International Journal of Engineering and Modern Technology (IJEMT) E-ISSN 2504-8848
P-ISSN 2695-2149 Vol 10. No. 5 2024 www.iiardjournals.org

Viability of Ikere Clay and Itawure Termite Hill Blends as Refractory Lining for Low - Medium Temperature Applications

[1] Kutelu, B.J; [2]Oluwaseyi, A.O; [3]Awoniyi M.E
[1,2, 3] Department of Mineral and Petroleum Engineering Technology.
The Federal Polytechnic, Ado-Ekiti, Ekiti, State, Nigeria.
richardfakolade@gmail.com

DOI: 10.56201/ijemt.v10.no5.2024.pg65.75

Abstract
Blending of clay with termite hill have the potential of raising refractory properties and, in consequence, expanding their use as lining materials for applications requiring medium to high temperatures. Consequently in this study, clay sample from Ikere Ekiti, Ekiti State and Itawure termite hill sample from Akure, Ondo state both in Nigeria were considered. Chemical compositions of the samples were determined by Atomic Absorption Spectrometer (AAS) - model 210 VGP. And following standard approach, as- mined clay samples were prepared and blended to obtain five blends; S-I, S-II, S-III, S-IV and S-V. Each blend was thoroughly mixed with water, and molded into cylindrical laboratory test specimens, air dried for 168 hours (7day) and subjected to the refractory tests (loss on ignition, bulk density, apparent porosity, permeability and linear shrinkage on firing). From the results, aluminum oxide (Al_2O_3) and silica (SiO_2) were the major constituents of the samples, while the other constituents were in trace quantities. Clay sample from Ikere Ekiti with mesh size 500 µm gave the highest mass retained (153g), while Itawure termite hill sample with mesh size 100 µm gave the highest mass retained of 233g. In general, refractory properties of Itawure termite hill sample was comparatively superior to Ikere Ekiti clay sample. Refractory properties of the blends were a major improvement over Itawure termite hill and Ikere Ekiti clay respectively. And optimum refractory properties of the blends was obtained with the S-V blend

Keywords: *Termite Hill, As-Mine, Blends, Refractory Properties, And Mass Retained*

1. INTRODUCTION

Clay is a naturally occurring material, primarily characterized by fine – grained minerals, which are less than 0.005mm in diameter, showing plasticity through a variable range of water content and hardened when fired/ dried (Attah, 2008; Abolarin *et al.,* 2004). Refractories are mineral and chemical – based materials with very high heat-resisting properties(Ugwuoke *et al.*, 2018; Elakhame *et al.*, 2016). Refractories are required to be chemically inert, have specific ranges of thermal conductivity and coefficient of thermal expansion, and possess high resistant to thermal shock (Okpanachi *et al.*, 2017; Hassan and Adewara, 1993; Chester, 1983). These materials included alumino-silicate, silica, magnesite, carbon, dolomite (Amuda *et al.*, 2019; Sadik *et al.*, 2014; Ndaliman, 2000).

Over 80% of total refractory materials are being consumed by the metallurgical industry for construction and maintenances of furnaces, kilns, reactors vessels and boilers, while the remaining 20% are used in non- metallurgical industries, including cement, glass and hardware (Apeh *et al.*, 2011; Ndaliman, 2000; Adondua, 1988). Special refractory materials are required for certain applications, while others do not. For instance, Zirconia is the most appropriate material where high temperature is required, and silicon carbide and carbon (graphite) are two other refractory materials used in some very severe temperature conditions, but they cannot be used in contact with oxygen, as they will oxidize and burn (Sayel *et al.*, 2012; Yami and Umar, 2007; Aderibigbe and Chukwuogo, 1984).

Termite hill have shown behavior comparable to firebricks obtained elsewhere when subjected to refractory tests (porosity, density, dimensional change and permeability), and hence have proven to be closely related to refractory properties of some standard clay materials (Agbajelola *et al.,* 2015; Omowumi, 2000). Ndaliman, (2001) blended termite hill with 25% corn husk and 25% sawdust and reported that the refractoriness of the two resulting was 1200^{o}C, and concluded that they can be suitably utilized as insulators. Further, an improved refractoriness of 1700^{o}C and 1600^{o}C were recorded when blended with 25% graphite powder and 25% asbestos respectively. Daniel-Mkpume *et al.* (2011) improved on the refractory properties of Nsu and Ibeku clays through blending as replacement for GP107-3 refractory brick in metallurgical industry.

Undoubtedly, Nigeria is endowed with vast quantity of clay deposits, scattered all over the states, which is put at estimated proven reserve of billions of tons (Babalola *et al.*, 2014). It is however worrisome to note that over 80% of the Nation's growing local industries' refractory needs are still being imported. There is therefore a compelling need to further research efforts at developing

2. MATERIALS AND METHOD

2.1 Materials

The clay and termite hill samples used for the investigation were obtained from Ikere Ekiti, Ekiti South West Local Government Areas of Ekiti State and and Itawure community, Akure South local Government Area of Ondo State respectively.The chemical analyses of the clays were done using Atomic Absorption Spectrometer (AAS) - model 210 VGP, and the results are presented in Table 1.

2.2 Method

2.2.1 Sample preparation, sieve analysis and blending

The clay samples were mined by digging through a depth of 3 m below the earth surface, and were consecutively sun dried for two weeks to reduce the moisture content and oven dried at 110°C for 24 hours to evaporate the remaining moisture content (Adamu *et al.*, 2018). Thereafter, they were crushed and soaked in water for seven days to allow the organic matters (both live and dead) capable of affecting the physico-chemical characteristics to float and be decanted (Amuda *et al.,* 2019; Salihu and Suleiman, 2018). The samples were then sun-dried for two days, and pulverized by consecutive crushing and grinding. Sieves of different with500 µm, 300 µm, 250 µm, 100 µm, 63 µm and 53 µm mesh sizes were arranged in ascending order on a sieve shaker, and the sieve shaker was operated for a period of 20 minutes. After which, the percentages of the retained clay and clay passing were determined by weighing the retained clay on each sieve and the weights were recorded accordingly. The clay samples were blended to produce five clay samples, weighing 600g each (Table 1). Each blend was thoroughly mixed with water, and molded into cylindrical laboratory test specimens using of mold of 200g and for adequate removal of moisture contents and easy handling, the specimens were air dried for 168 hours (7day). Fig. 1 depicts the blended sample

Table 1. Blending procedure of the samples

S/No	Batch code	Ikere Ekiti clay	Itawure termite hill	Total (%)
1	S-I	80	20	100
2	S-II	70	30	100
3	S-III	60	40	100
4	S-IV	50	50	100
5	S-V	40	60	100

Fig. 1.Ikere clay/Itawure temite hill blended samples

2.2.2 Loss on ignition

Test specimens with 50 mm diameter and 15 mm height, weighing 2g was cut from the oven dried. Empty porcelain crucibles were weighed and recorded as W_1. The 2g specimens were put in the porcelain crucibles, and weighed and recorded as W_2. The 2g specimens in the porcelain crucibles were put in a laboratory kiln and ignited at 1300°C, and weighed after cooling and recorded as (W_3). The loss of ignition was calculated using Eqn. 1

$$\text{loss on ignition} = \frac{W_2 - W_3}{W_2 - W_1} X 100\% \qquad 1$$

Where W_1 is the weight of the crucible
W_2 is the clay and crucible
W_3 is the weight of dried clay and crucible

2.2.3 Bulk density

Test specimens with dimensions 50 mm diameter and 30 mm height were cut from the air dried test specimens and oven dried at 110°C for 24 hours. The samples were further fired in a muffle furnace at 1200°C for 30 minutes and allowed to cool in the desiccators for 24 hours, and weighed and recorded as W_1. The specimens were suspended using inextensible string, with which they were transferred and immersed into a beaker of water. The beaker was heated for 30 minutes, allowing for the release of trapped air within their pores, and with the pores being filled with water (Olalere *et al.,* 2019). Weights of the specimens were measured and recorded as W_2. The specimens were then suspended in beaker of water placed on a balance, and their weights were measured and recorded as W_3. The bulk density was calculated using Eqn. 2

$$Bulk\ density = \frac{W_1}{W_2 - W_3} \quad (2)$$

Where W_1 is the weight of the dried specimen
W_2 is the weight of immersed specimen
W_3 is the weight of the suspended specimen

2.2.4 Apparent porosity

Test specimens of 50 mm diameter and 30 mm height were cut from the air dried test specimens and oven dried at 110^{o}C for 24 hours. The samples were put in a muffle furnace, fired to 1200^{o}C for 45 minutes, and allowed to cool in the desiccators for 24 hours. After which, weights of the dry specimens were measured to the nearest 0.01(dried weight) and recorded as W_D. The specimens were carefully submerged in beaker of water and left for an hour, ensuring that there was no bubbles from them, and their weight were measured and recorded as W_S. The specimens were then suspended in beaker of water placed on a balance. The suspended weights were measured and recorded as W_W. The apparent porosity was calculated using Eqn. 3

$$Apparent\ porosity = \frac{W_S - W_D}{W_S - W_W} X100\ \% \quad (3)$$

Where:
W_D is the weight of the dried specimen
W_S is the weight of immersed specimen
W_W is the weight of the suspended specimen

2.2.5 Permeability

Test specimens of 50 mm diameter and 40 mm height were cut from the air dried test specimens. They were completely scaled on the sides and the lower surface was exposed to an orifice. The cylinder was filled with 2000cm of water and the bell jar was put in place, the orifice was opened and the time taken for the 2000cm of water to displace equal volume of air through the specimen was taken. The pressure difference between the surfaces was measured by a manometer. The permeability number (PA) was calculated using Eqn. 4

$$Permeability\ number\ (PA) = \frac{VH}{APT} \quad (4)$$

Where V is the volume of air
H is the height of the specimen
A is the cross sectional area of the specimen
P is the pressure of air in water

T is the time taken for the water to displace equal volume of air

2.2.6 Linear shrinkage on firing

Test specimens of 50 mm diameter and 30 mm height were cut from the air dried test specimens. Each of the specimen were marked along a line in order to maintain the same position after heat treatment. Vernier caliper was used to measure the distance between the two ends of each of specimen and the lengths were measured and recorded as L_1. The specimens were further oven-fired at 110°C for 6 hours, cooled to room temperature, and the length was measured and recorded as L_2. The fired linear shrinkage was calculated using Eqn. 5

$$\text{Fired linear shrinkage} = \frac{L_1 - L_2}{L_2} X\ 100\% \qquad 5$$

Where L_1 is the initial length before firing
L_2 is the initial length after firing

3. RESULTS AND DISCUSSION

3.1 Chemical analysis

From the result in Table 2, it is obvious that the samples (Ikere clay and Itawure termite hill) are composed majorly of aluminum oxide (Al_2O_3) and silica (SiO_2), and since clays with silica content equal or higher than 46.6 % are characterized by high crushing strength (Olalere *et al.*, 2019), then both samples can be suitably utilized under high loading conditions, and at elevated temperature without breaking (Daniel-Mkpume *et al.*, 2011; Grimshaw, 1971). Also, the variations in SiO_2 content of the samples resulted from their mode of formation (Apeh, 2011).

Table 2. Chemical compositions of Ikere clay and Itewure termite hill samples

Oxide	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	Loss on ignition	Total
Ikere Ekiti clay	47.633	30.525	2.000	1.138	0.023	0.120	0.036	0.330	11.800	94.000
Itawure termite hill	51.341	28.100	1.820	1.763	0.164	0.210	0.051	1.084	10.097	94.630

3.2 Sieve analysis of the samples

Mesh sizes of 500µm and 100 µm gave highest mass retained of 153g and 233g for Ikere clay and Itawure termite hill samples respectively (Table 3). And it has been shown that bulk density and apparent porosity were influenced by particle size distribution within clay samples, and that clays with fine grains will compact more with lowest density gradients relative to clays with coarse grains (Amuda *et al.*, 2019; Agbajelola *et al.*, 2015; Chester, 1993). Consequently, Itawure termite hill, which is characterized by finer grains can be suitably utilized as binder than Ikere Ekiti clay.

	Ikere Ekiti clay sample			Itawure termite hill sample		
Mesh size (µm)	Mass retained (g)	% retained	% passing	Mass retained (g)	% retained	% passing
500	153	30.7	693	37	7.4	92.6
300	70	14.0	55.3	78	15.6	77.0
250	59	11.8	43.5	124	24.9	52.1
100	119	23.9	19.6	233	46.8	5.3
63	33	6.6	13.0	9	1.8	3.5
53	16	3.2	9.8	3	0.6	2.9
Pan	48	9.8	0	14	2.9	0

Total weight is 500g

3.3 Loss on ignition

Low loss on ignition value shown by Itawura termite hill as compared to Ikere Ekiti clay (Fig. 2) resulted from relatively less combustible materials (organic matters) of the latter (Osarenmwinda and Abel, 2014; Babalola *et al.* 2014). From the past research findings, loss on ignition values of all the samples (unblended and blended) samples are lower than the lower limit of refractory (12-18%), within the lower limit of low melting metals, but lower than the upper limit (3-15%) and within the lower limit of high melting metal, but lower than the upper limit of same of (4-12%) (Yami and Umar, 2007; Chester, 1983). The improved loss on ignition characteristics of the blended samples with increasing presence of Ituware termite hill and optimum loss on ignition value of 10.19 revealed by sample S-V with 40% Ikere Ekiti and 60% Itawure termite hill are understandable, and may be attributed to decreasing presence of combustible materials.

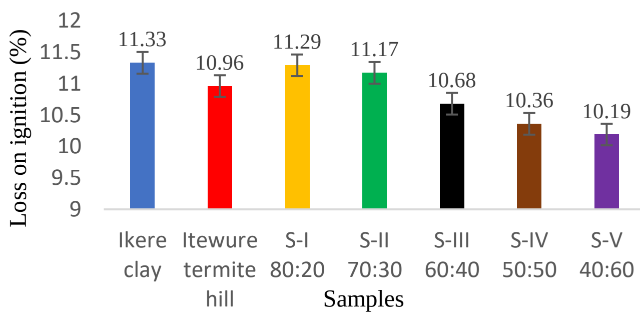

Fig. Loss on ignition characteristics of the unblende

Fig.2. Loss characteristics of the samples

3.4 Bulk density

From Fig. 3, bulk density values of Itawure termite hill and the blended samples are higher than bulk density value of Ikere clay. And from the literature, bulk density for high alumina refractory is within the specified standard range of 2.2 – 2.8 (Osarenmwinda and Abel, 2014; Obadinma, 2003; Chester, 1983). Consequently, Itawure termite hill sample offers better volume stability, heat capacity, resistance to abrasion and resistance to slag penetration than both Ikere Ekiti clay and blend samples. The improved bulk density characteristics of the blended samples with decreasing presence of Ikere

Ekiti clay and optimum bulk density characteristic revealed by S-IV were expected, while the former was due to increasing presence of Ikere clay and Itawure termite hill samples.

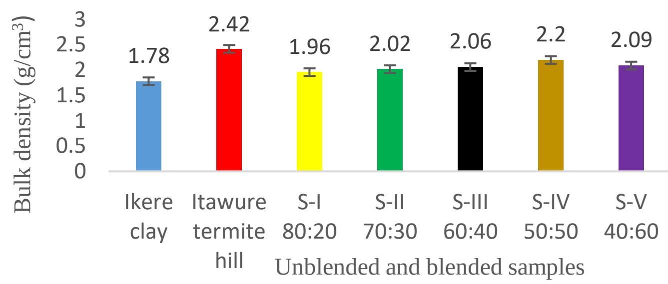

Fig. 3. Bulk density characteristics of the samples

3.5 Apparent porosity

From Fig.3, it can be seen that porosity value of Ikere Ekiti is higher than porosity values of Itawure termite hill and the blended samples respectively. And the observed decrease in porosity values of the blended samples, which resulted from increasing presence of Itawure termite hill was due to decreasing absence of combustible materials (Omotoyinbo and Oluwole, 2008). Specified upper and lower porosity values of refractory brick are 20% and 30% respectively (Attah, 2008; Chester, 1983), and since porosity is size dependent, porosity characteristic of Ikere Ekiti clay is within the lower range of refractory brick, porosity characteristics of Itawure termite hill and the blended samples are lower than the lower range of refractory brick. Consequently, the samples

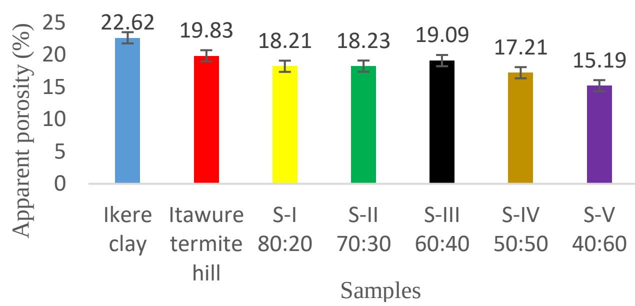

Fig.3. Apparent porosity characteristics of the samples

3.6 Permeability

Permeability value of Itawure termite hill is high relative to Ikere Ekiti clay (Fig. 4). This is in spite of the larger grains of the later (Table 1). Higher permeability characteristic of the former may be hinged on its pores that are well more connected (Olalere *et al.*, 2019; Omotoyinbo and Oluwole, 2008). Consequently, the later with low permeability value will allow for elimination of liquid leakage and penetration of gas through the lining than the former, whereas the former will allow for easy flow of liquid and gas than the later (Manukaji, 2013). For the blended samples, the optimum permeability shown by S-1, and S-11 was due to increased presence of the later. And due to permeability values of all the samples, they can be applied as lining materials, because the values are within the specified internationally accepted range of 25-90 mm/s for fireclay (Osarenmwinda and Abel, 2014; Babalola *et al.*, 2014; Chester, 1983).

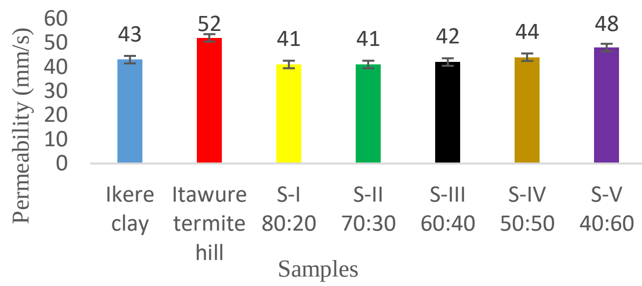

Fig. 4. Permeability characteristics of the samples

3.7 Linear shrinkage on firing

From Fig. 5. the high linear shrinkage on firing value of Ikere Ekiti clay relative to Itawure termite hill is attributable to large particle size, more porosity and pores, also contributory is the chemical composition (Salihu and Suleiman, 2018; Omowumi, 2000; Omotoyinbo and Oluwole, 2008). When used as lining, Ikere Ekiti clay shows high tendencies for heat loss in furnace, cracking in firing kiln, and warping and cracking of bricks as compared to Itawure termite hill (Abolarin *et al.*, 2004; Bello, 1991), and the observed more thermal stability of the blended samples with increasing proportion of itawure termite hill was expected, because of its relative low value of linear shrinkage on firing, and hence less volume change. It is obvious that the blended samples are more suitable for use in application requiring low to moderate temperature than Itawure termite hill and Ikere Ekiti clay correspondingly. For the blended samples, optimum performance if used under the specified operating condition(s) was revealed by S-V.

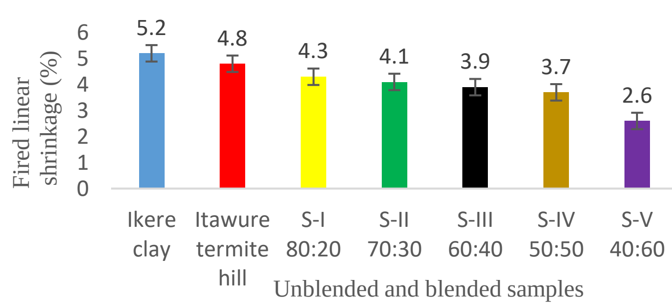

Fig. 5. Linear shrinkage on firing characteristic of the samples

4. CONCLUSIONS

Based on the results of the study, the following conclusions were drawn

1. Aluminum oxide (Al_2O_3) and silica (SiO_2) are the major constituents of the Ikere clay and Itawure termite hill samples.
2. Ikere Ekiti clay sample with mesh sieve size 500µm gave the highest mass retained (153g), and Itawure termite hill sample with mesh size 100µm revealed the highest mass retained of 233g.
3. Itawure termite hill sample shows superior characteristic relative to Ikere Ekiti clay sample. And upon blending, loss on ignition characteristics of the blend was improved with increasing proportion of Itawure termite hill clay sample.
4. Bulk density of Itawure termite hill (2.19g/cm^3) is higher than bulk density of Ikere clay. In general, bulk density of the blends increases with increasing and decreasing proportions of Itawure termite hill and Ikere Ekiti clay sample respectively.Apparent porosity of the unblended and blended samples show inverse relationship to the bulk density characteristics. Fired linear shrinkage characteristic of the unblended sample declines steadily with increasing addition of Itawure termite hill to equal addition of Ikere Ekiti clay. After which, further addition of Itawure termite hill led to rapid decrease in fired linear shrinkage characteristic of the blend. Itawure termite hill has high permeability as compared to Ikere Ekiti clay. And with increasing addition of Itawure termite hill to Ikere Ekiti clay, permeability value was found to increase.

The blends (S-V) can be suitably used as lining for applications requiring low and moderate temperatures respectively.

REFERENCES

Abolarin, M.S. Olugboji, O.A. and Ugwuoke, I.C.(2004). Experimental investigation on local refractory materials for furnace construction. *5th Annual Engineering Conference*, Federal University of Technology, Minna, Niger. pp. 82-85

Adamu, H.A. Ibrahim, M.E. Isa I.K. and Jimoh, S.O. (2018). Investigating the refractory property of Jalingo clay deposit, *International Journal of Scientific and Engineering Research*, 9(2),pp. 254-260 http://www.ijser.org

Aderibigbe, A. and Chukwuogo, B. (1984). Potentials of some Nigerian clay deposits as refractory material for steel industry, *Nigerian Society of Engineers*, pp. 132-8.

Adondua, S. (1988). Indigenous refractory raw materials base for Nigeria Steel Industries. *Journal of the Nigerian Society of Chemical Engineers* (NSCHE), 7(2), pp.322.

Agbajelola, D. O. Musa, U. Mohammed, I. A. Bala A, Suleiman, B. and Kure, A. (2015). Evaluation of refractory properties of selected clay samples from Sokoto State, North West Nigeria, *Journal of Science, Technology, Mathematics and Education (Jostmed)*, 11(2), pp. 180-189

Amuda, M.O.H. Ichetaonye, S.I. and Lawal, F.T. (2019). Refractory properties of Alumina/Silica blend, *The West Indian Journal of Engineering,* 42 (1), pp.22-32

Apeh, F. I. Esezobor, D. E. and Lawal, G. I. (2011). Characterization of Onibode and Owode-Ketu clays for use as refractory materials in foundry industry, *Journal of Engineering Research,* 16(3), pp.89-77

Aremu, D. A. Aremu, J. O. Ibrahim, U. H. (2013). Analysis of Mubi clay deposit as a furnace lining, *International Journal of Scientific and Technology Research*, 2(12), pp. 182- 187t www.ajer.us

Attah, L.E. (2008).The composition and physical properties of some clays of Cross River State, Nigeria, *African research review*, 2 (1), pp.84-93

Babalola, B. J. Folorunso, D .O. Bodunrin, M.O. and Balogun, P.O. (2014). Property evaluation of Igbara-Odo flay for refractories, *International Journal of Engineering and Technical Research (IJETR)*, 2(1), pp. 79-82 ww.erpublication.org

Chester, J.H. (1983). Refractoriness: Production and Properties‖. The Metal Society, London, UK, pp. 492-510.

Daniel-Mkpume, C.C. Offor P.O, and Obiorah, S.O. (2011). Blending of Nsu and Ibeku Clays: A Solution Towards the Replacement of GP107-3 Refractory Brick in The Metallurgical Industry ,*Nigerian Journal of Technology*, 30 (2), pp.

Elakhame, Z. Bello, S. A. Agunsoye J. O. Patric I. and Otitoju, O. (2016). Characterization of Ujogba Clay deposits in Edo State, Nigeria for refractory applications, *Journal of Science, Engineering and Technology* 12 (2), pp. 71-82.

Hassan, S.B, Adewara, J.O.T (1993). Refractory properties of some Nigerian Clays, *Nigerian Society of Engineering, Trans.* 28(3), pp. 21 – 5.

Ndaliman, M.B. (2001).An investigation on the properties of termite hill in Nigeria, Nigeria J. Ed. Tech, 2(1&2), pp. refractory

Ndaliman, M.B. (2000). Effect of certain additives on refractory properties of termite hill for furnace lining, Proc. 2nd Annual Engin. Conf. Fed. Univ. of Tech., Minna, Nigeria, 4-6 Sep., 2000. pp. 139-144.

Obadinma, E.O. (2003). Development of refractory bricks for Heat treatment facilities. *Journal of Science and Technology Research.* 2(2), pp. 13-17

Ojo, J.E. Kutelu, B. J. and Oshuoha, I.C. (2014). Effects of blending on refractory properties of some selected local clays in South Western Nigeria, *Journal of Research in Mechanical Engineering*, 2(2), 1-5

Olalere, A. A. Yaru, S.S. and Dahunsi, O.A (2019). Evaluation of the chemical and thermo-physical properties of locally aggregated kaolin-based refractory materials, *Journal of Mechanical Engineering and Sciences*, 13 (1), pp. 4743-4755.

Okpanachi, C. Sadiq. . S. Abdullahi, H. Z. IbrahimS, I. Ezika, V. C. Yisa, E. N. and Agada, G. O. (2017). Performance assessment of the physical properties of Kadna, Tagwai and Gbakoita clay deposits as refractory for furnace lining, IJISET-*International Journal of Innovative Science, Engineering Technology*, 4 (7), pp. 49-53

Omotoyinbo, J.A. and Oluwole, O.O. (2008). Working Properties of Some Selected Refractory Clay Deposits in South Western Nigeria, *Journal of Minerals and Materials Characterization and Engineering*. USA. 7(3), pp. 233-245

Omowumi, O. J. (2000). Characterization of some Nigeria clays as refractory materials for furnace lining. *Nigerian Journal of Engineering Management*, 2(3), pp.1-4.

Osarenmwinda, J. O. Abel, C. P. (2014). Performance evaluation of refractory bricks produced from locally sourced clay materials. *J. Appl. Sci. Environ. Manage*, 18(2), pp. 151- 157, Available Online at www.ajol.info and www.bioline.org.br/ja

Sadik, C. El Amrani, I.E. and Albizane, A. (2014), Recent advances in silica-alumina refractory: A review, *Journal of Asian Ceramic Societies*, Vol.2, pp.83-96.

Salihu, S.A. and Suleiman, I. Y. (2018). Comparative analysis of physical and chemical characteristics of selected clays deposits found in Kebbi State, Nigeria, *International Journal of Physical Sciences*, 13(10), pp. 163-173, http://www.academicjournals.org/IJPS

Sayel, M. F. Ghazi, S. A. Suleiman, Q. A. (2012). Improvement of the Refractoriness under Load of Fire-Clay Refractory Bricks".Adv. Theor. Appl. Mech., 5(4), pp. 161 – 172

Ugwuoke, J.C. Ugwu, O. J. and Ugwuanyi, B.C (2018). Characterization of Iboko and Nduage-Echara clay deposits in Ebonyi State, Nigeria for refractory applications.*International Journal of Engineering Inventions,* 7 (9), pp. 55-60, www.ijeijournal.com

Yami, A.M. and Umar, S. (2007). Characterization of some Nigerian clays as refractory materials for furnace lining, *Continental Journal Engineering Sciences,* 2(3), pp.30–35.