Synthesis, properties and application of butanolic ethers of condensation products of diphenylolpropane and formaldehyde

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Abstract – The main purpose of this work was to develop methods for the synthesis and modification properties of butanolic ethers of condensation products of diphenylol-propane and formaldehyde (BDPO), and well as creating based on them corrosion-resistant coatings for use as a means of sofeization. Coatings on the basis of the obtained resins are characterized by an excellent complex of physical and mechanical properties, good adhesion to metals and their use allows to prevent the formation of under film corrosion on the metal surface.

Key words – diphenylolpropane, butanol, formaldehyde, BDPO, coatings, corrosion-resistant coatings.

I. Introduction

Corrosion protection of expensive, responsible metal products and structures can prevent devastating impact on their environment. When protecting large oversized pieces of metal the most technologically advanced and cost-effective is the use of paints (coatings), the most common are putting on the solvent based, especially from a chlorinated polyvinyl chloride, polyvinylidene fluoride, polyurethane and epoxy- phenol- formaldehyde derivatives, and more. This along with various traditional primer, varnishes, paints and enamels recently spread means "sofeizatsiyi" based on phenolic derivatives, which are able to penetrate into the pores of the metal, removing moisture and oxygen, completely exclude the occurrence of corrosion protective layer, and create a stable and solid surface [1].

The main drawback so far developed coatings is the presence in their structure of organic solvents (up to ~ 68 %) and other organic volatiles (OV). Their presence causes a danger of putting both the source and use of coatings based on them. Entering the EU Directive 2004/42/SE restrictions on content in paints, as well as the use of expensive solvents led to the need to develop environmentally friendly resins that do not contain incorporates toxic solvents or fire safe.

II. Discussion of Results

Among the phenolic derivatives dyfenilolpropan (DFP) is the most environmentally friendly and safe, and almost does not contain residues of toxic phenol. Chemical properties of DFP similar to phenol, but it is the most effective antioxidant due to the presence in its structure of two -OH groups that can interact with active radicals to form less active. In this regard, DFP and condensation products of aldehydes can form the basis for the development of corrosion-resistant materials.

To create a corrosion-resistant coatings we have conducted research on developing methods for the synthesis and modification of the properties of esterified condensation products of formaldehyde and DFP. The first stage in the molar ratio of formaldehyde DFP and 1:3 and a temperature of 20 – 30^{0}C with the release of 75% were obtained metylolni derivative DFP. According to the literature, the corresponding synthesis method metylolnyh derivatives may be obtained mixture dominated by di-and trymetylolnyh derivative DFP, the structure (Fig. 1) of which was confirmed by the corresponding IR spectroscopic studies [2].

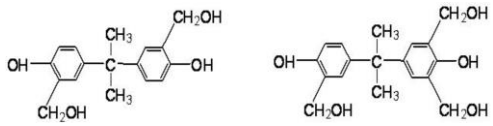

Fig. 1. Chemical structure of di-and trymetylolny derivative diphenylolpropane

The next step was conducted reaction esterification obtained metylolnyh derivatives butyl alcohol. Esterification reaction takes place in an alkaline medium (pH = 8-9) at a temperature of 90-120°C. Simultaneously along esterification polycondensation reaction happens through interaction with each other metylolnyh groups. This is evidenced by increased viscosity of the reaction mixture during the synthesis. According to the literature review [3] and held infrared spectroscopic studies obtained butanolizovany derivatives dyfenilolpropan-formaldehyde oligomers (BDFO) can be characterized by the following structure on the Fig. 2.

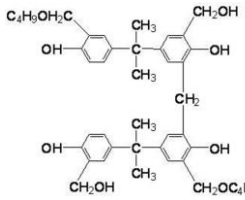

Fig. 2. Chemical structure of butanolizovanyh derivatives dyfenilolpropan-formaldehyde oligomers

These oligomeric products BDFO (in butanol solution of solids 59-60 %) at room temperature forming a transparent coating is not soluble in water, alcohols and other organic solvents. However, a significant drawback of such coatings have low elasticity (not less than 4 mm, according to GOST 6806-73), which significantly limits the scope of their use (see table 1).

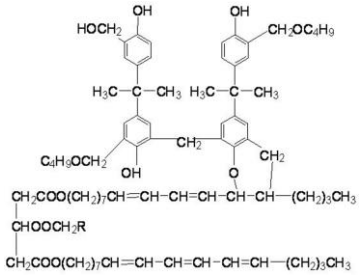

Fig. 3 Chemical structure of modified film-forming based on the BDFO

TABLE 1

PHYSICAL AND MECHANICAL PROPERTIES ARE NOT MODIFIED AND MODIFIED FILM-FORMING BASED ON THE BDFO

Significative	BDFO	BDFO containing 2 wt. % SO	BDFO containing 5 wt. % CF
Color iodometric scale, mhI_2/100	is not ≥ 5	is not ≥ 5	is not ≥ 5
Appearance	Transparent light yellow substance	Transparent light yellow substance	Transparent light yellow substance
Viscosity by viscometer VZ- 246 type with a diameter of 4 mm nozzle at (20 ±0,5) ^{0}C, s	120	94	96
Mass fraction of volatile compounds	59-60	70	75
Time of coating at a temperature of (20 ± 5) 0C, h	17-20	17-20	17-20
Flm bending elasticity, max, mm	4	1	1
Hardness by pendulum film flatware M -3, conv	0,58	0,62	0,57
Adhesion film, no more, points	1	1	1
Clean	Clean, without mechanical impurities	Clean, without mechanical impurities	Clean, without mechanical impurities
Solubility	In alcohol, toluene, xylene	In alcohol, toluene , xylene	In alcohol, toluene, xylene
Corrosion protection	Resistant to corrosion	Resistant to corrosion	Resistant to corrosion

The presence in the structure BDFO free metylolnyh groups enables its modification. To do this, we applied the reaction metylolnyh groups with unsaturated fatty acid residues fragments of triglycerides (fats of vegetable or animal origin) to form hromanovyh rings, as shown in the Fig. 3.

To modify BDFO used sunflower oil (SO) and chicken fat (CF). Particularly attractive is the use of chicken fat, because it is waste, is an environmentally friendly product that contains incorporates aliphatic fragments with the predominant content of C_{14}-C_{18} unsaturated, monounsaturated and polyunsaturated fatty acids.

Modification BDFO performed by adding CF and SO in an amount of 0.5 wt. % to 5 wt. %. With careful stirring and temperature 110-117^{0}C for 20-30 minutes. As a result of this modification obtained transparent resin light yellow (solution in butyl alcohol), which at room temperature forming a colorless coating with a good set of physical and mechanical properties, which are listed in table 1.

Conclusion

Use as CF and SO as modifier increases the elasticity of the film coating of 1 mm and the dry residue filn-forms increase to 70-75%.

Corrosion resistance of coatings on the basis of the resins was evaluated according to GOST 9.908-85 "Methods for determination of corrosion resistance". It was found that the synthesized oligomers can be used to obtain a thorough anticorrosive layer or as a separate coatings to protect metal products.

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