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Estimation of Intrinsic Oxides in Five Portland Cement brands in Nigeria.

Abubakar Zaid[1], Olabimtan Olabode .H*[2], Binod Adhikari[3], Batari Musa.L[4], Orijajogun Omohu.J[5]

[1]Nigerian Building and Road Research Institute, northwest Zonal Office, Department of Engineering Materials Research, Kano State, Nigeria.
[2]National Research Institute for Chemical Technology, Department of Industrial and Environmental Pollution Zaria Kaduna State, Nigeria.
[3]Tribhuvan University, Department of Civil Engineering Kathmandu, Nepal.
[4]National Research for Chemical Technology, Scientific and Industrial research Department Zaria Kaduna State, Nigeria
[5] Sheda Science and Technology, Chemistry Advanced Research Center Abuja, Nigeria.
Corresponding email address; Olabode4angel@gmail.com

Abstract: *The performance of* any cement brands is a function of its physical and chemical characteristics. Cement oxides are the chemical residues and components that activate the concreteness of the materials. Five brands of Portland cement; *Elephant, Unicem, Dangote, Eagle, and BUA* were investigated to determine the level of their oxide in the compound state. The results show that all the five brands examined to meet the ASTM C150-07 Standard requirements for cement oxides (oxygenated compounds) (SiO_2, CaO, Al_2O_3, MgO, Fe_3O_2 & SO_2) as two (Dangote and BUA) out of the brands were above Fe_3O_2 limit with ASTM C150-07 standards. The entire five brands can be optimized with additional practical approach(s) that prevent cracking.

Keywords: Cement oxides, Portland cement, ASTM C150-07 standards, cement physico-chemicals & Iron oxide.

1.0 INTRODUCTION

Cement is a complex manufacturing product, commercially produced in all developed countries. Blended through aggregates and water, it shapes into the general concrete for the construction of buildings, highways, structures and bridges. Mostly in places where wood is insufficient quality concrete, the design of residential buildings still plays a major role. In addition, twice as much concrete is used worldwide in construction than the sum of all other building materials [1]. The worldwide demand for cement in construction work is enormous. For the cement manufacturing industries as well as for the civil construction industries, the quality of cement according to standard requirements is very critical in order to make a strong and long life Structure. The cement and clinker's main constituent is calcium oxide (CaO), which is the key factor for the quality and consistency of cement [2]. Cement is a known chemical product, produced at a relatively accurate temperature from predetermined reactant ratios. Ordinary Portland cement is the product of the calcination of calcines and silica [3]. Cement consists of certain oxides of minerals, such as silica (SiO_2), lime (CaO), alumina (Al_2O_3), magnesium oxide (MgO), and ferric oxide (Fe_2O_3). They have a shorthand of S, C, A, M, and F respectively due to the complex chemical origin of such oxides in the cement industry [4]. Cement is a crucial construction content that functions as a binder as needed for almost any construction work. Accordingly, the cement composition is a matter of major concern to engineers in which to understand the structure of cement, it also has to understand the functionalities of the components. With the adjustment of the quantities of the ingredients during cement production, the desired consistency is attained. Cement concrete clinker is produced through sintering an appropriately defined mixture of element-containing raw materials, typically represented as oxides, CaO, SiO_2, Al_2O_3, Fe_2O_3, and trace quantities of other materials [5]. The crude paste or slurry is finely divided, blended deeply, and homogeneously. [6] Ability to measure cement concentrations in terms of the amounts of the major compositions available established a promising new method to clarify or forecast variations in engineering efficiency between cement products [2]. The ability to measure the proportions of the major compositions in a clinker or cement has substantial consequences. For biocompatibility, the availability of lime in sufficient amounts is needed to secure silicates and aluminates of calcium, silica as dicalcium and tricalcium silicate for organic materials, cement alumina for rapid setting property, magnesia for strength induction, iron oxide as a fluxing agent, gypsum or calcium sulfate ($CaSO_4.2H_2O$) delays the setting action of cement, sulfur trioxide for soundness and alkalinity ensuring cement product stability [6].

2.0 MATERIAL AND METHODS

2.1 Materials

Some quantities of each(Elephant, Unicem, Dangote, Eagle, and BUA) of the cement brands were obtained, analytical balance, Beakers, furnace, volumetric flask, measuring cylinder, the crucible, filter papers, burette, Chlorinated Acid

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(100% HCl) , EDTA, (ammonium chloride, oxalate, and nitrate), ammonia, salicylic acid, pH4, and 10 buffer solution.

Silicon dioxide (Silica), ferric oxide, aluminum oxide, calcium oxide, and magnesium oxide were estimated according to Asrar Adil El-gray, 2016 [2].

2.2 Oxides in Portland cement

3.0 RESULTS AND DISCUSSION

Table 1. Average values of the oxide compositions

Cement brand	SiO_2	CaO	Al_2O_3	MgO	Fe_3O_2	SO_2
Elephant	19.49	50.44	5.00	1.48	3.83	1.18
Unicem	18.29	50.90	5.17	2.38	4.01	1.28
Dangote	20.03	49.89	1.90	1.39	12.83	1.38
Eagle	21.94	48.92	4.04	1.69	2.48	0.87
BUA	20.11	49.80	3.21	2.34	12.27	1.42
ASTM C150-07	23	67	6	5	6	2.9

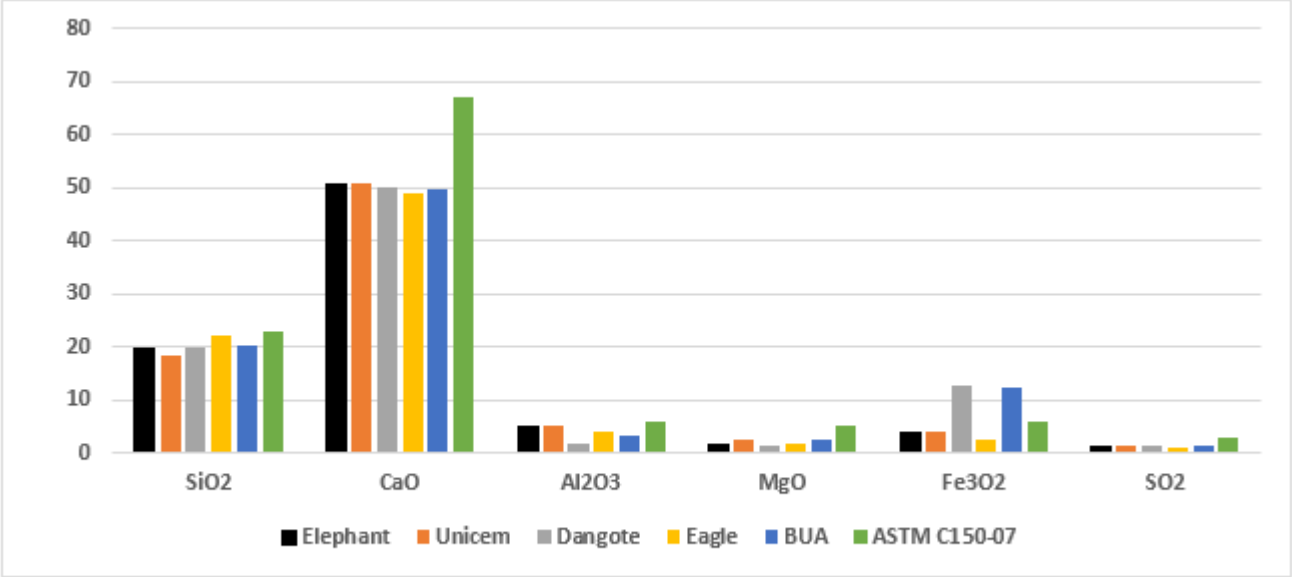

Figure 1. Oxide compositions of the Portland cement samples in percent.

Table 2. Statistical upper and lower average values of the oxide compositions of the Portland cement samples.

Cement brand	SiO_2 (%)	CaO (%)	Al_2O_3 (%)	MgO (%)	Fe_3O_2 (%)	SO_2 (%)
Elephant	19.48 ± 0.0141	19.48 ± 0.0142	19.48 ± 0.0143	19.48 ± 0.0144	19.48 ± 0.0145	19.48 ± 0.0146
Unicem	18.28 ± 0.0354	50.95 ± 0.2192	5.05 ± 0.6364	2.37 ± 0.0212	4.01 ± 0.0071	1.30 ± 0.0424
Dangote	20.05 ± 0.0707	50.02 ± 0.0283	2.20 ± 0.1414	1.41 ± 0.0212	12.72 ± 0.1414	1.40 ± 0.0354
Eagle	22.06 ± 0.3606	49.21 ± 0.0071	4.03 ± 0.0424	1.70 ± 0.0071	2.46 ± 0.0141	0.87 ± 0.0141
BUA	20.11 ± 0.0071	49.68 ± 0.0354	3.21 ± 0.0071	2.32 ± 0.0566	12.25 ± 0.0707	1.42 ± 0.0495

The level or the degree of the cement oxides are direct functions of the reactivity of such cement products. Five Portland cement brands were subjected to the oxide analysis as disclosed in table 1 and figure 1 as the average magnitudes as deduced from the triplicate estimations from the results. Silica (SiO_2) content was highest with Eagle and least with Unicem cement brands; calcium oxide (CaO) with Unicem as the highest and Eagle as the least, alumina (Al_2O_3) with Elephant and Unicem as the highest and Dangote as the least, magnesium oxide (MgO) with Unicem and BUK as the highest and Dangote as the least. Elephant, Unicem Dangote, and BUA at the highest points than to Eagle which the least value with sulfur oxide (SO_2) .iron oxide (Fe_2O_3) only in the cases of Dangote and BUA brands were significantly above the ASTM C150-07. In other words elephant, Unicem and Eagle cement brands have a definite value of silica, calcium oxide, alumina, magnesium oxide, iron oxide and sulfur oxide below the standard; while Dangote and BUA satisfy silica, calcium oxide, alumina, magnesium oxide and sulfur oxide under the specified limit as against iron oxide.

4.0 CONCLUSION

The brands of cement analyzed to meet the minimum standard stipulated by the ASTM C150-07 as the basic oxide compositions for effective and optimal performance in the construction industry. Within the limits, silica (SiO_2) activates the formation of di and tri-calcium for strength enhancement (deficiency causes rapid setting), calcium oxide enhances the aggregations (excess causes expansion), alumina (Al_2O_3) controls the clinkering temperature (excess induces weakness), magnesia (MgO) enhancing strength, iron oxide (Fe_3O_2) impacting color, hardness, strength and a catalyst for the formation of tricalcium aluminoferrite and sulfur oxide to activate slow setting action.

Dangote and BUA brands can be affirmed to be technically active with regards to the percentage of iron oxide present in them which enhances their setting time and strength. However, all the cement brands can be recommended for large concrete pours with provision for expansion joint to prevent cracking.

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