Mobile Phone Radiofrequency Radiation Assessment Based on Call-Related Factors and Physical Condition from Selected Mobile Phones

Ilesanmi B. Oluwafemi and Olusegun J. Adeoye

Abstract—The intensity of electromagnetic radiation around selected mobile phones is investigated in a bid to confirm their adherence to the specified radiofrequency exposure limit on non-ionizing radiation. Measurements were taken with the use of Radiofrequency Meter (RF) TM-96, 9V DC and Spectrum Analyzer (NA-773, 144/430 MHz) at distances 5 cm, 10 cm, 15 cm, 20 cm, 25 cm and 30 cm from the mobile phone users. The level of radiations from the selected mobile phones ranges from 0.3119 to 0.5407 mW/cm² during dialing. Out of the tested mobile phones, the radiation levels of Asus, Infinix 3 and Sicco X100 phones which are 0.5407, 0.5009 and 0.4506 mW/cm² respectively are above the International Commission on Non-Ionizing Radiation Protection (ICNIRP) reference level which is 0.45 mW/cm². Result from measurement showed that high radiation levels from a transmitting handset occur between seeking for connection and call establishment. It was also confirmed that the physical condition of mobile phones affects its radiation level.

Index Terms—Electromagnetic Radiation, Mobile Phone, Radiation Intensity, Radiofrequency.

I. INTRODUCTION

Mobile telephony has rapidly become the most popular method of voice communication in the world and in Nigeria the use of mobile phones has greatly increased which has also increased the people’s exposure to radiofrequency radiation from mobile phones. Different handset models with different qualities have also introduced into the Nigeria telecommunication market from different mobile phone manufacturers. This has generated many questions on the radiation level transmitted from these cell phones and the possible hazard on the mobile phone users. In [1] it is shown that the RF energy absorption by the human body is made possible by the tissue’s water content. The same way as microwave oven affect meat by heat and cook it, the same the power from a close cell phone can affect the tissue in the brain if the head is exposed to the mobile phone radiation for long periods of [2]. In [3] it was indicated a possible increase in the risk of deoxyribonucleic acid (DNA) mutations [3]. Changing of performance of neuron behavioral functions of office workers are on phone call for long period has been established in [4]. In [5] it was found that cardiovascular symptoms and perpetual speed in cognition, a study that conclusively indicates that the advert effect of low but extended period of exposure to radiation intensity from cell phone on human being cannot be eliminated. The emitted microwave radiation is absorbed by tissues. This radiation is emitted not just during active usage, but also during standby mode, since the phone is continuously polling for location nearest to the base station.

In [7] it was reported that RF energy from mobile phones leads to a negative effect on the human skin. According to [8], the amount of heat generated in a living organism because of exposure to mobile phone radiation depends mainly on the power density radiation once it has penetrated the system as well as the electrical properties of the biomass and efficiency of the body’s thermoregulation mechanism. The extent of such heating would depend on frequency of the radiation as well as the duration of exposure and efficiency of heat dissipation. In nine it was [9] observed that this poses a possibility of localization of hot spots or energy deposition in the brain due to internal reflections. A study on near fields Electromagnetic Radiation (EMR) from selected mobile telephones when in use using a tri-axis isotropic probe and electric field meter [10]. The EMR levels of some mobile telephones were found to be lower and others higher than the International Commission on non-Ionizing Radiation (ICNIRP) guidelines for exposure to general-public. It was equally shown that the Radio Frequency (RF) intensity depends on the operation and the distance between the mobile phone and the user.

The possible presence and intensity of RF radiation level from ten selected mobile phone models at a distance of less than 20 cm was investigated in [9]. Out of the ten handsets employed for the investigation, it was reported that all the measured values were within the safe limits of 0.6 mW/cm² set by Federal Communications Commission (FCC) [11], [12]. Research on the compliance of mobile unit on radiation limit must be continuous as more mobile phones are entering the market day by day, hence the need for this research work. This study therefore seeks to determine whether the electromagnetic radiation (EMR) levels from some selected mobile phones is within the specified radiofrequency (RF) exposure limits on non-ionizing radiation as specified by the ICNIRP [13].

II. METHODOLOGY

Different models of mobile phone handsets were sampled base on their cost, model (type) and manufacturer. These

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selected mobile phones were charged fully to prevent them from switching off during the period of radiation measurement(s). The handsets considered for the study are: Nokia-6300, ITEL 5070, Asus, Huawei LUA-U22, Gionee S6, Samsung Galaxy note 3, Infinix 3, Siccoo X100, Samsung-S7 and Infinix T350.

A. Measurement Equipment

The materials used are mainly broadband RF meter (TM-96, 9V DC), spectrum analyzer (NA-773, 144/430 MHz) and meter rule. The broadband RF meter, was used to measure the intensity of radiation (mW/cm²) emitted from mobile phones under-study. Depending on the distance, this equipment measures radiation within the frequency range of 100 kHz and 60 GHz. The spectrum analyzer was used for monitoring the RF signals frequencies and it responds to a signal of frequency range of 10 MHz to 18 GHz. The spectrum analyzer determines the frequency and power flux density of Electromagnetic fields. The meter rule was used to measure the distance from the equipment of the cell phones under test within the range of 5cm to 30cm. Final Stage

B. Measurement Procedure

The RF radiations of different types of cell phone which operate in one or all of the MTN, Airtel, GLO and Etisalat Global System for Mobile Communications (GSM) network operator in Nigeria were measured placing RF meter 5 cm interval until it reached 30 cm from mobile phones. 5cm spacing were marked with the ruler before each reading was taken. The readings were taken when the mobile phone was seeking for connection, establishing a call and during call conversation (dialing, ringing, calling, and receiving).

The radiation levels of mobile phones around the earpiece i.e. normal radiation level, are compared with radiation levels around the battery area first with cover and second without the battery cover. Radiation levels around the battery region of the selected and activated mobile phone models were measured when the battery region of the phones were cover and when they are not covered.

III. RESULTS AND DISCUSSION

The graphical representations of measurement radiation levels are shown in Fig. 1-10. These results shows the presence of different levels of RF radiations from all the selected mobile phone models, ranging from 0.3119 to 0.5407 mW/cm² during dialing, with the highest radiating mobile phone being Asus while the least is Samsung S7. Asus, Infinix 3 and Siccoo X100 have the radiation level of 0.5407, 0.5009 and 0.4506 mW/cm² respectively which are above the International Commission on non-ionizing Radiation’s safe exposure limits (ICNIRP).

As clearly seen in Fig.1 to 10, the power density (and hence the EM radiation exposure on a user) reduce with the increasing distance from the mobile phone handset. In particular, from the result it can be observed that the amount of EM radiations obtained in terms of power density decreased from about 30 to 20% if the mobile phone handset is moved from the EMF meter at every 5 cm measurement interval. It is also observed that radiation intensity is higher during call dialing generally and low during call receiving. This is attributed to adaptive power control (APC) which minimizes the power radiation of mobile phone during call conversation.

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Fig. 4. The radiation levels of Huawei Lua U22 during Call Establishment and Conversation

Fig. 5. The radiation levels of Gionee S6 during Call Establishment and Conversation

Fig. 6. The radiation levels of Samsung Galaxy note 3 during Call Establishment and Conversation

Fig. 7. The radiation levels of Infinix 3 during Call Establishment and Conversation

Fig. 8. The radiation levels of Siccoo X100 during Call Establishment and Conversation

Fig. 9. The radiation levels of Samsung S7 during Call Establishment and Conversation
Radiofrequency (RF) radiation levels varied with mobile phone models. The RF radiation levels from all the 10 tested handsets ranges from 0.3119 to 0.5407 mW/cm² with the highest radiating mobile phone being Asus while the least was Samsung S7. Asus, Infinix 3 and Siccoo X100 phones have a radiation level of 0.5407, 0.5009 and 0.4506 mW/cm² respectively which are above the ICNIRP’s safe exposure limits.

Therefore, the use of all these mobile phones in the Nigerian market may be detrimental to the health of the general public. The radiation intensities from transmitting handsets, when establishing a call, were determined to be high but decreased during call conversation. Using earpiece will reduce the user’s exposure to electromagnetic radiation. The use of speaker phone when dialing is therefore recommended for users. Radiation intensity around the battery compartment of all the transmitting handsets without a battery-cover (rear body-cover) was determined to be higher than the radiation levels from cased handsets and normal radiation levels (at the earpiece).

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Fig. 10. The radiation levels of Techno T350 during Call Establishment and Conversation.

Fig. 11 shows the radiation from the selected mobile phones with observation on the effect of the physical condition and battery compartment on the radiation level.

The results show that the intensity of radiation around a battery-covered compartment with respect to normal radiation levels varied amongst the tested handsets. The radiation level of battery-covered of Nokia 6300, Itel 5070 and Siccoo X100 were below normal radiation level, whereas the radiation level of Gionee S6, Asus, Techno T350, HUAWEI LUA-U22, Samsung S7, Samsung Galaxy note 3 and Infinix 3 were found to be above the respective normal radiation levels. The battery covers of Nokia 6300, Itel 5070 and Siccoo X100 are metallic but the casing of Gionee S6, Asus, Techno T350, HUAWEI LUA-U22, Samsung S7, Samsung Galaxy note 3 and Infinix 3 are plastic in nature. From the obtained results, it is evident that metallic casing attenuated more radiation than plastic materials. The results indicate that radiation levels around mobile phone battery compartment, without battery-cover or rear body-cover was above their corresponding and respective radiation levels as well as with the battery-covered. From Fig. 12, it shows that when the battery cover of a mobile phone is removing; the concentration of the radiation level is increase than the normal radiation level at any variance in signal level and separation distance of the mobile phone at any point to the user.

IV. CONCLUSION

Radiofrequency (RF) radiation levels varied with mobile phone models. The RF radiation levels from all the 10 tested handsets ranges from 0.3119 to 0.5407 mW/cm² with the highest radiating mobile phone being Asus while the least was Samsung S7. Asus, Infinix 3 and Siccoo X100 phones have a radiation level of 0.5407, 0.5009 and 0.4506 mW/cm² respectively which are above the ICNIRP’s safe exposure limits.

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