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PROSPECTS OF OBTAINING NEW PRODUCTS BY FORCED CARBONIZATION OF PRODUCTION WASTES

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Abstract. The article presents physicochemical analyses of Begovot barren sand, solid calcium waste from a soda plant, and lime dust, and their properties are studied. The possibilities of obtaining new types of building materials by forced carbonation based on these raw materials are studied.

Keywords: barren sand, lime dust, carbonization, building materials, research methods.

Introduction. Environmental protection and rational use of natural resources are one of the urgent global problems of our time. The most important environmental problem is the search for means to reduce the Earth's greenhouse gases, the emergence of which is associated with an increase in carbon dioxide emissions into the atmosphere as a result of fuel combustion at power plants, a sharp increase in the amount of waste from human production activities, an increase in motor transport, etc. The results of research by world scientists on determining the composition of the air show that the amount of carbon dioxide in the Earth's atmosphere is now 25% higher than 200 years ago [1].

Every year, humanity emits 7 billion tons of carbon dioxide into the atmosphere. At the same time, as a result of deforestation, which is one of the main consumers of carbon dioxide on Earth, the carbon dioxide cycle on Earth is disrupted, leading to a constant increase in the amount of greenhouse gases in the atmosphere.

In order to prevent such negative problems, the introduction of technologies for collecting and binding carbon dioxide gas can collect and reduce billions of tons of CO₂ per year. The only way to reduce the amount of carbon dioxide in the atmosphere is to collect it, and one of the promising technologies is carbonization, which is the reaction of carbon dioxide with materials to form stable carbonates containing Ca and Mg, and is used to produce new types of building materials [2].

The aim of the work is to obtain a new type of silicate building materials by forced carbonization based on the solid calcium waste of the Kungrad Soda Plant JSC, fine-grained mineral barren sands, and calcareous ash formed during mechanical sedimentation in cyclones and sleeve filters during the limestone burning process.

Research methods. The research was conducted mainly at the Khorezm Innovation Technopark Laboratory under Urgench State University, at the High Technologies Center under the Ministry of Higher Education, Science and Innovations of the Republic of Uzbekistan. The

chemical composition of the raw materials was analyzed using analytical chemistry equipment using new methods [3]. The chemical composition of the raw materials containing calcium oxide was determined in laboratory conditions using the method given in GOST 8677-76 [4]. The activity of lime ash was determined using standard methods and was 44%, the moisture content was 0.5%, the quenching time was 45 minutes, and the quenching temperature was 40°C.

Modern methods of physicochemical analysis were used to study the composition and properties of the initial raw materials and the forced carbonization samples.

The suitability of the barren sands selected for the research was determined through quantitative, granulometric, and chemical-mineralogical analyses. The sands of the barkhan were evaluated in terms of grain size according to the requirements of state standards, and it was shown that the main part of them has sizes up to 0.1-0.4 mm. Sieve analysis of the samples was carried out by the dry method GOST 22552.7-2019 [5]. The following formula was used to calculate the percentage of residue remaining on each sieve:

$$X = \frac{(m_1 - m_2) \cdot 100}{m}$$

Here m_1 - is the weight of the cup with the residue remaining on the sieve surface, g; m_2 - is the weight of the cup, g; m - is the mass measurement, g.

Results and their discussion. The article presents the results of scientific research on the production of wall-building materials based on hard calcium waste, lime ash and non-condensed Begovot barkhan sands (located 16 km from the center of Urgench) with a clay content of up to 10%, as well as calcareous waste, by forced carbonization.

Begovot barkhan sand is dense, with clayey interlayers, and the thickness of the sand is divided into three upper, middle and lower parts according to the lithological composition. The upper layer is 3.6 meters thick with fine particles, the middle part

is 4.1 meters thick, consisting of sand and clay fine particles, and the lower sand layer is 5.2 meters thick with admixture of coarse particles with clay lenses. The mineralogical composition of barkhan sand consists of quartz (85-90%), clay (3-5%), and

feldspar (5-7%). The reserve of sand is 9066.1 thousand m³. Today, sand stock is used as an additional raw material in the preparation of concrete and building mixes. The results of the analysis are presented in Table 1 below.

Table 1

Classification, mm	Fraction amounts for samples, %		
	Top layer	Medium layer	Bottom layer
Larger than 0.8 mm	5,1	10,1	11,2
0.8 mm to 0.4 mm	7,7	25,4	30,3
0.4 mm to 0.1 mm	75,1	50,4	45,4
Less than 0.1 mm	12,1	14,1	13,1
Total	100	100	100

Data obtained as a result of chemical analysis of barkhan sands are presented in Table 2.

Table 2

Examples	The amount of oxides, e.g. %									L.C., mass.%
	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	K ₂ O	Na ₂ O	TiO ₂	SO ₃	
1	80,98	4,68	3,06	2,94	0,82	2,42	1,06	0,03	0,09	3,92
2	80,88	4,7	3,11	2,86	0,88	2,41	1,09	0,05	0,08	3,94
3	81,01	4,56	3,26	2,81	0,83	2,39	1,07	0,07	0,11	3,89
Medial	80,95	4,64	3,14	2,87	0,84	2,41	1,07	0,05	0,1	3,91

The results of the chemical analysis of the solid calcium waste of the soda enterprise are presented in Table 3 below [6].

Table 3

Chemical composition. Mass, %						
CaO	MgO	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	SO ₃	Loss on combustion
54,60	0,32	0,40	0,06	0,04	0,09	44,49

Based on the study of the structure of the raw materials, fine-grained barren sand, hard calcium waste and lime dust were pressed in metal plate molds of the MIM-5LR-017 type in a semi-dry method in laboratory conditions with dimensions of 50x50x20 mm, 10% humidity and a pressure of 25 MPa in the mass ratios given in Table 4. Lime waste was measured in a constant ratio. The carbonization process of the samples was carried out in a semi-automatic carbonization chamber prepared in a

special laboratory with 100% concentration of CO₂ for 3600 s. The samples were placed in the carbonization chamber in a semi-dry state with pressed moisture. In the next stage of our experimental studies, the compressive strength limit, water absorption and softening coefficients of the carbonized samples were determined using standard methods. The results obtained are presented in Table 4 below.

Table 4

Mass Ratios %		Carbonized layer thickness, mm	Compressive strength, MPa	Water absorption, %
Barhan sand	Solid calcium waste			
15	45	24	28,1	7,1
25	35	20	22,2	6,8
35	25	17	18,9	7,9
45	15	10	16,2	9,2
55	5	5	12,3	9,8

The results obtained show that the content of barren sand in the samples is 35% and above, the carbonization index of the samples, the compressive

strength of which is less than 2.7 MPa. We can see that the carbonized layer of the samples with a content of 45% of solid calcium waste and 40% of

lime dust increased by 20%, which is due to the carbonization of the mass, the water absorption was determined to be 7.1%. This, in turn, is explained by the emergence of the binding properties of barren sand and calcareous waste and the carbonization of the components.

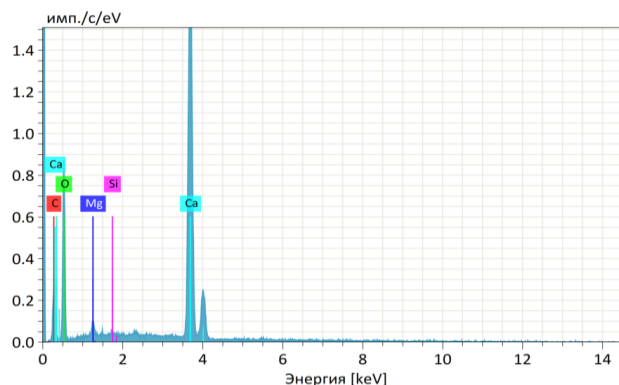
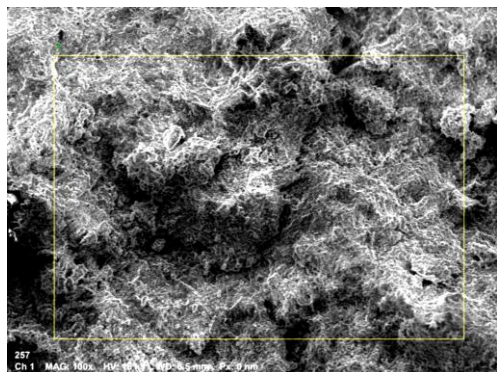


Figure 1. SEM image of the carbonized sample based on 15% barren sand.

The results of the analysis showed that the composition of the sample mainly consists of CaO - 28%, MgO - 20%, SiO₂ - 22%, CO - 14%, which confirms the presence of marbled calcite mineral in the composition.

A technological scheme for the production of building materials based on local mineral raw materials - barren sand, Kungrad soda ash waste, hard calcium waste and lime dust, by semi-dry pressing and forced carbonization under normal conditions is recommended. Based on the presented technological scheme, it is possible to produce building materials on an industrial scale using standard equipment.

Conclusion. As a result of the conducted scientific research, the Begovot barren sand and soda production enterprise experimentally proved the possibility of obtaining forced carbonized wall-forming building materials with a strength of 28.1 MPa based on solid calcium waste and lime dust, and expanding the raw material base for the production of new building materials based on barren sand in the Khorezm region.

The proposed forced carbonization of building materials will prevent the emission of carbon dioxide gases into the atmosphere in the process of industrial development and improve the ecological environment.

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