

# Investigation of Radio Frequency Emissivity Effect on Human Cells

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**Abstract-** This paper reviews some papers discussing the effect of radio frequency (RF) on human cells and proposal toward better experimental work. A prototype of radio frequency absorber box with air ventilation was introduced in order to investigate its effect on human cells. A few factors that contribute to the effect of radiation is recognized and studied. The success of our proposed iron mesh box to absorb RF signals was demonstrated wherein normal level of RF radiation is achieved within the closed system of the incubator. The mesh box has been shown to have absorbed at least 88.11% of total RF generated.

**Keywords-** Radio Frequency, Human, Health

## I. INTRODUCTION

As the technology grows, the use of various wireless communication methods has increased. The awareness of the effect on radio frequency wave is crucial for everybody so that the flexibility of using the technologies provide greater benefits over the adverse effects on human health. Wireless communication is needed for several applications but the RF channel propagation of the signals in different bandwidth and environment must be proven safe and harmless to other systems including human body.

In this paper, a few wireless technology characteristics are discussed for average daily usage. Two categories are observed; which are active and passive users. Active user is someone who is actively using any portable wireless technology devices while a passive user is someone who is not using that particular wireless technology but was present in the area which was occupied by certain wireless facilities. Fig. 1 shows data rate of common wireless facilities with range capability.

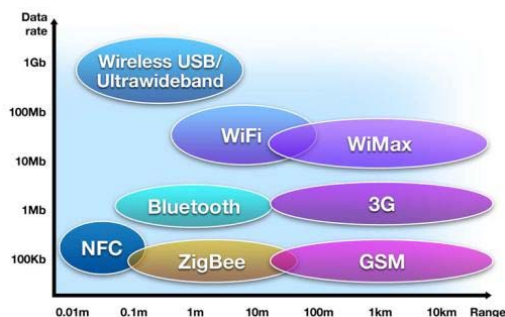


FIG 1: DATA RATE AND RANGE FOR WIRELESS FACILITIES

The use of RF and microwaves technologies in health and medicine has increased dramatically over the last ten years. RF and microwave therapies for the treatment of cancer in humans are well documented, and are presently used in many cancer centres. New modalities are being studied and focused on RF and microwave application. The enhancement of technology in drug absorption and microwave septic wound treatment, microwave imaging for the detection of breast cancer, epidemiological studies on the effects of rats' exposure to microwave, and also tissue regeneration using electromagnetic fields. Presently, the technology is being developed which allows for permanent implantation of microwave wireless sensors in humans [1]. A permanently implantable intra-cranial pressure monitor is one of the applications with the latter technology approach.

There are specific test guidelines introduced in order to prove the result obtained, and to ensure the safety of subject under study.

### A. Test Guidelines

The guidelines of RF exposure and radiation have been promulgated for nearly half a century. However, the understanding of biological effects of exposure to RF radiation is still evolving and more so for cellular mobile telephones and wireless personal communication devices [2]. The maximum power deposition which measured in specific absorption rate of RF energy-SAR allowed varies between 1.6 W/kg in 1 g and 2 W/kg in any 10 g of tissue in the head, from exposure to cellular telephone wireless radiation.

The standard of guidelines for maximum permissible levels of exposure to RF and microwave radiation is a valid approach to managing the risk of such exposures. Meanwhile the existing guidelines, are based on results obtained from acute, short-term studies that are atypical of the RF exposures associated with the handset of cellular mobile telephones.

A SAR test methodology has been developed by [3] in order to provide safety assessment for the two WNaN antennas in the range of 900 to 6000MHz frequency band. For the extreme wide band operating frequency, three sub-bands have been devised to minimize uncertainty from the measurements caused by the deviation of the permittivity and conductivity from the target values. A software tool has been developed to adopt error correction

and dielectric parameters prediction algorithms. A numerical solution using finite-difference time-domain (FDTD) modelling is also developed to evaluate the SAR measurements.

## II. RELATED WORKS

A few works done by other researchers are discussed and will be divided into two subtopics. First subtopic is works indicating that RF radiation is bad for human health and second subtopic is works indicating negligible effects of RF on human health. Before any statement is being judge, few of parameters should be considered.

### A. *Works indicating that RF radiation is bad for human health*

Radio Frequency (RF) radiation effects are strictly relying on few critical factors such as frequency, period of exposure and distance. Certain frequency ranges are absorbed in body tissue more than the other frequency range. The second factor is the duration of exposure. Where, over the period of time, the body will absorb more RF frequencies which hence will worsen the human tissue. The third factor is the distance of radiating elements from the human body. Hence, with respect to that unawareness of human towards the effects of the RF exposure, the study conducted by [4] simulated the base station radiation effects on human health.

The experiments was conducted using mice as it has the closest DNA structure to human and the frequency used in the experiments was 1.8 GHz [5]. The mice were exposed at 1.8 GHz frequency, certain level of intensity and over a period of time. Second test conducted was the histopathology to examine the tissue of the mice out from the autopsy. The third test was the blood count on red blood cells, white blood cells, hemoglobin and packed cell volume. From the tests which are conducted at veterinary Lab, there are evidences of degeneration of cells in some organs through histopathological procedures. While in through biochemistry test, the level of blood calcium and phosphorus were decreasing and the level of blood creatinine was increasing. All this evidences show that, exposure to certain level of frequencies will affect human body.

The group had proceeded to investigating WiFi frequency of 2.4 GHz [6]. The radiation was exposed to mice continuously everyday for 8 hours and for 6 months period. The research is conducted on a laboratory with a few cages consists of 30 male mice and they were placed at a far-field distance of 1.0m from the antenna of the RF generator source. Another cage control which consists of 30 male mice was placed far away from radiation area, almost under free-radiation. The results were categorized into three tests that are Pathology Lab, Blood Count and Biochemistry Lab. From the tests, it has been shown that the degeneration occurs in the cells on some organs through histopathological procedures.

In [7] they strongly claim that the exposure to RF radiation has some biological effects to the laboratory

mice as well as human being, as they have some similarities in biological characteristics.

Li Yang et al in [8] simulated the RF fields focused on the eye cells model and the eyes with glasses of metal frame respectively. A planar inverted F antenna is used as an exposure source at 900 MHz. Under this case, the intensity of the electrical field is calculated and analysed. Also, SAR is utilized to evaluate the absorption of the organs to the radiation. Through the simulation, the peak values of SAR per 1g tissue at the radiating power being 600mW are obtained. It is concluded that when people wear glasses of metal framework, the peak value of SAR is shown to be a little higher than the safety limits. It is suggested that the radiation from the mobile handset do more harm to the eyes of wearers glasses of metal frameworks.

### B. *Works indicating negligible effects of RF on human health*

The National Council on Radiation Protection published a two-tiered approach to exposure standards for several reasons. First, individuals exposed in the work place are generally informed of the potential hazards of the exposure and can decide to limit that exposure if desired. Such knowledge cannot be expected of the general population. Second, the general population contains individuals who may be rehabilitated in some manner and for whom occupational exposure levels may present undue risk. Lastly, the general population is much larger than the work population, and thus the number of people at risk is correspondingly larger. Consequently, a meaningful reduction in exposure levels is indicated in order to ensure proportionate risk levels for occupational nonoccupational environment.

Stephen in [9] said that there is no supportable evidence to show that radiation from cellular telephones causes adverse health effects. Therefore, the more intelligent yet effective approaches must be carried out for the sake of human safety

The two situations above shows that RF signals could give either bad effect or no effect at all to human health. In this work, a few criteria and parameters are counted in order to have more specific procedures especially for passive and active users.

## III. METHODOLOGY

In this research, animal culture cells are used to represent a life cell. These cells will be radiated with radio frequency with certain levels of power with variety of frequency. A signal generator was used to generate the RF signal and measurement of receiving power level was captured by spectrum analyzer. A directional antenna was used to radiate the cells in a special iron mesh box size (9.25" x 5" x 5.5"). This box has the capability to absorb the RF signal to make sure there is no radiation effect outside the box. The box is placed in an incubator to make

sure the cells alive. The diagram in Fig. 2 below shows the arrangement of experiment. The control experiment is placed in incubator without the radiation. The parameter of each device used is tabulated in Table 1.

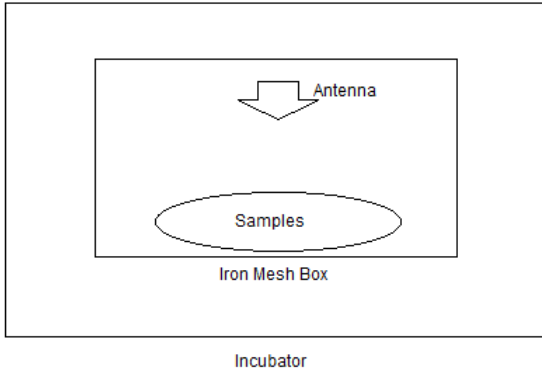


FIG. 2: BLOCK DIAGRAM OF EXPERIMENT SET UP

TABLE 1: PARAMETER USED IN EXPERIMENT

Parameter	Value
Frequency Used	900 MHz, 1800 MHz, 2.4 GHz
Power Transmit	0 dBm, 3 dBm, 6 dBm, 9 dBm
Distance from Antenna	1 m
Number of Samples	1000
Temperature & Humidity	37.5 Celcius

The iron mesh box was wound by three layers of iron mesh in order to protect the signal from penetrating to the outside. The mesh type of metal is used to make sure there are air ventilation in the box so that the cells remain alive.

#### IV. RESULT AND DISCUSSION

As a preliminary result, the reading of spectrum analyzer for certain frequency in and outside the iron mesh box is presented. Fig. 3 shows the setup frequency at 2.4 GHz and 8 dBm RF power level on signal generator.



FIG 3: READING OF SIGNAL GENERATOR WHEN 8 DBM POWER IS RADIATED

A reading for a controlled environment with background frequency of 2.4 GHz which is considered the normal environment is obtained as shown in Fig. 4. The average signal power was approximately -95 dBm as reference reading in a normal environment equipped with WiFi facilities.

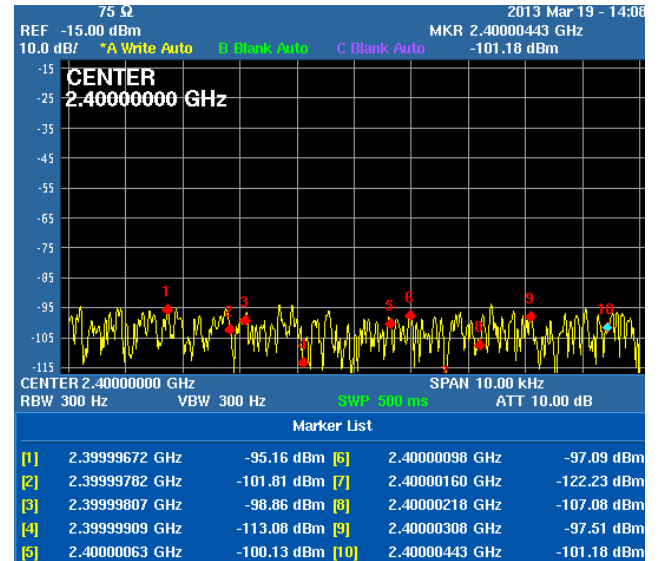


FIG 4: READING OF SPECTRUM ANALYZER FOR CONTROL ENVIRONMENT

After the signal generator is turned on, 8 dBm of RF power is radiated with one meter distance between the spectrum analyzer. The power received is captured as -46.93 dBm (refer marker number 5) as in Fig. 5.

The antenna was placed in the iron mesh box to measure the effectiveness of iron mesh box in absorbing the RF signal. Reading of spectrum analyzer outside of iron mesh box shows signal power is decrease at -88.28 dBm (refer marker number 5) as in Fig. 6. This indicated that 88.11% of RF is absorbed by iron mesh box.

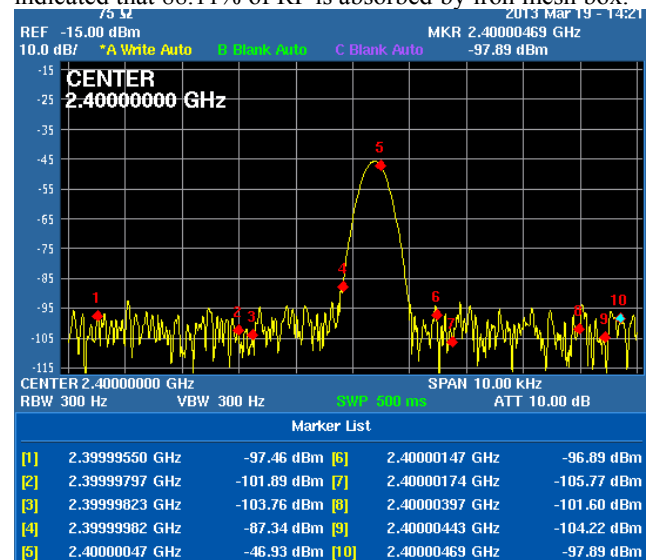


FIG 5: READING OF SPECTRUM ANALYZER WHEN 8 DBM POWER IS RADIATED FROM SIGNAL GENERATOR

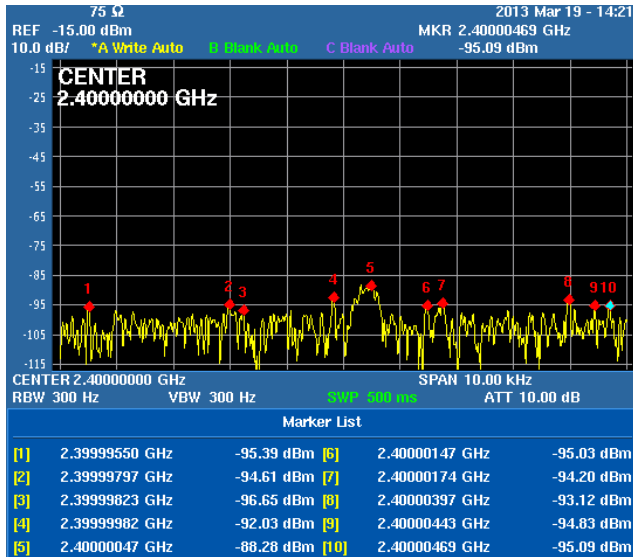


FIG. 6. READING OF SPECTRUM ANALYZER WHEN 8 dBm POWER WAS RADIATED FROM SIGNAL GENERATOR AND ABSORB BY IRON MESH BOX.

The data obtained is tabulated in Table II to compare the power radiated and received in the experiment.

TABLE II: PARAMETER USED IN THE EXPERIMENT

Power Transmit at Signal Generator	Power received (Outside the Box)	Power received (Inside the Box)
8 dBm	-88.28 dBm	-46.93 dBm

The results proved that the developed iron mesh box was able to block and absorb the radiated signal from signal generator about 88.11%. The value captured was similar as the reference condition at -95 dBm. Furthermore, the advantage of using mesh type material is the ability to allow the cells to breathe in incubator environment.

## V. CONCLUSION

The success of the iron mesh box in absorbing almost 88.11% of RF signals produced an environment of strength of the normal radiation for the cells within the box. The strength of the signals measured in the incubator was reduced significantly by the mesh iron box and they are well within the normal power level permitted. More experiments will be conducted in the future using the

emission of RF signal on animal culture cells and observations on the chemicals produced by the cells during the test will be carried out.

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