Chemistry and Materials Research
ISSN 2224- 3224 (Print) ISSN 2225- 0956 (Online)
Vol.8 No.10, 2016

Determination of the Composition of Cement Raw Materials and Mixes

Abdulhanan, A.O.   Ahmed, A. G.   Bulama, J.S.
Department of Chemical Sciences, Federal University Kashere, Gombe State – Nigeria

Abstract

This study determine the composition of cement, raw materials and mixes. The range of parameters determine in percentage were as follows: SiO_2 (0.7245-59.8512), Al_2O_3 (0.1915-18.0996), Fe_2O_3 (0.1326-33.1373) Cl (0.01), CaO (0.5231-56.7013), F/CaO (0.88), MgO (0-1.9301), K_2O (0.2102-0.4580), IR (0.5-1.5), LOI (0.72-42.99), SO_3 (0-1.6520), N_2O (0.1058). All these components were determined in accordance with the Nigeria Industrial Standard and the result obtained compare well with British Standard (BS) specification and Nigeria Industrial Standard. It is important that the concentration (in percentages) do not exceed certain limits because below or above the limits will have disastrous effect on the cement and concentrate that will later be produced.

INTRODUCTION

Every year a huge amount of Ordinary Portland Cement (OPC) is produced and used for construction of buildings, roads, highways and other local purposes. In Nigeria the uses of poor quality cement in structural and constructional works may cause a lot of problems to the citizens of this country which may include loss of lives and properties. As a result, quality assurance of Ordinary Portland Cement (OPC) has become an important and critical factor in cement industries, (Austin, 1985).

The cement to be used in construction works must have certain qualities in other to play its own part effectively in the overall structure when these properties lie within certain specification, (Austin, 1985).The history of cement is quite old. Calcined impure gypsum was used by ancient Egyptians. The Greeks and Romans used calcined limestone and add the lime and water, sand and crushed stone or broken tiles and bricks. Volcanic ashes and finely ground burnt clay were also used by the Romans.The active and the silica alumina in the ash and the tiles combined with lime to produce what becomes known as Pozzolanic Cement from the name of the village of Pozzuali near Vesuvius, where the volcanic ashes were first found (Neville, 1981).There was decline in the middle ages with regards to quality and the use of cement until 18th Century. John Smeaton, in 1756 commissioned to rebuilds the Eddystone light house of the Cornish coast, found out that the best mortar was produced when pozzalana was mixed with limestone containing clay matter thus becoming the first to understand the chemical properties of hydraulic lime.

James Parker obtained the “Roman cement” by calcining nodules of argillaceous limestone culminating in the pertinent for Joseph Aspidin, a lead builder in the year 1824. The Roman cement was prepared by heating a mixture of finely divided clay, and hard limestone in a furnance until all the carbon (iv) oxide (CO_2) has been driven off at a temperature lower than that necessary for clinkering (Neville, 1981).The prototype of modern cement was made in 1845 by Isaac Johnson who burns a mixture of clay and chalk until clinkering is achieved. Originally, the name Portland cement was given due of the resemblance in colour and quality of the set cement to a Portland stone which is a type of building stone that was quarried on the Isle of Portland in Dorset, England in the early part of the nineteenth century. This name has remained throughout the world to this day top describe cement.

EXPERIMENTAL

FLAME ATOMIC ABSORPTION SPECTROSCOPY

In the method, sample and standard solution are aspirated into a flame and atomized in gaseous form. While majority of the atoms remain in ground state, small fractions at ground state could absorb radiation of their own resonance wave length. As such a beam of light of this wave – length when passed through flame containing the gaseous atoms of the analysis could be absorbed by the atoms. Because each metal has it own characteristic absorption wave length, a source lamp composed of that element is used and amount energy at the characteristic wave length absorbed in the flame is proportional to the concentration of the element in the sample over a limited concentration range. In principle AAS measure the amount of energy absorbed by an unexpected ground state atom in other to undergone excitation.

COLORIMETRY

When metal irons in solution absorbs radiation in the UV/visible region, its electrons are excited and move from one energy level to another. In the process they give out radiation energy which is observed in form of colour. The intensity of the colour depends on the concentration of the metal ions in solution which is in obedience of Beer – lambert’s law.The law states that the concentration of the absorbing ion in solution is directly

proportional to the absorbance of the electromagnetic i.e.
A = Ecl
A = Absorbance
E = Molaraborptivity
C = Concentration of the absorbing specie
L = Sample path length. In principle UV spectrophotometer measure the reduction in radiated power brought about by the presence of analytic

X – RAY FLUORESCENCE (XRF) SPECTROSCOPY

X – ray fluorescence is the emission of characteristic "secondary" (or fluorescent), x – ray from a material that is excited by bombing with high energy x – ray or gamma ray.The phenomenon is widely used for elemental analysis and chemical analysis, particularly in the investigation of metals, glass, ceramics and for research in geochemistry, forensic science. When materials are expressed to short wave length x – ray or gamma rays, ejection of one or more electrons from the atoms may take place as the atom is exposed to radiations with an energy greater than its ionization potential energy. It is a non destructive analytical; technique and as a result, it is use as a process control tool is many extractive and processing industries. In principle, the XRF measures the individual components wave lengths of the fluorescent emission produced by a sample when irradiated with x – rays (Jonkins, 1988).

SAMPLING

All the raw materials and mixes uses were randomly collected from the respective sample points at Obajana cement factory.

SAMPLE PRETREATMENT

All the samples collected were each grinded and sieve through a 2mm mesh sieve. The product obtain after sieving were each homogenized and store ion different sample sacks until they are require.

GRAVIMETRIC AND TITRIMETRIC METHOD (CLASSICAL METHOD)

DETERMINATION OF MOISTURE CONTENT

Five grams (5g) of each sample material was weighted into a previous cleaned and weighted procelein crucible. This was placed in an oven set at 1100^0C for one hour. After this time, the crucible was removed from the oven until it completely cooled down. This was weighed and the weight noted down. The difference in the final weight and the initial weight of the sampled gave the moisture content. This process was repeated for all the samples.

LOSS ON IGNITION

One gram (1g) of each sample was weigh into a cleaned weighted platinum crucible and placed in a muffle furnance set at 1000^0 for one hour. After this time, the crucible was removed from the furnance and kept in dessicator until it completely cooled down. This was weighted and the weight noted down. The difference in the final weight and the initial weight of the sample gave the loss on ignition. This process was repeated for all this samples (NIS445: 2003, NIS 368: 1997).

INSOLUBLE RESIDUE

One gram (1g) of each sample was weight into a preciously cleaned and weighted platinum crucible. 3g of Na_2CO_3 was added to the crucible and stirred thoroughly with the aid of the flattened end of a glass rod. The crucible was placed in a muffle furnance and set at 1000^0C for one hour to fuse. After fusions, 5cm^3 concentrated HCl was added to dissolve the sample followed by the addition of 10cm^3 of distilled water and warmed. This solution was filtered through wattman No. 40 filter paper and washed with distilled water. The filtrate was set aside for SO_3 determination. The filter paper containing the residue was put into weighed platinum crucible and ignited in a muffle furnance set at 1000°C for 30mins. After this time the crucible was removed and kept in a dessicator until it completely cooled down. This was weighted and noted. The insoluble residue was obtained by difference expressed as a percentage of the initial weight of the sample taken. For cement sample, fussing is not required. 1g of cement sample was weight was added followed by the addition of 5cm^3 of distilled water and the solution was latter digested for 15m ins without boiling. The solution was filtered using wattman No. 40 and washed thoroughly with distilled water. The filtered was also kept aside for SO_3 determination. (NIS 455: 2003 and NIS 368: 1997), this process was repeated for all the samples.

DETERMINATION OF SO_3

The filtrate set aside during the determination of insoluble reside was diluted to 250cm^3 with distilled water and boiled to reduce the filtrate to 150cm^3. 10cm^3 of hot 10% barium chloride solution was added drop wisely to the filtrate with continue stirring until all the precipitate was formed. The liquor containing the precipitate was digested on water bath for four hours. Precipitated was filtered off through wattman filter paper No. 42. Residue was washed with hot distilled water. The filter paper along with the residue was put into a weighed crucible and ignited for one hour. The SO_3 was obtained by difference expressed as a percentage of initial weight of sample taken during insoluble residue determination (NIS 455: 2003). This process was repeated for the all sample.

DETERMINATION OF SILICA

0.5g of each sample was weighed in a platinum crucible and ignited for one hour. The silica was obtained by difference expressed as a percentage of the initial weight of the sample taken (NIS 455: 2003 and NIS: 368: 1997)

COMBINED OXIDE DETERMINATION

2.3g of ammonium chloride was added to the filtrate set aside during silica determination and boiled for 10mins. 2 to 3 drops of con C_2HNO_3 was added and the solution was allowed to boil for some minutes. On boiling 20cm^3 of concentrated ammonia was added until precipitate was formed. Those were follow by the addition of little excess of was observed con c_2NH_3 until no colour change was observed. The solution was filtered through wattman No. 41 filter paper and the residue was washed with hot distilled water and the filtrate was set aside for CaO determination. The nitrate solution followed by washing with hot distilled water fill the residue was free from chloride. The filter paper along with the residue was put into a weighted crucible and ignited for one hour. The combined oxide was obtained by difference express as a percentage of the initial weight of the sample taken for the determination of silica (NIS: 445: 2003 and NIS: 368: 1997), this process was repeated for all the samples.

VOLUMETRIC DETERMINATION OF IRON OXIDE

0.5g of each sample except cement was added into a clean platinum crucible. 1.5g of Na_2CO_3 was added to the sample with thorough stirring. The crucible along with sample was kept in a murfule furnance set at 1000^{0}c for an hour to fuse. After fusion, 10cm^3 of concentrated HCl was added to dissolve the fused sample followed by the addition of 10m^3 of distilled water. The solution was then boiled for 15mins. For cement sample, 0.5g of cement was weighted into a clean dried beaker follow by the addition of 10cm^3 distilled water with stirring to breaks the lumps, 10cm^3 of concentrate HCl was added and boiled for 15mins 5% stannous chloride solution was added drop-wisely until the solution got decoloourized. After decolourization was observed the solution was allowed to cool to room temperature after which 20cm^3 of saturated mercuric chloride solution was added and stirred. 20cm^3 of acid mixture (H_2SO_4 + H_4PO_4) was added followed by the addition of two to three drops of BDS (barium diphenyl sulphonate) indicator. This solution was titrated against 0.4N $K_2Cr_2O_7$ unit a purple colour was observed.

The percentage of ironxide was obtained by the formular

$$\frac{0.4 \text{ x volume of } K_2Cr_2O_7 \text{ consumed}}{\text{Weight of the sample taken}}$$

(NIS 445: 2003, NIS 368: 1997 and NIS4032: 1985), this process was repeated for all the samples.

Allumina

This was obtained by difference. The combined oxide is the combination of both iron oxide and aluminum oxide.
Combined oxide
R_2O_3
$R_2O_3 = Fe_2O_3 + Al_2O_3$
$Al_2O_3 = R_2O_3 - Fe_2O_3$
This process was repeated for the all sample
Gravimetric determination of lime (CaO)
The filterate set aside during determination of combined oxide was boiled to reduce the volume to 150cm2d after which 30cm^3 of 5% ammonium oxalate solution was added until a white precipitate was formed. The liquor containing the precipitate was digested on a water bath of four hour after which it was filtered through wattman No 42 filter paper and filtrate was set aside for magnesium oxide determination. The filter paper along with the residue was put into a weighed platinum crucible and ignited for one hour. The percentage line content was obtained by difference expressed as a percentage of the initial weight taken for determination of silica. This process was repeated for all the samples. (NIS 445: 2003 and NIS 368: 1997 and 154 - 402: 1985).

GRAVIMETRIC DETERMINATION OF MgO

Ten (10) cm^3 concentrated HCl was added to the filterate set aside during lime determination and boiled lime determination to reduce to 150cm^3. The solution was allowed to cool to room temperatures after which 40cm^3 of concentration ammonia was added. 10cm^3 of ammonium dihydrogen or thophosphate solution was added and stirred thoroughly until a cloudy precipitate was obtained. The liquor containing the precipitate was kept on a dark place overnight after which it was filtered through wattman No 40 filter paper and washed with hot distilled water. The filter paper containing the precipitate was put on weighed crucible and ignited for an hour. The MgO content was obtained by difference expressed as a percentage to the initial weight of sample taken for determination of silica. 445: 2003, NIS 368: 1997 and IS 4032: 1985).

Chloride determination

Five 5g of each sample was weighed into a dried clean baker 40cm^3 of distilled water was added followed by the addition of 10cm^3 of concentrated HNO^3 and boiled for 20mins. The solution was filtered through wattman No 40 filter paper. The residue was washed three times with 10% nitric acid solution and the filtrate made up to 150cm^3 mark of a conical flask with distilled water for titration. 5cm^3 of 0.5N $AgNO_3$ solution was added followed by the addition of 2cm^3 of 10% ferric alum indicator and then titrated against 0.05N ammonium thiocyanate till a raddish white colouration was observed. The procedure was also repeated for a blank (without the sample). Percentage of chloride was determined by the formular.

$$\%Cl = \frac{5}{V2}(V2 + V1) \text{ X } 0.001775 \text{ X } \frac{100}{\text{Weight of the sample}}$$

V_2 = Titre value for blank
V_1 = Titre value for the sample solution
(NIS 449: 2003: NIS 445: 2003 and ENV 196 – 4).

DETERMINATION OF K_2O BY FLAME ATOMIC ABSORPTION SPECTROPHOTOMETER

Digestion of sample

0.5g of each sample was weighed into 50cm^3 beaker 10cm^{3}distilled water was added in other to convert the sample into slurry, 10cm^3 of dilute, HCl (1:19) was added and the mixture was warmed until the sample has dissolved. Glass rod was used to break any lumps found and the solution was filtered through filter paper into 100cm^3 volumetric flask, the residue was washed with boiling water until the filtrate was about 80cm^3 in the 100cm^3 volumetric flask. The filtrate was allowed to cool to room temperature after which 10cm^3 of dilute phosphoric acid (1:19) was added to the solution and the solution was made to mark with distilled water. The solution was aspirated into the flame photometer and the absorbance of potassium was measured at 768nm, (NIS 449: 2003).

PREPARATION OF STANDARDS SOLUTION OF POTASSIUM

1.9g of KCl salt was weight into a clean 1dm^3 volume flask. The KCl salt was dissolved with distilled water and the solution was later made to the mark to obtain 1000ppm of potassium stock solution. Other concentrations of (0.05, 0.1, 0.15, 0.2, 0.25) ppm was obtained by serial dilution.

COLORIMETRIC METHODS FOR DETERMINATION OF IRON AS IRON (II) COMPLEXES

PREPARATION OF THE SAMPLE

0.12g of each sample was weighed into a clean dried 100cm^3 volumetric flask, 0.25cm^3 of concentrated H_2SO_4 was added to this flask and the solution was diluted to the mark. 1cm^3 of this solution was transferred into another 100cm^3 volumetric flask. 1cm^3 hydroxyl amine solution was added to this solution followed by the addition of 10cm^3 of 1,10 – phenanthrolinetate solution was added and the solution was diluted to the mark and then allowed to stand for 10mins with occasional shaking. The absorbance of iron in this solution was obtained at a wave length of 500nm, (Sandell, 1959). 0.07g of pure ferrous ammonium sulphate hexahydrate was weighed into 1dm^3 volumetric flask. 2.5m^3 of concentrated H_2SO_4 was added and the solution was diluted to the mark with distilled water. To prepare the standard solution of iron, 1, 5, 10, 25 and 50ml portion of this standard solution was pipette into five different 100cm3 volumetric flask and 50cm3 of distilled water was measured into another flask to serve as the blank. To each of the flask, 1cm$_3$ of hydroxylamine solution was added followed by 10cm$_3$ of 1, 10 phenanthroline solution and finally 8cm^3 of sodium acetate solution were added. The mixture was diluted to the mark with distilled water and allowed to stand for 10mins with occasional shaking (Sandell; 1959).

X – RAY FLUORESCENCE SPECTROMETRY (X.R.F)

PREPARATION OF THE SAMPLE

10g of each sample was weighed into a weighted boat. Four to five tablets (ethylene glycol solid) were added to the weighed sample and grind together with the aid of an automated milling machine. The grinded mixture are further pelletized (pressed) with the aid of a pelletizing machine inside a ring after which the ring was sent to the

X.R.F (H. Bougault and P. Cambon, 1987).

PRECAUTIONS

Polyethylene bags were used during sample collection.
All the glass-ware used were thoroughly washed with 1M HNO_3
Followed by washing with distilled water and dried in an oven

RESULTS AND DISCUSSION

RESULTS

Result of the project work out on the composition determination of cement, raw materials and mixes are presented in the table 1 – 6

Table1. below shows the result of the physical parameter of the various samples.

Samples	Colour	Appearance	PH	Conductivity US
Cement	Gray	Powder	12.42	9.77
High grade limestone	Ash	Crystallaine form	8.65	134.9
Mixed grad limestone	Milkish brown	Crystallaine form	8.72	161.6
Laterite	Reddish brown	Lump's form	8.20	136.6
Clay	Reddish brown	Lump's form	8.38	180.0
Kiln feed	Milky	Powder	8.51	212.0
Gypsum	Light cream	Crystalline form	10.61	2.34

Table 2. Shows the result of cement physical parameter

PARAMETER	VALUE
Blaine (cm^2/g)	3490
Free lime (%)	0.88
Normal consistency	26.35
Initial setting time (Mins)	180
Final setting time (Mins)	240
Residue, 90 micronsieve (g)	0.25
Residue, 45 micronsieve (g)	0.76

Table3. Shows the result obtained from flame photometer for potassium

Sample	Absorbance	Concentration (PPM)	% weight/weight
Cement	0.004	0.229	0.488
High grade limestone	N.D	N.D	N.D
Mixed grad limestone	0.003	0.172	0.344
Laterite	0.004	0.229	0.458
Clay	0.002	0.113	0.226
Klin feed	0.003	0.172	0.344

Then concentrations of potassium (K) in each solution of the sample were obtained by extrapolation from the calibration curve for the standard solution of potassium prepared earlier using potassium chloride salt. For example the calculation of percentage weight per weight of potassium in laterite sample is as shown below:

$0.229ppm \longrightarrow 100cm^3$
$X \qquad 1000cm^3$

$$X = \frac{0.229ppm \times 1000\ cm^3}{100cm^3}$$

$$= \frac{2259ppm}{100}$$

$$= 2.29ppm$$

But 1ppm = 1mg/L
:. 2,29ppm = 2.29mg/L
Convert to g/L

$$\frac{2.29mg/L}{1000} = 0.00229g/L$$

$$\% \text{ wgt/wgt} = \frac{\text{weight obtained}}{\text{weight of the sample taken}} \times 100$$

$$= \frac{0.00229g \times 100}{0.5g}$$

= 0.458%

Table4. shows the result obtained from colorimeter for iron

Samples	**Absorbance**	**Concentration (ppm)**	**% weight/weight (%wt/wt)**
Cement	0.1005	0.4188	3.49
High grade limestone	N.D	N.D	N.D
Mixed grade limestone	0.0521	0.2172	1.81
Kiln feed	0.0706	0.2940	2.45

For example, the absorbance of iron in cement solution was 0.1005 which has a corresponding concentration of 0.4188ppm. The percentage weight per weight is give as

0.4188ppm → 100cm^3
X → 1000cm^3
X = 4.188ppm
1ppm = 1mg/L
4.188ppm = 4.188mg/L = 4.188 x 10^{-3}g/L

$$\% \text{ wgt/wgt} = \frac{4.188 \times 10^{-3} \times 100}{0.12}$$

= 3.49

Table 5. shows the result obtain from x-ray fluorescence method of the analysis

Parameter	**CEM %**	**HGLS**	**MGLS %**	**LAT %**	**CLY %**	**K.F %**
SiO_2	19.9701	0.7245	10.3701	35.2263	59.8512	13.9802
Al_2O_3	3.8702	0.1915	2.5427	18.0996	12.8301	3.2582
Fe_2O_3	3.4881	0.1326	1.7424	33.1373	16.5613	2.4534
CaO	56.7013	52.4922	44.6029	0.8373	0.5231	42.3796
MgO	1.9301	0.3780	0.7012	0	0	0.7262
SO_3	1.6520	0.0934	0.0682	0.0075	0	0.0785
K_2O	-	0.0579	0.2829	0.4412	0.1202	0.3238
Na_2O	-	0	0.1013	0	0	0.1058

KEY:

CEM	**CEMENT**
H.G.L.S	HIGH GRADE LIMESTONE
M.G.L.S	MIXED GRAD LIMESTONE
LAT	LATERITE
CLY	CLAY
K.F	KILN FEED

Table 6. shows the result obtained from the classical method of analysis (Gravimetric and titrimetric method)

PARAMETER	**CEM %**	**HGLS %**	**MGLS %**	**LAT %**	**CLY %**	**K.F**	**GYPSON %**
SiO_2	19.10	0.76	10.10	34.78	58.99	14.12	
A_2lO_3	3.51	0.22	2.70	17.58	12.55	3.28	
Fe_2O_3	3.23	0.15	1.72	32.80	16.45	2.48	
CaO	55.80	51.92	43.66	0.88	0.49	42.18	
MgO	1.80	0.45	0.91	0	0	0.63	
SO_3	1.57	0.11	0.07	0	0	0.08	42.56
I.R	1.5	0.50	0.50	1.00	1.00	1.50	
Cl	0.01	0.01	0.01	0.01	0.01	0.01	
L.O.I (loss on ignition)	8.72	42.99	36.95	10.00	10.00	35.35	
Moisture content	0	0.88	1.12	1.24	3.24	0	1.24

DISCUSION

SILICA (SiO_2)

British Standard specifies the amount of silica in a Portland cement to be within the range of 21% to 22%. It was observed that Dangote cement deviated from the British standard specification but was found to lie within the range of Neville, 1981 specification.

ALUMINA (Al_2O_3) AND IRON (Fe_2O_2)

British Standard specifies the amount of alumina to be 6% Dangote cement was found to be slightly below the specified limit. On the other hand the amount in iron in Dangote cement, was found to be within the range of 3.50% as was specified by British standard. If the lime content is fixed and the silica becomes too high which may be accompanied by a decrease in alumina and ferric oxide, the temperature of burning will be raised and the special influence of high lime will be lost. If the lime content is too low, which means an increase in the alumina and ferric oxide the cement may become quick setting and contain a large or some amount of alumina compound which appear to imposed little value for their cementing qualities, rapid setting is undesirable and is not permitted by the standard specifications, because the cement sets so rapidly that it cannot promptly be worked before stiffing occurs (Neville, 1996).

LIME (CaO)

British standard specify the amount of lime in a cement to be within the range of 63% to 67%. It was observed that Dangote cement deviate slightly from this specification. The proper lime content is limited due to low early strength produced when the lime content of Portland cement is too low and unsoundness when lime content is too high (Neville, 1996). High lime content is associate with early strength, whereas slightly low cement of lime favour ultimate strength which develops gradually over a long period of time. (Pandey and Shukla; 1980)

In other to increase the strength, it is necessary to raise the lime content or grind finer or by combining both. But this has its disadvantages in the sense that high temperature will be required to burn the high lime mixture, (Neville, 1996).

MAGNESSIUM OXIDE (MgO)

British standard specify the amount of MgO (magnesium) not be more than 2.0% it was found out that Dangote cement was within the specified limit. The limit of 2.0% is so given because a high magnesium contents may be detrimental to the soundness property of cement especially at late age. Beyond this limit, it will appear in clinker as free-magnessium (MgO) known as periclase. Periclase react with water to form $Mg(OH)_2$ which is the slowest reaction among all other hardening reactions. Since $Mg(OH)_2$ occupies a large volume that the MgO and is formed on the same spot where the periclase particle is located, it can split apart the binding of the hardened cement paste resulting into cracks commonly known as magnesium expansion (Austin, 1985 and Neville, 1996). There is no advantage of adding extra line unless it is brought into combination with other constituent. If appreciable amount of lime is left uncombined, it may cause an expansion which leads to cracking of mortar or concrete, (Neville, 1996).The amount of free lime in Dangote cement was found to be 0.88% which is within the range of not more than 2% that was specified by the Nigerian Industrial Standard (NIS).

SULPHURE TRIOXIDE (SO_3)

British standards specify maximum amount of SO_3 in a Portland cement to be 1.5%. Dangote cement was found to slightly, exceed this specification. To control the setting time effectively cement need's a minimum amount of calcium sulfate mostly in the form of gypsum that is added to clinker grinding. Similarly the maximum allowable SO_3 content in a cement to prevent sulphate expansion as established according to various cement standard was found to lie within the range of 1.5% and 2.5% (Austin, 1985 and Neville, 1996).

INSOLUBLE RESIDUE (IR)

Insoluble residue (IR) is a non-cementing material which exists in a Portland cement. This residue material affects the properties of cement, especially the compressive strength of cement. To control the non-cementing material in Portland cement to British standard allow insoluble residue content to a maximum limit of 1.5%. Dangote cement was found to be within this specified limit. Presence of insoluble residue in Portland cement affect the comprehensive strength of a cement mortar during the early age which eventually decreases as the cement get's older.

CHLORIDE (Cl)

British standard specify the maximum amount of chloride in a Portland cement not to exceed 0.02%. Dangote cement was found to be within this specification. The significance of high amount of chloride in a cement or concrete is the corrosion of the structure. The magnitude of this corrosion problem in the transport sector (bridge) has been found to increase significantly over the last three decades and this impose more danger on this sector as the cost required to maintain the affected structure is extremely high. (Hoff, 1985).

LOSS ON IGNITION (LOI)

There is no particular recommendation on specified percentage of loss on ignition limit in cem II type of Portland cement (i.e. cement with additives). But British standard specified a maximum loss on ignition limit of

4.0% for cem I type of Portland cement (i.e. cement without additives). A high LOI (Loss on Ignition) indicates prehydration and carbonation which may be caused by improper and prolong storage or adulteration of Portland cement during transport. The possible reason for an observed deviation of Dangote cement from British standard could be as a result of any of the following;

a. Specification or raw materials
b. Non uniformity of mixture
c. And finally impurities from various stages of process and internal alteration

CONCLUSION

From the results of this analysis and the comparison with the standards, it is clear that Dangote cement conformed to the Standard set by British Standard and Nigeria Industrial Standard. This shows that the performance of Dangote cement in both constructional and structural works will be very satisfactory. Hence, Dangote cement could be seen as a cement of very high quality.

RECOMMENDATION

We recommended that people should patronize cement because it is high quality. Also, further research work should be carry out on Dangote cement, such work should includes the determination of heavy metal constituent present in Dangote cement.

REFERENCES

American Society for testing and materials, section ASTMC 150 – 92

Austin, GT, (1985); "Shreve's Chemical Process Industries", 5th ed McGraw Hill Book Company Singapore, pp. 135

Bririn – Yauri U.A (1993) Chloride in Cement, Study of the System CaO – Al_2O_3 – H_2O Ph.D Thesis submitted to the Department of Chemistry, University of Aberdeen, Scotland (UK) pp. 14 – 18.

Bougault H. and Cambon, P. (1973); Disperse X – ray fluorescence analysis on Board oceanographic vessles, Mar Geol Ltd, pp 37 – 41

Bougue, R.H (1995); "The chemistry of Portland cement" 2nd ed. Reinhold Publishing Corp, New York.

Jenkin, (1988); "Ron X – Ray fluorescence Spectrometry, John Wiley and Sons publishers New York, pp 51 – 53, 78 – 83, 87.

Neville, A.M. (1996); "Concrete technology", 4th Longman Ed Publishers Ltd, pp 20 – 21

Neville, A.M. (1981); "Properties of Concrete" 3rd Ed. Pitman Publishers Ltd London, pp 1 – 61

NIS 445: (2003); Methods of testing cement, chemical analysis of cement

NIS 368: (1996); Methods testing cement, chemical analysis of cement

Pandey G.N. and Shukla, S.D (1980); "A textbook of chemical technology Vol. 1 Vikas publishing House, New Delhi.

Sandel E.B. (1959); Colorimetric determination of trace of metals, 3rd ed. Interscience Publishers Inco. New York