POROUS AGGREGATE DEVELOPED USING CARBONIZED CLAY FROM THE ANGREN FIELD

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ABSTRACT:

Object: The article is devoted to determining the optimal composition of the charge for the production of artificial porous aggregate from coal mining waste and bentonite clays, which are considered local raw materials for the development of new generations of thermal insulation and ultra-lightweight and structurally strong concrete.

Methods: When developing the optimal composition of the charge for the production of porous aggregates from mineral rocks and coal mining waste, a method was used that was used as the basic theory for the production of expanded clay.

Findings: Calculated and proposed formulas for the optimal composition of the charge for the production of porous aggregates appropriate for both heat-insulating (porous, ultra-light) and structural (dense, heavier) categories, despite the fact that both types of aggregates were adopted in terms of true and bulk density on lightweight (porous) aggregates.

Conclusions: The optimal composition of the porous aggregate from the coal mining waste of the Angren deposits and bentonite clay from the Navbahar deposits has been determined

Keywords: mineral rocks, industrial waste, secondary materials, porous aggregate, charge, carbonized clay, bentonite clay, glass phase, operational load, lightweight concrete.

INTRODUCTION

In Uzbekistan, almost only expanded clay gravel is produced from porous aggregates, the quality and volume of production of which cannot ensure the fulfillment of the plan for the industrial construction of civil and industrial facilities in the future, due to the limited reserves of clay for its production and low mechanical strength. Therefore, lightweight concretes based on artificial porous aggregates from local raw materials and industrial waste are of particular importance for construction, which makes it possible to significantly expand the raw material base and reduce the cost of their production.

Many regions of the republic have huge reserves of substandard raw materials: dune sands, loess-like loams, industrial waste, on the basis of which new types of artificial porous aggregates have been obtained - keramorite, camporite, carboporite, etc. [1]

MATERIALS AND METHODS:

In the work, we used not only generally accepted methods of analysis, but also special ones. **X-ray diffraction analysis** was used to study the phase composition of aggregate samples subjected to heat treatment at different temperatures. This method was carried out on a URS-50 diffract meter with a Geiger counter and a BSV-3 X-ray tube. We used a tube with a copper anti-cathode - Cu and K radiation. The values of interplanar distances and the intensity of their line for each mineral were consistent with the reference data from the tabular data.

"The survey was carried out on a DRON-3 diffract meter with CoKα with filtered (Fe) radiation in the mode: I = 25-30mA, U = 30kV, V detect = 20 / min, V diff. tapes = 600mm / hour, measurement limit - 1x103 imp / s, τ = 0.5sec, slots: 1x4x1mm. The survey area is 2Θ = 2-750 for the initial samples.

The interpretation and identification of mineral phases was carried out according to standard methods using domestic catalogs and ASTM.

A scanning electron microscope (SEM) is an electron microscope-class device designed to obtain an image of the surface of an object with a high (up to 0.4 nanometer) spatial resolution, as well as information on the composition, structure and some other properties of near-surface layers.

3nm (2nm) @ 30kV, SE, W (LaB6), 4.5 nm @ 30 kV, BSD (VP mode), 15 nm @ 30 kV, 1nA, LaB6, 20 nm (15 nm) @ 1 kV, SE, W (LaB6), 10 nm @ 3 kV, SE

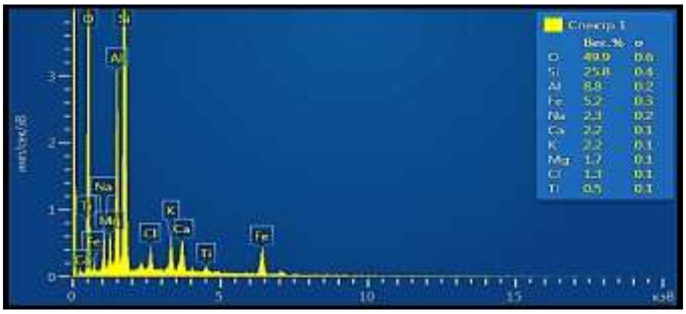
Method. Study of topography and surface structure, image acquisition in secondary and backscattered electrons. X-ray microanalysis of elemental composition using energy dispersive and wave dispersive spectrometers (EDS, WDS). Electron Backscattered Diffraction Detector - Phase Composition and Texture Analysis (EBSD).

Scope: In the fields of industry and science, where research is needed surface structures of samples and analysis of elemental composition.

Analysis of the characteristics of bentonite clay:

Bentonite clays got their name from the port of Benton, located in the state of Wyoming (USA), where the first commercial mining of them began at the end of the 19th century. In the subsequent period, interest in bentonite clays increased significantly, and their deposits were discovered on almost all continents of our planet.

In this quarry, a quality management system has been developed and implemented in accordance with the International standard of the ISO 9001: 2000 series. In 2008, the QMS was assessed and certified as meeting the requirements of ISO 9001: 2000 by the international company SGS. In May 2011, the company received the International Certificate of the Swiss Institute for Quality Standards SIQS. The enterprise has a great customer satisfaction mail.



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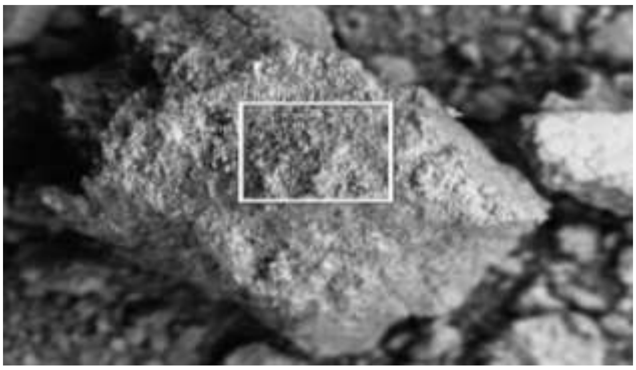

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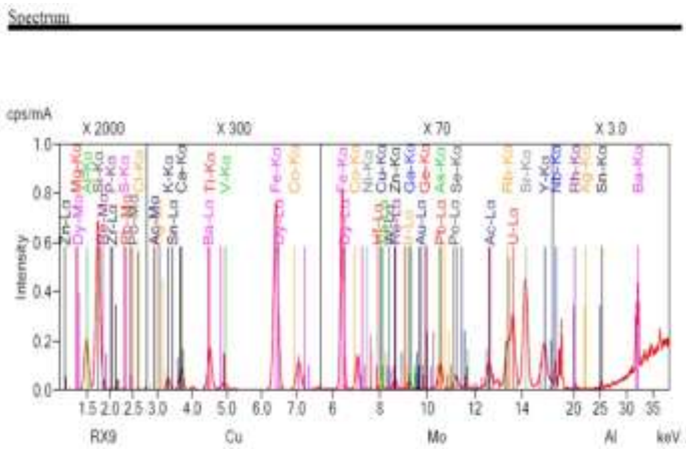

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Figure 1. a) Spectrogram of bentonite clay b) Photograph of grain bentonite clay enlarged 250 times, c) spectral diagram of the chemical composition of bentonite clays

When determining the chemical composition of bentonite clay with their specified weight ratios SiO_2 (75.19%) + Al_2O_3 (8.77%) + (Fe 5.21%) in this work spectrograms and tabular values of the chemical composition were obtained, similar to those presented in figure. Average values of concentrations of chemical elements and the relative error at one and the same accelerating voltage (E) was determined by test data of two samples of the same composition. The value of E had values of 10, 20 kW.

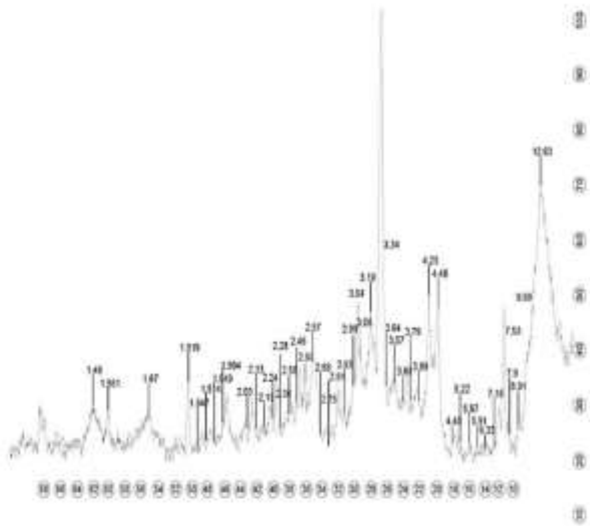


Figure 2. X-ray diffraction pattern of a bentonite sample from the Navbakhor deposit

X-ray phase study of samples of bentonite occurrences Navbahor (Fig. 2) observed lines refers to montmorillonite d = 0.446; 0.257; 0.246; 0.1496; 0.250; 0.278; 0.293; 0.275; 0.224; 0.1949 nm, quartz: d = 0.425; 0.334; 0.1994; 0.1819; 0.154.1 nm, k palygorskite: d = 1.263 nm, bydelite: d = 0.1695; 0.228 nm, illite: d = 0.357 nm. There are also lines close to polygarskite clays d = 0.304; 0.228; 0.1517 nm. In addition, there are lines d = 0.324; 0.1670; referring to both illite and montmorillonite [6].

Analysis of the characteristics of the Angren carbonized clay:

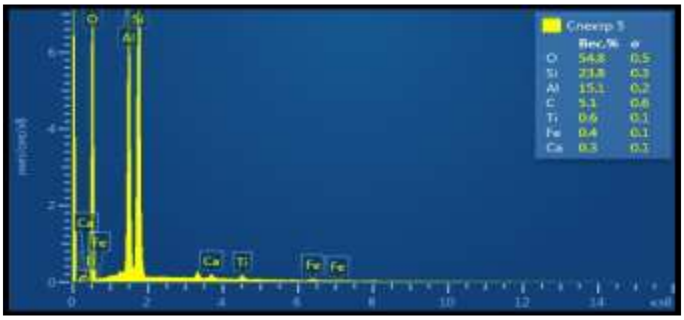
The coal industry is among the industries with the greatest negative impact on the environment. The currently relevant technologies of coal mining and enrichment at various stages provide for the formation of solid wastes, which take out of use large areas of land and worsen the state of water resources. In addition, the coal industry incurs significant costs associated with waste disposal.

One of the main problems when using waste from coal mining and processing as a secondary raw material is the heterogeneity and instability of their composition. This necessitates the preparation of waste before using it.

Waste from mining and processing of coal as a raw material for the production of building materials can be used in:

• As a component of the raw material mixture in the production of cement; • in the manufacture of ceramic (ceramic tiles and bricks, drainage pipes) materials and silicate (silicate brick, glass, etc.) materials; • as a raw material in the production of porous aggregates (aggloporite, azerite, expanded clay, etc.); • as a concrete filler; • as a substitute for earthen soil in the construction of hydraulic structures, foundations, highways, etc. • as a raw material in the production of porous sand; • as a raw material in the production of mineral wool;

Analyzing the chemical composition given in Table 3 it can be concluded that, in terms of the amount of silica, alumina and water (pp), the kaolin of the Angren deposit is close to the theoretical formula of kaolin - $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$.



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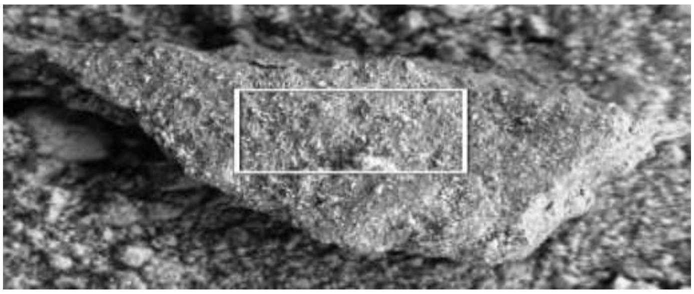

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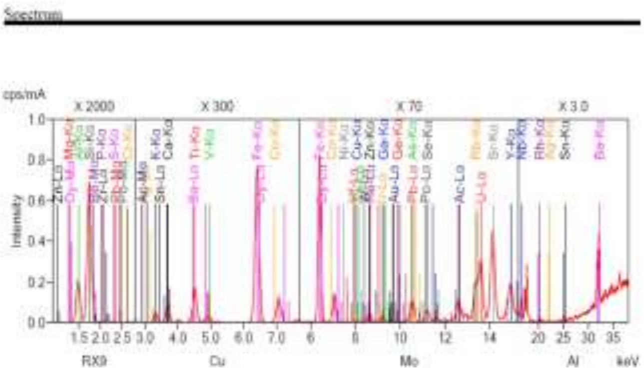

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Figure 3. a) Spectrogram of waste from coal mining b) Photograph of grain waste from coal mining enlarged 250 times, c) spectral diagram of the chemical composition of waste from coal mining

Spectral analysis was used to study Angren clay, which showed the presence of O-H bonds of hydroxyl groups with absorption waves of 3700-3670-3650-3630 cm-1, characteristic of kaolinite and Si-O bonds, characteristic of quartz sand in the region of absorption waves of 1800-800 cm $^{-1}$. The content of quartz monomineral on the IRS, confirmed the region of bonds Si-O 1800-800 cm^{-1}. Quartz porphyries contain OH bonds of hydroxides 3670-3600 cm-1. According to Fe-O bonds, absorption lines 3000 cm-1, Ca-O - absorption lines in the region 1400-1200 cm-1 refer to carbonates.

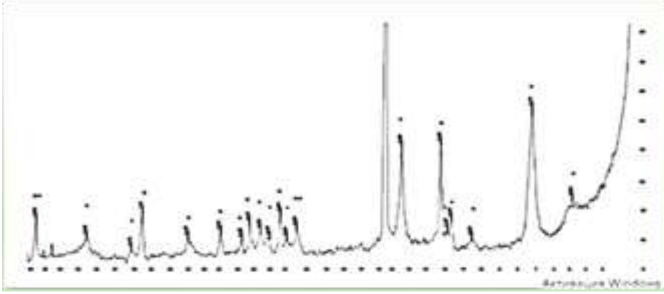


Figure 4. X-ray diffraction pattern of Angren clay

The X-ray diffraction pattern of Angren clay shows peaks characteristic of kaolinite with d = 0.459; 0.355; 0.253; 0.233; 0.150; 0.178; 0.148; 0.145; 0.128; 0.125; 0.123; 0.119 nm. The lines d = 0.424 were determined; 0.336; 0.245; 0.183; 0.166; 0.153; 0.138 nm related to quartz. Peaks 0.302 are noticeable; 0.227; 0.203; 0.199; 0.192 nm for carbonates.

LITERATURE REVIEW:

Due to the lack of raw materials for the production of expanded clay and agglomerite in Uzbekistan, there is an urgent problem of obtaining other types of porous aggregates - keramporite, camporite, quartzite, glass porous and carboporite, obtained on the basis of local raw materials and industrial waste at the Tashkent Polytechnic Institute (now TIACE) under the leadership of L.M. Botvina.

In the works of Botvina L.M. and Bilyalova KB to obtain porous fillers, the raw materials for production were dacite porphyries, loess rocks, dune sands, waste from sawing dolomite rocks and glass industry waste. The granules were molded using plasticizers and pore-forming agents. New types of lightweight aggregates were sintered in a rotary kiln. Unlike traditional porous fillers (expanded clay and aggloporite), new types have high strength indicators and properties - frost resistance, durability [19, 20, 21]. However, due to the complexity of the composition of the charge, such a porous filler is not produced.

RESULTS:

A mechanically mixed dry mixture of charge components in appropriate amounts was moistened and molded into granules on a laboratory granulator. In order to avoid sticking and change in shape, the granules were powdered during molding with dried and crushed carbonized kaolinite clay. The granulometry of the green rounded aggregate grains was 5-10 and 10-20 mm. The formed aggregate granules were pre-dried and then placed in a heated muffle furnace for further firing. Heat treatment of aggregate granules was carried out within the range of 1000-1100 ° C, determined in the course of preliminary studies.

The obtained porous aggregate in its properties meets the standard requirements for expanded clay.

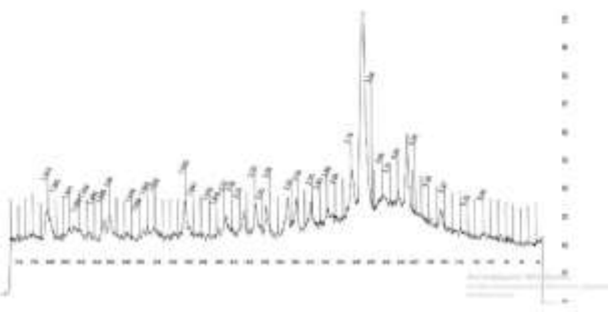


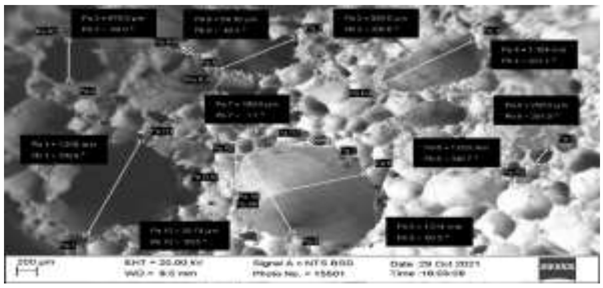
Figure 5. X-ray diffraction pattern of a porous gravel-like aggregate, fired at 1100 ° C and holding for 30 minutes

Studies have shown that when firing ceramic bricks based on beidellite clay and waste from the production of mineral wool at a temperature of 950°C, a liquid phase is formed, which initiates the onset of crystallization of mullite at 1050°C.

With an increase in the firing temperature to 1000°C, cristobalite lines appear on the X-ray diffraction patterns of samples of compositions 1.2 (d/n = 0.192.9; 0.404 nm).

An increase in the firing temperature to 1050°C contributes to the appearance of mullite (d/n = 0.182.1 nm; 0.204; 0.246; 0.251; 0.270 and 0.374 nm), which indicates the beginning of its crystallization.

The phase composition was determined by X-ray diffraction analysis of the finished product for a complete representation of the physical and mechanical properties of the porous aggregate fired at a temperature of 1100 ° C. As can be seen from Fig. 12, the reflections are d = 0.425; 0.334; 0.246; 0.223 nm, characteristic of quartz.



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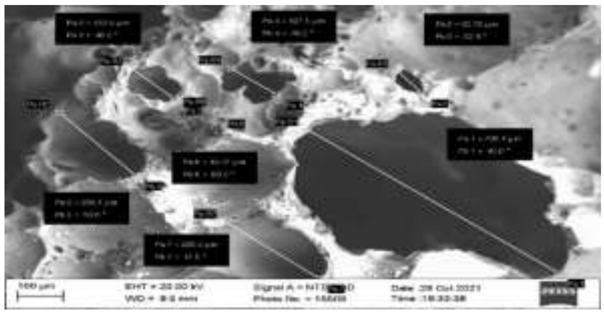

Figure 6. photographs taken with the A scanning electron microscope (SEM) during phase composition and texture determination (EBSD).

a) increased to 200μ with pore sizes

b) increased to 100μ with pore sizes

It has been established that when the granules are sintered during firing at temperatures above 1100°C, the mullite mineral is formed from the amorphous decomposition products of kaolinite contained in the original raw materials - bentonite clay and carbonized clay (waste of coal enrichment) (Table 4).

CONCLUSION

The possibility of obtaining a porous filler from bentonite clay and carbonized kaolinite clay of the Angren coal deposit has been determined. The composition of the charge for the aggregate has been optimized. The best physical and mechanical properties of the aggregate are provided when the content of bentonite clay (90%), carbonized kaolinite clay (10%) and the moisture content of the charge is 30%.

The technological regime (firing) of obtaining a porous aggregate has been optimized. It is shown that the regulatory requirements are achieved by preliminary drying of granules at a temperature of 100 ° C, firing at 1100 ° C and holding in a furnace for 30 minutes.

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