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PROCESSING OF LOW QUALITY EKIBASTUZ COALS ASHES AND NATURAL DIATOMITES TO OBTAIN ALUMINA AND FOAMED GLASS

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Analysis of technological solutions on complex processing Ekibastuz coals ashes displays efficiency of complex alkaline technologies. However their significant drawback is the necessity to utilize big volumes of alkaline-silicic solutions. This research demonstrates possibility of their rational utilization by using natural raw diatomites to obtain formed and pelleted foamed glass widely used in construction industry as a heat-insulating material. Based on the data from scientific literature and their own research the authors suggest an improved scheme of complex processing Ekibastuz coals ashes.

Keywords: Ekibastuz coals ashes, diatomite, Manvelyan-agglomeration method, foamed glass, heat insulation materials

INTRODUCTION

The Republic of Kazakhstan is one of the world leaders on extraction and burning of Ekibastuz low-quality coals to produce electric energy at 14 large power stations [1].

Ekibastuz coals are high-ash ones. Their ashes contain minerals like mullite and quartz. Accumulated stock of this techno genic waste in Kazakhstan makes over 1 billion tons with annual increase by 20 million tons. The ashes contain about 50 % SiO_2 and 30 % Al_2O_3 and can be considered at as a source of raw material to obtain construction materials [2].

Both in Kazakhstan and abroad numerous researches have been carried out and complex technologies have been suggested on wasteless processing of low-quality coals ashes. Those technologies offer either acidic or alkaline methods of processing [3, 4].

The most effective in the complex processing of ashes is Manvelyan's method that included high-temperature pressure leaching of low quality alumina raw materials, partially turning silica into alkaline-silica solution, which leads to changing the middlings silica index [5].

Combining Manvelyan's method with agglomeration allows obtaining alumina, chemical and construction products. However, when using this method significant volumes of alkaline-siliceous solution are obtained that require chemical transformations and bringing alkali back into a technological process, for example epthe process of caustification of alkaline-silica solutions with calcium oxide (lime) to obtain wollastonite used as a filling material in paper production [6].

The proposed research of Manvelyan - agglomeration scheme that will result in its becoming simpler and cheaper and allow to obtain large-capacity product, foamed glass, which is widely used in construction of both housing accommodations and industrial objects as heat insulator.

In this scheme, instead of caustification of sodium silicate with calcium hydroxide, alkaline-silica solution is blended with cheap natural raw siliceous material (diatomite) [7]. Then the mixture is thermally processed to obtain a modern heat-insulating product, foamed glass.

Diatomites, consisting mainly of hydrated silica, are the basis for the synthesis of modern construction materials.

The using of a ready-made silica matrix of diatomite allows synthesizing modern construction materials, including foam glass products, by heat treatment with alkaline-silica solution [8]. When alkaline solutions of highly ferrous varieties of diatomite materials are processed with alkali, alkaline-silica solution and an iron oxide pigment having a spherical particle shape are formed [9].

The objective of this research is to determine conditions of foam glass formation from diatomites and alkali-siliceous solution, which is a middling of coal ashes alkali processing to obtain alumina concentrate by using technologies adapted to high-silica alumina-containing raw materials.

EXPERIMENTAL

From sludge collector's moist ash (JS "Eurasian Energy Company) with the composition of mass. %:

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Table 1 **Experiment results on obtaining foam glass products from alkali-siliceous solutions and diatomite**

№ exp.	Diatomit / g	Shubarkul coal / g	alkaline-silica solution / g	SiO_2 diatomite /SiO_2 ratio	Product	Roasting temperature / °C	Specific weight / kg/dm³	Compressive resistance H/cm²
1	100	2	30	0,01	pressed	950	1,59	981
2	100	2	60	0,02	pressed	950	1,61	863
3	100	2	90	0,03	pressed	950	1,65	785
4	100	10	30	0,01	pressed	1 050	1,11	686
5	100	15	30	0,01	pressed	1 100	0,95	588
6	100	20	30	0,01	pressed	1 100	0,78	655
7	100	20	30	0,01	pellet	1 100	0,70	624
8	100	20	30	0,01	pellet	1 150	0,72	568
9	100	20	30	0,01	pellet	1 200	0,84	554

Table 2 **XRD of phases analysis results**

Component	Formula	experiment 1/ wt. %	experiment 2/ wt. %
Silicon Oxide	SiO_2	78,7	73,0
Albite	$Na(AlSi_3O_8)$	10,0	14,4
Hematite, syn	Fe_2O_3	6,4	4,1
Diopside	$Ca(Mg,Al)(Si,Al)_2O_6$	4,9	8,5

SiO_2 52,2; Al_2O_3 27,1; Fe_2O_3 6,5; CaO ≤ 3,7; W 9,5 were isolated of the cenosphere, the remaining pulp was leached with alkaline solution with Na_2O_k 250 g/dm³ concentration in autoclave at 125 °C for 180 minutes , liquid to hard = 3:1 with obtaining alumina concentrate and alkaline-silica solution. Alkaline-silica solution mixed with natural Kazakhstan diatomite and coal from JS "Shubarkul Komir". The mixture was pressed, sintered at the temperature from 1 050 to 1 200 °C for an hour with the rate of heating 15 degrees a minute. The samples obtained were crash-tested on the laboratory press MIP-25P to define arithmetic mean strength value.

RESULTS AND DISCUSSION

Experiment results on obtaining foam glass products from alkali-siliceous solutions and diatomite are given in Table 1.

Results of X-ray difraction (XRD) of phases analysis didn't show any significant differences in mineral composition (Table 2). Main phase is quartz with variety of alloys. XRD of phases analysis results are given in Table 2.

Table 3 **Porousity and heat conductivity of the product samples**

№ exp.	Na^+ cations in water extract	General porousity	Heat conductivity index(λ) at 25 ± 5 C Vt/(m*K)
1	Not found	28,50	0,034
2	Not found	45,25	0,037
3	Not found	57,75	0,024
4	Not found	62,00	0,021

Porousity and heat conductivity definition was performed by the Central Laboratory for Certifying Construction Materials "Celsim Ltd" Almaty (Table 3).

The results obtained show that increase in porousity and decrease in specific weight and heat conductivity index are caused by adding coal. Carbon dioxide that appears from carbon oxidation during heating sprouts the mass producing hollows (caverns) with thin walls.

Foamed glass obtained by heating the mass with small additions of coal becomes a rather dense mass with a few caverns. The material is easy to work with (cutting, abrasion) and looks like marble (see Figure 1a) Foamed glass with larger additions of coal has a very visible porous structure and hollows with thin black walls. The samples are also easy to process mechanically (Figure 1b).

To obtain foamed glass pellets the mix of components was moistened and pelletized in the laboratory disc-type granulator.

a)

b)

Figure 1 Foamed glass products from alkaline-silica solutions and diatomites

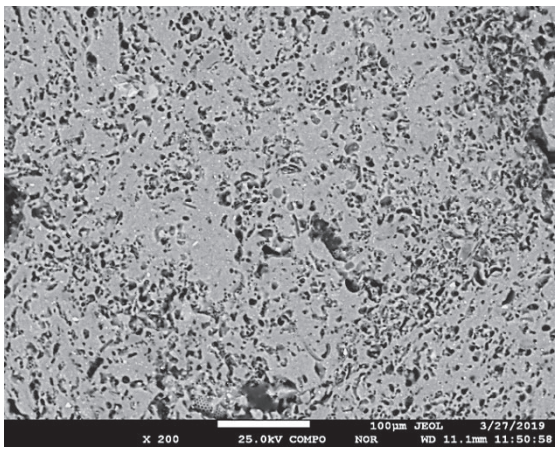

Figure 2 Photo of foamed glass structure taken with scanning electronic microscope JEOL

Process of obtaining pellets from heated mixture of alkali-silica solution and diatomite. Pellets containing 2 and 5 % of coal are light-coloured and porous on the inside while pellets with 10 % addition of coal are dark red and have a more obvious porous structure. Specific weight for pellets with 2-5 % of coal is 1,55-1,25 kg/dm^3, for pellets with 10 % of coal 1,05 kg/dm^3.

Research performen on scanning electronic microscope JEOL demonstrate uniform cell structure of foamed glass. (Figure 2).

An improved technological scheme for processing the ashes of Ekibastuz coal based on the studies was proposed, which allows to obtain foam glass, an effective heat-insulating building material, along with alumina concentrate. (Figure 3).

CONCLUSION

1 A simple technological scheme is suggested of utilization for alkali-silica solution, which is a middling of alumina obtaining from coal ashes of low quality Ekibastuz coals.

2 Conditions are defined for obtaining foamed glass from alkaline-silica solution, a middling of processing Ekibastuz coal ashes into alumina concentrate, and natural diatomite. Technical parameters of foamed glass are up to modern standards for heat-insulating construction materials.

3 An improved scheme if suggested of complex processing ashes of low quality Ekibastuz coals.

4 Organizing foam glass production industrially will allow to utilize large volumes of alkaline-silica solution.

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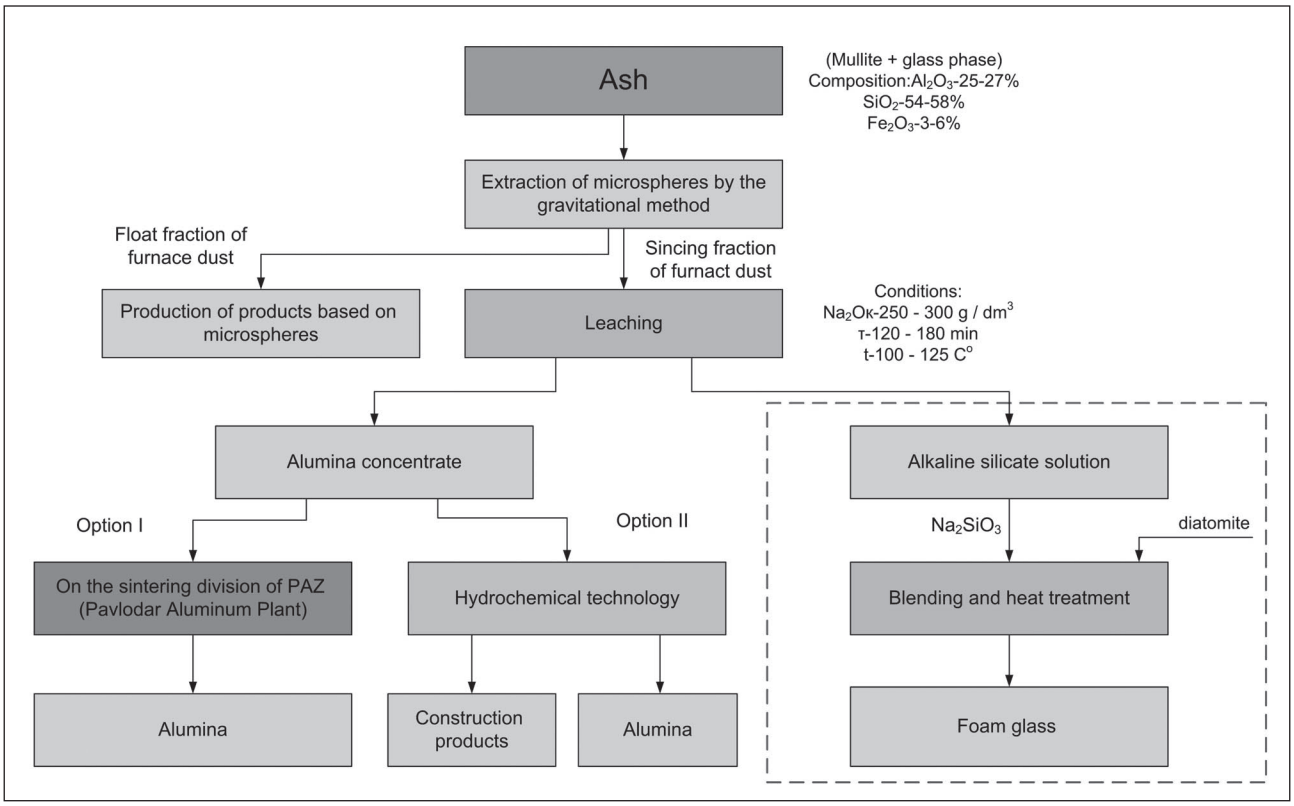

Figure 3 Improved technological scheme for processing ash from Ekibastuz steam coal with obtaining alumina and foam glass (new redistributions in the technological scheme were marked with the dashed line)

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