DOI: https://doi.org/10.54338/27382656-2022.2-014

Khungianos Stepan Yavruyan[1*], Evgeniy Sergey Gaishun[1]
[1]*Don State Technical University, Rostov-on-Don, RF*

CERAMIC MATERIALS WITH THE USE OF INNOVATIVE SUPPLEMENTS

The use of by-products of the coal industry in the production of wall ceramics is quite relevant. Coal waste is a promising raw material base for the production of ceramic wall materials. Coal sludge is widely used in the production of clay bricks at factories in the Urals and Kazakhstan. The most mastered technology is the use of coal waste as an additive in the production of ceramic products. The use of local waste allows to minimize raw material costs.

Keywords: *Production, raw materials, technogenic waste, technology, coal enrichment, additives.*

Introduction

Currently, the use of coal enrichment waste in the production of building materials is relevant. They are used as additives: in cement, ceramic products, in the production of binders, as well as in road construction. More than 500 mine dumps have formed on the territory of Eastern Donbass (Rostov region) for more than one hundred and fifty years of industrial development, occupying large areas of land.

Coal enrichment waste is a promising raw material base for the production of wall ceramics because they are in fact a ready-made mixture of highly efficient ceramic products, completely possible to replace the primary raw materials. The use of local waste will significantly reduce raw material costs, and will also make it possible to manufacture products with little additional fuel consumption.

Materials and Methods

An analysis of the chemical composition of the products of processing of coal preparation plants showed sufficient stability of the content of Al_2O_3 and SiO_2 oxides, which makes it possible to use these products as ceramic raw materials [1].

The economic efficiency of using coal enrichment waste in the production of ceramic wall products is determined by the reduction in the cost of process fuel, raw materials, as well as the removal and storage of these wastes at coal preparation plants. The maximum economic effect can be achieved by using coal waste at the place of their exit [2-3].

An average grain composition of coal preparation waste is presented in Table 1. It is characterized by a fairly high fineness modulus, and according to this indicator, it can be attributed to the group of sand with increased fineness, with a small amount of a fraction of 0.16-0.315 mm and less than 0.16 mm.

Table 1. Average grain composition of waste coal

Residue name	Residues, % by weight, on sieves					Passage through a sieve with mesh No. 016, % by weight	Fineness modulus
	2.5	1.25	0.63	0.315	0.16		
Partial	8.3	1.8	4.7	11.5	7.3	6.4	3.43
Full	28.3	60.1	74.8	86.3	93.6	–	

According to the chemical composition, coal enrichment wastes do not differ fundamentally from typical clay raw materials and are characterized by AI_2O_3 content from 16 to 22% and potassium oxide content of more than 4%. This is due to the peculiarities of the mineralogical composition. The average chemical composition of coal preparation waste is presented in Table 2.

Table 2. Average chemical composition of coal preparation waste, % by weight

ППП	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	K_2O	Na_2O	P_2O_5	TiO2
10.27	52-60	16-22	4-7	1-4	1-4	0.2-0.6	3-5	0.2-1.0	0.1-0.3	0.4-1.0

Results and Discussion

The technology for manufacturing laboratory samples is described next. The initial composition of coal enrichment waste was preliminarily dried them in an oven at a temperature of 100 ± 5 ºC during the day due to increased moisture content of 25% compared to the required 18-20%. It was then crushed and sieved into fractions of 0.16-0.63. The composition of the charge consisted of coal enrichment waste from 70 to 90% and clay additives from 10 to 30%. The molding process was executed at a humidity of 6 to 10%. Pressing was carried out according to the technology of rigid extrusion at a pressure of 15 to 25 MPa. The molded samples were dried for 24 hours at a temperature of 100 ± 5ºC. The samples were then fired in a muffle furnace at temperatures from 900 to 1050 ºC for 28 hours.

Below are graphs (Figures 1 and 2) of the dependence of water absorption and strength of fired samples on the degree of grinding of coal preparation waste and firing temperature. The graphs show that at a firing temperature of 1000°C and above, high strength indicators are achieved with a sufficiently low water absorption of the samples.

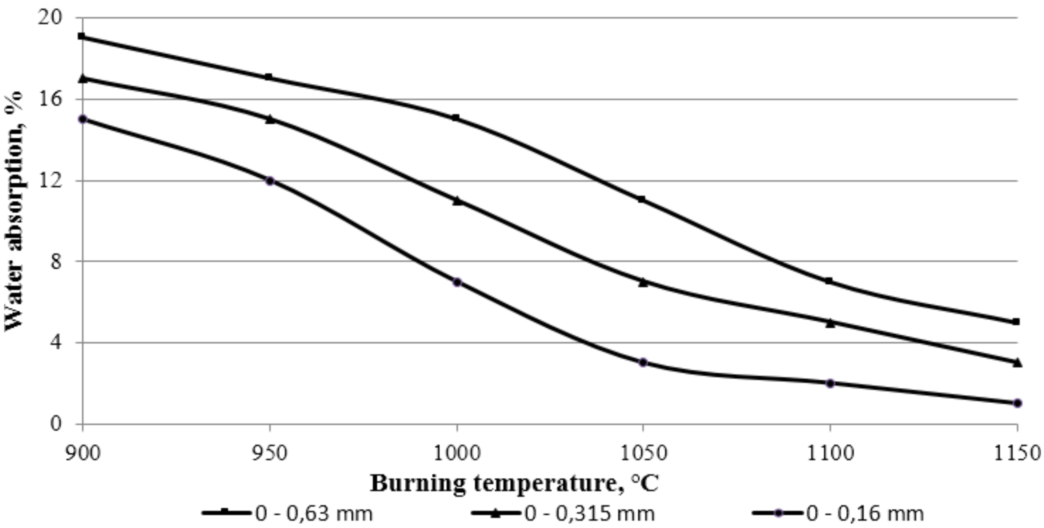

Fig. 1. *Influence of the degree of grinding and firing temperature on the water absorption of samples*

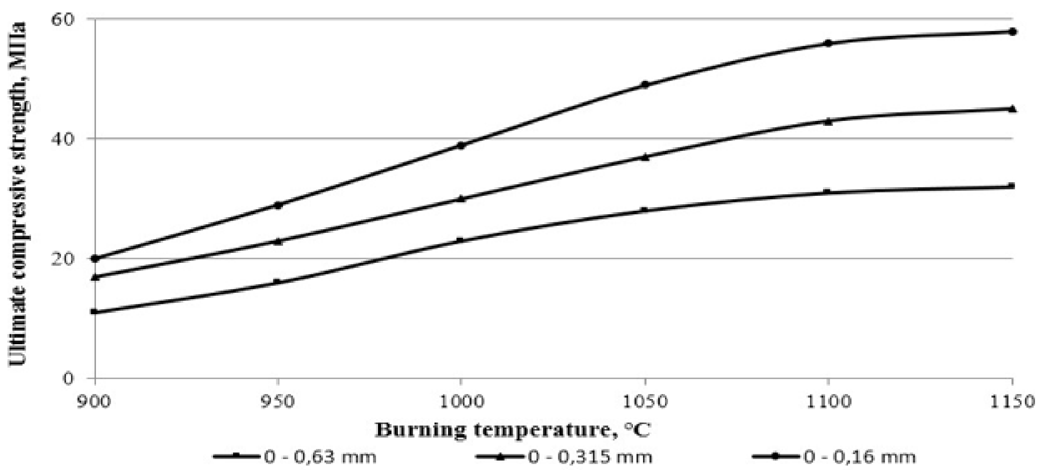

Fig. 2. *Influence of the degree of grinding and firing temperature on the compressive strength*

The use of coal enrichment waste as part of the charge makes it possible to reduce the sensitivity to drying of freshly molded samples. This is explained by the fact that coal enrichment waste is a lean additive. It is obvious that reducing the drying time will lead to lower costs in the manufacture of products. Fuel economy is also achieved due to the fact that the product contains a carbon component, which provides additional firing of the product from the inside. The most important thing is to maintain the gas supply to a temperature of 750°C, the rest of the temperature is provided by burnable coal. In the production of a batch of 1000 pcs. bricks from coal waste defect-free products sums up to 97%, and only 3% with minor defects. And when using clay for 1000 pcs. bricks defect sums up to 23% [3-8]. From this we can conclude that the production of bricks from coal waste is a good substitute for clay raw materials.

Conclusion

The conducted studies have shown that coal enrichment waste is a promising raw material for the production of various wall ceramic products. Their introduction into the raw masses will significantly reduce the cost of firing and, accordingly, the cost of products [9]. Involvement in the production of wall ceramics screenings from the waste heaps of the Eastern Donbass, in our opinion, is technically and economically justified and expedient.

References

[1]. B.C. Fadeyeva, G.P. Petrova, V.N. Burmistrov, Tekhnologiya keramicheskikh stenovykh materialov na osnove otkhodov ugleobogashcheniya. Building materials, 1975, 6, 17-18 (in Russian).

[2]. V.N. Burmistrov, Ye. Sh. Sheynman, Ye.Ya. Klimtsov, V.V. Kulemyakin, V.N. Orlovskaya, Proizvodstvo kirpicha polusukhogo pressovaniya iz otkhodov ugleobogashcheniya. Building materials, 12, 1986, 11-12 (in Russian).

[3]. V.N. Burmistrov, M.M. Bogatyreva, V.T. Novinskaya, Ekonomicheskaya effektivnost' izgotovleniya keramicheskikh stenovykh izdeliy iz porod ugleobogashcheniya. Building materials, 6, 1978, 6-7 (in Russian).

[4]. V.N. Burmistrov, B.F. Budanov, T.I. Karpunina, Otkhody flotatsii ugleobogatitel'nykh fabrik v proizvodstve kirpicha. Building materials, 6, 1982, 7-8 (in Russian).

[5]. B.N. Alentsev, Kirpich iz shakhtnykh porod. Building materials, 7, 1977, 24-25 (in Russian).

[6]. P. Muñoz Velasco, M.P. Morales Ortíz, M.A. Mendívil Giró, L. Muñoz Velasco, Fired clay bricks manufactured by adding wastes as sustainable construction material – A review. Construction and Building Materials, 63, 2014, 97-107.

[7]. L. Zhang, Production of Bricks from Waste Materials – A review. Construction and Building Materials, 47, 2013, 643-655. http://dx.doi.org/10.1016/j.conbuildmat.2013.05.043

[8]. G. I. Storozhenko, A.U. Stolboushkin, Ceramic bricks from industrial waste. Ceramik and Sakhteman. Seasonal magazine of Ceramic and Building. Winter, 2, 2010, 2-6.

[9]. V.D. Kotlyar, K.S. Yavruyan, Wall Ceramic Articles on the Basis of Fine-Disperse Products of Waste Pile Processing. Construction materials, 4, 2017, 38-41(in Russian).

Khungianos Stepan Yavruyan, *Doctor of Philosophy (PhD) in Engineering (RF, Rostov-on-Don)* ***-*** *Don State Technical University, Dean of the Faculty of Civil Engineering, Associate Professor at the Department of Technological Engineering and Expertise in the Construction Industry, khungianos@mail.ru*

Evgeniy Sergey Gaishun *(RF, Rostov-on-Don)* ***-*** *Don State Technical University, Assistant at the Department of Technological Engineering and Expertise in the Construction Industry, SUBARU156@yandex.ru*

Received: 11.05.2022
Revised: 24.05.2022
Accepted: 13.06.2022