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Optimization of Specific Absorption Rate in Human Brain

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ABSTRACT: The main objective of this system is to measure the SAR using PIFA antenna as well as the measurement of SAR for frequency between 900-1800 MHz and an analysis of dynamic SAR. The increased amount of electromagnetic emission has increased the health risks. Many researchers have simulated, measured, and evaluated the probable biological effects of M elds on the human and other living systems. Several researchers have simulated the human body models, specially the human head and have evaluated the effective parameters on SAR. Here in this paper specific absorption rate (SAR) inside a human head and the thermal effects due to exposure to a cellular phone calculated by modeling PIFA antenna at 900MHz and 1800MHz. By the aid of HFSS software program, SAR in the head model for six layer was investigated.

KEYWORDS*:* Brain, SAR, Colony Stimulating Factor, CSF, E-Field.

I. INTRODUCTION

It is well known that high frequency EM fields can damage human and other biological tissues by damaging molecular structure and rising of body temperature. The biological effects of radiofrequency fields and living systems can be evaluated at various levels including the molecular, subcellular, organ, or whole body environments. According to [1, 2], bioeffects from radiofrequency fields are classified into three categories: that is, high-level effects (thermal), intermediatelevel effects (athermal), and low-level effects (nonthermal). Thermal effects are energy depositions higher than the natural human thermoregulatory capacity. The studies show some effects due to nonthermal and athermal sources such as: blood brain barrier, morphology, immune system, gene and chromosomal morphology, enzyme activity, and tumour promotion. More information can be seen in [3–5]. In this paper dosimetry and SAR are defined. So the human head model (one and six layers) and an antenna as an exposure source are simulated in HFSS software. For validation of results two antenna types are used, dipole and PIFA. The results for SAR and E-field strength for these two models are shown and compared. Because of some limitations the standard phantom models are made of one layer. For example, because of the gel or liquid materials, it is not easy to model all tissues. For example, the human head is a multilayer tissue, and its modelling is very hard. These phantoms are not good models for the human tissue, because the real properties of tissues are different from each other. Also, the human head does not have equivalent electrical properties. So the Sixlayer phantom model is the better model of human head to simulate.

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II. SYSTEM IMPLEMENTATION

A. Measurements of EM Field Absorption

In this part the dosimetry is introduced. Some parameters have been used to measure EM fields. The SAR as a quantity for EM measurement at radiofrequency spectrum is defined and finally the electrical properties of tissues, that is, conductivity and permittivity, are described. Definition of asosimetry According to [7] the relationship between exposure levels and electromagnetic energy deposited in the body is called “electromagnetic dosimetry.” On the other hand, the electromagnetic dosimetry describes the relationship between the induced fields in biological bodies and distribution of an electromagnetic field in free space. Dosimetry information is very important to protect humans from probable electromagnetic field health hazards. 2.2. S□e□ifi□ □bsor□tion □ate. By the widespread wireless device applications, such as mobile phones, the persons, and operators living and working in near electromagnetic sources, the biological effects of exposure to these electromagnetic fields are an important subject. The safety standards, such as the Federal Communication Commission (FCC), the International Commissions on Nonionizing Radiation Protection (ICNIRP), and National Radiological Protection Board (NRPB), are established for human protection and safety from electromagnetic fields. The specific absorption rate (SAR) is used to quantify the energy absorbed in tissues at radiofrequency spectrum, which is expressed in units of watts per kilogram.

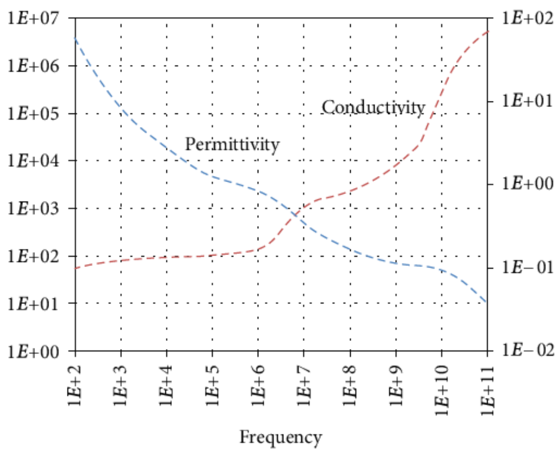

Fig.1 Dielectric properties spectrum of a high water content tissue

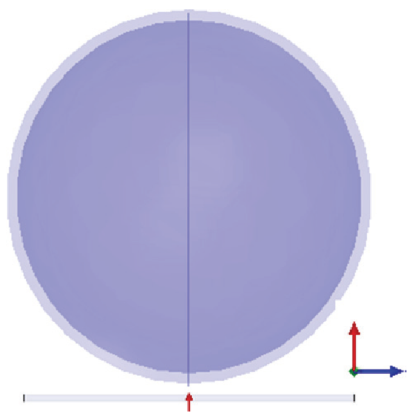

Fig. 2 One-layer human head model defined in HFSS software.

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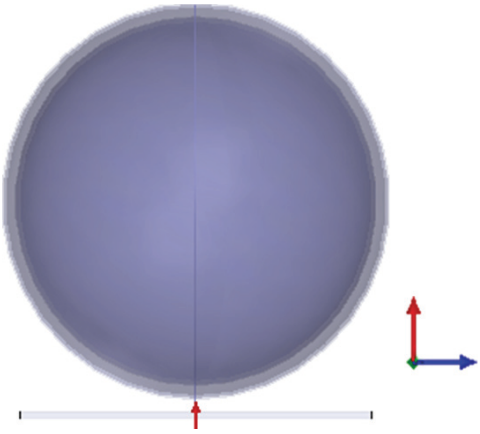

Fig. 3 Six-layer human head model defined in HFSS software

B. SAR-SPECIFIC ABSORPTION RATE

The quantity used to measure how much RF energy is actually absorbed by the body is called the Specific Absorption Rate or SAR. It is usually expressed in units of watts per kilogram (W/kg). From 1st September 2013,only the mobile handsets with revised SAR value of 1.6 w/kg would be permitted to be manufactured or imported in India.

III. LITERATURE SURVEY

Low-level exposure to radiofrequency electromagnetic fields: health effects and research needs - M. H. Repacholi - 2010 The World Health Organization (WHO), the International Commission on Non-Ionizing Radiation Protection (ICNIRP), and the German and Austrian Governments jointly sponsored an international seminar in November of 1996 on the biological effects of low-level radiofrequency (RF) electromagnetic fields. For purposes of this seminar, RF fields having frequencies only in the range of about 10 MHz to 300 GHz were considered. This is one of a series of scientific review seminars held under the International Electromagnetic Field (EMF) Project to identify any health hazards from EMF exposure. The scientific literature was reviewed during the seminar and expert working groups formed to provide a status report on possible health effects from exposure to low-level RF fields and identify gaps in knowledge requiring more research to improve health risk assessments. It was concluded that, although hazards from exposure to high-level (thermal) RF fields were established, no known health hazards were associated with exposure to RF sources emitting fields too low to cause a significant temperature rise in tissue. Biological effects from low-level RF exposure were identified needing replication and further study. These included in vitro studies of cell kinetics and proliferation effects, effects on genes, signal transduction effects and alterations in membrane structure and function, and biophysical and biochemical mechanisms for RF field effects. In vivo studies should focus on the potential for cancer promotion, co-promotion and progression, as well as possible synergistic, genotoxic, immunological, and carcinogenic effects associated with chronic low-level RF exposure. Research is needed to determine whether low-level RF exposure causes DNA damage or influences central nervous system function, melatonin synthesis, permeability of the blood brain barrier (BBB), or reaction to neurotropic drugs. Reported RF-induced changes to eye structure and function should also be investigated. Epidemiological studies should investigate: the use of mobile telephones with hand-held antennae and incidence of various cancers; reports of headache, sleep disturbance, and other subjective effects that may arise from proximity to RF emitters, and laboratory studies should be conducted on people reporting these effects; cohorts with high occupational RF exposure for changes in cancer incidence; adverse pregnancy outcomes in various highly RF exposed occupational groups; and ocular pathologies in mobile telephone users and in highly RF exposed occupational groups. Studies of populations with residential exposure from point sources, such as broadcasting transmitters or mobile telephone base stations have caused widespread health concerns among the public, even though RF exposures are very low. Recent studies that may indicate an increased incidence of cancer in exposed populations should be investigated further.

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Current state and implications of research on biological effects of millimeter waves: a review of the literature - A. G. Pakhomov, Y. Akyel, O. N. Pakhomova, B. E. Stuck, and M. R. Murphy - 2012 In recent years, research into biological and medical effects of millimeter waves (MMW) has expanded greatly. This paper analyzes general trends in the area and briefly reviews the most significant publications, proceeding from cell-free systems, dosimetry, and spectroscopy issues through cultured cells and isolated organs to animals and humans. The studies reviewed demonstrate effects of low-intensity MMW (10 mW/cm2 and less) on cell growth and proliferation, activity of enzymes, state of cell genetic apparatus, function of excitable membranes, peripheral receptors, and other biological systems. In animals and humans, local MMW exposure stimulated tissue repair and regeneration, alleviated stress reactions, and facilitated recovery in a wide range of diseases (MMW therapy). Many reported MMW effects could not be readily explained by temperature changes during irradiation. The paper outlines some problems and uncertainties in the MMW research area, identifies tasks for future studies, and discusses possible implications for development of exposure safety criteria and guidelines.

Exposure To High Frequency Electromagnetic Fields, Biological Effects and Health Consequences (100 KHz–300 GHz), International Commission on Non-Ionizing Radiation Protection - P. Vecchia, R. Matthes, G. Ziegelberger, James Lin, and R. Saunders - 2013 Intensive research has been performed over the last decades on the biological and health effects of electromagnetic fields. The studies have covered different areas due to the complexity ofthe issue, including analysis ofsources, exposure assessment, dosimetry, in vitro and in vivo biological research, and epidemiological surveys. An evaluation of possible risks of EMF exposure therefore requires a multidisciplinary approach, with expertise in the areas of biology, medicine, epidemiology, physics, and engineering. To this purpose, expert groups in several countries have been set up by national governments or health authorities.

IV. SYSTEM ANALYSIS

A. Existing System

Measurements of SAR and EM fields in the human body are difficult. The phantom have been designed to model the human body at normal body temperatures, they have many shapes, such as spherical and human-like bodies. A computer processor calculates the SAR of a single layer head model. These measurement systems have several problems.

B. Proposed System

A six-layer human head model has been tried instead of a one-layer common phantom model, because it models the real human head in a much better way. This new model is composed of six spheres, similar to a six layer model for the human head, that is,

- Skin
- Fat
- Bone
- Dura
- CSF
- Brain

A PIFA antenna has been used as the exposure source. The antenna is situated at 0.2mm distance from the head models in both one- and six layer models. The simulations have been done at frequency 900 MHz and 1800 MHz.

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V. RESULTS AND DISCUSSION

In this section, we provided the simulated results of entire project with its practical proofs.

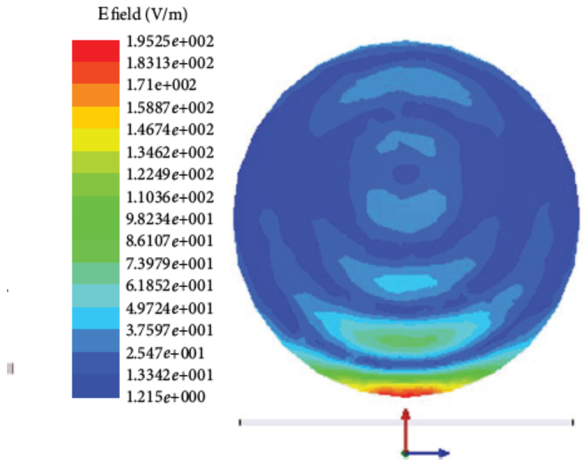

Fig.4 E-Field strength of a six layer human head

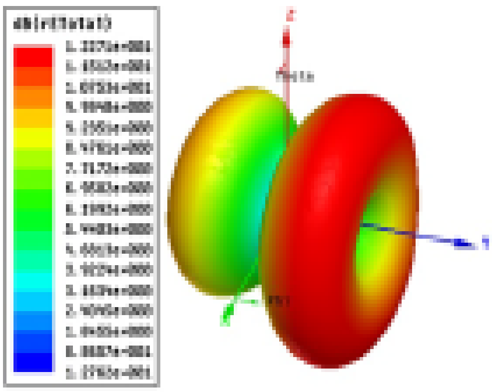

Fig.5 Radiation pattern of antenna when placed at 0.2mm

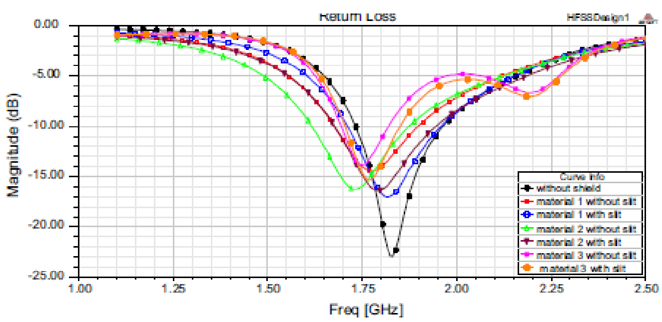

Fig.6 Return loss of a mobile phone antenna

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VI. CONCLUSION

SAR distributions in the six layer human head are investigated for the human brain, which is exposed to RF radiation from a cellular mobile communication device. We have been able to draw important conclusions from the simulations, because we observed the effect of distance and frequency of the mobile phone antenna.

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