



Investigation of factors affecting power density radiation of mobile phones

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Abstract

The use of mobile phones in Nigeria has greatly increased in the recent year. This has also increased the general population exposure to mobile phone radiation. In this research, the intensity of radiation around selected mobile phones base on some factors are investigated using Radiofrequency Meter (RF) TM-96, 9V DC and Spectrum Analyzer (NA-773, 144/430 MHz) in a bid to confirm how they affect the radiation level. Measurements were taken at distances of 5 cm from the mobile phones when seeking for connections, calls establishing and calls connections under different conditions such as periods of the day, when charging and when not charging, battery charged levels, single and dual SIMs and network signal levels. The radiation levels from the 5 selected mobile phones ranges from 0.3204 to 0.4824 mW/cm² during call conversation, with the highest radiating mobile phone being Asus while the least was Infinix 3. The radiation levels of these mobile phones are above the International Commission on Non-ionizing Radiation Protection (ICNIRP) reference level, 0.45 mW/cm². Results also shows that the cell phone battery level, network signal level, the number of inserted SIM cards increases the radiation level of the mobile phones.

Keywords: Radiation; Call Seeking; Call Establishment; Call Conversation; Exposure.

1. Introduction

The use of mobile phones in Nigeria has greatly increased in the recent year. The increment is as a result of advances in mobile communication which has led to increased broadband applications [1-4]. The increasing broadband applications has also led to increased exposure to mobile phone radiation by the general populace.

The effects of mobile phones under different conditions contribute to the increase in the radiation level of mobile phone. This study is to determine whether the radiofrequency (RF) radiation levels from mobile phones are affected by single and dual SIMs when seeking for connection, call establishment and call conversation and also with specific time of the day with different network operators in Nigeria.

It will help the mobile users to make use of the mobile phones appropriately especially when mobile is still seeking for connection, the user will not place it closer to himself. This is important for people's safety and effective protection. A research was carried out on two cases control studies on brain tumor including the assessment of use of mobile phones and cordless phones [5]. The result from the research revealed malignant of brain tumours as a result of too much radiation from the cell phones. A possible increase in the risk of deoxyribonucleic acid (DNA) mutations, changing of performance of neuron behavioral functions of office workers are on phone call for long period has been established by Abdul [6-7]. The effect on many symptoms such as the prevalence of neuropsychiatry was reported as result of long exposure to radiation from cell phone. Symptoms were 22.5% of headache, 38.2% of memory change, 18.8% of dizziness, 9.4% of tumors, 21.7% of depression symptoms and 23.5% of sleep disturbance. Reduced sperm counts and brain cancer to as a result of RF exposure are also reported in [8-9] These condition are aggravated due to low supply of blood to these organs. According to [9] there is considerable public concern about possible long-term adverse health effects of mobile phones. The mostly localized exposure target region is the head, most epidemiological studies focus on brain tumours. In [11], the EMR levels of some mobile telephones were found to be lower and others higher than the International Commission on non-ionizing Radiation (ICNIRP) [10] guidelines for exposure to general-public. It was further shown than RF intensity depends on the operation and proximity of the mobile phone to the user; the safest mode of operation was determined to be the use of short text message. It was reported in [13] that Low Frequency Radiation (LFR) (30 – 300 kHz) from the battery, would however be expected to contribute to the overall radiation level from the mobile phone. They further showed that if the calls were made while charging the batteries of mobile phones, extremely low frequency radiation (majorly from LCD display unit) would as well enhance the measured radiation. In this paper, investigation is conducted to the factors that affect the electromagnetic radiation level of mobile phone in use in Nigeria.

2. Method

Measurement Procedure base on the single and dual SIMs during call conversation

Different types of mobile 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 placed 5 cm distance from the RF meter. Before each reading was taken, point of 5cm was marked with the meter rule. The reading was then taken when the mobile phone was establishing a call with single and double SIMs; when seeking for connection, call establishment and call conversation; with different network operators in Nigeria; when charging and when not charging; with battery power levels and with signals levels of the mobile phones.

Considerable amount of electromagnetic energy is concentrated near the source and is inversely proportional to the square of distance, hence the inverse square law given in (1), [14]

$$I = \frac{PrG_o}{4\pi r^2} \quad (1)$$

Where I is the intensity of the electromagnetic radiation (mW/cm²), Pr is the radiated power (mW), r is the distance from the radiating source (cm) and Go is the maximum gain as in (1), the intensity of radiation exposure decrease from the source. Thus maximum intensity is absorbed next to the ear or the head of the mobile phone user Chen and Lin, as in [9]. The power density of the mobile phone decreases as the distance between the mobile phone and its user increases as in (2).

$$\rho = \frac{P_r}{A_e} \quad (2)$$

Where ρ is the power density and A_e is the effective are.

$$A_e = \frac{G_r \lambda^2}{4\pi} \quad (3)$$

As pointed in (3), the effective area cover by the mobile phone depends on wavelength of the electromagnetic wave.

$$P_r = \frac{(h_t h_r)^2}{d^n} P_t G_t G_r \quad (4)$$

Where h_t is the transmitted antenna height, h_r is the received antenna height and d is the distance between the transmitter and receiver.

Height of the antenna also affects the received power density of the mobile phone. As in (4), the higher the antenna the better the receive signal from the base station at any random function of time.

In determining the intensity of selected mobile phone radiation, the background radiation of the place was first measured as in (5).

$$I_x = I_c - I_b \quad (5)$$

Where I_x is the intensity of radiation emitted from handset under study, I_c is the cumulative power density and I_b is the intensity of background radiation.

3. Results and discussions

3.1. Radiation level of mobile phones with number of inserted sim during call conversation

Fig. 1 shows the radiation level of some mobile phones with Dual SIMs and with Single SIM. It can be observed that Nokia 6300 has a radiation level of 0.4210 with Single SIM and radiation level of 0.4484 with Dual SIMs. Infinix 3 has a radiation level of 0.4804 with Single SIM and radiation level of 0.5009 with Dual SIMs. Gionee S 6 has a radiation level of 0.4081 with Single SIM and radiation level of 0.4177 with Dual SIMs. Asus has a radiation level of 0.5254 with Single SIM and radiation level of 0.5437 with Dual SIMs and Siccoco X 100 has a radiation level of 0.4002 with Single SIM and radiation level of 0.4470 with Dual SIMs and all in mW/cm². It has been clearly shown in Fig. 1 that dual SIMs phones can lead to increase in radiation than single SIM phones. Increase in number of SIM increases the radiation level because each SIM will try to pull for signal connection from the base station which makes the dual SIM Phones emits more radiation than Single SIM.

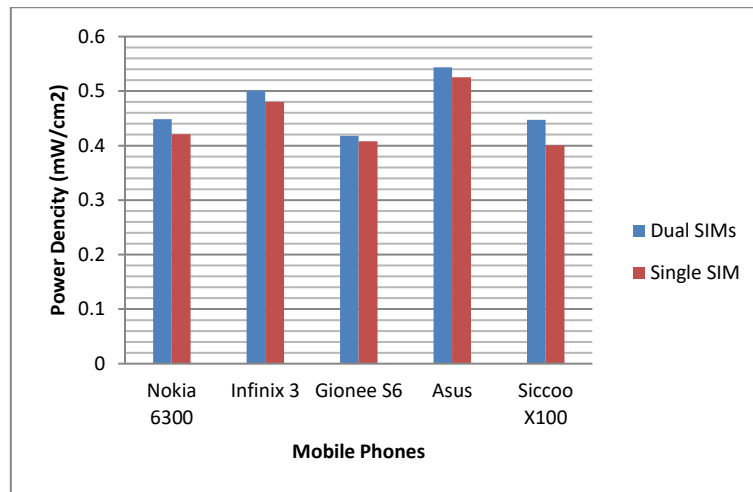


Fig. 1: The Radiation Level of Five Selected Mobile Phones with Dual SIMs and with Single SIM During Call Conversation.

3.2. Radiation level of mobile phones during seeking for connection, call establishment and conversation

The intensity of radiation from various mobile stations, when seeking for connection, establishing a call and call conversation was assessed as shown in Fig. 2. The same selected mobile phones were used. The result shows that cell phones are not on a constant level of radiation. Phone radiates higher when seeking and connecting to cellular towers. However, a moving phone will continually go in and out of tower range which automatically increases power to a maximum as the phone repeatedly attempts to connect to a new antenna. Fig. 2 shows that when connecting to the tower, the power of Mobile Phone is high. It is also clearly seen that the amount of EMF radiations was far higher when the phones dialed before picking than after picking. It also shown that mobile phone radiates higher power density when seeking for connection than when call is being established and also when call conversation is on and this exposes mobile phone users to large amount of radiation.

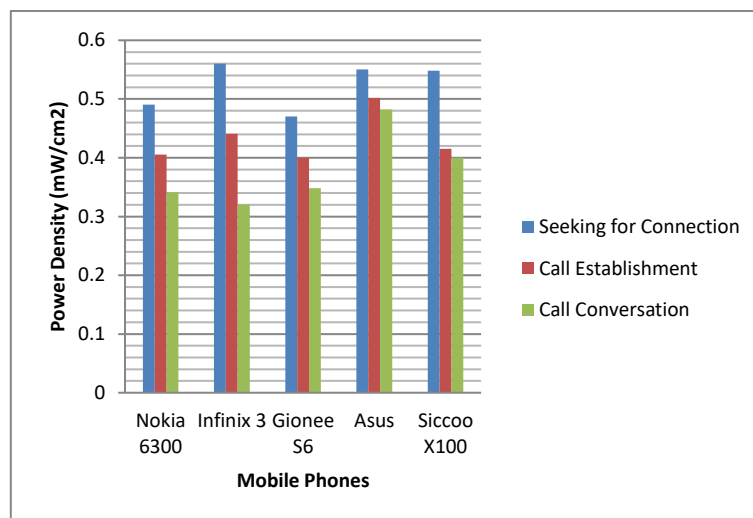


Fig. 2: The Radiation Level of Five Selected Mobile Phones during Seeking for Connection, Call Establishment and Conversation.

The intensity of radiation from various mobile stations, when seeking for connection, establishing a call and call conversation was assessed as shown in Fig. 2. The same selected mobile phones were used. The result shows that cell phones are not on a constant level of radiation. Phone radiates higher when seeking and connecting to cellular towers. However, a moving phone (when you are driving or walking) will continually go in and out of tower range which automatically increases power to a maximum as the phone repeatedly attempts to connect to a new antenna. It also shows from the result that when connecting to the antenna, the power of Mobile Phone is always high. It is also clearly seen that the amount of radiations was far higher when the phones dialed before picking than after picking. Fig. 2 also shown that mobile phone radiates higher power density when seeking for connection than when call is being establish and also when call conversation is on and this exposes mobile phone users to large amount of radiation.

3.3. Radiation level of mobile phones with network provider in Nigeria during call conversation

Fig. 3 shows the radiation level of mobile phone with different network provider in Nigeria. The results from Nokia 6300 with radiation levels of 0.4212 with MTN, it has a radiation level of 0.4220 with Aitel, it has a radiation level of 0.4120 with Glo and it has a radiation level of 0.4122 with Etisalat. For Infinix 3, it has a radiation levels of 0.5004 with MTN, it has a radiation level of 0.5002 with Aitel, it has a radiation level of 0.5002 with Glo and it has a radiation level of 0.5002 with tisalat. For Gionee S6, it has a radiation level of 0.4700 with MTN, it has a radiation level of 0.4703 with Airtel, it has a radiation level of 0.4700 with Glo, it has a radiation level of 0.4700 with Etisalat. For Asus, it has a radiation level of 0.5501 with MTN, it has a radiation level of 0.5502 with Aitel, it has a radiation level of 0.5502 with Glo and it has a radiation level of 0.5502 with tisalat. For Siccoo, it has a radiation level of 0.4680 with MTN, it has a radiation level of 0.4640 with Aitel, it has a radiation level of 0.4682 with Glo and it has a radiation level of 0.4680 with Atisalat in

mW/cm². From the result, it has been observed that the radiation levels vary only with the different mobile phone handset models and not with the network operators as it shown in Fig. 3.

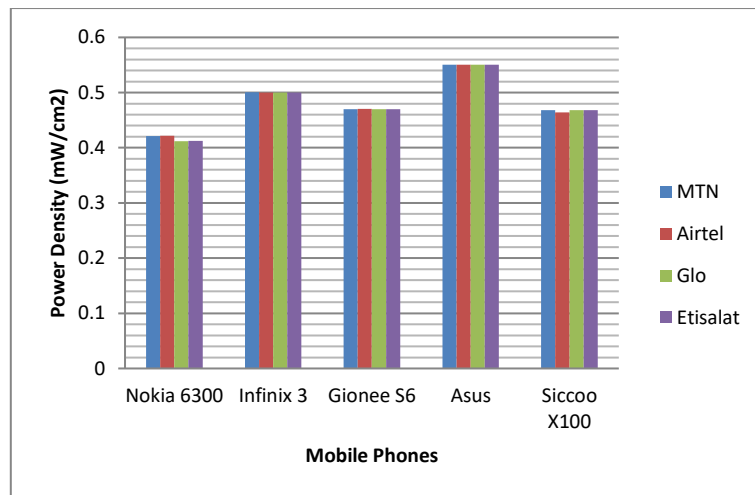


Fig. 3: The Radiation Level of Five Selected Mobile Phones with Different Network during Seeking for Connection at a Distance of 5 CM.

3.4. Radiation level of mobile phones when charging and when not charging during call establishment

The radiation levels of some selected mobile phones during charging and not charging situation are shown in Fig. 4. It is observed that making a call while charging will lead to significant increase in radiation levels of mobile phones. All chargers built using a switching mode power supply emit radio signals that are by definition called radiation. If the calls were made while charging the batteries of mobile phones, extremely low frequency radiation (majorly from LCD display unit) would as well enhance the measured radiation. The result in Fig. 4 also shows that when charging cell phones, it is not safe to establish a call.

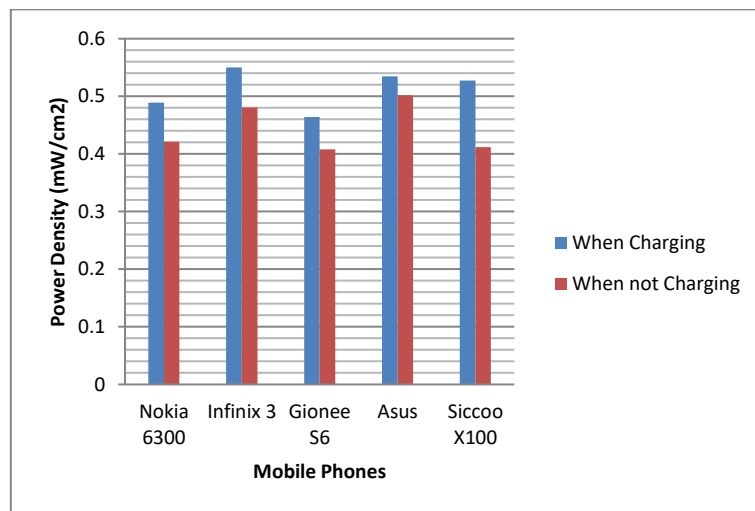


Fig. 4: The Radiation Level of Five Selected Mobile Phones When Charging and when Not Charging During Call Establishment.

3.5. Radiation level of mobile phones with low battery and high battery levels during call establishment

Fig. 5 shows the RF radiation with low and high battery levels. The result shows that Nokia 6300 has a radiation level of 0.4750 at low battery and 0.4212 at high battery level, Infinix 3 has a radiation level of 0.5247 at low battery and 0.4807 at high battery level, Gionee S6 has a radiation level of 0.4700 at low battery and 0.4082 at high battery level, Asus has a radiation level of 0.5704 at low battery and 0.5217 at high battery level. Siccoco X100 has a radiation level of 0.5075 at low battery and 0.4110 at high battery level and all in mW/cm².

The result from Fig.5 shows that mobile phones have high radiation levels when battery is at low level (25%) and it is not safe to establish a call when the Battery level of the Cell Phones is low.

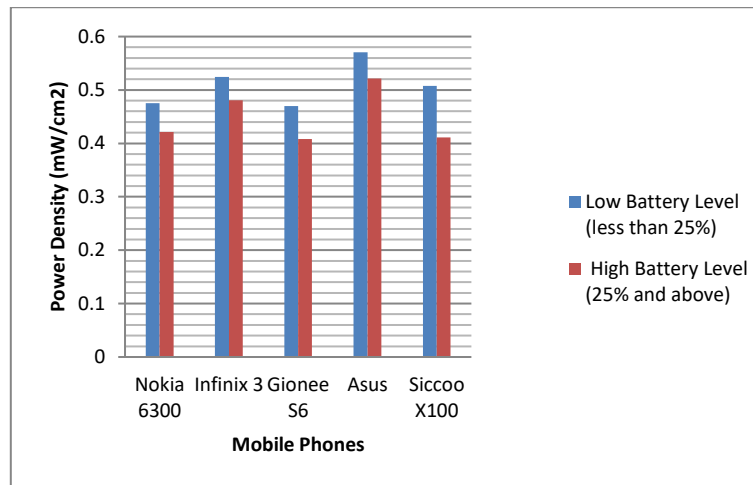


Fig. 5: The Radiation Level of Five Selected Mobile Phones with Low Battery and High Battery Levels during Call Establishment.

3.6. Radiation level of mobile phones with low signal and high signal level during call establishment

The phones work is to establish and maintain communications with the cell tower; it does this in the most power efficient way, thus decreasing power when close to the tower and boosting it when signal strength is low. Fig. 6 shows the radiation level with low and high signal level during call establishment. Nokia 6300 is seen to have radiation level of 0.4490 at low signal level and radiation level of 0.4212 at high signal level. Infinix 3 is seen to have radiation level of 0.5051 at low signal level and radiation level of 0.4805 at high signal level. Gionee S6 is seen to have radiation level of 0.4420 at low signal level and radiation level of 0.4081 at high signal level. Asus is seen to have radiation level of 0.5504 at low signal level and radiation level of 0.5217 also Siccoco X100 is seen to have radiation level of 0.4801 at low signal level and radiation level of 0.4002 at high signal level and all at 5 cm distance in mW/cm^2 .

From the result obtained, cell phones emit more radiation while low on strength of its network's signal as it shown in Fig. 6. In a low network area, the cell phone has to emit high radio frequency radiation to reach out to cell tower signals. In this condition, the cell phone battery charge consumption is higher. This leads to battery drain out.

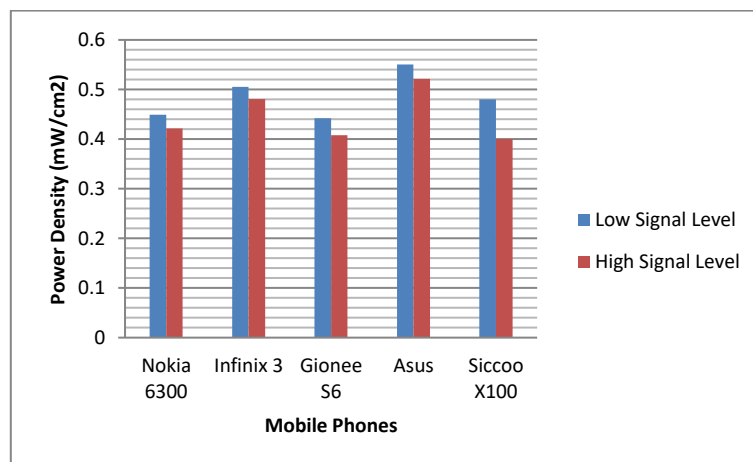


Fig. 6: The Radiation Level of Five Selected Mobile Phones with Low Signal and High Signal Level during Call Establishment.

4. Conclusion

The factors affecting the electromagnetic radiation level from cell phones has been investigated in this paper. It is discovered that the number of inserted SIMs, low signal level and low battery charged level lead to increase in radiation level. Also, radiation intensity of mobile phone is also seen to be higher during call establishment, call seeking period and when the mobile unit is connected to the power main.

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