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Research of Raw Material Resources of Uzbekistan for Obtaining High-Aluminium Mass

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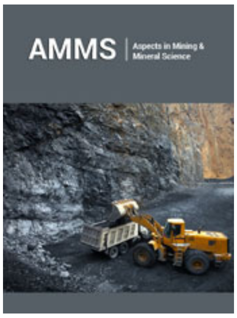

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Abstract

The chemical and mineralogical compositions, physical and chemical characteristics, and phase transformation processes occurring at various stages of roasting (1300-1500 °C) of kaolins and alumina-containing waste were studied. It has been established that firing is accompanied by phase transformations of clayey raw materials, as a result of which new formations occur in the form of mullite minerals. It has been shown that enriched kaolins from the Angren deposit (AKC-30 and AKF-78) and waste from the Shurtan gas chemical complex are suitable for developing the composition of high-alumina ceramic and refractory materials.

Keywords: Aluminium; Raw materials; Kaolins; Recrystallization; Shurtan gas chemical complex

Introduction

It is known that for the production of silicate and a number of other high-temperature materials, the main charge components are clay raw materials, the expansion of the raw material base of which is important in the national economy [1-3]. In this regard, the expansion of the raw material base of clayey non-metallic mineral resources. It should be noted that it has now been determined that the Republic has huge reserves of mineral raw materials and a sufficient number of different deposits of kaolins, refractory clays, and a number of other mineral resources have been geologically explored, which can be widely used for the production of silicate materials of various types. appointments. Among them, the Angren, Karnab, Zakhkuduk, Dzhamansay, Auminzatau, Teriklisay pyrophyllite kaolin deposits are potential and promising raw material sources for the production of high-alumina aluminosilicate ceramic and refractory materials. Baynaksai porcelain stones, Tozbulak nepheline-syenite, as well as andalusite rocks of the Zirabulak and Nurata mountains of the Kyzylkum [4-6].

It is noted [7-9] that for the production of high-alumina materials, kaolin rocks, which belong to the sillimanite (kaolinite, kyanite, sillimanite, andalusite) group, are mainly used as raw materials. In addition to kaolinite ($Al_2O_3SiO_2$ $2H_2O$), the other three minerals have the same composition, corresponding to the formula $Al_2O_3SiO_2$, which, after firing at appropriate temperatures, turn into mullite according to the reaction

$$3(Al_2O_3\ SiO_2) \rightarrow 3Al_2O_3\ 2SiO_2. + SiO_2.$$

In this regard, this paper presents the results of an experimental study of raw materials - enriched Angren kaolins produced by Angrenkaolini LLC of various brands: AKS-30, AKF-78, AKT-10 and alumina-containing waste of the Shurtan Gas Chemical Complex (GCC) of the Kashkadarya region of the Republic of Uzbekistan for the development of compositions of high-alumina ceramic masses based on their basis.

Methods and Materials

Chemical analysis was carried out using the classical gravimetric method [10]. X-ray diffraction examination of the samples was carried out at room temperature on a DRON-4M diffractometer using CuK radiation and a Ni filter. The radiograph was taken at a rate of generally 2deg/min. Monocrystalline quartz was used as an internal standard. The shooting conditions for all samples were kept constant. In the calculations and identification of phases, we used tables and reference books compiled by the authors of the works [11,12], as well as the international American card index on X-ray powder patterns [13,14]. IR absorption spectra of polycrystalline samples of initial raw materials were recorded on a Specord-75 IR spectrophotometer. In this case, standard methods were used for suspending samples in vaseline oil and pressing tablets with potassium bromide.

The phase transformation and the region of stability or change in the studied samples of raw materials were carried out on a derivatograph of the F. Paulik-I. Paulik-L. Erdey system, on which a synchronous recording of the differential curve with curves of changes in linear dimensions, in the form of shrinkage and weight loss, was simultaneously carried out.

Result and Discussion

The results of chemical analysis of clay raw materials, in particular enriched kaolins of the AKS-30 and AKF-78 grades, produced at the Angrenkaolin LLC enterprise, unenriched Angren kaolin, showed that the aluminium oxide content in kaolins is 27 wt.% (AKS-30), 32.75 wt.% (AKF-78) and 21.38 (Unenriched Angren kaolin) respectively. It can be noted that to develop the composition of a high-alumina material, its content is not enough, since to obtain a high-alumina material the aluminium oxide content must be above 50 wt.%. To increase the content of aluminium oxide in the ceramic mass, alumina-containing waste of the zeolite catalyst of the Shurtan gas-chemical complex was introduced, in which the content of aluminium oxide is 85.63 wt.% and its content in the calcined state at a temperature of 1300 °C is achieved above 90 wt.%. It should be noted that in AKT-10 grade kaolin the aluminium oxide content is extremely insufficient to develop the composition of high-alumina masses and is a quartz waste from the enrichment of the kaolin mineral.

It should be noted that the used alumina-containing waste, after its operation in the gas chemical complex, was pre-fired in laboratory silit furnaces at a temperature of 1300 °C with exposure at the final temperature for 1 hour. X-ray analysis (Figure 1) of kaolins of various grades shows that the main rock-forming minerals are kaolinite with diffraction maxima d=0.714; 0.357; 0.233nm and low temperatures β-quartz (d=0.426; 0.334; 0.182nm). The X-ray diffraction pattern of AKT-10 grade kaolin reveals the presence of intense diffraction maxima, related mainly to β-quartz minerals (SiO_2), and diffraction maxima with interplanar spacing and lower intensity and d=0.714; 0.357; 0.233nm refers to kaolinite minerals. Intense diffraction maxima also confirm the results of chemical analysis (Table 1), in which the content of the quartz mineral in AKT-10 grade kaolin is 82.61%. It should be noted that the content of quartz minerals in samples of AKT-10 grade kaolin is relatively high. Since in the X-ray diffraction patterns of AKT-10 grade kaolin, diffraction maxima often appear, related mainly to β-quartz minerals, and diffraction maxima with interplanar spacing and lower intensity and d=0.714; 0.357; 0.233 nm refers to kaolinite minerals. They also contain smaller amounts of the mineral's pyrite and siderite.

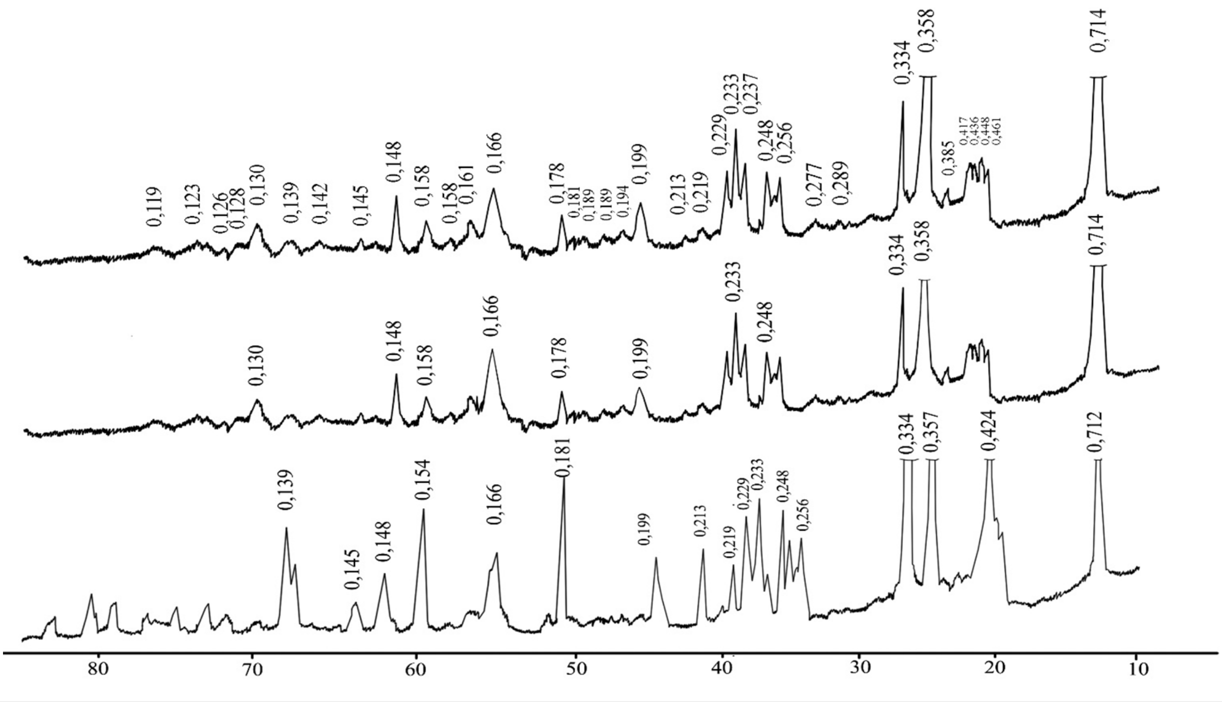

Figure 1: Rice. X-ray patterns of enriched kaolins: AKF-78 (1), AKS-30 (2) and AKT-10 (3).

Table 1: Results of chemical analysis of the studied raw materials.

Name of Raw Materials	Oxide Content, wt.% per Air-Dry Substance									LOI wt.%
	SiO_2	Al_2O_3	Fe_2O_3 general	TiO_2	MgO	CaO	Na_2O	K_2O	SO_3 general	
Enriched kaolin grade AKF-78	50,34	32,75	1,11	0,56	<0,30	1,00	0,05	0,33	0,30	12,84
Enriched kaolin grade AKC-30	58,51	27,00	0,72	0,52	<0,30	1,12	0,50	0,15	1,28	11,62
Kaolin grade AKT-10	82,61	10,78	1,29	0,41	<0,30	1,12	0,05	0,20	0,10	3,12
Unenriched Angren kaolin	67,45	21,38	3,14	0,58	0,34	0,55	0,35	0,25	1,18	9,35
Waste from the Shurtan Gas Chemical Complex (ShGCC)	0,48	85,63	0,01	0,10	1,35	1,88	0,03	0,03	0,10	10,81
Calcined waste from ShGCC (1300 °C)	1,33	90,55	0,20	0,22	0,80	<0,30	0,06	0,38	<0,10	-

In addition, based on the results of spectral analysis of kaolins of various grades, the presence of 16 chemical elements in them was mainly noted. Of these chemical elements, the rock-forming elements are silicon, aluminium, iron, the remaining elements do not exceed the clarke content. According to the conducted derivatographic analysis, three endothermic and two exothermic effects are observed on the DTA curves of enriched Angren kaolin (AKS-30) in the temperature range 20-1000 °C. The first endothermic effect was observed at 140 °C, associated with the removal of interlayer water and adsorbed water. The second endothermic effect is observed in the derivatogram of the studied samples at a temperature of 580 °C corresponding release of water of crystallization from the crystal lattice of kaolin minerals. The third endothermic effect at 800 °C refers to the destruction of the structure of clay minerals and the oxidation of organic substances of kaolin. The total weight loss when heating unenriched kaolin to 1000 °C is 11.64%, which indicates a high content of clay minerals. Presence of exothermic effects at 340 °C, apparently due to the oxidation of organic substances of kaolin. The second exothermic effect at a temperature of 940 °C is associated with the simultaneous superposition of thermal effects of dehydration and destruction of the structure of the kaolinite mineral, and is also associated with the recrystallization of amorphous decomposition products of clay minerals of unenriched kaolin.

According to the differential thermal analysis of enriched kaolin, it can be noted that the thermal curves of enriched and unenriched kaolin are similar. However, the difference is that there is no endothermic effect associated with the removal of interlayer water and adsorbed water in enriched kaolin. IR spectroscopic analysis established that the studied enriched kaolins of the grades AKF-78, AKS-30 and AKT-10 also belong to layered silicate compounds. The resulting IR absorption spectra are similar to the spectra of similar known layered aluminosilicate minerals. Accepting the fact that individual stretching vibrations of the Me^{+}-O bond were not detected in the IR spectra of the studied enriched kaolins. This is apparently due to the influence of the powerful charge and polarizing force of silicon ions (Si^{4+}), with which these ions in octahedral positions share easily polarized oxygen ions. Si-O is covalent in nature and is the strongest in the structures of polymineral natural aluminosilicate compounds.

Thus, the chemical and mineralogical compositions, physical and chemical characteristics of the initial raw materials and alumina-containing waste were comprehensively studied using modern methods of physical and chemical analysis. The processes of thermal phase transformation occurring at various stages of firing (1300-1500 °C) were studied. When considering thermal heating processes, it was found that firing is accompanied by phase transformations of the original raw materials, as a result of which new formations occur, i.e. mineral formation of mullite in aluminosilicate samples.

Conclusion

The results of physical and chemical analysis, such as elemental, chemical-analytical, X-ray diffraction, differential thermal and IR spectroscopic showed that clay raw materials - enriched kaolins of the Angren deposit of the AKS-30 and AKF-78 grades in combination with alumina-containing waste from the Shurtan GCC are suitable for developing the composition of high-alumina masses in the production of ceramic and refractory materials. Since, with the introduction of this waste into kaolin raw materials, the aluminium oxide content naturally increases and is above 50 wt.%. In addition, quartz waste AKT-10 obtained as a result of the enrichment of Angren kaolin can be used as a lean component in the raw material mass for the production of ceramic bricks and for other materials for construction purposes.

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