

Organosilicon Polymer Compositions for Building Materials

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Abstract: The article presents the synthesis of organosilicon compounds based on tetraethoxylan and industrial by-products, as well as the ratio of reactants, solvents and temperature to the reaction product. Hydrophobic compositions based on synthesized organosilicon polymers were also developed and tests of the building material - concrete - were carried out. As a result, it turned out that the water absorption of concrete is reduced by 40%.

Keywords: Ethyl esters, benzene, chloroform, tetrahydrofuran, dioxane, tetraethoxyxane, vinyl ethylmagnesium bromide, vinyl ethyl triethoxylan, urea, formalin, hypan, acrylic emulsion, liquid glass, hydrophobization, reaction efficiency, concrete, hydrophobic composition.

The world pays great attention to the production of moisture protection products based on modern technologies and their use to increase the moisture resistance of building materials and structures. The creation of chemical materials that increase hydrophobicity, and their inclusion in the composition of building materials is an urgent problem in all respects. Therefore, it is important to create a new generation of complex chemicals based on innovative technologies for the creation of moisture-resistant hydrophobic materials and their application in various fields [1,2].

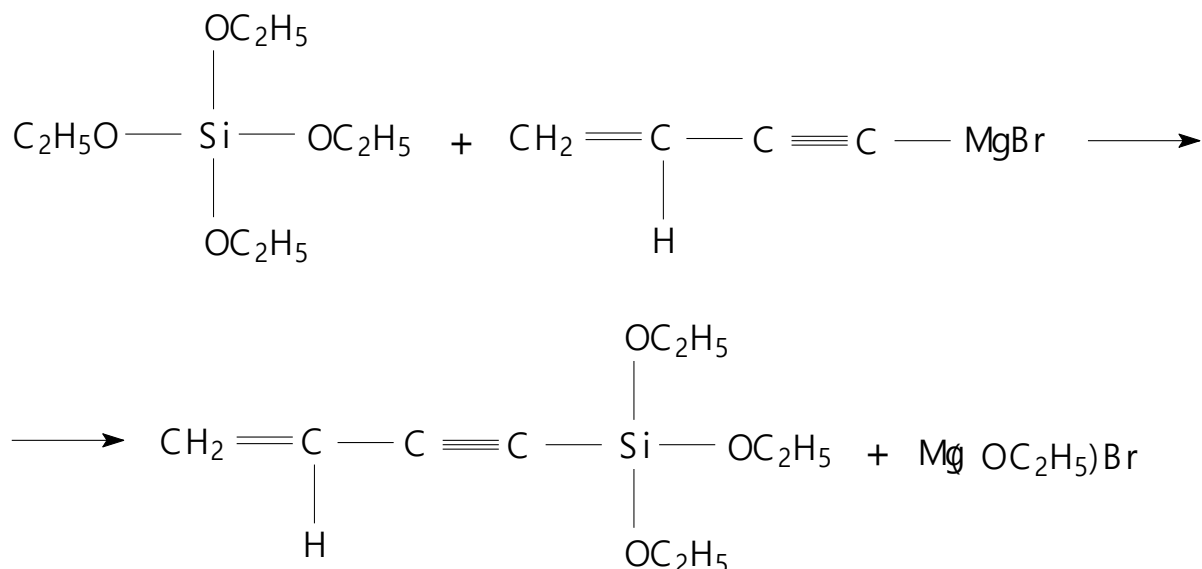
Currently, organosilicon compounds are widely used to protect building materials from aggressive environmental influences. This is due to the fact that organosilicon compounds have the property of film formation, and the film, in turn, being part of the processed material, consists of alternating atoms of silicon and oxygen. In addition, organosilicon compounds, on the one hand, bind to the workpiece by means of an oxygen bridge, and on the other hand, reduce the wetting of the object due to the presence of non-polar molecular alkyl or aryl radicals [3,4].

In connection with the foregoing, tetraethoxysilane and secondary industrial raw materials were used for the synthesis of new types of polymer compounds, the creation of new hydrophobic compositions, the production of hydrophobic building materials and the expansion of the range of the most widely used organosilicon compounds [5,6].

We have synthesized organosilicon polymers based on vinyl ethylmagnesium bromide. In a four-necked flask with a capacity of 1000 ml with 210 ml (2.0 mol) of ethyl ether (or other solutions: benzene, THF, etc.), equipped with a mechanical stirrer, a thermometer, a drip funnel and a dephlegmator for the synthesis of vinyl ethyl triethoxyl by mixing. In a four-necked flask with a capacity of 1000 ml with 210 ml (2.0 mol) of ethyl ether (or other solutions: benzene, THF, etc.), equipped with a mechanical stirrer, a thermometer, a drip funnel and a dephlegmator for the synthesis of vinyl ethyl triethoxyl by mixing. Then, to purify magnesium ethoxybromide, a small amount of the reaction mixture is poured into a dividing funnel, washed several times with distilled water (experimented with silver nitrate until bromine ions appear in the wash water).

The solvent is distilled into ethyl ether at a temperature of 35.6 °C (or 80.1 °C with benzene) using a vacuum pump at a pressure of 1.8-2.0 mm Hg for ethyl ether or 5-5.2 mm Hg for benzene [7,8].

The interaction of tetraethoxysilane and vinyl ethylmagnesium bromide in equimolecular ratios is accompanied by the formation of vinyl ethyltriethoxysilane according to the following scheme:



This reaction takes place at 30°C for 6 hours. The yield of the reaction is influenced by the ratio of the starting substances and the nature of the solvents. Unlike dry ether and benzene, in reactions carried out in toluene, dioxane and other solvents, the yield of the reaction is low [9,10].

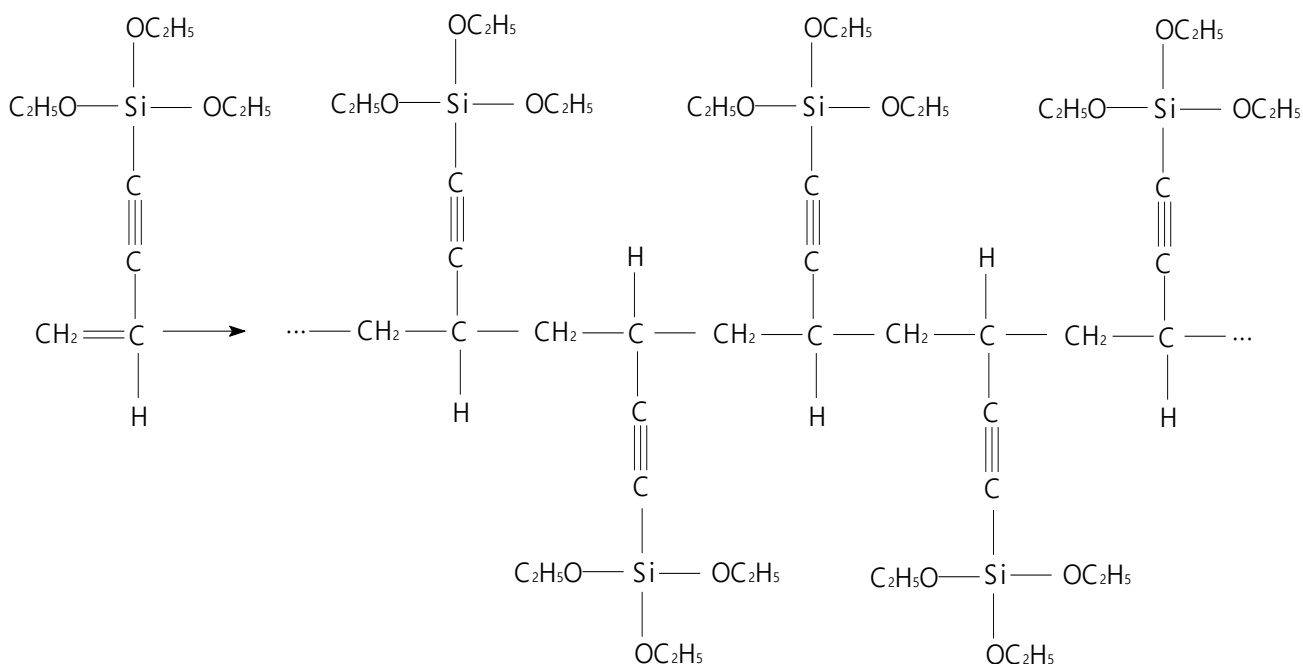
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The most common method of polymerization of organosilicon polymers is the thermopolymerization of monomers.

Viscous polyvinylethynyltriethoxysilane is a colorless, non-toxic substance that is odorless and insoluble in water. It is insoluble in lower alcohols, but soluble in many organic solvents and has high chemical resistance [11,12].

The resulting product is rectified for the presence of water, ethyl alcohol and unreacted monomer in polyvinylethynyltriethoxysilane, resulting in a product with polyvinylethynyltriethoxysilane in 150 ml (50%) or benzene in 140 ml (48%), D 1.4560; d20 1,0183.

The scheme of thermal polymerization of vinyl ethyl triethoxysilane monomer at a temperature of 30-40 °C can be represented as follows:



It is thermostable, the temperature increase is accompanied by a slight change in viscosity.

The effect of the ratio of starting substances and the nature of solvents on the formation of vinyltriethoxysilane at 30°C, depending on the duration of the reaction, was studied.

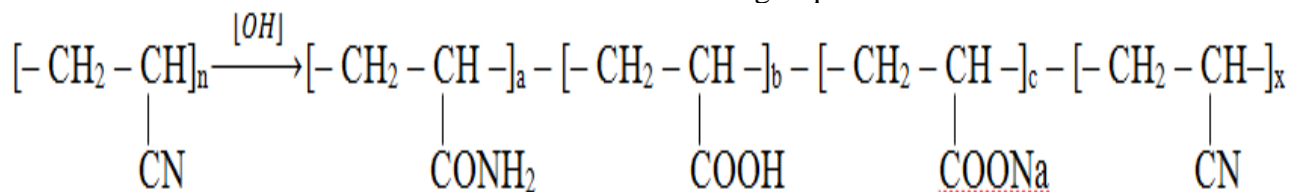
The effect of the nature of solvents on the reaction was studied in a solution of ether, benzene, chloroform, tetrahydrofuran and dioxane. It has been established that the reaction rate increases with increasing polarity of solvents. The highest reaction rate and maximum yield of the final product are observed in the medium of ether and benzene. Viscosity values are also determined, which are very characteristic of product samples [13,14,15].

In the above solvents, the reaction of vinyltriethoxysilane and tetraethoxysilane proceeds continuously, with virtually no induction period. The results of the experiments show that a change in the initial equimolar ratio of tetraethoxysilane and vinyltriethoxysilane also leads to an increase in the speed of the process.

The highest yield of the reaction is observed in an ether solution with an initial ratio of substances of 1: 1 and a temperature of 30 ° C.

Hydrolyzed polyacrylonitrile, which is a secondary industrial raw material, is obtained by hydrolysis of acrylonitrile. The number of functional groups may vary depending on the reaction conditions (temperature, catalyst type, presence of organic solvent).

The structure of GIPAN and its functional groups is described below:



A, B, C, X depend on the conditions and duration of the hydrolysis reaction.

For the synthesis of a hydrophobic substance in the reactor4, the binder tetraethoxysilane (Si(C₂H₅O)₄) and industrial secondary raw materials HYPAN were used in a ratio of 1:10 and at a temperature of 40 °C.

With the increase in temperature and amount of TEOS, the solid mass obtained by large-scale cross-linking becomes insoluble in solvents, which is probably due to the complete cross-linking of the reactants. The linear form of GIPAN is explained by the fact that the solubility of the resulting polymer decreases with increasing degree of transition to the lattice state and the formation of a solid mass [16].

The reaction of the functional groups of hydrolyzed polyacrylonitrile with tetraethoxysilane based on experiments is described below:

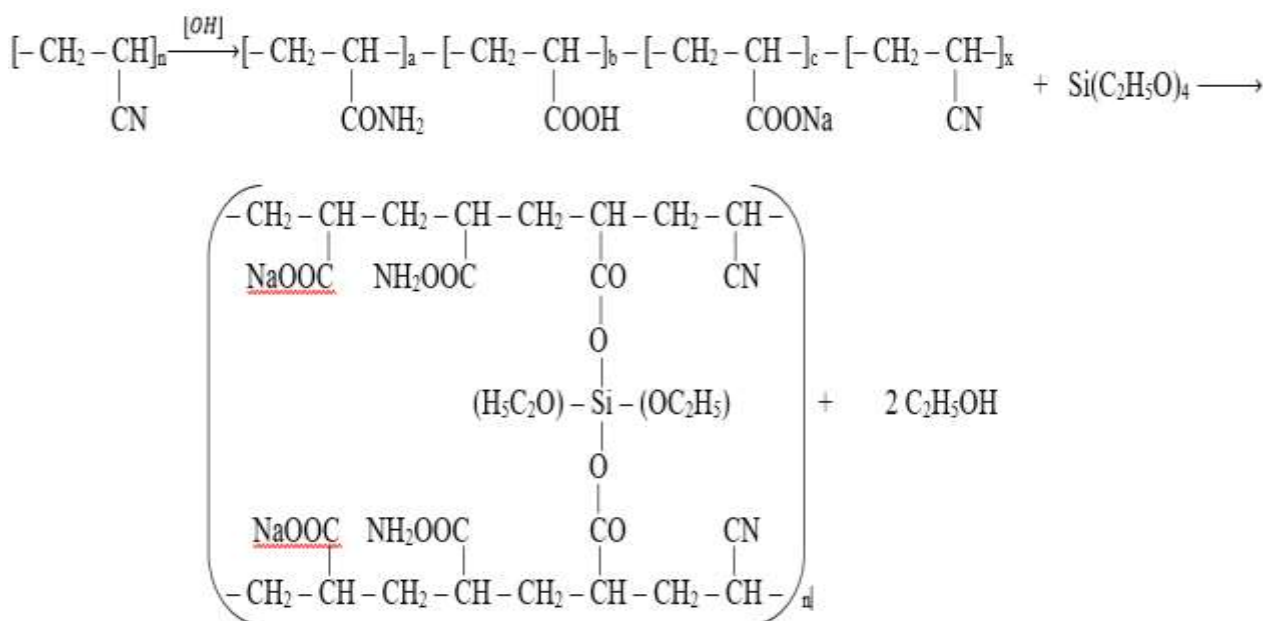


Diagram b (the number of functional groups in the schematic representation of hydrolyzed polyacrylonitrile) determines the level of cross-linking of CH-COO and the viscosity of the resulting polymer. Exceeding this value in the ratio of 10:1 leads to the transformation of the polymer into a solid (rubber-like) mass [17,18].

Thus, organosilicon compounds based on industrial secondary raw materials and tetraethoxysilane were synthesized. Compositions of hydrophobic compositions based on synthesized poly(oligo)mers have been developed and tested in concrete mixtures. Hydrophobic compositions based on synthesized organosilicon polymers were also developed and tests of the building material - concrete - were carried out. As a result, it turned out that the water absorption of concrete is reduced by 40%.

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