Refractory Properties of Termite Hills under Varied Proportions of Additives

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Abstract

The investigation centered on how additives such as Graphite, asbestos varied at different percentages can affect the refractory properties of pure termite hills. Experimental analysis was carried out on such properties as Refractoriness, porosity, permeability, thermal shock resistance, linear shrinkage, Bulk density and specific gravity. Through pure termite hill has low refractoriness (1400ºC). This was enhanced by graphite addition to as much as 1700ºC and asbestos to 1600ºC for the purpose of furnace lining. Other properties were also found to have been improved upon.

Keywords

Termite Hill, Refractoriness, Porosity Thermal Shock Resistance, Bulk Density, Linear Shrinkage

Introduction

The activities of termites are, perhaps more important than the activities of earthworms in the areas of day formation. Termites transport large quantities of materials from within the soil, depositing it on the surface. Some of the termites mould hills are about 5 meters tall and 7 meters in diameter. The earth movement activity of termites results in greater than - normal content of days.

It is because of the anticipated transformation of the original clay content that stimulated the research in this area. In an earlier paper [1], it was shown that the behavior of termite hill materials when subjected to refractory tests were in good comparison with the firebricks obtained elsewhere. It was then suggested that further improvement may be obtained when additives or other forms of rectification could be made.

Refractory materials include alumino-silicate silica, magnesite chrome, carbon and dolomite etc. These oxides are classified according to their chemical behaviour. Over 80% of the total refractory materials are being consumed by the metallurgical industries for the construction and maintenance of furnaces Kilns, Reactor Vessels and Boilers. The remaining 20% are being used in the non-metallurgical industries as cement, glass and hard ware [2].

It was also showed [3] that termite hills can be used to produced insulating refractory when 25% of additives (Corn Husk, Saw Dust) were used. However, low values of refractoriness (1,200ºC) were recorded for these cases. The application would require a compromise between insulation and operating temperature. In yet another investigation, which sought to increase the refractoriness, Ndaliman [4] used 25% each of graphite powder and asbestos with termite hill materials. It was found that the refractoriness of 1,700ºC and 1,600ºC were obtained in addition to improvements recorded in other properties.

This paper presents the results of further investigation conducted on the termite hills as refractory materials. The clays materials were mixed with different proportions at graphite powder and asbestos. The percentages of the additives are 20, 25, 30, 35 and 40. The effects of these variations are studied and presented in the following paragraphs.

Methods and Materials

The materials for investigation are the termite hills and the additives (Graphite and Asbestos). The termite hill used was those spread around Oshodi area in Lagos. They were dug up form a field divided into three (3) parts. Five hills from each of each part were used. They were crushed, sized graded by sieving to remove leaves and other materials. The chemical analysis was then conducted.

The samples were prepared by using 200g as the basis of each mixture. Each of the graphite powder and asbestos were added in the percentages of 20, 25, 30, 35 and 40 respectively. This makes up a total number of ten (10) samples for investigation. These mixtures were blended and molded with sufficient water. They were rammed into various test

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shapes with the use of a die and hydraulic press. The samples were then oven dried and fired to 1100C for further tests.

The method used in analysis of chemical composition is X-ray method. Other refractory properties investigated are linear shrinkage, refractoriness, thermal shock resistance, permeability, and porosity, bulk density, specific gravity.

The properties listed above have standard test procedures. Generally, the standard test methods as contained in BS 1902: Part 1A: 1966 [5] was used in studying the refractory properties of the samples.

Results and Discussions

The summary of chemical analysis is presented in Table 1. From the table, it is noticed that there is high proportion of silica sands. The hills can therefore be classified under siliceous firebricks, which are in consistent with the standard [1]. Generally the chemical compositions of the termite hill shown in Table 1 and 2 are consistent with the one shown in [1] and [3]. Therefore the discussion of the current results would be based on the fact that the suitability termite hills as refractory materials have been established by the previous researches. It is the optimum levels of each of the properties that are being determined using the varied proportions of the additives.

Table 1. Chemical Composition of the Termite Hills

Composition	Percentages (%)	Remo Termite Hill
SiO_2	58.06	68.46
Al_{2O3}	27.72	28.25
K_2O	2.59	0.34
Fe_2O_3	1.46	1.03.
TiO_3	0.87	1.40
CaO	0.20	0.01
MgO	0.36	0.15
Na_2O	0.30	0.02

Table 2. Refractory Properties of Termite Clay

S/N	PROPERTY	VALUES
1.	Refractoriness (°C)	1,400
2.	T.S.R. (cycles)	24
3.	Permeability (mm/s)	$0.79x10^{-4}$
4.	Porosity (%)	23.49
5.	Bulk Density (g/cm^3)	2.58
6.	Specific Gravity	1.13g
7.	Linear Shrinkage (%)	4.0%

Source: Akinbode (1999)

The properties investigated have been presented in Table 3 and 4. Table 3 gives the properties of the termite hill clay with the addition of graphite powder ranging from 20% to 40% while Table 4 give the same properties for Asbestos additive in the same range.

Table 3. Properties of Termite Hill Clay with Varied Percentages of Graphite Dust

S/N	Refractory Properties	Termite Hill Clay + %Graphite				
		20%	25%	30%	35%	40%
1.	Refractoriness (ºC)	1,700	1700	1,700	1,700	1700
2.	T.S.R (cycles)	18	14	14	10	10
3.	Permeability (mm/s)	$0.94 \cdot 10^{-4}$	$1.00 \cdot 10^{-4}$	$1.00 \cdot 10^{-4}$	$1.00 \cdot 10^{-4}$	$1.00 \cdot 10^{-4}$
4.	Apparent Porosity (%)	25.61	27.55	29.86	-	-
5.	Bulk Density (g/cm^3)	2.62	2.68	2.71	2.82	2.82
6.	Specific Gravity	1.72	1.70	1.70	1.68	1.62
7.	Linear Shrinkage (%)	4	4	4	4	4

Table 4. Properties of Termite Hill Clay with Varied Percentages of Asbestos

S/N	Refractory Properties	Termite Hill Clay + % Asbestos				
		20%	25%	30%	35%	40%
1.	Refractoriness (ºC)	1,600	1,600	1.600	1,600	1,600
2.	Thermal Shock Resistance (Cycles)	18	18	16	14	14
3.	Permeability (mm/s)	$67 \cdot 10^{-4}$	$5.8 \cdot 10^{-4}$	$57 \cdot 10^{-4}$	$55 \cdot 10^{-4}$	$52 \cdot 10^{-4}$
4.	Apparent Porosity (%)	26.27	30.43	30.99	331.48	32.47
5.	Bulk Density (g/cm^3)	2.52	2.60	2.66	2.80	3.01
6.	Specific Gravity	1.84	1.80	1.80	1.96	2.0
7.	Linear Shrinkage (%)	4	4	4	4	4

Linear Shrinkage

The values of the linear shrinkage remains uniform for all the samples investigated. The 4.0% shrinkage is within the allowable range as given by [5]. This firing shrinkage always gives an indication of the firing efficiency. The result of this property from the tables shows that there is uniform firing.

Refractoriness

The average refractoriness of the termite hill refractory is 1,400ºC. This is low compared to the values usually quote for most dense refractory clays (over 1,500ºC from [6, 7]. The high value of silica content and other particles such as Fe2O3 may have contributed to this low refractoriness [6, 7]. With the additives, enhanced values of refractoriness were obtained. The values remain uniform for particular type of additive. It is 1,600cfor Asbestos. With this level of achievement general-purpose bricks for retreating furnace doors, checkers, boiler and ladles can be produced from the materials.

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Density, Porosity and Permeability

These are parameters that affect the strength of refractory material as well as their insulating capabilities. Porosity determines the resistance of the material to penetration of molten slags, metals and flue gases. The apparent porosity of the termite hill clay is 23.49%. The porosity of termite hill clay with additives increases with the varying percentages. The value for the refractory with mixed graphite additive ranges from 25.61% to 29.85%. Thus, it increases with any increase in graphite up to 30% of graphite. Any increase in graphite proportion beyond 30% makes the refractory non-porous. From the result in Table 3 and 4, it is possible to use the refractory with 30% graphite or 40% asbestos for insulation purposes, since both the high values refractoriness and porosities would be maintain.

The bulk densities obtained for all categories are quite comparable with the standard values of firebricks. The highest value being that of asbestos-mixed this is 3.01 g/cm3. The general trend being the increasing values as the additive is increased.

The asbestos-mixed refractory is associated with low values of permeability and therefore, likely to exhibit good resistance to the penetration of molten slag, metal and flue gases.

Thermal Shock Resistance

The test showed the dense pure termite hill resist spalling up to 24 cycles. However, the additive-mixed ones showed that thermal shock resistance reduces from 18-10 cycles with the increasing amount of graphite alert from 20% through 40%, while that of asbestos reduces from 18-14 cycles over the same proportion of additive. The results obtained generally indicated that the resistance of the materials reduces with increasing percentage of additive.

Conclusions

Chemical analysis conducted of the termite hills indicated high silica contents in the clay, although other constituents are consistent with those normally obtained in fireclay refractoriness.

The important properties such as refractoriness and linear shrinkages remain the same as the proportions of additives were increased. However, a significant improvement was obtained because of the additives.

Thermal shock resistance and specific gravity decreased gradually, as additives were increase, while the density, porosity and permeability varied in reverse manner.

A significant discovery is that it is possible to select percentage composition that gives compromised values of certain properties.

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