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INVESTIGATION OF SOLAR THERMAL CHEMICAL PROCESSES OF STRUCTURE FORMATION OF ASH-CEMENT BINDERS USING SOLAR ENERGY

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ABSTRACT

The article discusses the structure-forming factors and their influence on the technical and strength properties of a highly filled cast ash-cement mixture. A mathematical model of solar thermal chemical processes of structure formation of ash-cement binders using solar energy is proposed.

KEYWORDS: solar energy, hydration, phase composition, structure formation, ash-cement materials, gel treatment, variable factors, regression model, optimal technology, thermochemical treatment, heat carrier, hydrophysical, plastometric and thixotropic indicators, pseudo-optimal zone.

THE RELEVANCE OF THE PROBLEM

The ash-cement mixture does not contain coarse aggregates and is a highly dispersed filled system. Consequently, it has a highly developed interface between the solid and liquid phases, which contributes to the development of intermolecular cohesion forces and increases the connectivity of the system as a whole, on the one hand, and on the other, requires a significant consumption of cement-water gel for coating ash particles.

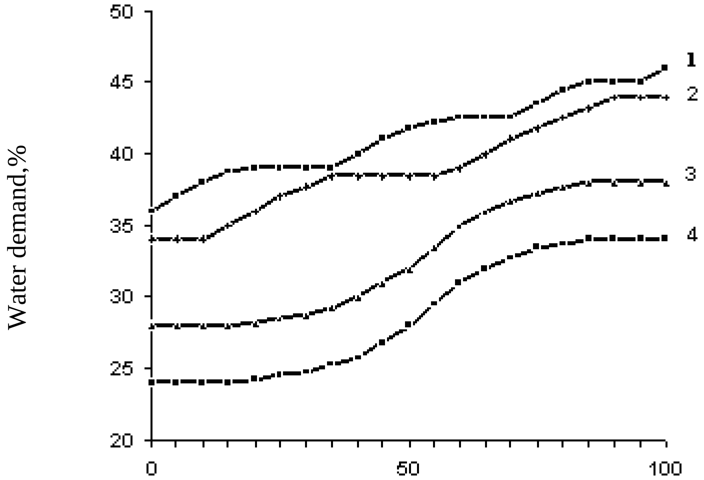
A sharp increase in water demand is associated not only with the growth of free and adsorption - bound liquid, but also with the high porosity of the ash particles themselves. The significant water demand of the highly filled ash-cement composition, as our studies showed, negatively affects its hydrophysical, plastometric and thixotropic indicators.

At the same time, theoretical studies of the influence of the degree of filling the mixture on its water demand showed that, contrary to the data given in various literary sources on the directly proportional relationship between water demand and ash content, a number of S-shaped curves were obtained (Fig. 1). The phenomenon established by us requires a radical update of the existing energy technologies for the production of ash-cement materials of polystructural structure [1,2,3].

The experiments carried out indicate that when the binder and filler are mixed with water, an ash-cement system is formed, the hardening process of which occurs at the level of microstructure formation. Its strength properties are determined by the processes occurring during the contact of the solid and liquid phases, and depend on the amount of filler, the physicochemical activity of the particle surface and the mode of heliotherapy and thermal activation.

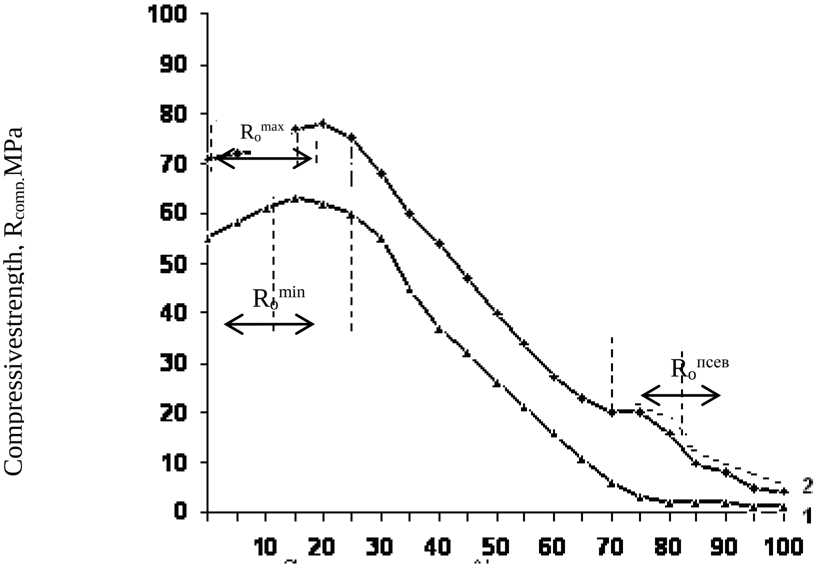
At a filler content in the range of 70-80%, an interesting effect was discovered for the first time, namely, the effect of reducing the strength of a highly filled structure (Fig. 2). This section is, apparently, the second zone of "pseudo-optimal" filling.

The influence of additives on the water demand of ash-cementdough for solar thermal treatment



Ash content, populace. % 1 - with the addition of 10% lime; 2 - 5% lime; 3 - no additives; 4 - with the addition of 0.3% MPD-2

Figure: 1. Compressive strength of products made of ash-cement material at the age of 28 days



Ash content, % from the mass of the composition 1 - no additive; 2 - with the addition of MPD-2 (0.3% by weight of blended binder) Figure: 2.

Along with the physical processes in the filler - binder contact, the processes of chemisorption accretion of ash particles with cement also take place. The nature of such an interaction depends on the energy characteristics of the particle surface and an increase in contact adhesion, which can be provided only in a complex manner - by heliotherapeutic action before the beginning and during the period of structure formation of multicomponent fine-grained materials with a polystructural structure.

It was found that in terms of the plasticizing effect, the optimal dosage of additives is in the following decreasing order: MPD – 1> MPD – 3> MPD – 2, which is 0.34, respectively; 0.30; 0.26% for highly filled (more than 60% ash) ash-cement mixtures [5,6].

The optimum lime content in the above system is 5-6%. The highest value of compressive strength at 80% filling was achieved with the introduction of 5% lime with MPD – 1 (15.5 MPa); MPD-2 (15.1 MPa) and MPD-3 (13.7 MPa).

Modification of highly filled ash materials with MPD-1 and MPD-2 additives without lime under stationary heat exposure does not give such a high effect of increasing the strength, but the data obtained are significant and amount to 11.5 and 12.3 MPa, respectively. It is shown that the intermittent-pulsating thermal effect upon the introduction of the MPD additive provides an increase in the strength of the optimally filled ash-cement composition by 25-34%, while the kinetics of a decrease in energy resources is observed in the range of 30-60%.

It should be noted that for the modified system, the optimal degree of filling shifts upwards by 5-6% and is 20-30%. The maximum increase in strength is 10-15%. At the temperature of water heated in the solar collector up to 305-312K, modification of the ash-cement material with additives provides an increase in bending strength by 20%, with optimal filling - 30%. A further increase in the temperature of the liquid medium and the degree of filling leads to a linear drop, $R_{28}^{изг}$ and the "pseudo-optimal zone" is absent in this case.

From the point of view of the combined mechanochemical and thermal effects, these phenomena can be explained as follows: at the optimum temperature of the liquid and turbulent mixing, significant velocity gradients appear in the mixture, the viscosity decreases, the thixotropic properties improve, and the dispersion of the system increases. When particles collide, an inert film is stripped off their surface. The dispersion process provides free access of water to ash and cement particles, which leads to an increase in the number of hydrated neoplasms and a deeper course of the hydration process.

Analysis of solar thermal chemical processes of structure formation of ash-cement binders using solar energy showed that when developing optimal modes of heat and mass transfer in order to intensify the hardening of the mixture, it was found that, along with ensuring high quality of products, it also becomes possible to predict energetically justified conditions of the technological process at economically optimal consumption of energy resources.

Researchhasfoundananalyticalrelationshipthattakesintoaccountthefollowingfactors:

- temperature rise at the design point due to internal heat release, taking into account the coefficient of radiation absorption

$$\Delta t_{q_i}^{j-1} = \frac{m_v \cdot \Delta\tau}{c \cdot \rho} \cdot q_{\text{э}\cdot i}^{i^*} + q_l^i \cdot k_i ,$$

where c is the specific heat capacity (830-870 W / mK), мv– is the mass of cement in 1 m^3 of concrete (180-295 kg / m^3), ρ – is the density of the product (1316-1530 kg / m^3), $q_{\text{э}}^{o}$ -is the intensity of heat release from cement hydration (W / m^3), q_l^i - specific heat due to absorption of solar radiation, (W / m^3), k_l^i - radiation absorption coefficient at 80% ash filling (0.81 W / m^{2}K).

The amount of heat released into the volume of the product during $\Delta\tau$

$$Q_{\text{э}}^{ij} = m_v \cdot \Delta\tau \int\limits_V q_{\text{э}}^{j} \cdot dv + \frac{1}{k_i} \int\limits_V q_{\text{э}}^{i} \cdot dv \approx m_v \cdot \Delta\tau \cdot \Delta x \sum_{j=1}^{K} Q_l^j + \frac{1}{k_i} \sum_{i=1}^{S} Q_l^i ;$$

where j, i –is the index of the moment in time, determined by the method of equal heat release and the time of radiation absorption.

Specific intensity of heat flux qe generated in a combined solar plant

$$q_F = -\frac{\lambda}{\Delta x}(t_r^{j-1} - t_1^{j-1}) + \Delta x \cdot \lambda \cdot c \cdot \rho (t_r^j - t^{j-1}) \cdot 0{,}5 - \lambda \cdot m_v \cdot \Delta x \cdot q_{\text{э}} \cdot 0{,}5 + \Delta x^2 + q\Delta x K_i$$

The amount of heat required to heat the product due to solar thermal treatment

$$Q_F^{ji} = q_{\text{э}}^j \cdot \Delta\tau + q_1^i \cdot \Delta\tau + q_l^i \cdot \Delta r^1 ;$$

Efficiency ratio

$$K = \frac{Q_э}{Q_r} \cdot 100\%.$$

The calculation algorithm is implemented in the TURBO PASKAL 6.0 language for Pentium-4. The counting time for each option is 15-17 minutes. The results of the problem posed for $l_1 \angle l_2 \angle l_3 \angle$ are analyzed in three sections that correspond to points N2, N3 and N4.

Boundary indicators of heliotheatlochemically treated fine-grained ash-cement product on interlayers have been established (Table 1).

It is noted that the data obtained correlate well with the kinetics of heat release in ash-cement systems (Table 2).

Filling with ash by 20, 40, 60 and 80% reduces heat generation by 17, 40, 50 and 57%, respectively. The introduction of MTD reduces heat release by 5; 6, 4; 8% in the following order MPD-1> MPD-3> MPD-2. This is due to the selective adsorption capacity of modified plasticizing additives on the active centers of the surface of ash and cement particles [7].

Table 1 Boundary parameters of a heliotheat-treated fine-grained ash-cement product on interlayers

Boundary points	$L_1 = 0{,}1 \pm 0{,}001$ м			$l_2 = 0{,}2 \pm 0{,}001$ м			$l_3 = 0{,}4 \pm 0{,}001$ м		
	Δt^I, ^0C	t^I, ^0C	$Q_Э^I$ МДж	Δt^{II}, ^0C	t^{II}, ^0C	$Q_Э^{II}$ МДж	Δt^{III}, ^0C	t^{III}, ^0C	$Q_Э^{III}$ МДж
N_2	16,2	79,10	1,44	18,9	77,91	3,32	18,97	71,32	4,92
N_3	14,6	80,45	1,31	18,1	76,21	3,11	14,17	60,62	3,41
N_4	13,9	80,67	1,31	17,2	73,20	2,93	9,07	51,07	2,32

As the thickness increases, the heating of the inner layers of the product, as research shows, significantly lags behind the heating of the outer layers. Therefore, the magnitudes of the maxima and the time of their appearance at the studied points of the article differ significantly from each other, which indicates the integral indicators of a fine-grained multicomponent article during solar thermal treatment (Table 3).

Table 2.Time indicators of heat release of ash-cement materialsduring solar thermal treatment

Time for determination of heat release, h	Temperature rise (^{0}C) with ash content, wt. %				
	0	20	40	60	80
5	18	9	7	5	4
10	38	28	21	12	8
15	29	25	23	29	16
20	17	18	16	19	16
25	13	12	10	9	8
30	8	7	6	6	6
35	6	5	5	4	4

Table 3. Integral indicators solar thermalprocessed ash-cement fine-grained product

l, м	$q_э$, kW/м^3	r^{max}, h	$Q_э$, МДж/м^3	Q^*, МДж/м^3
$0{,}1 \pm 0{,}001$	4,86	5	4,31	42,10
$0{,}2 \pm 0{,}001$	4,11	6	8,20	39,81
$0{,}3 \pm 0{,}001$	2,07	8	15,31	38,21

l, м	t, ^{0}C	Δ t, ^{0}C	Q_f^*, $МДж/м^3$	τ,ч	$Q_э^*/Q_f^*$,%	$Q_э^*/Q_{треб}^*$,%
0,1 ± 0,001	80,45	14,42	13,21	5	31,87	16,84
0,2 ± 0,001	77,92	16,94	11,84	11	38,39	15,92
0,3 ± 0,001	60,14	13,63	10,37	13	36,85	15,28

Analyzing the results of calculations for fine-grained products of various thicknesses, the following can be noted: the thickness of the product affects not only the quantitative characteristics of heat release, but also changes its kinetics. It was also found that the thicker the product, the more heat is released in absolute units and the greater its share in the total amount of heat for heating.

This is easily explained by the fact that with an increase in the thickness of the product, based on the specific area of the heated surface, an increase in the volume of the product is also observed. At the same time, it should be noted that there will be no such direct dependence on the specific volume.

REFERENCES

1) AlinazarovA.Kh. Energy and resource-saving technology for obtaining building materials and products by the method of solar thermal treatment. Monograph, Moscow: Rusyns, 2017.-118 C.
2) Alinazarov A.X. Use of non-conventional energy sources in engineering networks. Study guide. Toshkent 2017.AlinazarovA.Kh., Ikramov N.M. Solar Thermochemical Treatment of Ash-Cement Compositions. - Namangan:NIPI, 2005. - 51 p.
3) .AlinazarovA.Kh., Mamadzhonov M., Khaidarov Sh. Influence of solar radiation during the intensification of hardening of ash-cement building materials. International scientific journal scientific periodical "SognitioRerum" Russia, 2017 10-12 b.
4) AlinazarovA.Kh., Mamadzhonov M., Khaidarov Sh. Method of calculating non-stationary temperature fields taking into account radiation absorption in products made of composite building materials. SocietyofScienceandCreativity, Russia, 2017, 16-18 p.
5) AlinazarovA.Kh, Mazhidov N, ZhuraevKh Research methodology for optimizing the modes of solar thermal treatment for highly filled ash-cement compositions. Academic Journalism, Russia, 2017 No. 5 8-14 Art.
6) AlinazarovA.Kh. Investigation of the operational properties of ash-cement materials with modified-plasticizing additives of polyfunctional action.Scientific and technical journal FerPI, spec. edition, 2018.55-61 p.