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Study of ceramic brick using bottom ASH

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Abstract
The problem of waste disposal is urgent all over the world now. On our planet, the issue of solid household waste recycling and obtaining new products has intensified. Diminishing the raw material scarcity and disposal of waste in landfills leads to the development of more sustainable building materials. According to this knowledge, this work studies the incorporation of biomass bottom ash into ceramic bricks for brick production to reduce currently unused waste reuse and clay extraction operations. The results indicate that special properties bricks can be made using environmentally sustainable ceramics adding unused waste.

Keywords: bottom ash, solid household waste, ceramic brick, sustainability

Introduction

The construction sector is one of the most crucial sectors for the development and welfare of the population. Constructing new buildings or to repair of old buildings is important for the comfort of the growing population. However, the construction sector is also highly polluting.

Expanding the resource base of the construction industry and providing necessary raw materials, creating resource-saving technologies in the production of construction products, reducing their cost, as well as solving the environmental problem to a certain extent create a great need. In recent decades, rapid industrial, economic, and social development has led to the generation of a large amount of solid household waste, which has a negative impact on the environment and human health [1]. Currently, waste disposal is one of the main environmental problems, because it not only pollutes the environment but also burdens the soil [2].

Currently, the number of ceramic bricks in the structure of the production of small wall materials is 13.5 billion bricks. This is about 65% of construction materials. More accurately, ceramic materials make up a high percentage of materials used in the construction of buildings. In turn, brick is the most used ceramic material [3].

Co-use of waste is a perfect solution to the problem. On the one hand, unused waste is used and not thrown into landfill. On the other hand, the cost of the final product, bricks, is low. In addition, in most cases, this waste can be incorporated without major changes to the equipment or process. Incorporating waste into new materials allows the creation of sustainable materials in the context of a circular economy [5].

In the current research area, the use of ash during waste incineration takes an important place. The use of ash is one of the ways to increase the efficiency of ceramic brick production. The main target of the work is to create technological solutions for the production of ceramic bricks that allow the large-scale use of ash obtained from waste incineration to replace part of the clay, as a result, saving material and fuel resources. For the precise use of ash obtained from waste incineration, it is important to study its physical, chemical, and mechanical properties. Because the final material can have different properties. These properties embrace resistance, color, heat, and acoustic isolation [6].

The chemical composition of clay and waste incineration ash is shown in Table 1.

Table 1: Chemical composition of clay and ash

Substances	Ash	Clay
CO_2	0,21	0,30
P_2O_5	8,85	0,15
Al_20_3	12,8	18,0
C aO	8,7	0,64
MgO	3,35	3,01

Ash from waste incineration contains high amounts of P2O5, water-soluble salts. Considering that almost all ash content has poor carcinogenic properties, proper attention has been paid to studying its toxicological properties [7].

Table 2 shows the content of radionucleotides in ash. To produce ceramic bricks, ash cannot be added to the mixture as a main component, only its permissible limit (<370 bq/kg) can be added. When mixing ash with clay, the radioactivity of the mass decreases [8].

Table 2: A number of radionuclides in ash.

Radionucleotide	Determination of the specific activity of ash	
	Cu/kg	Bq/kg
Cs-137	$6.63•10^{-7}$	24560
Sr-90	$2.08•10^{-7}$	7690
K-40	$7.35•10^{-8}$	2721
Th-232	$1.34•10^{-8}$	508
Ra-226	$4.30•10^{-9}$	160

After carrying out the various tests mentioned above, several results are obtained, which are described in detail here and will serve to form the result of the work. The importance of using currently unused solid waste, such as biomass bottom ash, should be emphasized. Its use in ceramic materials for bricks leads to a significant reduction in material extraction and a lower economic and environmental value of the final material, as well as a reduction in the deposition of this waste in landfills. In short, it has less impact on the environment. The results obtained are as follows

1. Physico-chemical characteristics of clay and biomass bottom ash reflect compatibility between both materials. This fact is important to achieve homogenization of both materials and therefore to obtain a quality final material. The particle density of clay and bottom ash is 2.44 and 2.85 g/cm3, respectively, which is quite like them.
2. Physical tests on different groups of samples formed with increasing percentages of bottom ash and clay showed similar results of reduced weight loss after firing. Regarding cold water absorption, hot water absorption and open porosity increase as the percentage of bottom ash increases. This fact is directly related to the compressive strength and, in turn, to the thermal and acoustic insulation of suitable ceramics.

Matched color groups of samples were measured and quantified with a colorimeter. These groups presented a range of colors from traditional ceramics to more whitish colors with a rising percentage of bottom ash. Figure 1

Fig 1: Color of samples. (100% clay on the left, 100% clay on the right).

3. One of the most urgent economic problems of the country, with the addition of bottom ash obtained from waste burning, is the use of waste in construction materials through environmentally safe processing.

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