International Journal of Innovative Scientific & Engineering Technologies Research 13(1):90-93, Jan-Mar., 2025

© SEAHI PUBLICATIONS, 2025 www.seahipublications.org ISSN: 2360-896X

doi:10.5281/zenodo.14845741

Production And Characterization Of Ceramic Body For Laboratory Use By Incorporation Of Environmental Waste Materials

[1]Tederhi Omwirhiren & [2]Eduwen, Esohe

[1,2]Department of Chemistry,
Federal College of Education (Tech), Ekiadolor, Benin City, Nigeria
[1]Corresponding author Email: ted4real2010@gmail.com/Phone no: 08038551659

ABSTRACT
This research seeks to look at the processes involved in the production of ceramic using waste materials from the Federal College Of Education Technical Ekiadolor, Benin City's environment which would have constituted environmental pollution. The focus was on production of porcelain ceramics. It all started with the selection of raw materials, which are typically inorganic, nonmetallic solids like clay, wood particles, feldspar and silica. The materials were collected, sorted and processed to remove any contaminants or unwanted materials. This involved crushing, grinding, sieving to achieve the desired particle size and uniformity. The mixture is then shaped into the desired forms using method of pressing or extrusion. The shaped materials were then air dried to avoid cracking. The products were then subjected to firing in a kiln to a temperature of about 850 to 1000 ^{0}C. The results from the analysis showed that Sample A has density of 2.5 g/cm^3 and less porous compare to samples B and C which is as result of more presence of silica (SiO_2) in it. This shows that it can withstand tensile tress and wear in application. The incorporation of environmental waste (glass powder and wood ash) into ceramics body has improve their physical, mechanical and thermal properties and can be used in production of laboratory apparatus.
Keywords: Production, characterization, ceramic, environmental waste

INTRODUCTION

Ceramics have permeated human history for years. A formally known pottery or fired clay, have evolved into complex, high-performance materials that play a vital role in modern technology and industry. Eze *et al* (2013) quoting, Idenyi and Nwujagu (2003) assert that Ceramics apart from being used in producing domestic and industrial products such as ceramic wares, pottery, bricks, roofing mica industries, refractories, rocketry, carbides of silicon, tungsten, and other elements, are used as abrasive and cutting tool materials .Ceramic is non-metallic material derived from clay. They are broadly used in various science laboratories due to their unique combination of properties, such as high thermal resistance, chemical inertness, and good electrical insulation.

Laboratory has been an indispensable tool for effective teaching and learning of science, it must be well equipped to meet the desired need of the subject matter. Starting from the laboratory fittings which include table and benches. Integrated Science laboratory as a laboratory that houses all the other science

apparatus where several equipment, reagents and apparatuses needed for effective teaching and better understanding of the subject.

Ceramic material has been an essential material because of its various needs ranging from the construction of laboratory to manufacturing of different apparatus like crucible, mortar and pestle, spatulas, chromatography columns, combustion boat, evaporating dishes, beakers, Buchner funnels, combustion boats, porous plates, piezoelectric transducers. Getting these teaching aids sometimes poses challenges as a result of government policy which have effect on procurement of needed equipment in schools. Therefore, the need for this research work.

Human Beings have come a long way in terms of understanding and processing of ceramics, a formally known as pottery or fired clay which have now be transformed through technological advancement into various materials useful in day to day activities.

A lot of scientific researches have been carried out on the study of the physical and chemical properties of ceramic materials in their production process in order to optimize their final properties (Cultrone et al., 2004a; Vassilev *et al.,* 2013). It is well known that material production industries which include ceramic production, have been recognized as the largest fuel consuming sectors of the economy (Koroneos and Dompros, 2007). The energy cost for large-scale production in the ceramic industry has become a critical issue. Therefore, incorporation of natural fluxing within clay bricks can contribute to energy savings by reducing the energy requirements of the brick during firing.

Ceramics have been widely used in science laboratories due to their unique combination of properties which include high thermal resistance, chemical inertness, good electrical insulation, porosity. Ceramics can withstand high temperatures without melting or degrading, making them ideal for crucibles, evaporating dishes, and combustion boats used in heating and melting experiments. Many ceramics are resistant to corrosion from acids, bases, and other chemicals, making them suitable for storing and handling reactive materials. Certain ceramics are excellent electrical insulators, making them valuable for electrical components and high-voltage applications. Some ceramics are porous, allowing for filtration, chromatography, and gas flow control.

MATERIALS AND METHODS

Materials:

The materials used for this research include feldspar, quartz, calcium carbonate, magnesium carbonate, glass powder, kaolin grog, carbide waste and ventonite.

Method:

We used method of pressing/extrusion which involves pushing pottery (paste) to form a shape. The materials were collected, sorted and processed to remove any contaminants or unwanted materials. This involved crushing, grinding, sieving to achieve the desired particle size and uniformity. These materials are then mixed depending on the proportion and desired of the properties of the final product. The mixture is then shaped into the desired form using different methods such as pressing or extrusion. The shaped materials are then air dried to avoid cracking. The product are then subjected to firing in a kiln to a temperature of about 850 to 1000^0C. The raw materials are then taking through the processes of beneficiation which entails comminution, purification, sizing, classification, calcining, liquid dispersion, and granulation in order to improve the quality of the ceramic to be produced. Clay: The foundation of ceramics, clay comes in various types, each with unique properties affecting the final product's color, texture, and firing temperature. Common types include earthenware, stoneware, and porcelain. But in this work we were focused on the porcelain. Materials like sand or grog are added to the clay to prevent cracking and shrinkage during drying and firing. The glazing is done by coatings which is applied to the fired clay body for decorative effects, waterproofing, and increased durability. Glazes come in various colors, textures, and finishes.

RESULTS AND DISCUSSIONS

Table 1 chemical composition of the ceramic bodies

Sample	SiO_2	Al_2O_3	Fe_2O_3
A	60.2	20.5	5.3
B	55.1	25.2	6.7
c	50.5	30.1	8.4

Table 2 Physical properties of the ceramic bodies

Sample	Density (g/cm^3)	Porosity (%)
A	2.5	10.2
B	2.3	12.5
C	2.1	15.1

Table 3 Mechanical properties of the ceramic bodies

Sample	Compressive strength	Flexural strength
A	120	80
B	100	70
C	90	60

Discussion

Form table 1 above, it can be seen that SiO_2 (Silica) is the major component of the material which acts as the network former providing strength and durability to the ceramic. The presence Al_2O_3 in the ceramic material enhance its hardness and chemical resistance. Which is very vital for handling chemicals in laboratory. While Fe_2O_3 acts as refluxing agent which helps lowering the firing temperature.

Closer look at the physical and mechanical properties of the produced ceramic bodies shows that there is an inverse relationship between density and porosity (see table 2). The implication is that, the sample A (from the table 2) with density 2.5 has more hardness and strength, thus, is more resistant to wear and can withstand tensile stress. This is also confirmed in table 3 above.

CONCLUSION

The incorporation of environmental waste (glass powder and wood ash) into ceramic body has improve their physical, mechanical and thermal properties. The ceramic body produced in this research had high strength, durability and thermal resistance, making them suitable for laboratory use. This research demonstrate the feasibility of using environmental waste materials to produce ceramic product, providing a sustainable and cost effective alternative to traditional materials.

The incorporation of environmental waste in the production of ceramic body for laboratory use has presented promising hope for both sustainability and material properties. By fusing glass waste provides a sustainable solution for waste management, by reducing the amount of waste sent to landfill and minimizes the environmental impact associated with waste disposal. The addition of waste materials can also modify the properties such density, porosity, mechanical strength and thermal conductivity. It also have a positive impact such as reducing the consumption of raw materials and minimizing the environmental footprint associated with ceramic production.

RECOMMENDATIONS

1. The researchers recommend that the ceramic produced from the mixture of feldspar, quartz, calcium carbonate, magnesium carbonate, glass powder, kaolin grog, carbide waste and ventonite are suitable for production of laboratory apparatus such as crucible, evaporating dish, mortar and pestle, hence, production of which should be scale up to commercial level.
2. The temperature range of 850 to 1000^0C was used in the experiment, other researchers could use temperature above this range to ascertain its thermal response above 1000^0C.

REFERENCES

Cultrone, G., Sebastián, E., Elert, K., de la Torre, M.J., Cazalla, O., Rodriguez–Navarro, C., 2004. Influence of mineralogy and firing temperature on the porosity of bricks. J. Eur. Ceram. Soc. 24, 547–564.

Eze Stephen, Ugwu Emmanuel, Amah Alexander and Agbo P.E., (2013). Communications in Applied Sciences. Vol.1 ISSN 2201-7372

Idenyi, N.E. and Nwajagu, C.O. (2003), Non-metallic Materials Technology, 1st Ed.Olicon Publication, Enugu

Koroneos, C. and Dompros, A. (2007). Environmental assessment of brick production in Greece. Build. Environ. 42, 2114–2123.

Vassilev, S.V., Baxter, D., Andersen, L.K., Vassileva, C.G., 2013. An overview of the composition and application of biomass ash. Fuel 105, 19–39.