UDC 725:69.059.28

DEVELOPMENT OF BINDERS FROM SECONDARY RAW MATERIALS OF COAL ENRICHMENT AND THEIR USE IN RESTORING AND ERECTING CONSTRUCTION OBJECTS

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Problem statement. The process of coal enrichment is accompanied by the formation and accumulation of coal enrichment waste in significant volumes, which has a significant negative impact on the environmental condition of their storage sites. This occurs due to the large areas they occupy and the risk of contamination of even larger areas due to possible infiltration into the soil and subsequent contamination of groundwater. There is a problem of developing a technology for using such waste, for example, in the resource-intensive industry of production of clinker-free binders in order to reduce energy costs, emissions during production and further use of materials based on such binders in the restoration and construction.

The aim of the research is to develop technological solutions for the restoration and erection of structures using the binder developed.

Main content. Coal industry waste has become a serious problem for further use. More than 50 % of waste ends up in landfills, where it can easily leach into the environment.

Coal enrichment waste is represented by clay minerals, quartz, pyrite, a small amount of carbonates, impurities and combustible substances.

Coal enrichment process is carried out by gravity and flotation methods. Waste with a coarse grain composition (particle size up to 2−3 mm) is formed during the enrichment of rock by the gravity method. During flotation method sludge with moisture content of 60 % is formed, which contains particles up to 0,04−0,05 mm in size.

Gravity coal enrichment waste was used in the raw material charge in the production of Portland cement clinker, as a component part to reduce technological fuel costs for its production [1; 2], as well as in the production of clinker-free binder from coal enrichment waste and limestone at a temperature firing up to 1 100 °C [3].

It is possible to produce clinker-free binding coal slurry without grinding, since it mostly contains solid particles, which are smaller than 50 nm. In the proposed technology, limestone was subject to grinding and subsequent granulation together with coal slurry and firing at a temperature of 1 000 ^oC.

As a result of firing, the mineralogical composition presented in the radiograph (Fig.) was formed. According to the results of the obtained diffraction maxima from the X-ray, the binder mainly consists of calcium oxide (CaO), dicalcium silicate ($2CaO \cdot SiO_2$) and silica (SiO_2) and can be used in the future for autoclave hardening of structures.

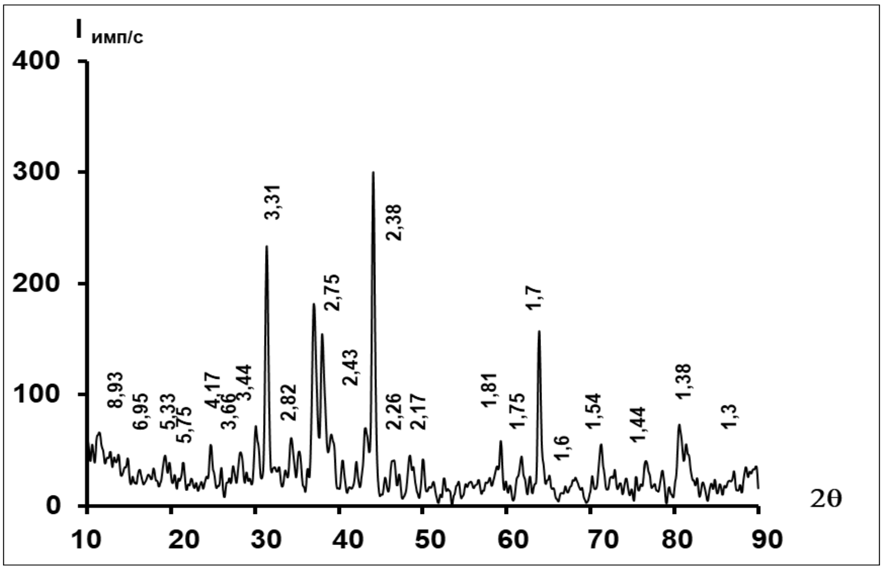

Fig. X-ray diagram of the binder fired at 1 000 ^oC

When using a binder without autoclaving, it is necessary to bind the maximum amount of lime with silica.

Complete bonding of calcium oxide with silica and the formation of dicalcium silicate ($2CaO \cdot SiO_2$) at firing temperatures up to 1 100 ^oC is possible due to the use of mineralizers, which will lower the decarbonization temperature of calcium carbonate ($CaCO_3$) and intensify solid-phase reactions between CaO and SiO_2.

From the obtained binder, samples were made to determine the strength. According to the results of the tests, it was established that the strength of the samples is 100−120 kgf/cm^2.

The goal of the research is to obtain a clinker-free binder with strength of at least 300 kgf/cm^2 using energy- and resource-saving technology. The technology could reach to a 30−40 % reduction in technological fuel consumption when using coal enrichment waste, eliminating the grinding process and reducing the firing temperature when using mineralizers.

The obtained binder can be widely used in the production of concrete, building mortar, silicate brick, fencing structures, road paving products, and curb stone. Nowadays, the possibility to use it by the 3D printing method is considered.

The use of binding materials with coal enrichment products in combination with modern 3D printing construction technology can allow shortening the construction period and reduce its cost while adhering to the concept of sustainable construction with careful consumption of natural resources and the simultaneous use of secondary raw materials.

Conclusion. 1. The presented binder is planned to be applied during the construction of new or during the restoration and reconstruction of structures. Therefore, it is necessary to increase its strength by increasing the content of dicalcium silicate in its composition. 2. The use of secondary raw materials makes it possible to simultaneously achieve positive effects in terms of reducing the impact on the environment from its use and reducing the cost of construction works by reducing the cost of materials.

References

1. Pryhodchenko V.L., Slasheva O.E. [and others]. The main areas of application of wash slurry wastes in building branch of industry. IGTM NASU. 2013, pp. 220−227. (in Ukrainian).
2. Shpirt M.Y. Waste-free technology. Disposal of waste products and processing of combustible fossils. Ed. by B.N. Laskoryn. Moscow : Nadra Publ., 1985, 367 p. (in Russian).
3. Dvorkin L.I. and Lapovska S.D. Construction materials science. Rivne: NUWM, 2016, 448 p. (in Ukrainian).