

Research of the magnesia cement stability to the impact of corrosive biological environments

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Abstract. Constructional materials with low bio stability are the reasons for the growth of microorganisms, what in its turn can cause the rise of epidemics. The article deals with bio stability of building mixes based on various types of mineral cementing materials: magnesia cement, cement and gypsum. The research was conducted by the method of maintaining the sample materials contaminated with spores of mold fungi, under optimal conditions, with the following evaluation of the fungal resistance of the coating. The results described show, that the gypsum samples have the least fungal resistance. The samples of the cement have different levels of resistance to the growth of mold fungi depending on the type of bio destructor. The magnesia cement samples possess the greatest resistance to contamination with fungal media and prevent their spreading. As a result, the higher concentration of used activator is, the stronger fungal resistance of magnesia cement. There is an assumption about interrelation between the fungal resistance and the phase composition of the magnesia stone.

1. Introduction

When operating building structures of premises with increased sanitary and hygienic requirements, the surface of concrete products can be a basis for settling on them various types of microorganisms - bacteria and fungi, which, as a result of their vital activity, produce chemical substances and cause corrosion. Bio stable constructional materials are not only resistant to the biological factor of corrosion, but also have the ability to create an environment with favorable sanitary and hygienic conditions, which is especially important, for example, in livestock breeding complexes and health-promoting institutions. The use of bio stable constructional materials in such facilities in combination with regular disinfection of premises will prevent the spread and development of microorganisms, which in turn prevents the spread of various infections and reduces economic losses [1].

Bio stable materials are materials which are resistant to any kind of microorganisms (fungi, bacteria and watergrass) [2,3]. The requirement for the material to be resistant to certain types of microorganisms is specified by the environmental conditions in which this material will be maintained.

Fungi are the most common contaminants and destroyers of building products and structures in the premises, as well as allergens and pathogens of human diseases [4,5]. Soil dust with different microbiota composition can be transported over long distances by the wind and penetrate into unsealed rooms or structures contaminating them. Fungus spores easily detach from the contaminated surfaces



of constructions and decorations, as a result, they airlift and worsen indoor air quality. They can disease the patients with compromised immunity and cause outbreaks of nosocomial (hospital-acquired) infections [6-10].

With the reference to the above mentioned, we can conclude that the research of the constructional materials resistance to the impact of this type of bio corrosion is most relevant. The subject of the research is plaster mixes based on three different types of binders: cement, gypsum and magnesia. The objective of the work is to identify the most resistant plaster mixes to fungi impact.

To achieve the goal we set the following tasks:

- To produce samples on the basis of cement and gypsum binders, as well as samples on a magnesia cement with various activators used.
- To compare fungal resistance of cement, gypsum and magnesia stone by placing the samples in the same conditions and subsequently contaminating them with four main fungi bio destructors (including fungi of the genus *Aspergillus*, which can also be causative agents of frequently occurring invasive aspergillosis- hospital-acquired mycosis with high mortality).
- To select the most effective type combinations of the used activator and its concentration, at which the maximum fungi-resistant effect is achieved.

2. Materials and methods of research

A screening study of mold fungi effect on sample materials 1-8 was conducted in the laboratory of mycology FBIS KRIEB Rospotrebnadzor of RF (Federal Service for Supervision of Consumers Protection) from 28.06.17 to 14.07.17. Table 1 shows the data on the samples used.

Table 1. Data on the samples used.

Sample marking	Binding material	Used activator	Density of used activator solution	Brand of binding material
1	Magnesia	Aqueous magnesium sulfate solution	1,22	-
2	Magnesia	Aqueous magnesium sulfate solution	1,20	-
3	Magnesia	Aqueous magnesium sulfate solution	1,18	-
4	Magnesia	Aqueous magnesium chloride solution	1,20	-
5	Magnesia	Aqueous magnesium chloride solution	1,22	-
6	Magnesia	Aqueous magnesium chloride solution	1,24	-
7	Cement	Aqua	1,00	M500
8	Gypsum	Aqua	1,00	G5

The magnesia cement used for making the samples was obtained from the Satka deposit dolomite by firing at 650 ° C. Hydration of magnesia cement was activated by mixing with saline solutions to a normal density of mixture. The properties of the obtained magnesia cement are specified by technical conditions [11]. The cement and gypsum samples were mixed with water in accordance with the requirements of the relevant technical regulations [12,13]. Samples were made in the form of cubes with 2 cm rib size.

The principle of the method is to maintain samples contaminated with spores of mold fungi under optimal conditions for the development of fungi, with a subsequent fungal resistance evaluation of the coating on 4-point scale (from 0 to 3 points) [14]. Spore suspension was produced in sterile distilled water from fungi grown in agar medium for contaminating the samples. The spore suspension was laid on the surface of the nutrient medium and the samples. The tests were carried out within 14 days at a temperature of 29 ± 2 ° C and a relative humidity of over 90% in Petri dishes on a Saburo nutrient medium. The experiment was carried out in triple repeatability.

We used the following types of fungi from the list of GOST (State Standards) 28206-89: *Aspergillus niger (brasiliensis) van Tieghem* (BKMF-1119=ATCC 9642), *Aspergillus terreus* Thom (BKM F-65)

Penicillium funiculosum Thom (BKM F-285), *Trichoderma viride* Pers. Ex. Fr. (BKM F-426).

3. The research part

At the end of the test period, the samples were visually examined in diffused light and then under a microscope with 50-fold magnification. The research results are presented in Table 2.

Table 2. The research results of the samples to the fungi resistance

No	Species of fungi	No Sample	Growth degree of mold fungi	Specification
1	<i>Aspergillus niger</i>	1	0,0,0	0-When examined under a microscope, the growth of moldsfungi is not visible 1- Growth of fungiis visually absent, but it is visible under a microscope 2- Fungi are visible on visual examination, but cover no more than 25% of the surface
		2	1,0,0	
		3	1,0,0	
		4	0,0,0	
		5	0,0,0	
		6	0,1,1	
		7	1,1,1	
		8	2,2,2	
2	<i>Aspergillus terreus</i>	1	0,0,0	0-When examined under a microscope, the growth of moldsfungi is not visible 1- Growth of fungiis visually absent, but it is visible under a microscope 2- Fungi are visible on visual examination, but cover no more than 25% of the surface
		2	0,0,0	
		3	0,0,0	
		4	0,0,0	
		5	0,0,0	
		6	0,0,0	
		7	1,1,1	
		8	2,2,2	
3	<i>Penicillium funiculosum</i>	1	0,1,0	0-When examined under a microscope, the growth of moldsfungi is not visible 1- Growth of fungiis visually absent, but it is visible under a microscope 2-Fungi are visible on visual examination, but they cover no more than 25% of the surface
		2	1,1,1	
		3	1,1,1	
		4	1,1,1	
		5	1,0,0	
		6	0,0,0	
		7	1,1,1	
		8	1,2,2	
4	<i>Trichoderma viride</i>	1	1,0,1	0-When examined under a microscope, the growth of moldsfungi is not visible 1- Growth of fungiis visually absent, but it is visible under a microscope 2-Fungi are visible on visual examination, but they cover no more than 25% of the surface 3-Fungi cover more than 25% of the surface
		2	1,0,1	
		3	1,1,0	
		4	2,1,1	
		5	0,1,1	
		6	0,1,1	
		7	1,2,2	
		8	3,2,2	

According to the results, we can come to the conclusion that the provided samples of the magnesia stone No. 1, 2, 3, 5, 6 have fungal resistance of 0-1 points, sample No. 4 has fungal resistance of 0-2 points, sample of cement stone No. 7 has fungal resistance of 1-2 points, sample of gypsum No. 8 has fungal resistance of 2-3 points. Thus, we can make the conclusion that the materials on the magnesia cement have a greater fungal resistance than materials based on cement or gypsum. According to the

results of all tests, samples No. 1, 5, 6 have the maximum fungal resistance, however, we cannot speak about the fungicidal effect of the samples (figure 1). To approve these samples have a fungicidal effect, they need to be maintained no less than 28 days as suggested by the technical regulations [14].

The shortened time of maintenance made the main and crucial difference between the screening method and the method of the above-mentioned GOST (State Standards). The screening method was chosen in order to exclude deliberately non-fungal resistant materials. Thus, it is possible to justify a further study using a longer procedure only for samples No. 1, 5, and 6 to identify the degree of their fungal resistance or fungicidal activity.

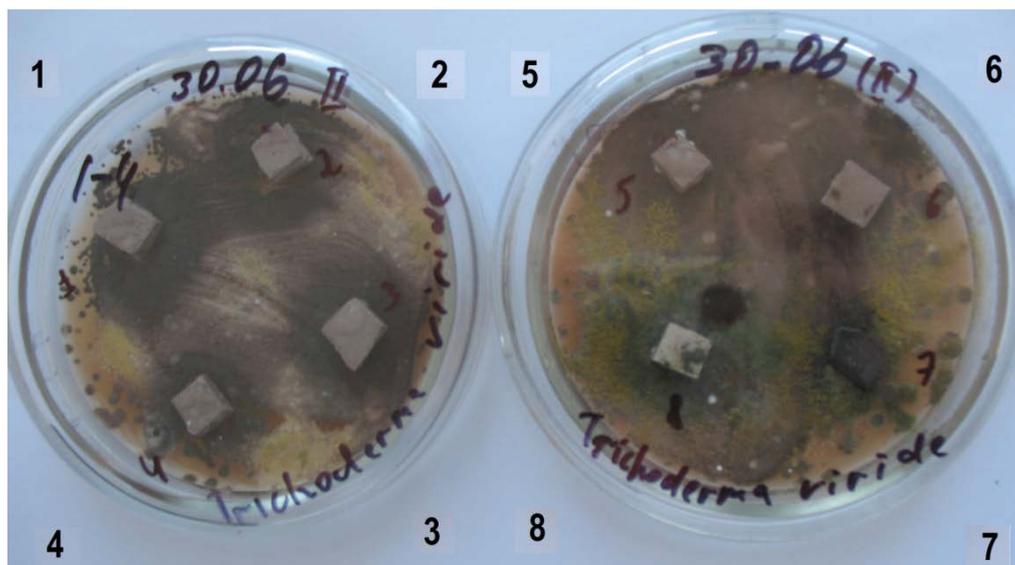


Figure 1. Form of samples, contaminated with *Trichoderma viride* after maintaining in thermostat within 14 days.

4. Conclusions

Plasters based on the magnesia cement possess the most fungal resistance. Cement plaster mixes have a conditional resistance to some species of fungi. Samples of gypsum plaster mixes are unable to resist fungi growth.

The experimental results show that strengthening concentration of the solutions used for activation of magnesia cement hydration leads to the fungal resistance increase of the material obtained on its basis.

It is known that type and quantitative content of hydration phases in hardened magnesia stone depends on the type and concentration of used activator [15-20]. Thus, taking into consideration that fungal resistance depends on concentration of used activator we can assume that phase composition affects the material capacity to resist fungi growth.

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