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INFLUENCE OF FLOTATION WASTE LEAD ORES AND SOLID WASTE FROM SODA PRODUCTION ON THE SWELLING OF AGLOPORITE

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Abstract
The article examines the influence of pore-forming waste from various industries on the porosity and swelling of the resulting lightweight agloporite material.
Based on the results obtained, it was determined that an increase in the amount of soda production solid waste (SPSW) from 5 % to 15 % in the charge composition increases the swelling coefficient from 1.23 to 1.48, and proportionally reduces the volumetric weight of the resulting material from 1068 to 1020 kg/m3.

Keywords Porous material, physicochemical properties, swelling, pore formation, industrial waste, phosphogypsum, kaolin, solid waste from soda production.

INTRODUCTION

Currently, the world considers an important scientific and practical task to be the development of innovative technologies that contribute to the development of a high-tech production base for the integrated processing and rational use of mineral raw materials and industrial waste in the construction industry, which is the most material-intensive sector of consumption of raw materials. In this direction, it is relevant to create new methods of complex processing and develop energy- and resource-saving technologies for producing porous silicate aggregate using inorganic waste from the mining, metallurgical and chemical industries.

In nature, all deposits of solid minerals are complex. Therefore, an important approach is that, along with the extraction of main and associated components, including the industrial use of waste from various industries. This helps reduce environmental pollution and save natural raw materials.

One of the building materials obtained from natural low-melting clays as raw materials is agloporite. This is an artificial porous ceramic material obtained by sintering sand-clay materials on the grid of a sintering machine. Porosization of raw materials when producing porous silicate aggregate is achieved by removing water, burning out organic inclusions and other combustible substances. It should be emphasized that the use of raw materials characterized by intense swelling leads to the closure of air infiltration channels; the melt formed under high temperature conditions dissolves quartz particles at a depth of 10-20 mm, and carbonate inclusions up to 5 mm [4-11].

Based on this, this work investigated the influence of various technogenic wastes such as flotation waste from the enrichment of lead-containing ores, phosphogypsum, solid soda production waste (SPSW), as well as coal waste on the swelling and pore formation of lightweight silicate material - agloporite.

Material and methods

To obtain agloporite, the following materials were used as raw materials and intensifiers of phase transformations, such as Angren secondary kaolin, industrial waste - flotation waste from the lead enrichment plant of the Almalyk Mining and Metallurgical Plant (LEP) as an aluminosicate component, ash and slag from the Angren thermal power plant, phosphogypsum and solid waste from the soda production of the Kungrad soda plant as intensifiers of phase transformations, swelling and sintering of the resulting material (Table 1).

Table 1

Chemical composition of the initial raw materials

Name of raw materials	Oxide content (wt.%)									LOI, wt.%
	SiO_2	Al_2O_3	TiO_2	Fe_2O_3	CaO	MgO	Na_2O	K_2O	SO_3	
LEP waste	53.20	15.10	0	8.41	1.40	5.00	2.70	3.60	5.69	4.90
Angren secondary kaolin	62.26	18.95	0.41	1.87	1.91	0.53	0.12	1.11	0.12	12.72
Ash and slag	58.77	22.60	1.30	7.10	4.30	1.00	1.30	1.20	1.72	0.71
Phosphogypsum	10.43	0.42	-	0.15	28.78	-	0.04	0.04	40.50	19.64
SPSW	1.10	0.40	-	-	48.10	4.20	-	-	3.80	42.40

RESULTS AND DISCUSSION

We have prepared experimental mixtures based on flotation waste from a lead enrichment plant (LEP), kaolin and ash and slag with different contents of soda production solid waste (SPSW) from 5% to

15%. At the same time, the content of phosphogypsum and coal waste is constant at 5% and 10%, respectively (Table 2).

The calculated chemical composition of the prepared experimental mixtures given in Table 3 shows that the chemical compositions of the prepared mixtures, both in terms of the content of basic oxides and in terms of the value of losses on ignition due to the combustion of burnt-out components, are quite consistent with the calculated ones.

Table 2

Compositions of the studied raw materials for the production of porous silicate filler based on LEP flotation waste

Name of raw materials	Composition					
	LKS-1	LKS-2	LKS-3	LKS-4	LKS-5	LKS-6
	Components, mass %					
LEP waste	50	50	55	55	60	60
Angren secondary kaolin	10	15	10	15	10	10
Ash and slag	10	10	10	10	10	10
SPSW	15	10	10	5	10	5
Phosphogypsum	5	5	5	5	5	5
Coal	10	10	10	10	5	10

Table 3

Calculated chemical composition of experimental mixtures with different SPSW contents

Name of Samples	Oxides content, mass %									LOI, wt.%
	SiO_2	Al_2O_3	TiO_2	Fe_2O_3	CaO	MgO	Na_2O	K_2O	SO_3	
LKS-1	39,39	11,79	0,57	5,11	9,98	3,28	1,49	2,03	5,62	20,74
LKS-2	45,71	13,57	0,65	5,54	7,77	3,19	1,58	2,19	5,45	14,35
LKS-3	41,99	12,52	0,61	5,53	7,64	3,32	1,63	2,21	5,72	18,82
LKS-4	45,05	13,45	0,63	5,62	5,33	3,14	1,64	2,27	5,53	17,34
LKS-5	44,65	13,28	0,65	5,95	7,71	3,57	1,76	2,39	6,00	14,03
LKS-6	44,60	13,26	0,65	5,95	5,31	3,36	1,76	2,39	5,81	16,91

Since many building materials are produced by firing, therefore, changes in melting point values significantly affect the material, chemical and mineralogical compositions, structure and other physical and chemical characteristics, technological processes, as well as the cost of the final product. Therefore, when developing charge compositions for producing agloporite, the temperature of the beginning and end of melting of the developed new compositions is of particular and very important importance.

We determined the temperatures of the beginning and end of melting of the studied experimental compositions based on LEP-kaolin-waste coal (SKU) with different contents of burnable additives (Table 4). The table shows that changing the amount of SPSW in the lightweight charge from 5 to 15% does not significantly reduce the melting temperature of the charge.

Table 4

Temperatures of the beginning and end of melting of samples based on kaolin and LEP flotation waste, with different contents of SPSW

Name of Samples	Melting temperature, °C		Temperature range, °C
	Start	End	
LKS-1	1180	1197	27
LKS-2	1190	1218	38
LKS-3	1178	1205	37
LKS-4	1185	1211	36
LKS-5	1175	1208	43
LKS-6	1177	1213	46

The results of determining the beginning and end of melting, test samples with different contents of kaolin clay and LEP flotation waste containing solid waste from soda production (SPSW) showed that the melting point of all compositions is within the range of the firing temperature of agloporite (Table 4), but compositions LKS-1, LKS-3 and LKS-5, compared to other compositions, have a lower temperature of the beginning and end of melting due to the influence of SPSW waste.

For porous lightweight silicate materials, the swelling coefficient of the fired material is of particular importance. The expansion coefficient of the developed experimental mixtures with additives was determined as the ratio of the volume of the expanded granule to the volume of the semi-finished product granule. The volume of each grain of semi-finished expanded clay crushed stone and gravel is determined according to GOST 5978-12 [9, 10] and is calculated by the formula:

$V = (\pi D2/4)h$

The coefficient of swelling of clay raw materials is determined by the formula:

$K rev = d V2 / V1$

where: V1 is the volume of a granule (grain) of a semi-finished product placed in a kiln for firing, cm3;

V2 - the volume of the expanded granules of expanded clay gravel and expanded clay crushed stone, cm3.

Table 5

Intumescence of charges based on flotation waste LEP, with different contents of SPSW

Name of Samples	Expansion temperature, °C	Swelling coefficient	Volume weight, kg/m³
LKS-1	1145	1,48	1020
LKS-2	1150	1,41	1031
LKS-3	1140	1,35	1053
LKS-4	1145	1,33	1055
LKS-5	1140	1,29	1060
LKS-6	1140	1,23	1068

Determination of the swelling properties of compositions based on LEP waste fleet and various amounts of SPSW (Table 5) shows that swelling processes occur in all tested compositions.

The calculated volumetric weight of the prototypes shows direct proportionality between the volumetric weight and the swelling coefficient.

CONCLUSION

In this way, the influence of burnt-out waste from various industries on the porosity and swelling of the resulting porous material was studied.

Based on the results obtained, it was established that an increase in the amount of soda production solid waste (SPSW) from 5% to 15% in the charge composition increases the swelling coefficient from 1.23 to 1.48 and proportionally reduces the volumetric weight of the resulting material from 1068 to 1020 kg/m3, respectively.

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