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PROPERTIES OF COMPLEX ADDITIVES AND INDUSTRIAL WASTES ADDED TO FOAM CONCRETE

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Kalit so‘zlar: issiqliq himoyalovchi, ko‘pik xosil qiluvchi, urbanizatiya, kompleks qo‘shimcha, sanoat chiqdisi, metalugiya shlagi, ikkilomchi.

Аннотация. В условиях ежегодного роста потребности в теплоизоляционных материалах производство высокоэффективных композиционных материалов на основе местных и промышленных отходов может стать одним из решений данной проблемы. Одним из видов таких материалов является пенобетон.

Ключевые слова: теплоизоляционный, пенообразующий, урбанизация, комплексная добавка, промышленные отходы, металлургический шлак, вторичный.

Annotation. One of the solutions to this problem is the production of highly efficient composite materials on the basis of domestic and industrial waste, while the need for heat insulation materials is increasing year by year. One of these materials is foam concrete.

Keywords: heat-shielding, foaming agent, urbanization, complex additive, industrial output, metallurgical slag, secondary.

INTRODUCTION.

By using industrial waste as secondary material resources, it is possible to solve a number of important tasks such as conserving raw materials, preventing pollution of water bodies, soil and air, increasing the production of spare parts and products, and mastering the production of new products for enterprises.

ISSN 3030-3907

The development of industry and the growth of urbanization in any country inevitably lead to environmental problems. Over the past 15 years, the strategy of waste utilization has significantly changed in both industrialized and developing countries. The main reasons for such changes are: environmental pollution and its negative impact on health, changes in environmental policy and legislation, and the influence of public movements on environmental protection. In industrially developed countries, waste management policy is mainly aimed at reducing the amount of waste and developing methods for its disposal. This makes it possible to reduce the flow of waste disposed of at relatively low cost by up to 40 percent.

Therefore, today the global trend in the field of waste utilization in the world is aimed at transitioning from disposal and incineration to industrial recycling. This article considers the formation of certain types of waste by industrial complexes and their characteristics, taking into account the diversity of industrial waste.

MATERIALS ANALYSIS AND RESEARCH. For the continuous consideration of secondary by-products, they can be classified according to the industries in which they are generated.

From this point of view, they can be divided into the following groups:

1. Secondary products of metallurgy: blast furnace, ferroalloy and smelting slags; slags from non-ferrous ore smelting; ore beneficiation products, nepheline and others (powder-like products).

2. Secondary products of thermal energy and fuel industry: ash, fuel slags, materials extracted from mines, coal enrichment products, oil-gas pitch (a substance remaining after boiling tar, used as an insulating varnish), acid gudron (waste).

3. Secondary products of the chemical industry: wastes containing iron and gypsum; sludges containing salts and hydroxides and simple products; phosphorus slags, secondary polymer products.

4. Secondary products of the mining industry: overburden rocks exposed during the extraction of mineral resources and rocks extracted along with them.

5. Secondary products from processing raw materials obtained from wood and other plants: bark, chips, sawdust, lignin, cotton stalks, hemp waste and others.

6. Secondary products in the production of construction materials: cement, asbestos cement, glass, ceramic waste, polymer production, non-metallic industry, concrete and reinforced concrete.

7. Urban waste: worn-out vehicle tires, rags, paper waste, solid residues of wastewater, used polymer materials.

Therefore, the structure of production of artificial porous aggregates can be improved by producing agloporite, slag pumice and other aggregates from industrial waste, especially from fuel-containing raw materials.

ISSN 3030-3907

Metallurgical slags. The main amount of waste from metallurgical processes is formed in the form of slag. Slags are products of high-temperature interaction of the components of the initial materials (fuel, ore, molten substances and gaseous environment). Their chemical composition and structure vary depending on the porous (loose) structure of the composition, the type of smelted metal, the characteristics of the metallurgical process, and the cooling conditions. Metallurgical slags are divided into ferrous and non-ferrous slags.

Depending on the nature of the process and the type of furnace, ferrous metallurgy slags are divided into the following types: blast furnace, steelmaking (open-hearth, converter, Bessemer and Thomas, electric smelting); ferroalloy production; cupola slags.Among them, the blast furnace produces the largest amount of slag, where slag amounts to 0.6–0.7 tons per 1 ton of pig iron. The amount of slag produced during the smelting of 1 ton of steel is significantly lower: in the open-hearth process – 0.2–0.3 tons; in Bessemer and Thomas processes – 0.1–0.2 tons. During steel smelting in electric furnaces – 0.1–0.4 tons; in ferroalloy production and cupola processes, the amount of slag is relatively small. In non-ferrous metallurgy, the amount of slag formed depends on the composition of the initial charge. When copper concentrates containing 10–15% copper are smelted in reverberatory furnaces, the slag output is 10–20 tons per 1 ton of metal. When smelting in shaft furnaces, if the copper ore contains 1–2% copper, the slag amounts to 50–100 tons; during shaft smelting of acidified nickel ore – 100–200 tons.

The chemical composition of blast furnace slag is represented by four main oxides:

CaO (29–30%), MgO (0–18%), Al_2O_3 (5–23%) and SiO_2 (30–40%). They contain small amounts of iron oxides (0.2–0.6%) and manganese (0.3–1%), as well as sulfur (0.5–3.1%). In addition to the main components, non-ferrous metallurgical slags may contain small amounts of trace metals such as copper, zinc, lead, nickel, and others.

When evaluating slags as raw materials, an important characteristic for construction materials is the ratio of basic and acidic oxides in their chemical composition, i.e., the basicity modulus:

M_o-$(SaO+ MgO)/(SiO_2 + Al_2O_3)$,

$M_o > 1$ — If it is greater than 1, the slags are classified as basic;

$M_o < 1$ — If it is less than 1, the slags are classified as acidic.

The chemical composition of slag melts directly affects their physical properties, structure, solidification, and the properties of the solidified slags. An increase in calcium oxide content in slags leads to an increase in melting temperature and a decrease in fluidity. The oxides included in the slag composition

ISSN 3030-3907

form various minerals. Based on the analysis of phase diagrams corresponding to oxide systems, it has been established that slags contain about forty binary and ternary compounds, among which silicates, aluminosilicates, aluminates, and ferrites occupy a leading position. In almost all metallurgical slags, along with crystalline products in varying amounts, there is also a glassy phase.

In dumped and slowly cooled basic slags, the glass content is not high; however, in blast furnace slags this amount reaches up to 98%. Glass is a thermodynamically unstable phase, and it to some extent determines the chemical activity of the slag. It has been established that slag glasses interact with water much more intensively than crystalline mineral phases.

Among all types of metallurgical slags, blast furnace slags are widely used in the production of construction materials. Their extensive use in the overall slag balance is mainly due to the similarity of their composition to cement mixtures, their acquisition of hydraulic activity during rapid cooling, and other factors. The main volume of blast furnace slag is obtained during the smelting of pig iron and cast steel. Blast furnace slags are products of the interaction of fluxes (calcium and magnesium carbonates), gangue from iron ore, and coke ash. The composition of slags varies depending on the composition of the iron ore and coke, which differs according to regions.

In the slags produced by metallurgical plants of the central regions and the south of Russia, the content of Al_2O_3 is low (6...10%), while the content of CaO is relatively high (up to 50%), and sulfide sulfur reaches up to 3...4%.

In the Ural and Kuznetsk metallurgical basins, slags are smelted from iron ores rich in aluminum oxide and low-sulfur coke; the content of Al_2O_3 reaches up to 20%, and sulfide sulfur up to 1%.

For the slag of the first group, $M_0 > 2$, while for the second group $M_0 < 1$; the observed difference lies in hydraulic activity and other properties. In general, basic slag glass has significantly higher hydraulic activity compared to acidic slag glass.

The chemical activity of slag is determined by the quality coefficient K according to the following formula:

when contained up to MgO 10% :

$K = CaO+Al_2:O + MgO/SiO_2 + TIO2$

when it is above *MgO* 10%:

$K = CaO + Al_2O+10/SiO_2 + TiO_3 + (MgO-10)$

The essence of the widely used slag processing method is granulation, i.e., the slag melt is rapidly cooled using water, steam, and air, as a result of which glassy granules with a size up to 10 mm are formed. Two granulation methods are used: wet and semi-dry.

ISSN 3030-3907

In wet granulation, rapid solidification of molten slag is usually carried out in reinforced concrete basins filled with water. The equipment for wet granulation is not complex, has high productivity, and does not require large financial costs for the technological process. However, wet granulation has high moisture content (10–30%), which leads to freezing in winter, increases transportation costs, and creates the need for drying with additional energy consumption. Semi-dry granulation is more efficient and is based on a combined solidification method of slags: first with water, then in air. The final moisture content of granulated slag reaches 4–7%.

Mainly blast furnace slag is granulated. The main portion of granulated blast furnace slag is used in the production of slag Portland cement. They are also used in the production of local clinker-free binders, slag-alkali concrete, mineral wool, slag-crystalline products, and as fillers for cement and asphalt concretes.

In the CIS countries, more than 60% of steelmaking slag is obtained from open-hearth (Martin) production and more than 35% from converter production. About 30% of steelmaking slags are processed; in ferroalloy production, slag is mainly used as crushed stone, and slag powder is used as mineral fertilizer.

Slag from non-ferrous metallurgy is currently used only in small quantities in cement production as an iron-containing component and active mineral additive, as well as in mineral wool and cast product manufacturing.

Fuel and energy industry wastes. Solid coal waste is used as low-grade fuel. In world practice, coal wastes are used for filling mined-out ore deposits. Coal waste is formed during coal enrichment processes for coking, energy, and other purposes, and consists of a mixture of sedimentary rocks, coal, and coal reserves. Waste is used as energy raw material for re-burning, gas processing, sulfur extraction, production of construction materials, construction of underground structures, and land reclamation.

Ash and slag wastes are produced when solid fuel is burned in thermal power plant furnaces at temperatures of 1200–1700°C.

Fuel-containing products include wastes formed during extraction, enrichment, and combustion of solid fuels. Stone coal and brown coal are the main types of solid fuel. During coal mining and enrichment, mine and overburden rocks, as well as coal enrichment waste, serve as by-products.

Slag and ash. Slags are the main wastes formed during the lump combustion of fuel. During pulverized combustion, slag formation accounts for 10–25% of ash content. Slags are formed as a result of sintering of individual particles on furnace grates at temperatures above 1000°C or cooling of the molten mineral part of fuel at temperatures above 1300°C.

ISSN 3030-3907

METHOD. Coal enrichment wastes with the least variable composition and properties are of great interest for use in the production of construction materials. They exist in various forms: argillites, siltstones, sandstones, etc. The unseparated coal content during the enrichment process may reach up to 20%. Coal enrichment wastes are mainly in the form of 8–80 mm fragments.

After the main processing in coking chemical production plants, products remain in the form of sludges with moisture up to 30% and particle sizes smaller than 0.14 mm, mine rock materials consisting of fuel with a size of 3 mm, as well as large fragment residues.

Loose rocks corresponding to stone coal deposits are products of combustion, while glieys are clay and clay-sandy rocks baked in underground fires within coal seams, and burned mine wastes are also considered their types.

Natural burned rock reserves are widely distributed in various regions of the country. Their true density is 2.4–2.7 g/cm³, bulk density 1300–2500 kg/m³, compressive strength 20–60 MPa. In terms of their main physical and chemical properties, they are close to clays calcined at 800–1000°C. The chemical-mineralogical composition of burned rocks is diverse, but the common feature is the presence of radially structured active alumina from dehydrated clay minerals, or active alumina, silica, and iron compounds. Unlike ash and slag, burned rocks contain almost no glassy components and are characterized by high sorption capacity. The unburned fuel content is 2–3%, while in waste burned rocks it may be significantly higher.

If the fuel component contains a large amount of carbonates, low-basic silicates and calcium ferrites capable of interacting with water are formed in the ash.

Conclusion: Ashes of brown coal and stone coal from several deposits in Central Asia and Siberia, as well as combustible shales, contain high-calcium ash.

Ash contains small amounts of the following impurities: free calcium and magnesium oxides, sulfates, sulfides, etc.

Ashes usually contain carbon in various forms and as coke residues. Their content depends on the type of fuel: for coal and combustible shales it is less than 4% according to standard indicators, for stone coal 3–12%, and for anthracite 15–25%. The amount of unburned particles is lower in fine-dispersed ash fractions compared to coarse-dispersed ash.

The chemical composition of ash wastes varies depending on the coal deposit. The approximate content of the main oxides in different thermal power plant (IES) ashes, %: SiO_2 – 37–63; Al_2O_3 – 9–37; Fe_2O_3 – 4–17; CaO – 1–32; MgO – 0.1–5; SO_3 – 0.5–2.5; $Na_2O + K_2O$ – 0.5–5. The loss on ignition, which characterizes the amount of unburned coal particles in the ash, is 0.5...30%.

ISSN 3030-3907

Important indicators of ash quality are its dispersity and granulometric composition. The dispersity of ash waste is expressed by the specific surface area determined by the air permeability method, as well as by the residue on sieves. There is no direct correlation between these two indicators. The specific surface area of ash wastes is 1000...4000 cm²/g. In many cases, it approaches the specific surface area of cement. Ashes with a high content of unburned fuel residues have higher specific surface area values.

Many thermal slags are characterized mainly by a high content of iron oxides in acid slags (20% and more). The glassy phase content is 85...89%, while in basic slags it may be lower. The crystalline phase may contain mullite, gehlenite, pseudowollastonite, dicalcium silicate, and other minerals. Ashes and slags of thermal power plants are classified into 6 types according to the content of unburned coal particles (%): up to 1–5; 2,6. .10; 3-11... 15; 4-16...20; 5-21...25, 6 more than 25.

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