Causes and Modeling of Power Losses On Electric Power Distributors And Its Effects On Household Appliances In The Nigerian Power Distribution Network

France O. Akpojedje

Department of Electrical/Electronic Engineering Technology, National Institute of Construction Technology, Uromi, Nigeria.

Abstract

Power losses and voltage variations are very common with Nigerian electric power distribution network today. The effects of power losses and voltage fluctuations (variations) have become source of concern to the end users because voltage variations can cause damage to their electrical and electronics appliances both at homes and offices which has led to the use of various voltage protection system currently in Nigeria. This notion is true to an extent for electrical and electronics appliances that actually respond to voltage broadening negatively. Therefore, this paper aims at x-raying the causes and modeling of power losses on electric power distributors and its associated effects on households and offices appliances in the Nigerian electric power distribution network.

Keywords: Distribution network, Distributors, Household and office appliances**,** Power losses, Parametric modeling, Voltage variations.

1.0 INTRODUCTION

"Electricity plays a vital role in maintaining a healthy and successful society" [1]. The existing electric grid can no longer support the twenty - first century demands and the growing population [2], yet there are still high power losses and voltage variations (fluctuations) in the grid today, especially the distribution network. The widening gap between energy demanded and supply in day-to-day Nigerian electrical power distribution network is as a result of constant growth in demand of electrical power against electrical power supply in the Nigerian power sector. As at today, the existing utility facilities are ageing and they are being overstretched due to increase in loads without commensurate improvement and overhauling of the power network facilities to match the increasing loads for several past decades to improve consumers' satisfaction and reliability.

The existing Nigerian electric power distribution network facilities have been overstretched due to constant growth in energy demand by consumers. As the demand for electric power grows, so does the expectation of the consumers for reliable electric services increase; but this expectation of Nigerian utilities consumers have been dashed due to erratic power supply they experience often. The epileptic nature of the power supply in Nigeria power sector has been a recurring decimal for several past decades, despite several reforms the Nigeria government has embarked on. The Nigerian power system is still been characterized with erratic, inadequate and inefficient power supply, voltage drop, undervoltage and high power losses, especially in the distribution network [3&4].

"The losses in transmission and distribution lines represent a significant proportion of power loss in both developed and developing countries" [4]. According to Anumaka [5], "The Nigerian electricity grid has a large proportion of transmission and distribution losses - whopping 40%" which is a far cry as "compared to world average of less than 15%" [6]. Furthermore, according to Zafar [7], "Distribution network is considered as the weakest link in the entire power system, since the distribution losses is approximately 50%." "This high distribution losses are visible in the Nigerian distribution network due to excessive voltage drop, power losses, undervoltage and unregulated voltage fluctuations at consumers point on Nigeria power distribution network" [4]. The issues of power loss is not new in the Nigerian power sector and also, several researches and publications have been made on the said issues but the recurring decimal of the power losses and increase of the losses on the distributors as well as sparks occurring due to bridges of distributors and its effects on household and offices appliances has become a source of concern to Nigerian power engineers. The incessant fire outbreak at homes, frequent burning of homes appliances and sparks on the distributors when interrupted power supply is being restored in the

Nigerian power distribution network have become worrisome and bothersome as they create serious source of concern when these faults become recurrent in the system. Consequently, this research work aims at x-raying the causes and modeling of power losses on power distributors and its effects on household appliances in the Nigerian power distribution network.

1.1 CAUSES OF POWER LOSS ON ELECTRIC POWER DISTRIBUTORS

"Voltage irregularities is one of the greatest problem bedeviling electrical power system; especially the distribution network" [4]. One of the major causes of voltage irregularities is the power loss in the distributors of the network; Voltage drop and overloading are not exceptional. The following discuss the common causes of power loss on the Nigerian electric power distributors of the distribution network:

i. **Lengthy Distribution lines [4]:** One of the major sources of power losses on the distributors is the length at which the distributors feed their service main cable. They extend at a longer distance to distribute energy to consumers from substation. "Distribution lines in Nigerian electric power system have been characterized with haphazard connections and they are extended over a longer distance to feed load scattered over large areas" [4]. "The 11kV and 415volts lines in rural areas are practically extended over long distances and the primary and secondary distribution lines in rural areas are largely and radially laid over a long distance" [8]. "A long line will have a higher resistance, resulting to larger losses in the system. This is because the longer the line, the larger the resistance of the system" [4].

ii. **Haphazard Connections of Service Cables:** In Nigeria power distribution network today, the service cables are connected or tapped from the distributors haphazardly to the consumers' meters. And this is characterized with undersized and oversized cables with whimsical load connections to the distributors. This unregulated and unprofessional use of both undersized and oversized service cables to connect all manner of loads to the distributors has caused high power losses on the distributors of Nigerian distribution network.

iii. **Improper Spacing of Distributors:** The indiscriminate use of spacers in power distribution network lines cannot be overemphasized. Spacers are used in the distribution network to separate the distributors line from bridging and also, damp oscillation during wind period. Spacers dampers as it is sometimes called has a key function of keeping the distributors from bridging in a three phase, four - wire system. The spacing devices are used on three phase, four wire system to maintain sub-conductor separation and for distributing the damping effect along the spans. There are various types of spacers in the market today and their functions are similar. Presently, Nigeria power distribution network is faced with lack or inadequate use of spacers on the distributors and this has brought about bridged of distributors during wind period and when interrupted power is being restored. This has resulted to sparks, flashpoints and flashover in the distributors, thereby resulting to heating up of the conductors. Consequently, this has led to high power losses and breakability of the distributors which the network linesmen experience often today.

iv. **Low Power Factor of Distribution Network:** In most of the low tension (LT) distribution circuits, low power factor is experienced in Nigeria power system [4]. Normally, the power factor of most LT distribution circuits ranges from 0.65 to 0.75 [8]. "This low power factor is caused by nonlinear loads in the system" [4]. "A low power factor contributes towards high distribution losses" [8]. According to Pabla, [9], "The overall power factor of a system is likely below 0.7 lagging, unless corrective measures are taken to improve it." Also, according to Adejumbi and Adebisi [10], "The assumed power factor for the distribution system is 0.7 and the distribution losses account for the bulk of power system losses". Consequently, "The operation of power distribution network at

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low power factor is highly uneconomical to electric power consumers as well as the supplier (utility companies) [11]. For a given system, if the power factor is low, the current draw-in is high and the losses is proportional to the square of the current will be more [8]. Consequently, high power losses in the distributors is as a result of low power factor of the distribution network.

v. **Neutral Failure:** Neutral is the returning path for current in a single phase of four wire system of a distribution network and is connected to the earth or grounded from the common point of a star (Y) connections. The effects of neutral failure or broken neutral conductor on voltage sag and swell (fluctuations) cannot be underestimated in distribution network. A loss of neutral or broken neutral conductor on a three phase distribution transformer will cause the single phase voltage to float up to the line voltage depending on the load balancing on the network [12], and as well as the voltage can drop to a very low value too. This type of fault condition may cause damage to the consumers' equipment connected to the supply [12] due to voltage fluctuations in the system.

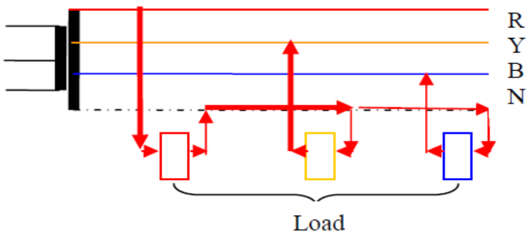

Figure1: Three Phase Transformer with Broken Neutral Conductor [12].

"Under normal conditions, current flows from the phases to the load and back to the source through the neutral wire" [12]. But from Figure 1 above, "When the neutral conductor is broken, the current from the red phase will go back or flows to the yellow or blue phase resulting in line to line voltage between the loads" [12]. "Similarly, the same will apply to other phases" [12]. In other words, some consumers will experience voltage swell (surge or overvoltage) and others will experience voltage sag or dip (undervoltage) as a result of voltage fluctuations in the network due to broken neutral conductor or neutral failure. This voltage fluctuation is harmful to household appliances and utility equipment. It also, causes high power losses in the system and building up of heat.

vi. **Inappropriate Sizing of Conductors in Distribution Network:** Under and over sizing of conductors in Nigeria power distribution network due to haphazard connections, unregulated load expansion and bad workmanship [4]. "The Nigerian technicians, craftsmen and electrians have not employ their expertise when connecting loads to the distribution network" [4]. "All manner of cables are being used to connect load to the distribution network without considering the effects on the system" [4]. All these unprofessional connections increase the power losses in the distribution network.

vii. **Unbalanced Phase Loading:** "Load balancing on the three phase circuits in the distribution transformer is the easiest way of power loss minimization in the distribution network" [4]. "But the distribution network today is characterized with unbalanced load and phase current" [4]. "Consequently, high power losses are experienced in the distribution network" [4].

viii. **Transformer Siting:** The appropriate siting of distribution transformer is requisite for even distribution of loads in the distribution network. In most cases, distribution transformers are not located centrally with respect to consumers load. When the distribution transformer is not properly sited at the centre of the load to be powered, it can create uneven supply of voltages or distribution of voltages to the loads. This can cause low voltage at the farthest end of the distribution network. In Nigeria today, even when the distribution transformer is properly sited; load expansions and haphazard (unregulated) connections of load to the distribution transformers have caused the unevenness of voltage distribution at the distribution level which has led to serious undervoltage and high power losses in Nigeria power distribution system. Any plan action has not been taken to guide against this ugly menace.

ix. **Overloading of Distributors:** In Nigeria, the power distribution network has become epileptic because of system overload. Due to haphazard and whimsical load connections to the distributors, most distributors are heavily overloaded causing voltage drop, undervoltage, cable sag and power losses in the system. These unregulated connections of loads to the distributors have become recurrent decimal and their effect is detrimental to both consumers and utility companies.

x. **Ageing Distributors:** Most conductors used as distributors in Nigerian electric power distribution network have become old due to age and overloading which has caused heat to build-up and damage the insulation of the conductors. According to IEC, ageing can be defined as "Irreversible deleterious change to the serviceability of insulation systems."

xi. **Management Lapses:** One of the major challenges of the Nigerian electric power distribution network is ineffective management system of the network facilities and ineffective use of the available once. The managerial ability of the network managers/handlers is poor. It ranges from negligence and "I don't care attitude" of the electric power distribution network personnel towards fault and this is alarming. Even when broken conductor occurs, it takes a longer time to be fixed and this has caused redundancy in the distribution system.

xii **Drop of J&P Fuse:** A fuse is "A safety device consisting of a strip of wire that melts and breaks an electric circuit if the current exceeds a safe level." The drop of J & P fuse in electric power distribution networks cause serious voltage fluctuations in the system. Consequently, voltage sag and swell experienced when J & P fuse drop cause high power losses in the distribution network and the risk of damaging the consumers' appliances is very high.

xiii. **Non-replacement of Fall-off of Line Spacers:** The non-replacement of fall-off of lines spacers has been a recurrent decimal in Nigeria electric distribution network, and this has caused serious bridge of distributors in the network. Most line spacers or separators used for distribution network are made of a wooden material which rotten and fall-off overtime but the replacement by the distribution network personnel (Benin Electricity Distribution Company) on time has become a challenge which has led to the bridge of the distributors during wind period and when interrupted power is being restored.

xiv. **Bad Workmanship:** Bad workmanship greatly contributes significantly toward increasing distribution power losses [8]. "Inexperienced technicians and craftsmen have contributed greatly to the undervoltage and power losses experienced in Nigeria electric distribution network today" [2]. "Bad or shoddy work carried out by inexperienced electrians has led to high power losses in the system and the haphazard connections witnessed has also contributed to undervoltage and power losses occurring today in the distribution network" [2].

xv. **Hot Spot [4]:** Due to inexperienced technicians in the distribution system, shoddy jobs are carried out. Bad workmanship has caused weak joints and poor terminals in the distribution network, resulting to high power losses in the system. Wherever a mechanically weak joint and poor termination are made, high resistance point is formed. Thus, the joint or termination will undergo a progressive failure due to heat created in the point.

xvi. **Poor Joints and Terminations:** Poor joints and terminations are one of the contributing factors of high voltage drop on the feeders [13]. Poor joints and terminations are as a result of loose contact between the two conductors which are joined together [13]. Because of inexperienced technicians in the system, bad or shoddy jobs are the order of the day, where loose joints and poor or bad terminations in the distribution network

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are carried out by inexperienced technicians [2]. This bad workmanship has led to increase in resistance and consequently, voltage drop and power losses at the weak point [4].

Table 1: Causes of Power Loss on the Distributors in Nigerian Electric Power Distribution Network at Glance

Serial Number	Causes of Power Loss on Distributors
1	Lengthy Distribution lines
2	Haphazard Connections of Service Cables
3	Improper Spacing of Distributors
4	Low Power Factor of Distribution Network
5	Neutral failure
6	Inappropriate Sizing of Conductors in Distribution Network
7	Unbalanced Phase Loading
8	Transformer Siting
9	Overloading of Distributors
10	Ageing Distributors
11	Management Lapses
12	Drop of J & P Fuse
13	Non-replacement of Fall-off Lines Spacers
14	Bad Workmanship
15	Hot Spot
16	Poor Joints and Terminations

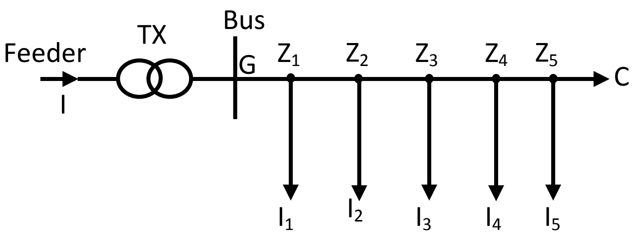
1.2 PARAMETRIC MODELING OF POWER LOSSES ON DISTRIBUTORS

Distribution networks are low voltage systems which supply the consumers the required voltage with minimum variations of a regulated percentage of ± 6% of the voltage up-to 650V [14] at the farthest end under peak conditions and normal system of operations [4]. Often time, the significant portion of the power that utility generates is lost in the distribution processes [4]. "These losses occur in numerous or various small components in the distribution system, such as transformers, distributors etc." The losses in transmission and distribution lines represent a significant proportion of power loss in both developed and developing countries [4]. According to Anumaka [5], "The Nigerian electricity grid has a large proportion of transmission and distribution losses -whopping 40%."

The effect of line resistance is to cause voltage drop and active power loss in the line and also, the effect of line inductance is to cause voltage drop and reactive power loss as well in the line. Consequently, the parametric modeling of total power loss (S_{LT}) is an inclusive model of power losses in the distributors caused by the resistance and the inductance of the line.

1.2.1 DEVELOPMENT OF PARAMETRIC MODEL OF POWER LOSSES ON DISTRIBUTORS

Consider Figure 2, having a feeder, feeding a 11/0.415kV transformer with a single distributor GC emanating from the 415volts side of the transformer; distributing to various load with current I_1, I_2, I_3, I_4, I_5, ... I_n and impedance of Z_1, Z_2, Z_3, Z_4, Z_5, ... Z_n as shown below.



TX = Transformer

Figure 2: Single Line Diagram of a Feeder Feeding a Distributor

Computing the power losses on distributor GC feeding various loads as shown above. The impedance of the system can be expressed as follows:

$Z_1 = R_1 + jX_1$, $Z_2 = R_2 + jX_2$, $Z_3 = R_3 + jX_3$, ..., $Z_n = R_n + jX_n$

The total active power loss (P_{Lt}) in the distributor GC is given as:

$$P_{Lt} = I_1^2R_1 + I_2^2R_2 + I_3^2R_3 + I_4^2R_4 + ..+ I_n^2R_n \quad (1)$$

$$P_{Lt} = \sum_{g=1}^{n} R_{gc} I_{gc}^2 \quad (2)$$

Where $I_{gc} = I_g$ (3)

The total reactive power loss in the distributor GC is given as:

$$Q_{Lt} = I_1^2X_1 + I_2^2X_2 + I_3^2X_3 + I_4^2X_4 + ..+ I_n^2X_n \quad (4)$$

$$Q_{Lt} = \sum_{g=1}^{n} X_{gc} I_{gc}^2 \quad (5)$$

$$Q_{Lt} = \sum_{g=1}^{n} X_L I_g^2 \quad (6)$$

Where X_{gc} is the reactance of the distributor GC. Since the capacitance of the distributor GC is negligible due to low voltage.

Hence, $X_{gc} = X_g = X_L = 2\pi f L_d$ (7)

Where L_d is the inductance of the distributor GC.

Assuming symmetrical spacing between the distributors and the neutral line; then the inductance (L_d) of the distributor GC is given as half of the loop inductance of conductors (Distributors):

$L_d = 1/2L_c = 10^{-7} [\mu_r + 4\log_e{}^{d/r}]$ H/m (8)

Where μ_r = relative permeability of the distributor

d = distance between distributors

r = radius of the distributor

L_c = inductance of conductors (distributors)

Then the total power loss in distributor GC (S_{LT}) is the summation of (equation 2 and 5): the total active power loss and the corresponding total reactive power loss in the distributor of the distribution network is given as:

$$S_{LT} = \sqrt{P_{Lt}^2 + Q_{Lt}^2} \quad (9)$$

$$S_{LT} = P_{Lt} + Q_{Lt} \quad (10)$$

$$S_{LT} = \sum_{g=1}^{n} R\, I_g^2 + \sum_{g=1}^{n} X_L I_g^2 \quad (11)$$

Where $I_g = I$ (12)

$$S_{LT} = I^2 \sum [R + X_L] \quad (13)$$

Where $R = \dfrac{\rho L}{A}$ (14)

$$X_L = 2\Pi\ f L_d \quad (15)$$

Therefore, the total power losses (S_{LT}) in the distributor GC of the distribution network is modeled as follows:

$$S_{LT} = \sum I^2 [\frac{\rho L}{A} + 2\Pi f L_d] \quad (16)$$

Where I = current flowing in the distributor

L = length of the distributor

A = area of the distributor

ρ = specific resistance of the distributor

F = operating frequency of the network

L_d = inductance of the distributor

1.3 MATERIALS AND METHODS

The effects of power losses and voltage sag or dip on households and offices appliances cannot be underestimated in the Nigerian electric power distribution network. Today, the effects ranges from burnt and under-performance of household and office appliances due to incorrect voltage supply. Thus, this experimental setup is to verify the effect and performance of households and offices appliances when there is fluctuations (variations) in the supplied voltage especially voltage sag. The experiment was setup with the various equipment such as: Powerstart (Variac) of a range of 0 - 250V, a Voltmeter (DT9205A) with a range of 200mV - 750V and Ammeter (Clamp Meter 266) with a range of 0 - 1000amps.

1.3.1 Method of Measurements

The overview of the experimental setup is used to study the influence of voltage and voltage variations on the functionality and performances of household and office appliances is shown in Figure 3. The block diagram shows a mains or power-source of 220 - 240V that can be programmed or varied by the powerstart (variac) of 0 - 250V range of calibration to delivers a sinusoidal voltage with the desired voltage levels. The voltmeter is used to measure the voltage across the appliances and the ammeter, measures the current flowing through the appliances tested. The test connections is shown in Figure 3. The experimental test were performed on some household and office appliances. The currents were measured with respect to time interval for different voltages.

1.4 DISCUSSION OF MEASURED RESULTS AND ITS EFFECTS ON HOUSEHOLD AND OFFICE APPLIANCES

The measured results and its effects on household and office appliances were discussed. When the supply voltage was widened by the widener (variac); from the measurements result, the examination of the effects of broadening the voltage on the functionality and performance of the household and office appliances and the discomfort of the consumers as well was examined on some household and office appliances.

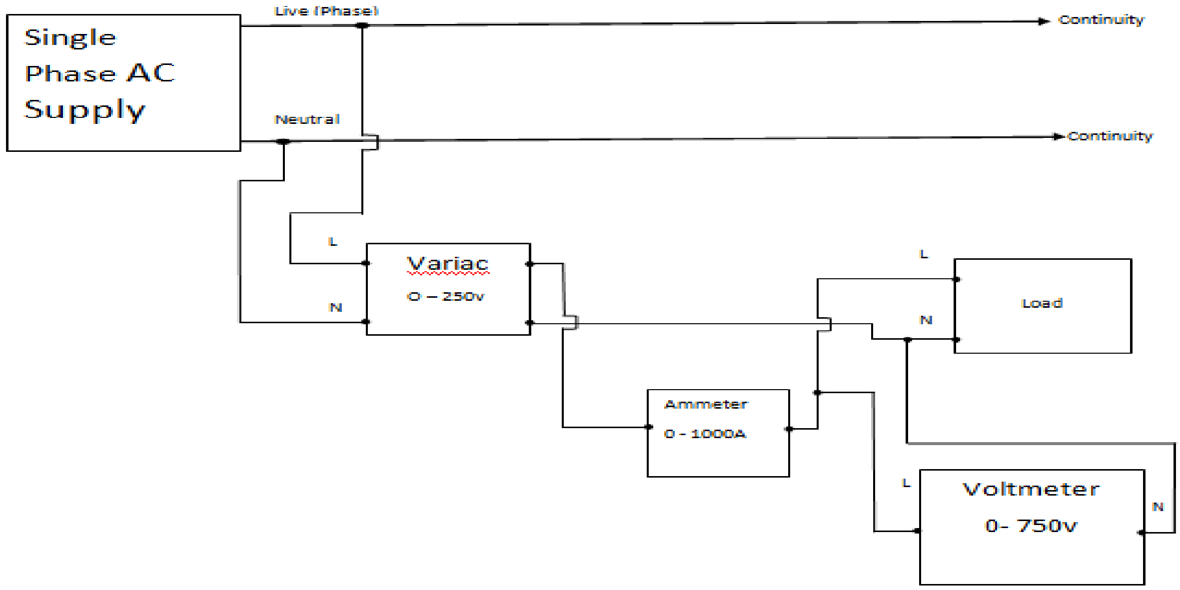


Figure 3: Block Diagram of Experimental Setup

1.5 TYPES OF ELECTRICAL AND ELECTRONICS HOUSEHOLD AND OFFICE APPLIANCES

Various type of household and office appliances were performed differently during the voltage variations. The effects of broadening of voltages on the performances of electrical and electronics devices was examined by the experimental setup, and the appliances were classified into two types of load as follows:

i. Resistive load appliances
ii. Inductive load appliances

Grouping the appliances verified in this experiment into inductive and resistive loads respectively as shown below in tabular form.

Table 2: Types of Household and Office Appliances at Glance

S/N	Resistive Load	Inductive Load
1	CRT Television	Ceiling Fan
2	Heater (Water Ring Boiler)	Air Conditioner
3	Computer (Laptop)	Refrigerator
4	Lighting Lamp (Incandescent Lamp)	Microwave Oven
5	Printer	Washing Machine

1.5.1 Resistive Load Appliances

The resistive load appliances are appliances that have resistance effect on the system when voltage broadening occurs. The following discuss the effects of voltage variations on resistive homes and offices appliances:

1.5.1.1 Incandescent Lamp

A tungsten filament bulbs were used to performed and verified the effect of voltage variations on the performance and efficiency of the lighting lamp. From the experimental setup, it was showed that the lamps (incandescent lamps) consumes more energy at higher voltages; as the voltage increase, the lamp brightness (intensity) increases. Similarly, as the voltage decreases the lamps brightness appear dim. It should worth saying here that as the brightness increase at a higher voltages, so it consumes more energy and it may lead to a shorter lifespan of the lamp. One of the foremost effect of voltage variations on the incandescent lamp was lamp flicker. Lamp flicker is an effect on a lamp brightness in which there is rapid visible changes or variations of the intensity or brightness level for the incandescent lamp. The fluctuations in the brightness or intensity of the lamps causes inconvenience or discomfort to the utility consumers.

1.5.1.2 Computer

From the experimental setup, it was clearly showed that the computer (Laptop) consumes a constant power with voltage variations. As the voltage varies with the corresponding variation in current at 70volts, the laptop was still consuming the same power but one effect is noticed with the charger becoming hotter showing high current presences at the time of very low voltage which can damage the charger overtime.

1.5.1.3 Television

The CRT (Cathode Ray Tube) television of 34cm, 14" was used for this experimental verification to see the effects of voltage variations on the performance of the CRT television. The CRT television was verified on a broader voltage, it was showed that the CRT television consumes constant power at both high and low voltages. This is because most electronics devices have SMPS (Switch Mode Power Supply) device which converts the incoming AC voltage from 12 -to - 24volts system of voltages which is required for many electronics devices or appliance. Hence, the effects of voltage broadening on the CRT television was not visual (noticeable) during the experimental processes at 70volts. But in the case of extremely low voltages, the pictures and it quality will start wavering until the television goes off completely.

1.5.1.4 Heater

The electrical "Water Ring Boiler" ("O" Ring Boiler) was used to experiment the effect of broader voltage on the performance of heaters. It was showed that as the voltage increases the Water Ring Boiler heat the water faster thereby consuming more energy at a higher voltage with lesser time to do the required work. Similarly, as the voltage dwindles, the effectiveness of the "Water Ring Boiler" was affected by taking longer time to boil the same quantity of water thereby causing waste of time and discomfort to the end users.

1.5.2 Inductive Load Appliances

The inductive load appliances are those appliances that have inductive effect on the system when the voltage broadening occurs. Most homes inductive appliances are voltage and current variations unfriendly and their behavioural paradigm during the voltage fluctuation was x-rayed as follows:

1.5.2. 1 Ceiling Fan

Fans are widely used for domestic and commercial applications. Fans are significant electromechanical devices for homes and offices application. Their uses ranges from shop ventilation to boiler or hot devices cooling process. "Fans are critical for process support and human health." The ceiling fan of 62" (62 inches), O.R.L. product was used for the experimental setup to verify the effects of voltage variations on fans performance. As the voltage range was broaden, the effect on the speed of the fan was evidential because at 70volts the speed of the fan was reduced drastically compared to 220volts speed etc. But at low voltage, it was noticed that the ceiling fan became hotter. This is because when voltage gets low, the current must increase to provide the accurate amount of power needed to drive the electric motor of the fan. Consequently, at low voltage, more current is needed to power the fan which can lead to overheating, shortened of lifespan, reduced efficiency, low starting ability etc. Therefore, voltage variations cause discomfort to both the appliances and its end users.

1.5.2.2 Refrigerator and Air Conditioner

Refrigerators and Air conditioners are critical electromechanical devices both at homes and offices for preserving and cooling processes. As a result of their essentiality, the effects of voltage range broadening was examined through the experimental setup in Figure 3. It was observed that voltage broadening has negative effects on the refrigerator and air conditioner especially at low voltage. Most of electrical and electronics devices are designed to operate on a specified voltage, power and frequency. Outside these specified ratings, the deviation posed serious threat to the refrigerator and air conditioner because too wide variations of supplied voltage at the refrigerator and air conditioner terminals will cause reduction in the electromagnetic torgue of the motor driving the compressor which might lead to malfunctioning of the devices with low output; since the electromagnetic torgue of the driver motor is proportional to the voltage squared. When supplied voltage dwindle, it causes the stalling of the compressor with preceding vibration of the refrigerator and air conditioner.

1.5.2.3 Washing Machine

Washing machines are essential device both in the private and commercial services. The power consumption and the effect of voltage variations on the performance of the machine was examined through the experimental setup in Figure 3. At low voltage, the power consumption was low and more current was drawn-in to match the low voltage. Consequently, more time is taken by the washing machine to heat the water to a required temperature, thereby leading to a longer washing cycle. At voltage range of 70 -to- 190volts, the washing machine stop working and humming began showing the effect of low voltage on the device but when the supplied voltage was increased to the range of 210 -to- 250volts, the washing machine started working with high power consumption rate. Hence, at higher voltage the washing machine consumes high energy with high efficiency performance in turning process. Similarly, at lower voltage, the power consumption was low with lower efficiency performance. The humming of the washing machine at low voltage shows high impact of low voltage which can cause damage to the washing machine.

1.6 CONCLUSION

The Nigerian electric power distribution network is characterized with lengthy distributors and haphazard connections with under/oversized service cables which has caused high voltage drop and power losses in the distribution network. Having x-rayed the causes and modeling of power losses on the distributors and its associated effects on households and offices appliances in the Nigerian electric power distribution network and as well as the discomfort of the consumers. It is imperative to state here that the effects/impacts of power losses and voltage variations beyond the statutory limit of ± 6% on household and office appliances varies depending on the appliances. The effects ranges from stalling of compressors, overheating, burnt coils, dimness of lamp, burnt lamps, shorter lifespan, risk of fire outbreak etc. Thusly, both at high and low voltages the performance of the appliances were affected leading to undesired operation of the appliances and as well as the discomfort of the end users.

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AUTOBIOGRAPHY

France O. Akpojedje obtained his Bachelors of Engineering from the Ambrose Alli University, Ekpoma, Edo State, Nigeria in 2009 and Masters of Power and Machines in Electrical and Electronics Engineering from the University of Benin, Benin City, Nigeria in 2012. He is currently a Ph.D Scholar in Electrical and Electronic Engineering (Power and Machines Options) at the University of Benin, Benin City, Nigeria. He is a registered member of the Nigerian Society of Engineers (NSE), International Association of Engineers (IAENG) and the Council for the Regulation of Engineering in Nigeria (COREN). Also, he is the former Acting Head of Electrical/Electronic Engineering Department and currently, the Acting Dean, School of Engineering Technology, both at the National Institute of Construction Technology (NICT), Uromi, Nigeria. His research interest include: smart networks, energy management systems, power system modeling and protection, network reconfiguration, renewable energy, machines design and power systems optimization.