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The Use of Silica Sol in the Lime Formulations for Restoration of Buildings

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Abstract

The information about the technology of the silica sol. The problems of stabilization of the sol. The efficiency of the silica sol as additives in lime dry building mixtures used for the restoration of buildings of historic buildings.

Keywords: silica sol, the stability, the aging of the sol, lime, dry mix

Introduction

Preservation of architectural heritage of the past, restoration of architectural monuments, as well as rehabilitation of buildings in areas of historic buildings often require special finishing materials. Traditional materials, which have been used for many years used for have calcareous compositions [1]. Restoration of historic buildings finish has certain difficulties caused by incompatibility of lime plaster with modern materials. The best results (when surfaces are plastered by lime plaster solutions) are achieved by using paints that are close to historical counterparts in composition. Paints of this type have a high vapor permeability, do not cause stresses in the plaster material without destroying it. However, the use of lime formulations for the restoration of architecture

causes certain difficulties associated with the use of special additives that we buy abroad, etc. As a result there is a need to find new solutions to improve lime formulations resistance intended for restoration and decoration of buildings and structures.

Is [2, 3] proposed for composite materials with improved properties the sol-gel technology. Currently in solving technological problems more and more attention is paid to the colloidal dispersion of silica-gel. The basic of idea the system "sol - gel" as additives in composite is the base of mineral binders is the use of sol structure to create additional structure-reinforcing element.

The Results of Studies

In this regard at the development of lime compositions formulations intended for the restoration of historic buildings, additive - silica sol was used. To obtain silica sol column filled with cationite resin KU-2 was used. The optimal concentration sodium silicate solution to a sol produce of silicic acid is 6,2-6,6%. Exceeding this concentration of sodium silicate led to unsustainable formation silica sol and gelation in cationite column. By reducing the concentration of a solution of sodium occurred formation of silicates nanotechnology diluted sol (Table. 1).

When using sol as an additive in lime silica formulations used sol having a pH of 4.5-5 density 1013 kg / m ^{3}. Stability formulations kremny acid sols is strongly dependent on pH. Relatively fast they can become a gel at pH 5 - 6 and at a pH less than 1 in the pH range 2 - 4 silica sols resistance increases we bare. Investigates the effect of sodium silicate, silica modulus by the density of the silica sol. Fig. 1 shows the density value of the sol depending on the modulus of sodium silicate.

It has been established that with increasing silica modulus of sodium silicate we have observed increase in concentration and thus the density of the silica sol. Thus, when the module sodium silicate sol is 2.8 the density 1013 kg / m ^{3}, when a module of 2.9 - 1019 kg / m^3.

Table 1

Influence of concentration on the stability of sodium silicate silica sol

Concentration Na_2SiO_3,%	Density of the solution Na_2SiO_3, kg / m^3	The stability of the sol
4,8–5,2	1043	diluted nanotechnology
6,2–6,6	1056	Sustainable and technologically
7,0–7,4	1064	Unstable

However, the further studies have shown that the optimal basis of stability, we have sol, corresponding to the value 1013 kg / m^3. Thus density is obtained the 4% sol of silicic acid, diluting it to a 2% sol, which was used for the production of calcareous finishing compositions.

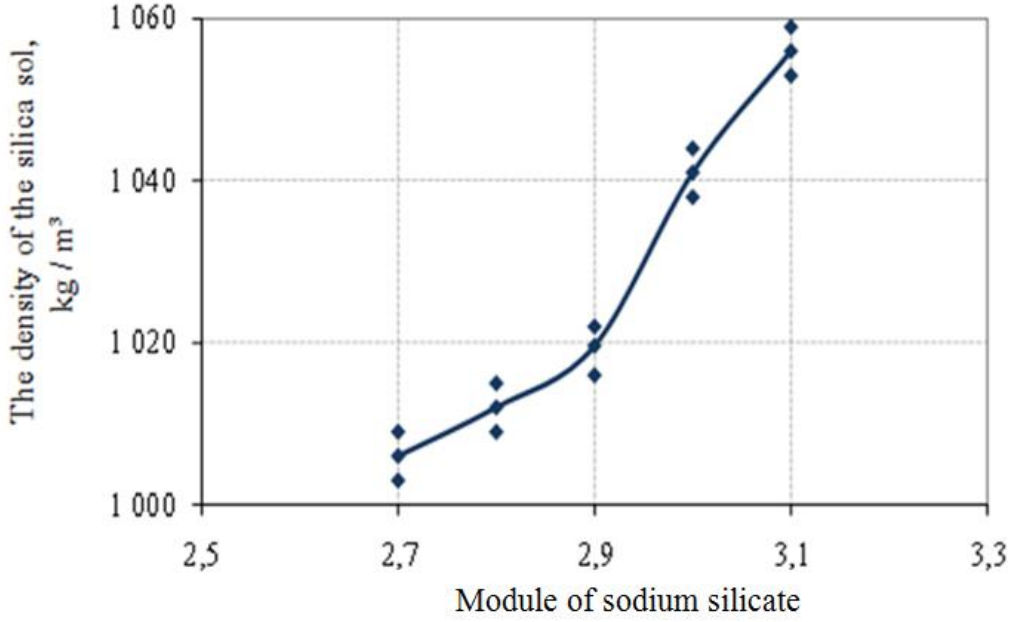

Fig. 1 The dependence of the silica sol density on sodium silicate silica module

Determination of the particle size of the silica sol was done by turbidimetry. The values were determined by particle size of the silica sol depending on the duration of aging. Table. 2 shows the values of the sol particle radius, depending on the time of aging.

Table 2

The dependence of the particle radius of the time of aging of the silica sol

Silica sol aging time, days	The radius of the sol particles, nm
1	17
3	18
4	22
5	25
7	57
12	83
15	113
19	140

Experimental studies suggest that the aging period ranging from 15 days, coarsening of particles of silica sol acid is visually observed, which leads to a decrease in its activity

Further confirmation of the high dependence sol activity is the data for calculating of sol particles shift.

The mean square shift particles in the time interval τ is determined by the law of Einstein - Smoluchowski Calculations bone showed that for 10 second with mean square shift particles with a radius of 72 nm was 7, 72 • 10^{-6} m. The mean square shift particles with a radius of 17 nm was 1, 89 • 10^{-5} m, which determines the high activity of the silica sol at term aging 1 day [4, 5].

Stabilization of the silica sol was evaluated by the value of the surface potential and the value of the thickness of the diffuse ion layer. The calculation results show that the magnitude of the thickness of the layer is greater than 10 diffusive nm with aging time up to 15 days; hence, the sol of silicic acid can exist without violating aggregate stability.

The dzeta potential (ζ-potential) was determined as a function of the length of aging silica sol (Table. 3). The obtained value of ζ-potential indicates the stability of the sol.

Table 3

Effect of aging of the silica sol
on the electro-kinetic potential
and the thickness of the diffuse ion layer

Age, days	Thickness of the diffuse ion layer, nm	ξ- potential, V
1	29,5	(–)0,103
5	20,7	(–)0,074
10	15,6	(–)0,053
15	11,2	(–)0,030
19	6,5	(–)0,020

Silicic acid sol is stable up to 15 days. Electro - kinetic potential is 0,03 - 0,103 V. Later, a decrease in ξ- potential.

In conducting studies have investigated the stabilization of silica sol following polymeric additives (gelatin, polyvinyl alcohol, polyvinyl acetate dispersion and cation acryl amide K- 280).

Table 4

Experimental data
definition stabilizers silica sol

The volume of the solution of stabilizer,% by weight of the sol	The stabilization effect	The volume of the solution of stabilizer,% by weight of the sol	The stabilization effect
Polyvinyl acetate dispersion		Cation copolymer acrylamide K-280	
1	+ +	2	+ + +
1,5	+	4	+ + +
2	–	6	+ + +
4	–	8	+ + +
6	–	10	+ +
Gelatin		12	++
1	+ + +	14	+
2	+ + +	16	–
4	+ + +	18	–
6	+ +	20	–
7	+		
8	–		
10	–		
12	–		
14	–		

The experiment established that effective stabilizers for the silica sol are gelatin, polyvinyl acetate dispersion, and copolymer of acrylamide cation K - 280 [6].

The compounding of lime plaster composition containing hydrated lime, sand fraction 0,314-0,14 mm, silica sol stabilizer, aluminum sulfate [7,8]. The technological and operational characteristics of the finishing composition listed in Table 5

Table 5

Technological and operational properties of finishing compositions

indicator	The index value
Adhesive strength, Megapascal	0,8–1,0
Compressive strength, Megapascal	1,5–1,7
Viability when stored in open containers, hour	6–8
Drying time to degree "5" at (20 ± 2) ° C, min, max	52–55
Water-holding capacity,%	98
Recommended thickness of a single layer, mm	5–15
Fuel finish composition at applied in one layer thickness: - 1 mm kg / m ^{2} - 10 mm, kg / m^2	– 1,1–1,3
Presence of cracks due to shrinkage	no
workability	good
Pc resistance to static exposure of water at (20 ± 2) ° C, h	>72
Coefficient of permeability μ, mg / (m • h • Pa)	0,011

Compressive strength and adhesion strength of lime plaster decorative coating is 1.5-1.7 and 0.8 - 1.0, respectively MPa. Viability when stored in open containers is 8-10 h, water-holding capacity - 98%. Consumption of plaster when applied in one layer with a thickness of 10 mm is 1.1-1.3 kg / m ^{2}.

Conclusions

Thus, the results of studies have confirmed the efficacy of the formulations in the lime silica sol

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