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EFFECTS OF SCRAP GLASS POWDER ON ELECTRICAL PORCELAIN

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ABSTRACT

In power systems, there is an ever-increasing demand placed on porcelain insulators especially for outdoor applications. Additionally, the huge cost of importation has resulted in a growing need for the local manufacture. To this end, an electrical porcelain insulator was manufactured from Ukpor Clay. Universal Composition of triaxial porcelain (kaolin, 45%; ball clay, 5%; feldspar, 25% and quartz, 25%) was used to produce a test piece, labelled as Sample A. Another sample labelled B were produced with glass powder as an additive, replacing 5% of feldspar. The pulverized and thoroughly mixed composition was compacted and fired at a temperature of 1200°C. The physical and Electrical properties were investigated. The results show that the sample has low water absorption and dielectric constant between 9.0 and 10.9 within the frequency range considered. These results when compared with those of the commercial variety show that the locally manufactured sample satisfies the stringent requirements of a good insulating material.

Keywords: *Scrap Glass poweder, Electrical Porcelain etc*

I. INTRODUCTION

Non-metallic Minerals account for the major part of the value of global non-fuel mineral production. They are produced and consumed in virtually all countries and are utilized in the production of all manufactured goods, as well as in construction, agriculture and environmental protection. Mining of Non-metallic minerals is one of the oldest professions of the world and grew with the evolution of man and the civilization. Against this background, it may seem paradoxical that the production and utilization of Non-metallic Minerals are rarely accorded a commensurate level of priority in our national development plans.

Statement of problem

Insulators are extensively used for high and low voltage applications in generation, transmission and distribution of electrical power. In spite of the enormous wide range of application and availability of raw materials in Nigeria, mostly used insulators are still imported into the country due to manufacturing of electrical insulators in small quantities

Research Motivation

Estimate shows that about 50% of total budget for a typical transmission and distribution system of electric energy is spent on insulation alone and prominent among them is porcelain.

For over three decades, Nigeria has continued to depend almost entirely on oil for her revenue and the volatile nature of the oil market has made it imperative for us to diversify the mono-product economy through exploitation and processing of our abundant solid mineral resources
Non-metallic minerals such as Kaolin, ball clay, feldspar, quartz etc are utilized in the production of electrical porcelain insulators for high voltage and low voltage applications.

II. MATERIALS

Kaolin

Kaolin is a clay mineral made up of aluminum, silicon and water. It is a hydrated aluminum silicate, with an approximately 46% Silicon, 30% aluminium and about 14% is made up of calcium, iron, magnesium sodium and water. It has a melting temperature of about 1700℃ and it is triclinic in its crystal system (Birks,1960). Kaolin as a mineral is described technically as a white alumina-silicate. It does not react with other materials and is insoluble in water (Egbai, 2013). About 800 million tones of probable/proven deposits of kaolin in Nigeria have been quantified (FMST,2010).

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Feldspar
Feldspar is a group of closely related, rock forming alumino-silicate minerals, which contain varying proportions of potassium, sodium and calcium. Feldspar is the most abundant of all minerals, comprising over 50% of the earth's crust. It forms the major constituent of most igneous and metamorphic rocks, as well as arkosic sediments (Anih,2005).
There are wide occurrences of feldspar in the granite and pegmatite rocks of Nigeria (Ibrahim, 2000).

Quartz
Quartz constitutes one of the most readily available geological materials used in industries and factories such as glass manufacturing companies. Silica (Sand/Quartz) are said to consist of high optimal percentage of silicon dioxide (SiO_2) which is a very good chemically stable element and it remains almost the same no matter the series of cycles it may have gone through, either in transportation or re-deposition(Anih,1988). Quartz is silica occurring alone in pure state. Silica/glass sand on the other hand are products of weathering, erosion and transportation by rivers or/and the sea.

Nigeria has extensive deposits of good quartz silica sands in almost all the states of federation.
Ball clay
Ball clay is an earth material of very fine particle size which forms as an end result of the residue due to weathering or by hydrothermal action which is a result of sedimentary deposit..
Various grades of ball clay occurs in commercial quantity in Enugu, Anambra State of Nigeria.
(FMST,2010).

sourcing and Processing

Kaolin which was sourced from Ukpor in Anambra State was first washed to remove some deleterious materials followed by sun drying. The dried material was broken into smaller pieces and soaked in water for two days to slake.

The sample was mixed with water and sieved with a 100µm sieve. The filtrates were allowed to settle and were decanted after two days. The remaining material was dried and milled into powdered form.

Quartz and feldspar were sourced from Odo river in Awgbu, Anambra state and Lokoja in kogi state respectively. Ball clay and waste glass was source from Ekwulobia in Aguata Local Government Area of Anambra state.

Scrap glass was obtained from domestic waste products, broken into smaller pieces and machined milled into powdered form. The resultant product was sieved with a 100µm sieve to remove coarser particles.

III. METHODOLOGY
Universal composition of Triaxial porcelain was used. 45% of the processed kaolin was weighed out. 5% of Ball clay was added to make up the composition of Clay material to 50%. 25% of feldspar and 25% of quartz were carefully weighed out in accordance with Birks (1960) and mixed thoroughly with about 8% of water in a bowel using a stirrer. And labelled as sample A. 5% of processed scrap glass were added as an additive to another compostion with 20% of feldspar, while all other materials remain unaltered, hence was labelled as sample B. The mixtures of the two samples were separately kneaded manually until they became homogenous. The kneading was also aimed to exclude as much trapped air as possible in the mixture before compaction.

The slightly damp mixtures were collected into the steel mould lubricated by paraffin oil and was well compacted. The shaping was done with a mould fabricated from hardened steel. A rectangular and circular mould were used in the shaping with dimension of (25x15x5)mm and 25mm diameter and 5mm thickness respectively, punch was fabricated to match the internal dimensions.

The samples were allowed to dry for 48 hours before firing; the samples were fired in an electrically operated furnace with a gradually rising temperature up to 1200°C. At the end of the firing period, the samples were gradually cooled.

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IV. RESULT & DISCUSSION

The physical and electrical properties of the porcelain produced was obtained as shown in the table below

Table 1. Physical properties of the produced porcelain samples

Properties	Sample A	Sample B
Total shrinkage (%)	6.60	6.60
Apparent porosity (%)	10.37	10.02
Apparent density (g/cm^3)	2.12	2.12
Bulk density (g/cm3)	1.79	1.78
Water absorption	5.49	5.50`
Modulus of Rupture	16.85	16.80

Addition of glass powder to feldspar shows that porcelain mix changes the amounts of the different alkalis in the mixture and increases the amount of calcium and magnesium, the result shows that addition of glass powder as an additive lead to reduction of alumina. This implies change in viscosity of the liquid formed during firing, hence lowering the firing temperature of the porcelain sample.

Table 2. Electrical properties of the produced porcelain samples

Frequency (Hz)	Dielectric constant A	Dielectric constant B
50	10.9	10.8
100	10.4	10.4
1000	9.7	9.6
10000	9.0	8.9

The maximum value of the dielectric constant of the kaolin-feldspar-quartz (kfq) sample is 10.9, suggestive of a good insulating material. Good insulating materials are materials with dielectric constant below 12 (Anih, 1988). The significance of the low dielectric constant is that the charge storage capacity of the insulator is low and this is the main difference between dielectrics for insulator and capacitors. Thus the insulator could be used as capacitor bushings where low charge storage capacity is very desirable. Materials with dielectric constant above 12 are generally materials for capacitors and transducers. The result shows that the additive enhanced the value of the dielectric constant which implies improvement in quality of the porcelain sample produced.

Based on the experimental results obtained in this study and in comparison with commercial porcelain, the following can be inferred:
(a) That using the locally available raw materials, electrical porcelain with good dielectric properties can be produced since it has dielectric constant below 12.
(b) That the characterized universal composition, kaolin from Ukpor, locally obtained feldspar and quartz has the potentialties of good electrical insulator.
(c) That the insulator might be more efficient when some percentage of glass powder is added as an additive.

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V. CONCLUSION

The raw material availability and processing requirements have been ascertained for successful production of high quality porcelain from Nigerian's minerals. There exists a big potential for development of small and big scale manufacturing enterprises in the sector with multiple benefits to the economy.

Insulator manufacturing business is a labour intensive one and hence can create employment opportunities for the skilled and unskilled. It is highly expected that local production of insulator will improve not only the economy but the power sector tremendously.

REFERENCES

1. *Anih. L. U (2005) 'Indigenous manufacture and charcterization of Electrical porcelain Insulator' Nigeria Journal of Technology, vol.24, No*

2. *Anih, L.U (1988). Characterization of Kaolin-Quartz-Feldspar Triaxial Porcelain for Insulation Application.*

3. *Birks, J.B (1960) Modern Dielectric Materials, London, Heywood and company Limited.*

4. *Egbai, J.C (2013) Kaolin Quantification in Ukwu-nzu and Ubulu-Uku using electrical resistivity method: IJERS Vol 14, Issue 3*
5. *FMST(2010), Federal Ministry of Science and Technology, Non metallic mineral endowments in Nigeria.*

6. *Ibrahim, B. (2000), Visual Art Made Easy for School, Movic PublishingCompany Ltd., Lagos.*