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A Survey of Electrical Materials Counterfeiting in Bayelsa State: A Case Study of Yenagoa Local Government Area

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ABSTRACT

Electrical cables are the bedrock of every electrical wiring and installation. In this study, some essential cable properties (size, electrical resistivity and flame retardant) of electrical cables sold in Bayelsa state were determined according to NIS-approved methods. Four commonly used electrical cables (1 mm^2, 1.5 mm^2, 2.5 mm^{2,} and 4 mm^2) in Bayelsa State were sampled. Results obtained showed that most of the electrical cables sold within the Yenagoa metropolis fell below International Standards. Only 58% of the 1 mm^2, 43% of the 1.5 mm^2, 62% of the 2.5 mm^2 and 46% of the 4 mm^2 cables met the NIS recommended sizes. For electrical resistivity, most of the cables failed to meet the NIS recommendations. The resistivity of 45% of the 1 mm^2 sampled cable, 39% of 1.5 mm^2, 52% of the 2.5 mm^2 and 33% of the 4 mm^2 sampled cable were above the maximum limits approved by the Nigeria Industrial Standard. High resistivity observed in these cables can lead to electrical fire due to temperature buildup within the cable. Most of the cable insulators were made from good fire retarding materials. 92% of the 1 mm^2, 93% of the 1.5 mm^2, 89% of the 2.5 mm^2 and 87% of the 4 mm^2 cable insulators had flame retarding characteristics. Results from this study can be used as a guide by standard regulatory agencies to monitor the sales of electrical cables in the state since most of the cables sampled in this study fell below National and International standards.

Keywords: Electrical cables, electrical fire, electrical resistivity, fire retardant, standards

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INTRODUCTION

Electrical cables and wires are made from metallic conductors mostly copper, aluminum or silver. Since silver is an expensive metal, copper and aluminum are widely used in producing electrical wires and cables (Stauart et al., 2000). Copper electrical cables are of superior quality, compared to aluminum electrical cables because; they have smaller resistivity and better electrical conductivity than aluminum cables. Copper had a resistivity of 17.51Ω mm, while aluminum has a resistivity of 28.51Ωm; affirming that in normal condition, copper will permit the flow of electrical current better than aluminum. But in special cases when weight is a factor to be considered (mostly in transmission and distribution lines), aluminum cables are preferred due to their lightweight. Cables use for household electrical wiring are usually coated with insulating materials to prevent electrical shocks (Adetoro, 2012; Cable Jointer, 2019). According to Adetoro (2012), electrical cable has four major components which are: the metallic conductor, insulating material, mechanical protection and filler materials (which are absent in some electrical cables). All these components must adhere to national or international standards before the cable can be certified by the Standard Organization of Nigeria (SON). Polyvinyl chloride (PVC) is the commonly used insulating material in cable production due to its fire and high-temperature resistivity, good tensile properties, high durability and chemical resistivity (Omnexus, 2018).

Eze (2017); Onyekachi and Nduka (2019) had shown that Nigeria is flooded with counterfeit and substandard electrical materials. Apart from the poor metallic conductor used in the production of these substandard cables, their insulating materials fall short of NIS: 172 standards.

Figure 1: Map of Yenagoa, Bayelsa state. Source: Google map (2020).

According to Steward et al. (1998) the insulating material of every electrical cable must withstand the applied voltage and thwart current leakages in odd directions; hence minimizing the menace of electrical fire and electrocution. According to SON, there is a high proportion of substandard electrical materials in the country, which had led to electrical disasters in residential and commercial buildings; thereby destroying lives and properties (Agbakwuru, 2019). The greatest damages caused by the utilization of counterfeit electrical materials in the electrical installation are loss of properties and electrocutions (Schneider Electric, 2015). According to Schneider Electric (2015), China is the highest exporter (34%) of counterfeit electrical materials to Africa; India and the rest of Asia countries exported 31% of counterfeit materials to Africa; while 18% of these counterfeit materials are produced within Africa countries. Amaechi (2014) stated that a market survey is one of the best methods of checking substandard electrical materials in Nigeria.

This is because, since Nigeria's borders are very porous these materials can easily flow into Nigeria's markets. Additionally, Schneider Electric (2015) reported that Nigeria is the leading manufacturer of counterfeit materials in Africa and the volume of counterfeit electrical materials manufactured in Nigeria is higher than those imported from Singapore, Japan and Thailand.

Nigeria's government just like other Africa countries had adopted various strategies in combating the menace of counterfeit and substandard electrical products across their countries. The Standard Organization of Nigeria and other sister agencies have located and destroyed tons of electrical materials across the country within the last decade.

In 2012, SON made a major breakthrough by seizing counterfeit electrical cables worth over 800 million naira at that time in Lagos State, the economic hub of Nigeria (Onwumere, 2014).

The success of these regulatory agencies hinges on relevant information received from the public and appropriate research work. Although some studies have been done to evaluate the qualities of electrical cables and wires in the Nigerian market; there is no recorded literature on the qualities of electrical cables in Bayelsa state markets. Therefore, this study was done to investigate the qualities of small sizes electrical cables sold in Bayelsa state markets.

MATERIAL AND METHODS

Study Area

This study was conducted within Yenagoa Local Government Area (LGA) of Bayelsa State, Nigeria (Figure 1). Yenagoa is the Capital of Bayelsa state, with an average population of 352,285 people and a landmass of area of 706 km², according to the 2006 National population census (NPC, 2006). Yenagoa is one of the few upland regions in the state with large human population, and it is called “Little London” by the rural dwellers. Apart from being the administrative capital, it is the economic hub of the state, as almost all the major markets in the state are located within the Yenagoa LGA. There are a total of 21 sub-communities within Yenagoa LGA, namely: Yenagoa, Igbogene, Akenfa, Yenegwe, Etegwe, Edepie, Agudama, Kpansia, Akenpai, Okutukutu, Opolo, Biogbolo, Yenizue-Gene, Yenizue-Epie, Okaka, Azikoro, Ekeki, Amarata, Onopa, Swali and Ovom.

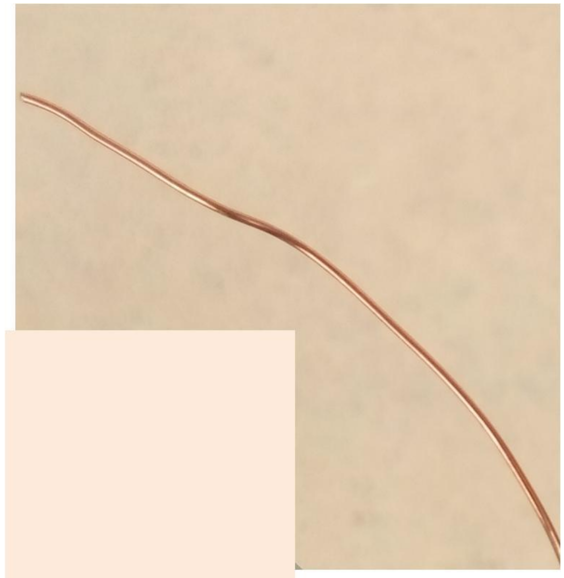

Figure 2: An exposed cable metallic conductor.

Conurbation had occurred among all these communities; hence, all the area is usually referred to as "Yenagoa"

Research Design and Data Collection

The research designs adopted for this study were qualitative analysis and descriptive research methods. The 1mm^2, 1.5mm^2, 2.5mm^2 and 4mm^2 electrical cables evaluated in this study were procured from 10 major electrical shops within Yenagoa LGA. These cable sizes were selected because they are the most commonly used electrical cables in electrical wiring and installations. For each electrical shop, four (2 m length) samples of each cable size were collected for laboratory tests.

Laboratory Tests

All the laboratory tests were carried out in accordance with the procedures approved by the Institute of Electric and Electronics Engineers (IEEE 400, 2012) and Nigeria Industrial Standard (NIS).

Determination of Cable Size

The diameter of the cable core was measured using a digital micrometer screw gauge, with an accuracy of 0.001 mm. This (diameter) measured was done after peeling the insulator from the cable to expose the metallic conductor (Figure 2). Then the area of the cable core was calculated using the expression presented in Equation 1.

$$Area = \frac{\pi d^2}{4} \qquad (1)$$

Flame Retardant Test

The combustive approach was adopted. The insulator was peeled off the electrical cable, and set on fire with the aid of a gaslighter. Any cable insulator that burns vigorously after the gaslighter had been removed is considered as having poor flame retarding ability. Then any cable insulator that extinguishes (cease to burn) after the gaslighter had been removed is considered as having good flame retarding ability.

Cable Resistivity

The resistance of the electrical cable core was measured using standard instruments and the resistivity was calculated using the expression provided in Equation 2.

$$\text{Resistively}(\rho) = \frac{RA}{l} \qquad (2)$$

Where R = measured resistance of the electric cable core
d = Measured diameter of the electric cable core
l = measured the length of the electric cable core.

Statistical Analysis

The results obtained were statistically analyzed using the MS Excel 2015 (Microsoft Corporation Redmond, WA 98052). The summary of the readings was plotted using Microsoft Excel 2015.

RESULTS AND DISCUSSION

Cables Sizes

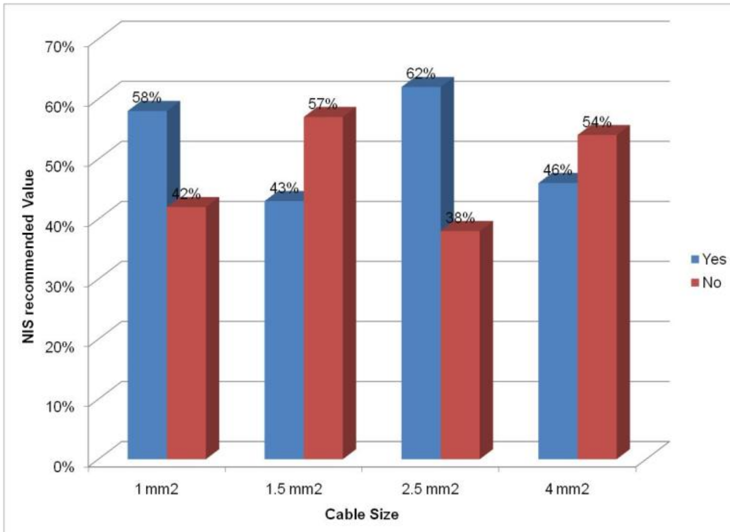

Figure 3: Average size of the sampled electrical cables.

The results of the cable sizes sampled in this study are shown in Figure 3. Out of the cables sizes (1 mm^2, 1.5 mm^2, 2.5 mm^2 and 4 mm^2) sampled, none of them wholly met the NIS: 172 recommendations for electrical cables. This study showed that only 58% of the 1 mm^2 cable, 43% of the 1.5 mm^2 cables, 62% of the 2.5 mm^2 cables and 46% of the 4 mm^2 cables met the NIS recommended sizes for electrical cables. This portrayed that 42% of the 1 mm^2 cable, 57% of the 1.5 mm^2 cables, 38% of the 2.5 mm^2 cables and 54% of the 4 mm^2 cables were either substandard or counterfeit. According to the Nigerian Industrial Standard (NIS) specifications; the core diameter of the 1mm^2, 1.5mm^2, 2.5mm^2 and 4mm^2 of copper cables must not have core diameter smaller than 1.30 mm, 1.38 mm, 1.78 mm and 2.23 mm respectively. The study result showed that1.5 mm^2 and 4 mm^2 cables recorded the higher percentages of the cables that fell short of the NIS recommended sizes for electrical cables. This could be attributed to either their high demand for electrical works in the area or the higher influx of these counterfeit cables into the region (Bayelsa State). A similar high influx of substandard 1.5 mm^2 and 4 mm^2 cables into Abia, Kano and Rivers state were earlier reported by Onyekachi and Nduka (2019). Although the volume of 1 mm^2 and 1.5 mm^2 cables within the capital city is above 50%, the remaining substandard cables within the State capital can play a significant role in causing electrical disasters within the state. This is because, most of the electrical materials shops located inside Bayelsa State are in the rural areas and the purchases buy their stocks from these major electrical stores located within the State capital.

Cable Resistivity

The mean results of the four sampled cables are shown in Figure 4. Comparing the results with the standard values recommended by NIS revealed that most of the cables failed to meet the NIS recommendations. NIS recommended that the resistivity of 1mm^2, 1.5 mm^2 and 2.5 mm^2 cables must fall below 2.15 X 10^{-7} Ωmm, 2.0 X 10^{-7}Ωmm and 1.85 X 10^{-7}Ωmm (Adetoro, 2012). As presented in Figure 4, the resistivity of 45% of the 1 mm^2 sampled cable, 39% of the 1.5 mm^2 sampled cable, 52% of the 2.5 mm^2 sampled cable and 33% of the 4 mm^2 sampled cable were above the maximum limits approved by the Nigeria Industrial Standard. This indicated that most of the cables had higher electrical resistances, despite their smaller size areas.

Electrical resistivity is one of the critical factors that are used to determine the standard of electrical cables. The Standard Organization of Nigeria stated that poor electrical cables usually have very high electrical resistivity. This high electrical resistivity, coupled with the smaller sizes of the cables can lead to heat buildup within the cable (Adekoya, 2019). It had been established that cable with high resistance and resistivity had three major limitations which are: drastic voltage decline across the cable length, which will affect the operation of the electrical equipment connected to it; if the resistance of the electrical equipment is fairly small, additional resistance of cable becomes hazardous to the equipment; the cable becomes easily heated up by the current due to the high resistance, and if the temperature continues to rise, at a point the cable becomes too hot and melt creating an electrical fire (Electrical Engineering, 2020).

Fire Retardant

Figure 5 showed that most of the cable insulating materials were made from non-combustible materials. According to the results, 92% of the 1 mm^{2}cable, 93% of the 1.5 mm^2 cables, 89% of the 2.5 mm^2 cables and 87%

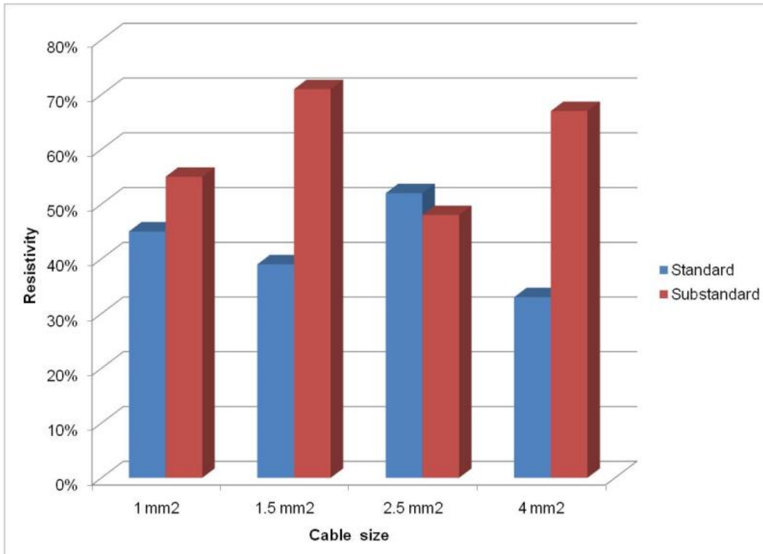

Figure 4: Average resistivity of the sampled electrical cables.

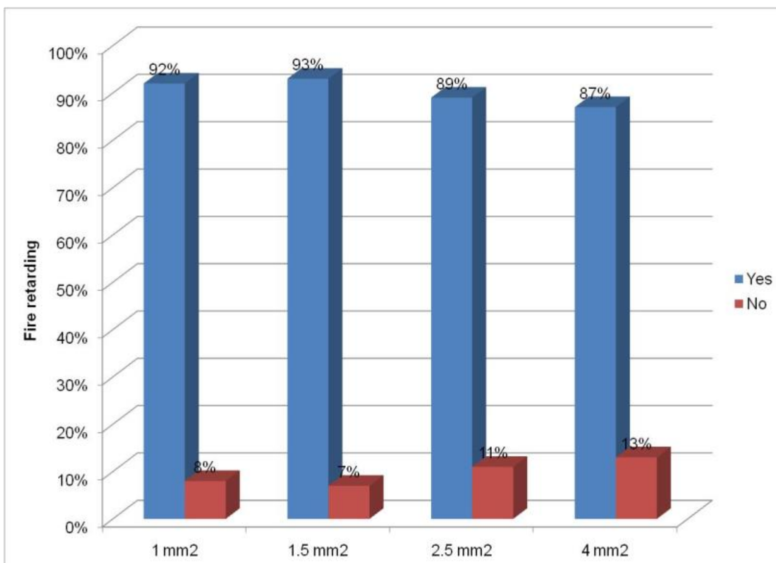

Figure 5: Average fire retardant of the sampled electrical cables.

of the 4 mm^2 cable insulators had flame retarding characteristics. This showed that only a few percent 8% of the 1mm^2 cable, 7% of the 1.5 mm^2 cables, 11% of the 2.5 mm^2 cables and 13% of the 4mm^2 cables failed to meet the NIS recommendation. As recommended by NIS 170: 1983, electric cables must have fire retarding characteristics. It is essential for electric cables and wires to resist fire, to minimize the spread of electrical fire, resulting in electrical sparks. Apart from the electrical resistivity of cables, other standards that are used to judge electric cables are the tensile strength of the metallic conductor and the insulator, the fire-retarding capacity of the insulator, operating temperature and thickness of the insulator as stated by NIS 170: 1983. Schneider Electric (2015) reported that although Nigeria is trying its best to combat the counterfeiting of electrical materials; the rate of counterfeiting is too high that arrests the culprits, and destroying the fake materials cannot put a stop to it. This study had shown that a lot had to be done, in containing the menace of counterfeit and substandard electrical materials in Nigeria.

Conclusion

Results obtained from the size and resistivity tests revealed that most of the cables were not in conformity with NIS recommendations. Also, the study revealed that most of the cable insulating materials had good fire retarding properties. The high resistivity observed in the cables can lead to an electrical fire, through the high-temperature buildup within the cable. Results obtained from this study will be useful to the Nigeria standard regulatory agencies in monitoring the qualities of electrical materials sold in Southern Nigeria if they comply with National standards. This will help to minimize the occurrence of electrical tragedies occurring in the country.

REFERENCES

Adetoro AK (2012). Assessment of the quality of cables produced in Nigeria. Global Advan. Res. J. Eng. Technol. Innov., 1(4): 097-102.

Agbakwuru J (2019). Nigerian markets flooded with counterfeit goods – Buhari. https://www.vanguardngr.com/2019/09/nigerian-markets-flooded-with-counterfeit-goods-buhari/(Accessed 5 July 2020)

Amaechi CV (2014). Standards as tools for durable infrastructures in Nigeria. Conference paper presented at Nigeria society of Engineers (NSE) monthly general meeting.

https://www.academia.edu/33028473/standards_as_tools_for_durable_infrastructures_in_nigeria

Cable Jointer (2019). Electrical Wiring Components and Accessories. https://ncert.nic.in/vocational/pdf/kvcj103.pdf(Accessed 9 July 2020).

Electrical Engineering (2020). Resistance of wire. Available online at: https://electronics.stackexchange.com/questions/477904/resistance-of-wire. (Accessed 5 July 2020)

Eze J (2017). Ending influx of substandard cables in Nigeria. Thisday Business News. https://www.thisdaylive.com/index. (Accessed 5 July 2020)

IEEE 400 (2012). Guide for Field Testing and Evaluation of Electrical Cables. Cable Testing Standards. https://www.ieeexplore.ieee.org/document/6213052 (Accessed 5 July 2020)

National Population Census-NPC (2006). Bayelsa State Population Census, National Population Census, Federal Republic of Nigeria.

Omnexus (2018). Comprehensive Guide on Polyvinyl Chloride (PVC). https://omnexus.specialchem.com/selection-guide/polyvinyl-chloride-pvc-plastic(Accessed 5 July 2020)

Onwumere O (2014). Africa a dumping ground for substandard electrical wares. Available online at: https://www.esi-africa.com/top-stories/africa-a-dumping-ground-for-substandard-electrical-wares/(Accessed 5 July 2020)

Onyekachi EM, Nduka NB (2019). Empirical analysis of core diameter and insulation thickness of house wiring and installation cables in Nigeria. Int. J. Adv. Res. Sci. Eng. Technol., 6(9): 10689 – 10694.

Schneider Electric (2015). Survey on Electrical Counterfeiting in Africa. Available online at: http://www.apo-mail.org/150322.pdf(Accessed 5 July 2020)

Stauart RO, Ball KA, Charles ST (2000). Electrical Wiring and Installation. Oxford University Press: 16 – 84.

Steward WE, Stubbs TA, Williams FO (1998). Modern Wiring practice. Oxford University Press.pp.268 – 283.