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Quality Assessment of Copper Wire Samples Used for Conduit wiring in Maiduguri Borno State, Nigeria

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Abstract: *This study is on assessment of Copper wire samples used for conduit wiring in Maiduguri Borno state, Nigeria. Five (5) copper wire samples of different dimensions i.e. 1.5mm, 2.5mm, 4mm, 6mm and 10mm were analyzed. The samples were collected from Babanlaye electrical stores within Maiduguri Borno state. The concentrations in % of copper (Cu), aluminium (Al), lead (Pb), and iron (Fe) in some copper wire samples were determined using AAS machine. Cu in 1.5 mm diameter from sample A and Fe in 2.5 mm from sample B were significantly higher in the wire samples observed with percentages of 69 % and 59% respectively. While Fe in 1.5 mm from sample A has the least percentages of 2 %. The trend in the concentration of metals in % in the samples is* Cu > Fe > Pb > Al. *The study revealed that, the percentages of Cu and the alloyed metals detected in the electrical wire samples were not within the IACS permissible limit.*

Keyword: *Copper wire, metals, maiduguri, percentage, dimension*

INTRODUCTION

Copper with symbol Cu is brownish-red element that is one of the most widely used metals. Copper is one of the transition elements of the periodic table. The atomic numbers of Cu is 29 (Sawyer, 2009)

Copper was known to prehistoric people and was probably the first metal from which useful articles were made. Copper objects have been found among the remains of many ancient civilizations including those of Egypt, China, South Eastern Europe, Cyprus (from where the word copper is derived), and Crete (Kriti). It was known to Native Americans, and American ores were found by the European explorers. It is found in pure state (Horace, 2010).

Copper was one of the first metals to be used by man for making tools. During the bronze age. Cu was mixed with iron to fashion implements of bronze. Since the industrial revolution, one of the most popular uses is manufacture of copper wires (Allan, 1990).

Of its many desirable properties such as its conductivity of electricity and heat, its resistance to corrosion, copper has long been used in a wide variety of applications. The principal used are electricity (Anyakoha, 2010).

An electrical conduit is an electrical piping system for protection and rotting of electrical wiring. In order to obtain the required properties unalloyed high purity Cu is almost always used. Purity value for Cu wires according to the international electro-technical commission (IEC) is 99-99.9%. International electro-technical commissions (IEC) (2020) regard copper wire as the best wire use in electrical conduit wiring. This means that Cu provides more current carrying capacity for a given diameter of wire than any other engineering metal. Today, Cu conductors used in building wire actually have a conductivity rating of 100^{o}C or better, base on the international annealed copper standard (IACS) (Armstrong, 2002). During a copper shortage in 1970s aluminum was substituted in many applications but improper design caused fire accident (Gilchrist, 1989).

Gilchrist, (1989) reported that, in 2007, the number of reported fires in United Kingston homes started by accident was over 43,000. Of these accidents however 19% were caused by electrical faults while a further 25% were caused by people not using electrical equipment and appliances. Atsuya, (2004) a Japanese analyzed and determines the percentage of Cu in aluminum alloys using AAS to run the analysis 0.003% of Cu was found in aluminum alloys which did not affect the good linearity calibration curve.

The problem of fire disaster have become order of the day. This is as a result of low quality copper wires and cables. BBC News 13th January, (2013) fire disaster this January claims many lives and properties worth millions of naira.65% of the fire disasters are connected with electrical faults. According to the BBC report, the fire accident occurred in Jinkara market in Lagos state, in Otta farm in Ogun state, which is in Olesegun Obasonjo's house and also in the INEC headquarters in Abuja and many other places January 2013 alone.

Daily trust, 5th November, (2012) reported that, the director of enforcement of standard organization of Nigeria (Son) Louis Njoku, when briefing journalist in Onitsha, Anambra state that, the standard organization of Nigeria impounded sub-standard cables and wires in Onitsha market worth over 15 million naira. He said that, the electrical cables and wires were made of Iron instead of Cu, adding that Cu was the type of metal use for production of quality wires and cables. He said such fake products were the cause of electrical faults responsible for most fire disasters.

Dairly trust, (2012) John Achukwu, the director, testing services SON said that, cables and wires that are magnetic were fake as they would heat up when electric current flowed through them. And Cu cables and wires were not magnetic and could not heat under

current flow. The standard for the production of electric wires and cables is 99.9% copper. Such fake products of electric wires were the cause of electrical faults responsible for most fire disasters in the north east region and Nigeria in general.

This is the motive for investigating the copper wire samples used for conduit wiring in northeaster Nigeria to ascertain whether or not the concentrations are within the international standards

MATERIALS AND METHODS

Sample Collection for Copper wire samples Analysis

From a brand of a manufacturing company, five wires of different dimensions i.e. 1.5mm, 2.5mm, 4mm, 6mm and 10mm were analyzed. The samples were collected from babanlaye electrical stores within Maiduguri Borno states. The samples were marked, A, D C D and E according to their manufacturers. Therefore, copper wires from five (5) dimensions from a manufacturing company were labelled and used for the study

Table 3.1: Sampling dimensions and codes of copper wires in (mm)

Dimension of wires in (mm)	Sampling Codes
1.5 mm	A
2.5 mm	B
4 mm	C
6 mm	D
10 mm	E

Table 2.1: Sampling locations and dimensions of Copper wires in mm

SAMPLES	DIMENSION OF WIRES IN (mm)				
	1.5	2.5	4	6	10
A					
B					
C					
D					
E					

Wire samples from electrical stores or manufacture and from difference dimensions was collected in order to determining the quantitative and qualitative analysis The sample wires collected were labeled differently (Yan, 2003).

An amount of 0.5g each of the sample wires were weighed separately. Each amount was placed in to 250ml beaker and then dissolved in 10ml of Nitric acid ($HN0_3$). Each of the flasks was gently warmed in a hood to dissolve the Cu wires completely. A watch glass is placed over the beaker. The solution was then diluted with 25ml distilled water and then transferred quantitatively to 50ml volumetric flask and diluted to mark) (Harris, 1995. In this work a wet digestion technique was adopted. (Harris, 1995). A blank was also prepared without sample being added. The solutions were used to investigate the presence of some metallic impurities to determine the percentage of Cu, Fe,, Pb Al in each sample using the atomic absorption spectrophotometer (AAS) and to determine the presence of Cu, Fe,, Pb, Al, etc in each sample by qualitative analysis (Hogness, 1991).

Table 3.1: IEC and IACS Standard Values on Copper Wires 2020) and (2002)

Cu%	**Zn,Mn,Fe,Pb,Al**	**Resistivity at 20^0c**	**Electrical conductivity at 20^0c**	**Density**
99.9% - 100%	0.0021	$1.68\text{-}1.78\times10^{-8}$ Ωm	$5.2\text{-}5.8108\times10^{7}$ Ωm	8.8-8.96gm/cm^3

Adopted to IEC and IACS (2002)

Table 3.2: SON Standard Values on Copper Wires

Cu%	**Alloys**	**Resistivity at 20^0c**	**Electrical conductivity at 20^0c**	**Density**
99.9%	0.0021	1.68×10^{-8} Ωm	5.2×10^{7} Ωm	8.8gm/46 %cm^3

Adopted to Son ( )

RESULTS AND DISCUSSION

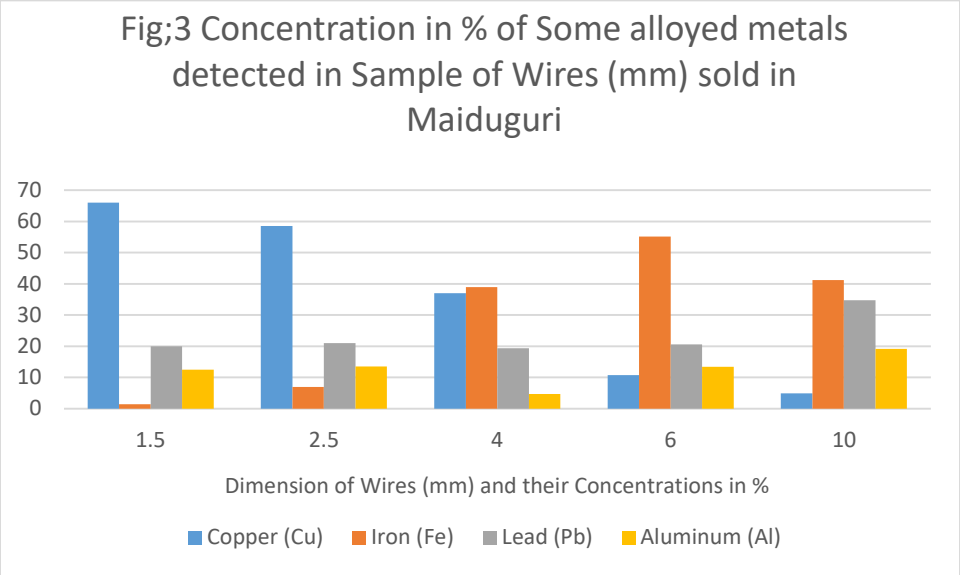

Figure ;3 above shows the percentages of some metals detected in 1.5 mm diameter, 2.5 mm, 4 mm, 6 mm and 10 mm diameters of copper wire samples sold in Maiduguri Borno state. The results indicated that, the percentage of copper (Cu) in sample A i.e 1.5 mm diameter is 69 %, in B i.e 2.5 mm is 59 %, in C i.e 4 mm is 48 %, in sample C i.e 6 mm is 40 % and in sample E i.e 10 mm diameter is 15 % respectively. The results shows that the percentage of copper (Cu) in 1.5 mm diameter sample were found to be highest with the percentage of 69 %. Whilst the least is found in iron (Fe) with the percentage of 2 % in sample 1.5 mm diameter wire. The result has this trend; Cu > Fe > Pb > Al. Copper supposed to be the major component 99'9 % and iron supposed to be 0.0021 % in the samples (IACS, 2002). Because Fe and other metals are cheaper than Cu, so the manufacturers alloyed them in the wires. This was comparable with the research carried out by Armstrong, (2002) who detected high concentration of Fe and other alloyed metals in a sample. This was supported by SON, (2012) detected significant amounts of Fe and other alloyed metals using bar magnet to identify magnetic wires contain Fe and other alloyed metals while nonmagnetic ones contain Cu in a sample. Gilchrist, 1989) during a copper shortage in 1970s aluminum was substituted in many applications but improper design caused fire accident (IACS, (2002). 65% of fire disasters are connected with electrical faults caused by low quality wires. This results is not within the international standard of 99.9 % copper (IACS, 2002) and (IEC, 2020).

SUMMARY AND CONCLUSION

The results of the percentage of copper wire samples of the locations obtained generally shows the following trend; Cu > Fe > Pb > Al. The percentages of Cu was predominately higher in the samples though, is still negligible. Copper supposed to be the main component

of electrical wires and cables because it possess all the electrical properties such as corrosion resistant, ductility, resists stretching neck down, creep nicks and breaks resistant .Coppers exceptional strength compared to aluminum conduction is another reason it has remained the conductor of choice in wiring system (Horrace, 2010).But because copper is expensive, the manufacturers prefer to alloy the wires with cheap metals making the wires substandard.

These results indicated, that, electrical wires sold in Maiduguri borno state were not within the international standard of 99.9 % copper and 0.0021 % of alloyed metals in all copper wires (IACS, 2002) and (IEC, 2020) . And so such fake products were the cause of electrical faults responsible for most fire disasters.

REFERENCE

Allan, P (1990). Metallurgy of Copper in Aluminium.Copper hand Book.Mcgraw hill, Sanfransisco, pp. 30 – 40

Anyakoha, M, W (2010). Electricity and Magnetism: New school Physics.African first publishers. Ibadan, Nigeria, pp79 – 81

Armstrong,P (2002).Some observations on the electrical conductivity of commercial electro- refined Copper, journal of the institute of metals, vol. 100:pp. 125- 130

Astuya, I (2004).Metallurgy of Copper and Nickel. Transition of the Metallurgical society of ATME, pp. 236 – 361

BBC News (2013). Nigeria and fire disaster January 2013. Retrieved On 20th February, 2013 from news.bbc.co.uk/2/hi/8506369

Daily independent (27th dec. 2010). Nigeria:Electrical fults, causes Of major fire disasters in Niger.Retrieved on line 6th oct. 2012 African global media;http// www.africa .com.

Daily Trust (30th November 2012). Son impounds wires and cables Worth 15 million naira.Retrieved on line 15th dec. 2012 from http//www.news.daily trust.com/index content and view art icle=16388.

Gilchrist, D (1989).Extraction metallurgy, 3rd ed, pergamon press Headington Hill hall, oxford OBW,England

Hogness, B (1983). High Conductivity Copper Alloy Wire (Cu, Fe, Pb) Soc.Chem.Ind.Vol. 50,pp55-57.

Horrace, P (2010). The Metallurgy of Copper wire HM Wire Intenat

Ional, Inc.online www.hm Wire.com Retrieved, 2012.

IACS, (2022).Hand book, part 3 of international anneal copper standard. Pp 6 - 20

IEC, (2020). Handbook, part 7, International electro technical

Commission, warrendale, PA, Table 11- 3.

Sawyer, B (2009). Chemistry Experiments for Instrumental.

Walls, Ltd, pp.242-253.

Skoog W.H (1996). Determination of Copper by Atomic Absorption

Spectrophotometry.Fundamentals of Analytical Chemistry,

London, Chapman Ltd, pp, 614 – 638.

Wisner, R (2001).Qualitative analysis and ionic equilibrium. Qualitative analysis

Of cations.New York, USA macmillian.PP, 20 - 40