ALUMINOSILICATE MICROSPHERES AS EXTENDER OF COMPOSITE POLYMERIC MATERIALS

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Contemporary practice of leading industrial countries demonstrates the trend of material selection, which according their technological operating characteristics were unified, from the one hand, relating to the objects of different purposes (buildings, pipe conduits, industrial objects and constructions) while from the other hand, fulfilled wholistically some different functions (regarding thermal protection, hydro protection, corrosion protection, protection against mechanical damage, decorative function).

The necessity of elaboration of new materials and modification of existing ones for the purpose of augmentation of temperature operational range, fire proofness, mechanical strength, lightfastness under simultaneous degradation of heat conduction coefficient, toxicity, moisture absorption.

It is established, that positive role during solving of enumerated problems play hollow glass microspheres used as extenders.

The hollow glass microspheres may be manufactured of different materials, including sodium borosilicate and aluminosilicate glass (ASG). The advantage of latter items is natural method of their production and, therefore, lesser cost of final products.

Aluminosilicate glass properties are specified in Table 1.

Table 1. Properties of glass spheres (aluminosilicate glass)

parameter	value
appearance	grey-white powder
thermal conductivity, W/mK	0,05-0,13
floatability, weight %	99,3
true specific gravity, g/cm ^{3}	0,7
packed density, g/cm ^{3}	0,4
frost resistance	more than 20 cycles
temperature of fluxing onset, ºC	1400
hygroscopicity, %	up to 0,15

Atomic analysis (“Spectroscan”) indicated that in aluminosilicate glass (ASG) presents admixtures of Fe, Cu, Mn besides some elements usual for the glass.

As polymeric basis of composition extended by ASG butadiene-styrene, styrene-acrylate and other latexes were investigated. The selection of bonding agent was made with allowance for dependence of composition endurance and adhesion of polymer to extender {1}. Table 2 demonstrates comparative endurances of latex foils, impregnated by 40% bonding agents and delamination loadings between glass and polymer.

Table 2. Physiomechanical indices

latex of polymer	extension coefficient, %	foil endurance, MPa	delamination loadings between glass and polymer, N/m	endurance of composition, MPa
acrylate A-70	1600	0,10	130	0,7
nitrile BN-2	1600	0,16	350	1,2
primal E 1950	3000	0,12	450	0,9
butadiene-styrene BS-65	230	2,35	110	3,5
SB-278	500	3,76	450	4,0

Table 2 demonstrate that aluminosilicate glass is active extender, enhancing endurance of polymeric bonding agent regardless of its chemical nature. Regularity signifies, that lower endurance of bonding agent results in higher effectiveness of extender.

On the basis of latex SB-278 and aluminosilicate glass new strong thermal insulation material was derived. This material has heat conduction coefficient equal to 0,03 W/mK, high thermal resistance (250ºC), thermal fastness ($T_{н.р.}$= 280ºC, E_a = 98 kj/mol), specified as hardly flammable (temperature increase of exhaust gases from 200ºC up to 250ºC, weight loss during combustion - 20%; combustion proceeds in flameless mode) {2, 3, 4 }.

Aluminosilicate glass positively impacts upon such characteristics of polymeric compositions as endurance, thermal resistance, thermal conductivity, flammability.

Certain scientific interest appeals interaction of surface of AMG extender with polymer bonding agent. Adhesion force of glass to one of acrylate latex (A5) is 350 N/m, while to polyurethane this force is twice as much - 700 N/m. In turn, adhesive capability of polyurethane to different, first of all, to polar polymers is well-known. Quite probably, that particles of AMG extender covered by polyurethane nanofoil will be combined tighter with bonding agent and it will impact positively on physiomechanical characteristics of composition.

For examination of this hypothesis process engineering of aluminosilicate glass covering by polyurethane foils of different dispersability, in particular, of 30 mcm, 100 mcm, 200 mcm was developed {5}.

This process engineering allows to derive coverings of thickness of 10 nm and more. The results of atomic-powered microscopy have proved that foils are void-free and glass phases are absent on the surface of particles.

Blanketed extender keeps its flowability, there are no any agglomerates in it. Modified extender is resistant to impact of acids and alkalis. Assumption that modified aluminosilicate glass is more active extender than initial one, was proved (Table 3).

Table 3 . Comparative endurance of polymeric compositions with initial and modified aluminosilicate glass

No.	foil composition	extension coefficient E, %	rupture strength F, MPa
1	latex A5	>1600	0,17
2	latex A5, 10% AMG	1300	0,23
3	latex A5, 30% AMG	930	0,40
4	latex A5, 50% AMG	520	0,53
5	latex A5, 10% AMG laid the grain	1490	0,35
6	latex A5, 30% AMG laid the grain	1180	0,54
7	latex A5, 50% AMG laid the grain	800	0,68

Conclusion

Aluminosilicate microspheres impact wholistically and positively upon characteristics of polymer composition, viz. endurance, thermal resistance, thermal conductivity, flammability.

Modification of the surfaces of aluminosilicate microspheres by polyurethane nanofoil and assigns them steadfastness to aggressive media and promotes hardening of polymer compositions.

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