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Synthesis of Organosilicon Polymers Based on Carbamide Formaldehyde Resin

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ABSTRACT

The article presents the synthesis of organosilicon compounds based on industrial secondary raw materials of urea-formaldehyde resin and tetraethoxysilane. The structural characteristics of the synthesized hydrophobic polymer have been studied. Compositions of hydrophobic compositions based on synthesized poly (oligomers) have been developed and tested in concrete mixtures.

KEYWORDS: Tetraethoxysilane, Urea, Formalin, Hypane, Acrylic Emulsion, Water Glass, Hydrophobization, Reaction Efficiency, Concrete, Hydrophobic Composition.

INTRODUCTION

Today, one of the urgent tasks is the creation of new generation protective equipment with complex properties based on the achievements of modern technologies in the field of increasing the moisture resistance of building materials and structures. Therefore, it is important to create a new generation of complex chemicals based on innovative technologies in the creation of moisture-resistant hydrophobic materials and their use in various fields. In this regard, the synthesis of new organosilicon polymers, the study of their properties and the creation of a technology of moisture-resistant compositions on their basis is an urgent task.

Today, much attention is paid to the creation of highly effective organosilicon compounds to protect building materials from aggressive environmental influences and, on their basis, to increase the moisture resistance of building structures and materials. This is due to the fact that organosilicon compounds have the property of film formation and the film, in turn, being a part of the processed material, consists of alternating silicon and oxygen atoms.

THE MAIN PART

In addition, organosilicon compounds, on the one hand, bind to the workpiece through an oxygen bridge, and on the other hand, they reduce the wetting of the object due to the presence of non-polar molecular alkyl or aryl radicals [1,3]. Accordingly, to carry out targeted scientific research in the fields, including the creation of models of the mechanisms of physical and thermochemical processes occurring in protective coatings under the influence of moisture; development of compact, accurate and fast methods for assessing the effect of hydrophobic fillers on the moisture resistance of building structures and materials; Creation of a new generation of highly efficient hydrophobic coatings based on widespread natural resources is one of the important tasks.

In connection with the above, tetraethoxysilane and secondary industrial raw materials were used to synthesize new types of polymer compounds, create new hydrophobic compositions, obtain hydrophobic building materials and expand the range of the most widely used organosilicon compounds.

We have synthesized organosilicon polymers based on urea-formaldehyde resin with tetraethoxysilane. As a new component, formalin is first mixed with urea in the presence of a binder tetraethoxylane ($Si(OCH_2CH_3)_4$) and an emulsifier until it becomes gummy. The reaction was carried out in a reactor at a temperature of 250C in various ratios. In this case, the reaction of urea with formaldehyde proceeds violently. Therefore, it is advisable to mix the crosslinking agent and the emulsifier prior to adding formalin to the urea. The formation of resin in the form of mono and dimethylol is controlled by the ratio of the reagents.

The properties of urea-formaldehyde resins, in particular their stability, can be improved by adding some additives. In this way, resins with desired properties can be obtained.

We also studied the ratio of reagents in the joint polycondensation of urea, the duration of the reaction and

the effect of temperature. The dependence of these parameters on the molecular weight of the oligomer was analyzed.

The formation of tri- and tetramethylolureas in the reaction leads to the formation of an insoluble mass. The optimal modes of parameters were selected based on the weight of the dry residue during the firing of the obtained oligomer.

In addition, the solubility and viscosity of the oligomer change with an increase in the amount of TEOS solvent and the degree of crosslinking, which indicates its cryoscopically determined molecular weight and residual dry weight remaining upon combustion, taking into account its use under various conditions.

Table 1. Molecular weights of the oligomer at different temperatures and quantitative values of the dry residue

Indicator		Dry residue and calculated molecular weight,%			
		I	II	III	IV
Temperature, in ^{0}C, reaction time-1 hour	20	37,1/780	31,5/770	34,6/600	32,7/450
	30	36,4/692	31,1/666	34,0/590	31,4/443
	40	36,0/606	30,7/660	33,7/547	31,0/430
	50	35,3/578	30,3/554	33,2/480	39,3/424

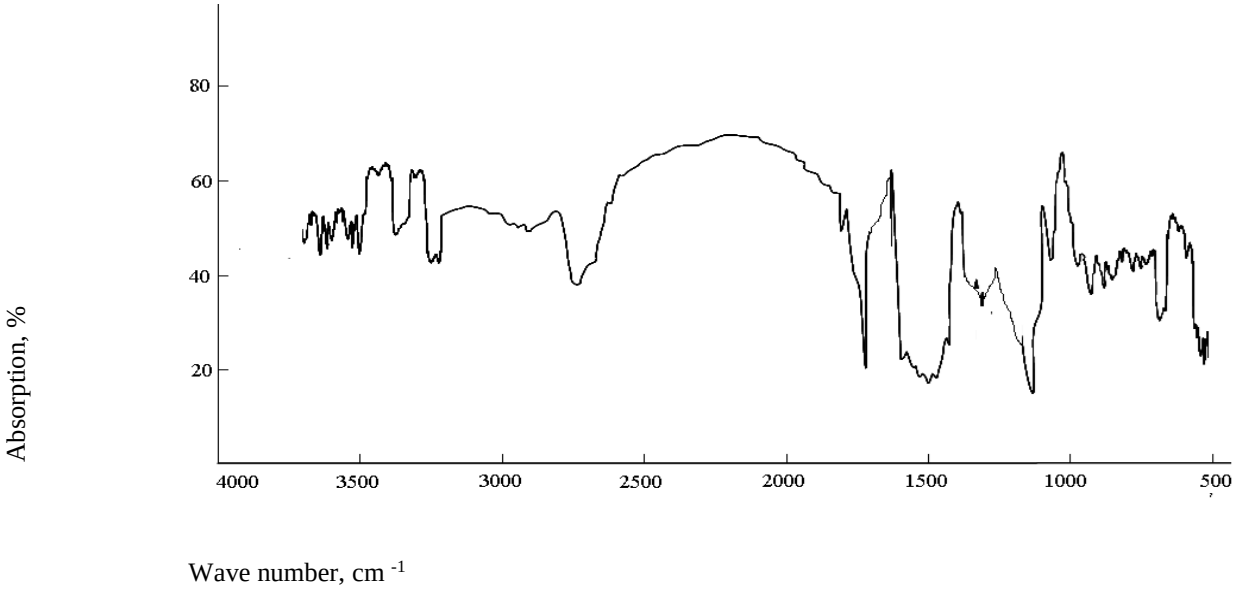
Note. The numerator is the dry residue, and the denominator is the calculated molecular weight.

The decrease in the relative viscosity in the variants can be explained by the decrease in the intermolecular distance. This, in turn, shows that there is a dependence on intermolecular van der Waals forces.

Since the synthesized oligomer is soluble only in organic solvents, it is used in a mill after grinding to a dispersed state. Subsequent tests were carried out on the basis of the obtained (oligo) polymer and hydrophobic compositions were prepared.

We have studied the structural characteristics of the synthesized hydrophobic polymer. In infrared spectral images, which do not depend on the state of aggregation of matter, each line characterizes the intensity of the matter.

The IR spectrum is the most convenient modern way of identifying a substance. It differs in its reliability from simple physical methods such as measuring the temperature of a liquid, measuring the refractive index of light, measuring density, used to identify a substance.



Picture 1. IR spectrum of polyvinylethynyltriethoxysilane

To determine the structure and identification of the obtained substances, the method of IR spectroscopy was used in a wide spectral range - 500-4000 cm^{-1}. For vinyl group ($\upsilon_{(C=C)}$) In the monomer, in the IR spectrum of polyvinylethyltriethoxysilane, characteristic absorption lines of vibrations of polyvalent valence are not observed.

To study the resistance of polymers to moisture and salinity, hydrophobic compositions were prepared, various compositions were created, their hydrophobic properties were studied, and alternative options were selected. Optimal parameters of technological processing (consumption of a hydrophobic substance and concentration of a working

solution, hydrophobization technology), ensuring the maximum efficiency and effectiveness of hydrophobic protection, depend on the properties of the processed material, such as density, porosity, binding characteristics and chemical composition of the material.

Studies of the technology of surface hydrophobization of inorganic building materials in various ways show that materials of dense structures require a special technology of hydrophobic protection.

It should be noted that organosilicon water repellents differ from other water repellents in that they protect the material from the inside, the recycled building material fully retains air permeability and has a very long service life. This is due to the fact that sunlight is almost the only aggressive factor for organic silicon compounds.

For research, samples were taken to change the structural parameters of building materials such as ceramic bricks, cement and heavy concrete.

Ceramic samples were made using semi-dry samples, the average density of the samples was 1840 kg / m^3, and the open porosity index was 20%. When we ground a large concrete sample, the average density of the cement-lime mixture (cement to sand ratio 1: 2.5 W / C = 0.35) was 1950 kg / m^3 with an open porosity of 14%. Organosilicon hydrophobizators were used in the form of solutions 3-5% by weight of the sample.

The hydrophobic method was carried out by gas-dry deepening of air-dried samples on the lateral surface, waterproof in a water-like resin-like solution, to a depth of 1 cm along the height of the sample. The total duration of construction: 1 min for cement-sand samples, 4 minutes for ceramic samples, the duration of each stage of processing was 30 s and 2 minutes for cement-sand and ceramic samples.

CONCLUSION

The control parameters of the hydrophobic method were the viscosity of the working solution and the concentration of the active substance over the surface area of the processed material.

Thus, organosilicon compounds based on industrial secondary raw materials and tetraethoxysilane have been synthesized. Compositions of hydrophobic compositions based on synthesized poly (oligomers) have been developed and tested in concrete mixtures.

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