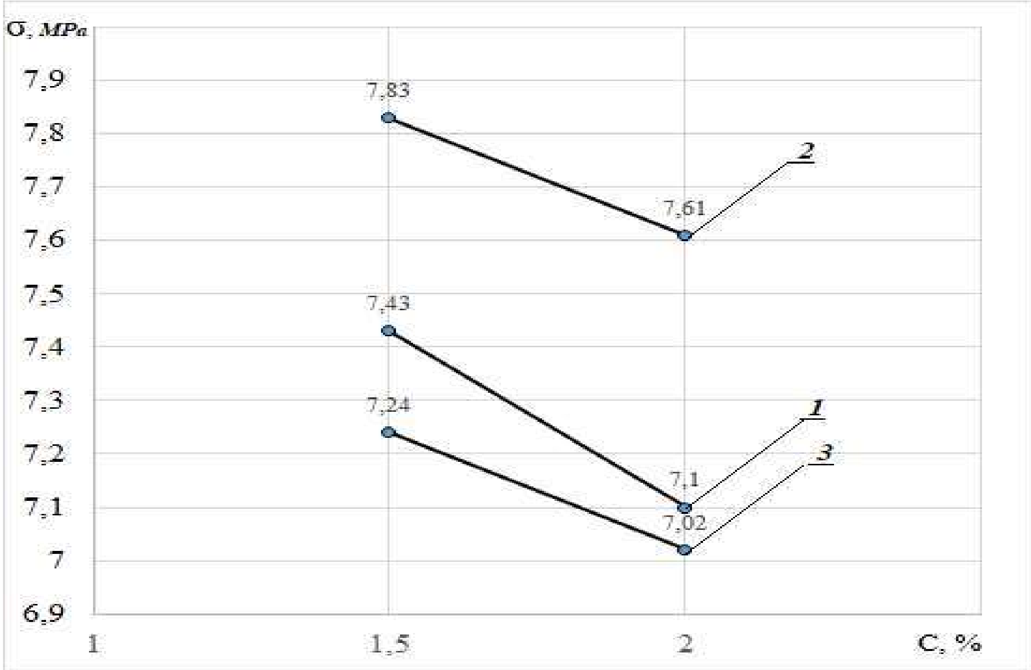
Table 2

Adhesion strength of epoxy water-emulsion systems

Sample numbers [table 1]	Mass fraction of epoxy resin in the emulsion system, %	Emulsifier concentration by weight of epoxy resin, %	Adhesion strength, $\sigma_{adhesion}$, MPa
1		0,5	destruction of the emulsion system
2	50	1,0	destruction of the emulsion system
3		1,5	7,43
4		2,0	7,10
5		0,5	destruction of the emulsion system
6	60	1,0	destruction of the emulsion system
7		1,5	7,83
8		2,0	7,61
9		0,5	destruction of the emulsion system
10	70	1,0	destruction of the emulsion system
11		1,5	7,24
12		2,0	7,02

Discussions. The data obtained from the results of testing the adhesion strength of samples of aqueous emulsions containing epoxy oligomer with concentrations of 50, 60, 70 percent of the total mass of the emulsion system are presented in table 2. The table made makes it possible to compare the performance of twelve samples. From the table it can be seen that all samples of the emulsion system with concentrations of carboxymethyl cellulose 0.5 and 1.0 percent were subject to destruction in the interval of 720 hours. Samples of the emulsion system with concentrations of carboxymethyl cellulose 1.5 and 2.0 percent did not lose the emulsion appearance. Thus, adhesion tests were carried out on samples of emulsion systems with concentrations of carboxymethylcellulose 1.5 and 2.0 percent by weight of the epoxy resin. According to the indicators of the samples that retained the emulsion appearance, a diagram of the dependence of the adhesive strength of the samples of water-emulsion systems of epoxy resin on the concentration of the emulsifier -

carboxymethyl cellulose was compiled. This diagram is shown in Figure 1.



1 - a sample of the emulsion system containing 50% epoxy resin; 2 - a sample of the emulsion system containing 60% epoxy resin; 3 - a sample of the emulsion system containing 60% epoxy resin.

Figure 1. Diagram of dependence of adhesive strength - σ of epoxy aqueous emulsion on emulsifier concentration

The chart in Figure 1 shows that as the emulsifier concentration increases from 1.5 percent to 2.0 percent, there is a trend towards a decrease in adhesive strength for all three samples of water-based epoxy resin systems. An increase in the adhesive strength of the samples is observed with an increase in the concentration of epoxy resin in the emulsion system from 50% to 60%. However, sample number 3 with a 70% epoxy concentration shows a low adhesive strength compared to samples number 1 and 2. The reason for this may be due to an increase in the concentration of the emulsifier. an increase in the concentration of the emulsifier in the emulsion system prevents the timely release of water from the emulsion system and in the system there is a partial non-solidification of the dry residue.

Conclusion. Thus, the experiments carried out in this article indicate the possibility of obtaining a water-emulsion system based on epoxy resin. The possibility of using carboxymethyl cellulose as an emulsifier of an epoxy aqueous emulsion is shown. According to the results obtained, it was revealed that the optimal concentration of carboxymethylcellulose will be 1.5 percent by weight of the epoxy resin. It was determined that the highest adhesive strength among the samples of an aqueous emulsion of epoxy resin was shown by sample number 7, which includes 60 percent of epoxy resin and 1.5 percent of carboxymethyl cellulose by weight of epoxy resin.

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SYNTHESIS OF A NON-ISOCYANATE URETHANE OLIGOMER BASED ON PHTHALIC ANHYDRIDE

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Abstract:

Objective. The purpose of this work is to study the method of synthesizing an oligomer containing urethane groups without the isocyanate method, as well as to conduct an infrared spectroscopic analysis to determine the formed chemical bonds and functional groups in the resulting urethane oligomer. The

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