ISSN 2347-4289

Kaolin Mineral Material For Automobile Ceramic Brake Pad Manufacturing Industry.

Aderiye Jide

Glass And Ceramics Technology Department
Federal Polytechnic, Ado-Ekiti. Nigeria.
E-Mail: Jideaderiyedesign@Yahoo.Com, Aderiyejidedesign@Gmail.Com.

Abstract: Kaolin clays were found within Ise-Orun and Emure Local Government Areas of Ekiti-State in Nigeria. Kaolin mineral resources within these areas have being fully apprised in this research work. While other related studies were intensively reviewed. The deposition of kaolin mineral within this region was by geological and transportation formations. These formations were formed with other minerals within the basement and quaternary deposits as deposited by water erosion mainly from the Granitic rocks at Ikere-Ekiti and environment. Scanty researches and little studies have been done to identify major minerals in these two local governmental areas of Ekiti-State. Other minerals largely found within the axis include Silica Sand along Rivers Ipaso and Ogbese respectively. Kaolin, Moscovite, Cassiterite, Titanium and Colombite were obtained at Aba Repairer, Iroko and Idiosa. Very large quantity of kaolin was found within Orun to Eporo and Ago Olaleye in a triangular depositional formation. At Emure Local Government Area, large Koalin with Silica Sand were available at Emure to Ose area. Whereas Southward of Emure to Ago-Owa and Aba-Ola contain large kaolin deposits also. However, Sand and Montmorillonite clay were interwoven with kaolin in this zonal area. Proper beneficiation method was applied at these deposits to purified kaolin clay from other mineral materials within the geographical areas mapped out. Factually, kaolin was the commercial and industrial mineral of this axis. It was intensively and technically examined under this present study. However, valuable minerals that were largely unevaluated initially were technically evaluated in this research work and used for Nigerian economic growth and rapid industrial development.

KEYWORDS: KAOLIN,BRAKE,PAD, INDUSTRIALIZATION.

INTRODUCTION.

Both the drainage and relief structures within the local government areas of Ise- Orun and Emure -Ekiti within Ekiti-State of Nigeria have shown sedimentary and secondary deposition of clays in very large quantities. These were found in various (grey, white and brown) colors on the surface to various depth areas. Geologically, these clays were mainly found verily to be refractory clay group after some scientific examinations. Below twenty five meters thickness, exploration and exploitation of clays were carried out. At various technical and analytical laboratory tests; mineralogical, chemical and characteristic examinations were carried out. Probing holes made shown large quantities of clay deposits were buried beneath organic matters and lateritic clays. These clay mineral materials were mixed with lateritic materials from the surface to five meters depth after the organic matter layers have been removed. Significantly, clay deposits were found at Aba Repairer, Iroko and Idiosa. Samples from the deposits were beneficiated by wet washing method, while the unwanted materials such as silica sand and other mineral maters were removed and economically used for burnt brick production. From the study area, five different clay samples from {Orun, Eporo, Ago Olaleye, Aba-Ola and Ago-Owa, Aba Repairer, Iroko, Idiosa} were randomly taken, beneficiated and characterized. From three to fifty meters various holes were created and clay samples were thereafter taken for various characteristic examinations. With the use of probing holes both the quantity survey and geological evaluations of the clays were analyzed and found at above sixty million metric tons within the two local government areas. Apart from other associative minerals such as Colombite, Tin, Moscovite, Silica, and Titanium that were present therein; commercial kaolin clays were found as major mineral material in these areas of Ekiti state. Clay particulates were therefore characterized and developed for ceramic automobile brake pads. Thermal Differential Analysis (TDA), X-Ray Diffractometer (XRD), X-Ray Fluorescence (XRF), Atomic Absorption Spectrotometer (AAS) and other characteristic properties shown clay deposit samples were plastic in nature, the kaolin group was also rich in silica and alumina contents. But characteristically both the drying and firing shrinkages were relatively high for brake pad usage. Therefore, shrinkage allowances should be anticipated in the manufacturing of vehicles' ceramic brake pads and in the production of ceramic products or related industries.

MATERIALS AND METHODS.

Literarily, most Ekiti-State commercial clays and their deposits, related ceramic products and ceramic matrix composites literature and reasonable journals were surveyed. But, very few researchers and scholars have worked on this axis before. The recent geological studies of these areas have been carried out on kaolin clay group within the sedimentary mineral material zone of Ise-Orun-Emure local government areas. The clay major characteristic properties were also examined, beneficiated and processed for automotive friction lining material. Five clay deposits were surveyed and examined which contained large kaolin clay group at certain specific depth and areas of the study. The deposits were specifically beneficiated for ceramic, automobile parts, friction lining materials and other related industries because of their thermal, shock, wear resistance and material cost. Clays obtained were mainly natural earthly fine grains that were crystalline particles packed together in solid form; but not very energetically bounded. Yet, the clay grains were loosely attracted with their definite round grain shapes. Structurally, Kaolin did not absorb water like the lateritic clay (Aderiye, 2005, and Ahmed, 1986). Its thermal property improves with calcinations (Aniyi, 1985). Technically, Kaolin clay group could therefore be used because of it heat resistance, as industrial raw material for friction lining material in automotive industries, refractories, electronic products, technical works and ceramic manufacturing

ISSN 2347-4289

industries (Aderiye, 2010). Therefore, five Ekiti-State clays examined, characterized, and were technically employed as vehicle brake pad filler as particulates in this glass matrix composite development because of its thermal shock and wear resistance in this research. Characteristically, the kaolin sample thermal property was majorly explored exploited and investigated between 1000 to 1400^{o}C temperatures before its usage in the automobile brake pad experimentally produced. Ceramic brake pad manufacturing being a bankable research project could be viably established as a small scale industry if it is stimulated with financial support. This was based on the research findings of the clay quantities and qualities. Kaolin clay was explored, exploited and employed in this recent research work specifically for ceramic disk brake pads. Clays generally in Ekiti State have not been utilized adequately for industrial purposes for many decades. But, feldspar deposit as found at Oke Owu in Ijero local government area of the state was the only commercial mineral explored, exploited and sold at commercial level within a (1987 to 1997) decade; aside some few stone and granitic quarries operated as small scale enterprises in Ekiti-State of Nigeria. Industrial utilization and associative problems of most commercial clays in Ekiti could be traced to the research works (Aderiye, 2005; Aderiye, 2012 and Shittu, 1989). The study explains how most Ekiti clays are very economically useful with the high alumina and silica contents after beneficiation process. Aside being plastic, most Ekiti- state clays are also very refractory in nature. Shittu, (1989) further suggested that most Ekiti clays should be adequately purified before being industrially used. Reasonably, 25% clay plasticity, according to makes clay workable industrially (figure 2). Additional 25% water to a very dried clay makes such clay somehow workable than other dried clays industrially (Heckroodt, 1994).

Samples and Beneficiation process.

Wet sieving method of purification was used to beneficiate the raw clay samples from the numerous deposits. All clays obtained were processed with less than 45 micron sieve to obtain kaolin grain size of 45 micron at 67% distribution of overall sample. Raw lump clay samples were prepared by dissolving the lumps in water for a week before they were properly blunged and mixed homogeneously. Water solvent made the clays and other impurity particles separated and spread out in a suspended solution as a result of the adequate mixing process. The clay as a solute dissolved in the water solvent which resulted in a muddy solution. The clay was thereafter sieved out from the unwanted impurities with a 45 micron sieve. Sediment clay sample was obtained at 67% less 45 micron of fine particle material after the purification process water was removed after clay sedimentation. 33% coarse unwanted materials were also sieved out and could be economically used for brick production. The beneficiated clay obtained was further dried at 110^{0}C and fired at 1400^{0}C temperature in a furnace. The vitrified clay was allowed to cool down between 37 to 0^{0} C temperatures before it was ground to 45 micron grog. The bunt kaolin particles were further characterized with the use of X-Ray Differactometer. Mineral interpretation of the clay material phases was made from the (X.R.D) graph in (figure 3).The map shown kaolin as the major compound found in the calcined clay sample. 45 micron kaolin was eventually employed as particulate fillers in the waste glass matrix composite for the automobile brake pad experimentally developed.

Samples and Instrumentation.

Geological economy, Physical, chemical, mineralogical and thermal characteristic property of the kaolin clay deposits were specifically investigated with some examination devices as suggested by some researchers (Ahmed, 1986; Aniyi, 1985 and Oyinloye, 1991). Various tests were also conducted on the characteristic properties of these deposit samples to determine both the industrial implications and commercial applications of these refractory clay samples for further improvement of the automobile ceramic brake pad system. Plasticity tests of the clay samples were determined by the Atterberg Plasticity Index (API) test. The kaolin clay binding ability and its workability within glass matrix composite for the ceramic brake pad were characteristically investigated. Technically, this was to ascertain the significant uses of the kaolin sample as a binder after the purification method. Investigations of all clay deposits were also carried out to determine whether the raw clay samples require additives to improve the clays before were finally beneficiated. More, so all the plasticity tests carried out before and after the beneficiation processes aided to understand and determine the characteristic behaviors of the raw clay samples, the beneficiated clays, and the vitrified kaolin samples as particle filler and binding agent within the friction lining glass matrix composite material developed. To examine all the kaolin samples' thermal characteristic properties, Differential Thermal Analysis (DTA) device was used. The Kaolin mineral material was detected at 600^{0}C temperature. Thereafter, X-Ray- Diffractometer (X.R.D) device was further used to confirm the kaolin mineral group present in the vitrified kaolin clay sample. Significantly, $SiO_{2,}$ AlO_3, FeO_3, CaO, MgO, K_2O and Na_2O were revealed from the vitrified Kaolin clay sample when the Atomic Absorption Spectrophotometer (AAS) and X Ray Fluorescence devices were simultaneously used. Geological analyses of solid mineral materials found above 300 microns indicated major minerals such as Gravels, Organic matter, Sand, Mica, Tin and Colombite particles. These mineral materials were largely present at above 53% of the representative raw clay samples taken. The beneficiation method used reveals the oversized solid materials and other mineral materials through the wet sieving process employed. At above 300 micron unwanted materials were sieved out. Minerals such as gravels, quartz, sand, Cassiterite, Columbite, Tantalite, Granite and Charnockitic particle materials were taken as gauges that constitute above 33% of samples taken at random sampling. Ores from the axis were mixtures of extractable and other extraneous rocky materials (Oyinloye, 1988). Instrumental examinations presented the gangues and ore materials as oxides of silicates with other organic matters largely.

RESULTS AND DISCUSSIONS

Material grain size distribution analyses.

Characteristically, the higher the kaolin grain size sample after 45 micron beneficiation process the lesser the quality of kaolin required for the ceramic brake pad biding and filling. This was due to the acceptable cut of 45 micron size within the clay sample which increased the beneficiated kaolin plasticity at the acceptable cut. But the kaolin thermal property was increased after due vitrification of 1400^0C temperature. Therefore heat resistance of kaolin material was increased as calcined kaolin was used within the brake pad as particulates. The volume of 67% Kaolin obtained significantly improved the production quality required for the pad characteristic properties. From the ceramic friction lining material produced experimentally, wear, noise and dust pollution were reduced due to compatibility of 40% burnt kaolin and 60% waste glass matrix composite. Efficiently, eliminated mineral materials from the raw clay samples like magnesium, silica and calcium could be beneficially used for abrasive, chemical and sand paper industries. For the kaolin and waste glass material processing, milling time, energy, capital and labor used were reduced by 50% due to the use of composite material that had initially been processed. For reasonable ceramic brake pad development fine particles of all composite materials were employed. The pad samples were acceptably used at 45 micron sieve size. Bigger grains above 0.0002mm were avoided. All the composite grains used within the brake pad development were in homogeneity. Empirically, various ceramic pad particle sizes were reviewed and researched upon before the experimental particle size usage. They were in correlation of 45-100 microns. Hypothetically, larger grain ceramic brake pad samples could also be technically used in further research work. Kaolin purity, composite particle sizes and dense package for the brake pad were the determinable variable factors used in this experimental research work.

Material mineralogical and chemical composition analyses.

X-Ray Diffraction (X.R.D); and Differential Thermal Analysis (D.T.A) were used to study and revealed the mineral compositions of the two kaolin clays samples. The major mineral phases present were known through the use of (X.RD) method by simple calculative analyses through standard charts. These major minerals from the beneficiated clays were: Kaolin with an average of 36%Alumina, 58% Quartz; 3% Feldspar, 2% Montmorillite and 1% Illite. Therefore, purified clay samples were also effectively used in the ceramic brake pad development because of 36% kaolin and 58% quart refractoriness presence in the beneficiated clay samples. However the kaolin group employed as filler in the frictional lining material chiefly contained mineral phases of Dickite, Nacrite, Anauxite, Halloysite, Liversite, and Kaolinite. This kaolin group has a chemical formulaof:

$$\{Al_2O_3 \ . 2SiO_2 \ .2H_2O\}$$

Furthermore, confirmation was made with the use of (D.T.A) method where the standard mineral charts were used to compare the Ise and Emure kaolin samples. Mineral analyses of Ise and Emure kaolin samples graphically explained the kaolin usefulness with their thermal characteristic properties. For example the melting points of these two beneficiated kaolin samples were found at 1804 and 1919^oC temperatures respectively. These high temperatures were responsible for the high thermal and wear resistance relationship used in preventing the high temperature usually created within the brake pads in the motor system when brake is applied at high speed. Industrially, the two large kaolin deposits are very significance to Ekiti-State ceramic matrix composite manufacturing because of their economic and technical benefits. Principally, the two kaolin clay deposits were used for the brake pad production because of their beneficiated minerals with the refractoriness as examined (Aderiye, 2005 and Doyle, 1979).

Material characteristic properties and analyses.

There were high shrinkage capacities (figure 4) between 10 to 15% in all the clay deposits tested for dryness and firing. This was due to organic material contents present in the samples that weathered down by water erosion from the tropical forest of Ikere granitic rocks and high lands. Thermal property is very significant in today's vehicle braking system because their brake pads operated at very high temperatures. These racing vehicles need brake pads that are very efficient across a range of high temperature (Aderiye, 2012). Issues considered in this ceramic brake pad development included temperature range, dusting, noise and pad wear life. Cooperatively, the kaolin and waste glass matrix pad experimentally produced met the stated above issues. Characteristically, the research results and discussions have indicated that the ceramic brake pad eventually made is better than organic brake pads.

CONCLUSION

Exploration, exploitation and utilization of the identified kaolin deposits were developed through experimental research. Significantly, the research exploited the characteristic properties of kaolin mineral in order to complement the existing areas of application in brake pad development. The study also determined new areas of applications in kaolin and glass matrix composites with the use of kaolin thermal characteristic properties. It also discovered the potentials of using kaolin as reinforced particles in the production of friction lining material. Based on the results from these research investigations, recommendation was deduced for further research works on Ekiti kaolin clays to be employed as particulates in ceramic waste glass matrix composite materials. Industrial designers, Engineers and Researchers should intensively study other clays within the local government areas of Ekiti State in Nigeria for geostrategic reasons, scientific and industrial application. Although, kaolin as a mineral material still has technological challenge to be employed in automobile brake pad development. This has made the research tested certain Ekiti kaolin mineral material at laboratory level. Also through this study reasonable scientific data were gathered for commercial uses. While intellectual expertise and literature on these Ekiti-State kaolin deposits as utilized within a waste glass matrix automobile brake pad developed.

REFERENCES.

[1]. Aderiye, J.(2012). Development of an environmentally friendly friction lining material from locally sourced ceramic composite. Ph.d (research proposal), Ahmadu Bello University, Zaria. Nigeria

ISSN 2347-4289

[2]. Aderiye, J.(2005). Development of firebricks for furnances. M.Sc. Thesis,

[3]. Ahmadu Bello University, Zaria, Nigeria.

[4]. Ahmed S.A.(1986):Development of phosphate bonded fireclay refractory castables. M.Sc.Thesis, Chemical Engineering Department, Ahmadu Bello University; Zaria.

[5]. Aniyi J.A.(1985): Investigation of the refractory property of Kankara clay. M.Sc.Thesis, Chemical engineering department, Ahamadu Bello University Zaria

[6]. Doyle, J.P.(1979): Refractories materials Glass making today . Red Hill Port Press. U.S.

[7]. Heckroodt (1994): Evaluation of plasticity Technical forum, Keramicos, summer 1997

[8]. Olarewaju, V. O.(1981). Geochemist of the charnockitic and granitic rocks of basement complex (Ado – Akure axis) w/s Nigeria. Ph.d. Thesis. University of London. Britian.

[9]. Oyinloye, A.O.(1998). Exploration of mineral resources in Ekiti and Ondo States for industrial development. Journal of technoscience Vol.3.

[10]. Oyinloye A.O. (1991): Application of Kaolinitic clays in industrial clay technology ,TERRA Journal of Environmental concern. (Vol 1, no 1

[11]. Shittu, O. J and Aderiye, J. (1998). Explotation of clay as building material in Ekiti State. The Journal of Techno – science Vol. 2, No 1. 1998 Pp. 13-19.

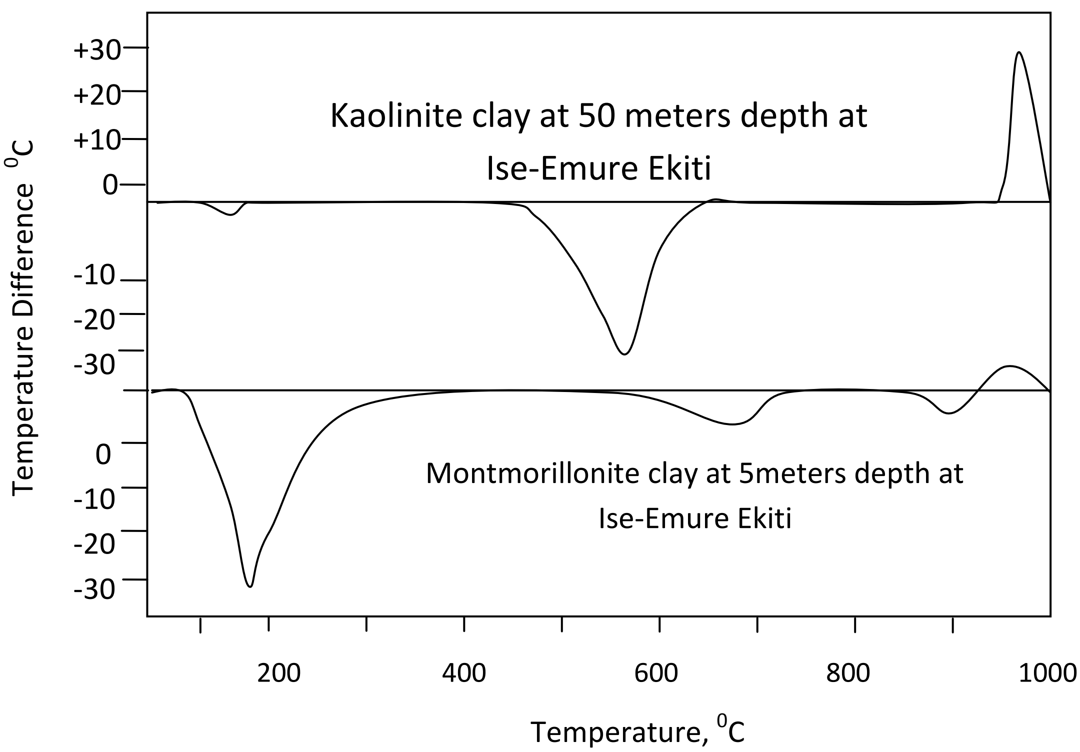

Figure 1. Different Thermal Curves for Kaolinite and Montmorillonite found at Ise-Emure Deposits.

ISSN 2347-4289

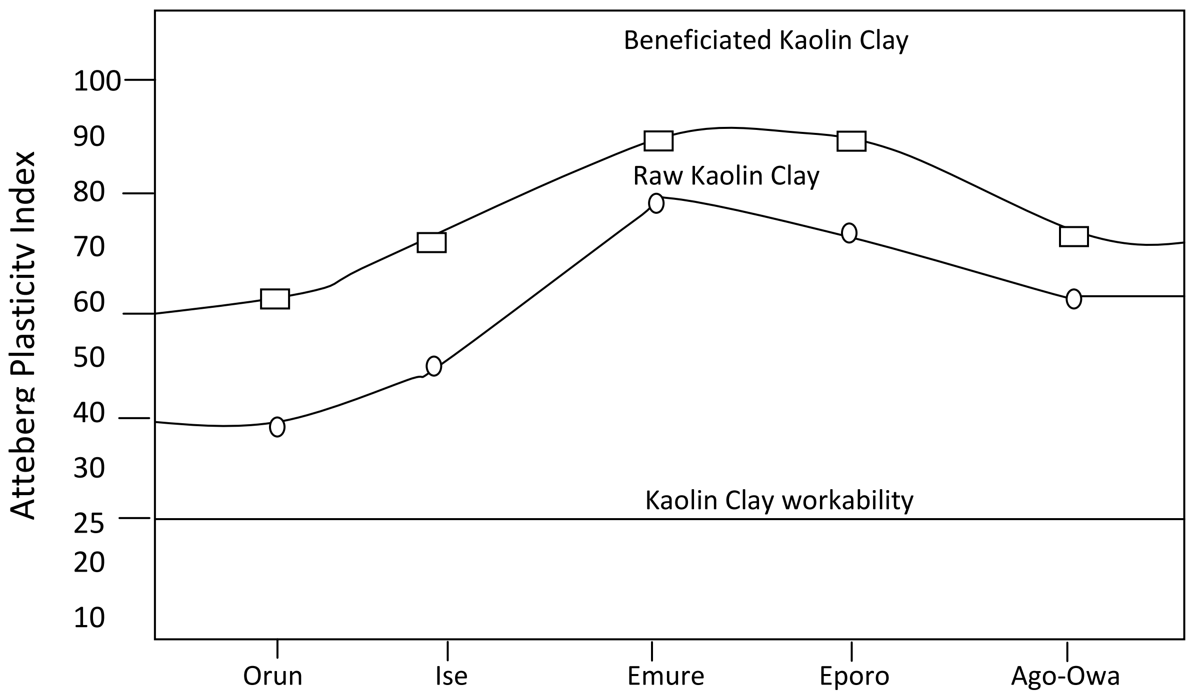

Figure 2. Atteberg Plasticity Indices for the Local Kaolin Clays