Effective Protective Polymer Materials Stable to Destructive Factors

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***Abstract* – To protect of various objectsfrom destruction under the action of a(biotic) and man-made destructive factors, epoxy polyurethane compositions were created using an epoxy base, a polyurethane prepolymer modified with [Cu,Zn]organometallic compounds, which have high indicators of adhesion, cohesion, resistance to biocorrosion, UV radiation, chemical agents and wear resistance, waterproofing.**

Key words – epoxy polyurethane composition, adhesion, destructive factors, stability

Introduction

The use of new polymer more effective materials as protective coatings for anti-corrosion protection of object structures ensures: reliable prolonged operation of metal, reinforced concrete structures, buildings and structures under conditions of dynamic abiotic, biotic and man-made loads; practically eliminating the destruction of concrete surfaces protected by polymer materials from the alternating effects of positive and negative temperatures and the duration of their operation; restoration of the mass of damaged metal, reinforced concrete, and concrete structures and guaranteed prolonged operation of objects after repair works.

Polymers based on epoxy resins have high operational properties, namely: high adhesion to metals, concrete and other materials, but they are fragile and short-lived for use as adhesives, coatings. Technological and physico-mechanical properties of compositions based on epoxy resins can be adjusted in a wide range by combining them with some polymers.

To protect materials and structures of various types from destruction under the action of a (biotic) and man-made destructive factors, epoxy polyurethane compositions (EPC) were created using an epoxy base (EP), polyurethane prepolymer (PFP) with terminal isocyanate groups, modified metal [Cu, Zn] organic compounds and an amine hardener (AH), which have high adhesion, cohesion, resistance to biocorrosion, UV radiation, chemical agents, and are waterproof and wear-resistant.

Polyurethane prepolymer is obtained on the basis of polyurethanes of different structure and composition by combining linear polyurethane (LPU) with terminal isocyanate groups, obtained by the interaction of 2,4(2,6)-toluenediisocyanate (TDI) or hexamethylenediisocyanate (HMDI) with 2,4-pentanedionate (PD) transition metal Cu(II) or Zn(II) (molar ratio of DIC: PD=10-15:1), with the addition of a polyester component, polyoxypropylene glycol, L-1000. Next, reticulated polyurethane (RPU) is introduced into the system based on a prepolymer - a product of the interaction of TDI and primethylolpropane (TMP) with subsequent interaction with L-1000.

Polyurethane modifier $PU_{30/70}$ is obtained by combining linear and mesh polyurethanes (mass ratio LPU:RPU=30:70). The basis of the epoxy composition is modified with the obtained PU30/70 in the ratio of EP:$PU_{30/70}$ = 100:10-50 parts by mass, for hardening of which an amine hardener is used (mass ratio EP:AH=100:20).

The results of the study of the influence of a complex atmospheric factors: UV and IR radiation (sunlight), elevated temperature (50±5)^{o}C and air humidity (96%) on EPC based on the aromatic diisocyanate TDI showed (Table 1) that the samples somewhat lose strength and change color. Research has also established that all EPC samples modified with polyurethanes of different structures and compositions based on aliphatic diisocyanate HMDI are resistant to UV and IR radiation. The stability of the unmodified source EP is lower than EPC [1-3].

And in general, as the research results showed, EPKs modified with polyurethanes of different structures and different compositions with the content of organometallic modifiers (MOM) are characterized by an increase in adhesive/cohesive properties.

Table 1

The results of the study of the influence of a complex atmospheric factor on the properties of EPS and EP

NN	EPC	Physical-mechanical properties			
		Cohesive strength original samples EPC		Cohesive strength samples EPC after the climate chamber	
		σ, MПa	ε,%	σ, MПa	ε,%
1	EPC /Cu	43,8	80	40,5	70
2	EPC /Zn	43,8	80	39,5	65
3	EP	33,7	70	23,4	60

Studies of fungicidal properties showed that before the beginning of the study, one colony of mycodestructors (mold fungi) up to 1-2 mm in diameter, spore-bearing, was noted on the samples of the original EP, from which they were isolated and identified *Penicilium cyclopium.* .

Table 2

The results of the study of the fungicidal properties of EPC and EP under the action of mycodestructors

№	ЕПС	DIC		MOM		Evaluation of the effect of mycodestructors (fungi growth, points)			
		TDI	HMDI	Cu	Zn	On samples before the start experi-ment	In the wet camera	On the nutrient medium higher without infection	On the nutrient medium higher than infection
2	ЕПС/Cu	25	-	+	-	0	0	0	0
3	ЕПС /Zn	30	-	-	+	0	0	0	0
7	ЕПС/Cu	-	20	+	-	0	0	0	0
8	ЕПС /Zn	-	10	-	+	0	0	0	0
11	EP	-	-	-	-	1	1	1	2

Before the start of the study, mold fungi were not detected on the EPA samples containing organometallic modifiers (Table 2). All EPC samples with MOM content have fungicidal properties, their fungal resistance is 0 points in a humid chamber, on a nutrient medium without additional infection and on a nutrient environment with infection. An increase in the colony was noted on the initial EP sample.

A comparison of the parameters of the physical and mechanical properties of the original EP and EPK samples and samples after the action of mycodestructors (mold fungi) shows that EPC/Zn and EPC/Cu have resistance to biodegradation, unlike EP.

It should be noted that the fixation of functional compounds of MOM [Zn,Cu] in the macrochain of the polymer makes it impossible for them to diffuse to the surface of the material with their subsequent removal and, thus, prolongs the protective functions of epoxy-polyurethane compositions, which is an advantage of the latter in relation to similar materials, both domestic and imported production/

The results of the study of the resistance to chemical environments of the epoxy polyurethane composition obtained by the proposed method show that the obtained composition is resistant to water, oil, gasoline, dilute acids and alkalis (Table 3).

Table 3

The results of the study of the resistance of EPC to the action of chemical environments

NN	EPC	DIC		Weight gain of samples of EPC when exposed to chemical agents for 90 days, wt. %				
		TDI	HMDI	water	auto-mobile oil	Aviati of on gasoline	20 % solution H_2SO_4	20 % solution KOH
2	EPC /Cu	25	-	2,00	1,1	1,20	2,80	3,30
3	EPC /Zu	30	-	2,10	1,2	1,20	2,60	3,20
7	EPC /Cu	-	20	1,70	1,02	1,0	1,80	2,30
8	EPC /Zu	-	10	1,80	1,07	1,03	1,60	1,95

The achievement of the set goal - the creation of effective polymer materials for the protection of structures and objects of various types from destruction under the action of a(biotic) and man-made destructive factors is ensured by the proposed method of obtaining an epoxy-polyurethane composition modified with polyurethanes of different structures and different compositions with the content of organometallic modifiers, MOM[Zn,Cu], which makes it possible to controllably vary the structure, and therefore the properties of the epoxy polyurethane macromolecule.

Owing to this, EPC for the protection of various types of surfaces from destruction under the influence of a(biotic) and man-made destructive factors has high indicators of adhesion, cohesion, resistance to biocorrosion, to UV radiation, to chemical agents, has waterproofness, wear resistance and high indicators of operational properties.

Epoxy polyurethane compositions are recommended for use in the chemical, light, food industry, at enterprises of the ministries of construction, architecture and housing and communal services, infrastructure, as protective compositions, adhesives and binders that have resistance to the action of microorganisms - biodestructors, waterproofing properties and resistance to UV – irradiation, resistance to chemical agents.

References

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