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POSSIBILITIES OF OBTAINING HYDROPHOBIC CONSTRUCTION MATERIALS BY INTRODUCING POLYMER COMPOSITIONS INTO CONCRETE AND CERAMIC BRICK

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ABOUT ARTICLE

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Abstract: The article presents the synthesis of an organosilicon water-repellent based on vinyl ethynyl magnesium bromide for building materials. The reduction of water absorption due to the water repellent's effect on the material is also scientifically substantiated. A comparative analysis of the synthesized water repellent with existing water repellents is described.

INTRODUCTION

Much attention is paid worldwide 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 production of chemical materials that increase hydrophobicity and their inclusion in building materials is a pressing issue in all respects. Therefore, it is important to create a new generation of complex chemicals based on innovative technologies to create moisture-resistant hydrophobic materials and use them in various fields.

In the modern world, the target of research in the field of moisture resistance, including moisture resistance of coatings under the influence of moisture and the production of highly effective hydrophobic coatings of a new generation based on resources, is a serious task.

Optimal technological parameters of processing (consumption of hydrophobic material and concentration of the working solution, hydrophilization technology), ensuring maximum efficiency and

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effectiveness of hydrophobic protection, depending on the properties of the material being processed, such as density, porosity, binding properties, and chemical composition of the material.

However, the data of modern literature contain the most general recommendations on the technology of surface hydrophilization of building materials, which complicates the application of this effective and economical method in modern construction practice at the same time. Our research into the technology of hydrophilization of surfaces of inorganic building materials by various methods shows that materials of dense structures require special technology of hydrophobic protection. It should be noted that organosilicon water repellents differ from other water repellents in that they protect materials from the inside of the recycled building component that retain air and vapor permeability, and they have a very long service life. This is because almost the only aggressive factor for organic silicon compounds is sunlight. For laboratory studies of changes in the structural parameters of building materials, samples of ceramic brick, cement, and heavy concrete were taken. Ceramic samples were made from semi-dry substances, the average density of the samples was 1840 kg/m3, and the open porosity index was 20%. When we crushed a large concrete sample, the cement-lime-sand mixture (cement-sand ratio 1:2.5 and W/C = 0.35) had an average density of 1950 kg/m3 with an open porosity of 14% (Table 1).

Table 1
Approximate indicators for which tests were conducted

Form material	Average density, kg/m^3	Degree of porosity, %	Total pore volume, cm^3/g	Surface consumption, m^2/g
Ceramic material	1840	20	0,1451	2,0521
Cement-sand mixture	1950	14	0,1100	6,8563

Hydrolyzed polyacrylonitrile, urea-formaldehyde, and solutions based on PVETEOS, protected with a tetraethoxysilane solution from 1% to 5%, were used as soluble organosilicon water repellents.

The hydrophobic method was carried out by gas drying buried samples of the side surface with air drying, waterproofed in a resin-like aqueous solution, to a depth of 1 cm along the height of the sample.

The total construction time is 1 minute for cement-sand examples, 4 minutes for ceramic samples, the duration of each processing stage is 30 seconds, and 2 minutes for cement-sand and ceramic samples, respectively.

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

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The main objectives of the surface hydrophilization technology, providing the maximum level of moisture protection for a specific material, are:

1) to ensure better absorption of the material by a permeable solution;

2) optimal distribution of hydrophobic roots over the surface of pores and coatings of the waterproofing agent.

Thus, the performance indicators of hydrophobic properties are determined in:

- the depth of the non-wetting layer on the surface of the waterproof material;

- the amount of water absorbed by the hydrophobic surface of the material under conditions of fine assimilation for 24 hours of treatment.

The thickness indicators of the non-aqueous layer were determined by wetting the cut surface of hydrophobic samples.

The concentration of hydrophobic radicals on the surface of a hydrophobic material depends mainly on the concentration of the solution, as well as on the flat surface of the material being treated, i.e., on its chemical nature.

The degree of absorption of a hydrophobic solution depends on its properties, such as density, surface tension, and dynamic viscosity. These properties were determined experimentally for aqueous solutions of polymers.

The data analysis shows that the proportional increase in viscosity with the increase in the concentration of the polymer working solution from 1 to 5% indicates an increase in the number of loops in the polymer. The maximum number of pores for the material types is about 0.1-0.5 mm for small holes, but for cement-lime sand samples, a maximum of 10-50 μm is mixed with a large hole area and 90% of the total area. The cavity volume for ceramic samples is 0.1 - in the region of 10 μm,i.e., the porous structure of ceramic samples is even larger. The visible structure of cement-lime sand samples is characterized by a more developed specific surface with a smaller porosity volume compared to ceramic samples(Table 2).

Table 2
Parameters of samples before and after treatment

Material form	Before processing, porosity volume, % and interval distance, µm					Porosity after treatment in % and spacing in µm				
	<0,1	0,1-1	1-10	10-50	50-250	<0,1	0,1-1	1-10	0-50	0-250
Ceramic material	5,31	39,01	51,00	2,27	2,41	5,15	37,8	49,47	2,2	2,33
Cement-sand mixture	21,91	7,73	5,73	55,27	9,36	21,25	7,47	5,56	53,6	9,08

The studies have shown (Table 2) that increasing the concentration of working polymer solutions in the studied range does not affect the amount of impregnated solution and, consequently, the penetration depth into ceramic and cement-lime sand samples.

The solution consumption is 2.8 l/m2 for ceramic samples and 3–3.2 l/m2 for cement-lime sand samples on average. The absorption rate in cement-lime sand samples is much higher than in ceramic samples, which is more than 1 minute and more than 4 minutes for ceramic materials, which is explained by the denser structure of ceramic samples and, consequently, lower absorption of the solution (Table 3).

Table 3
Properties and efficiency of hydrophobic treatment of samples

Concentration of working solution, %	Consumption of working solution, l/m^2	Consumption of active substance, g/m^2	The thickness of the anhydrous layer, cm	Water absorption, g/m^2
Ceramic samples				
2,4	2,79	67	1,7	247
3,1	2,80	88	1,6	104
3,8	2,77	107	1,7	48
Sample	-	-	-	5112
Cement-lime sand solution				
1	3,10	31	0.0	720
2.5	3,16	79	0,15	521
3	3,25	102	0,16	428
5	3,04	152	0,42	339
Sample	-	-	-	3465

According to the table data, the minimum water absorption in the hydrophobic ceramic samples is 1.7 cm at a working solution concentration of up to 2.4% when using a standard solution and an active substance consumption of 67 g/m2.

Treatment of ceramic materials in samples with concentrated solutions is ineffective since the degree of water absorption in ceramic materials increases from 2.4 to 3.86%, which is 2-5 times higher than that of a polymolecular organosilicon layer. As a result, the hydrophilic ends of hydrophobic molecules are activated 1.3 - 1.6 times.

The thickness of the dehydrated layer of hydrophobic cement-lime sand samples, unlike ceramic samples, directly depends on the concentration of the working solution and the consumption of the active substance, up to a maximum of 0.42 cm when using a 5% working solution, the consumption of the active substance is 152 g/m2, and the minimum water absorption rate is up to 339 g/m2.

The fact that the dehydrated layer of hydrophobic ceramic samples and cement-lime sand samples have different characteristics can be explained by the fact that the specific surface of the pores is much more developed. It can also be said that the polymer molecules have high adsorption activity. The reason is that the nature of the hydrated formation of this surface can be explained by the specific surface with a more developed adsorption activity than that of cement-sand samples and their polymer molecules since the cement stones OH - groups are located in the active center of the hydrated OH - group in clinker minerals and interact with them.

The study of the hydrophobic process of solid cement and ceramic materials showed that the efficiency of hydrophobic treatment depends not only on their compositional properties but also on the adsorption activity of the molecules of the water-repellent agent on the porous surface. The higher this activity, the more concentrated the solution should be under these conditions. Under these conditions, the concentration does not affect the structural nature of the material being processed, that is, the swelling of the hydrophobic solution. The optimum technological parameters of hydrophobic treatment of materials with aqueous polymer solutions have been determined. For ceramic bricks, it is recommended to use active substances of at least 60-70 g/m2 if this solution is mixed in a ratio of 1:20, 40% for polymer product, 2.7 - 3 l/m2 of the working solution is consumed, so that 1. A layer of less than 7 cm is formed, and water absorption is reduced by 100 times. For binders with a porous structure, when mixing the solution in a ratio of 1:10, 40% polymer product consumes 2.7 - 3 l/m2 of the working solution, forming a layer of less than 1.6 cm and absorbing water for 24 hours. Reduced by 10 times.

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