EFFECT OF MOBILE PHONE RADIATION ON HUMAN BODY

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ABSTRACT

The electro-magnetic field strength and specific absorption rate have been calculated in close proximity to mobile phones base stations in this paper. The induced Specific absorption rate inside human body tissues, particularly in fat and muscles due to mobile phone base station frequency (900-1200 MHz) has been evaluated. The calculated values of Specific absorption rate have been compared with standard limits given by various international authorities like Federal Communication Commission (FCC), International Radiation Protection Association (IRPA/INIRC), International Commission on Non-ionizing Radiation Protection (ICNIRP), Institute of Electrical and Electronics Engineers (IEEE), etc.

Keywords: Electromagnetic radiation, Specific absorption rate, Human body tissues

1. INTRODUCTION

In present scenario human body is usually exposed to electromagnetic radiation of much intensity, which depends upon the location of the human body. The human body is complex function of various parameters, like electrical conductivity, density and its complex permittivity¹. The electromagnetic radiation is characterized by its frequency, intensity of electric and magnetic fields, their direction and polarization characteristics in free space. The fields inside the tissues of biological body can interact with them and therefore, it is necessary to determine these fields for general quantification of biological data obtained theoretically. When an electromagnetic field falls upon the human body, then it partially penetrates into human body and is attenuated by human body tissues and its parts are absorbed by body tissues². The absorption of electromagnetic radiation is expected to raise the body temperature³. The variation of induced electric field inside human body tissues at two commonly used frequencies of mobile phone has been calculated by Kumar & Pathak⁴. Here, theoretically calculated internal fields have been used to evaluate Specific absorption rate at different distances from the electromagnetic radiation source.

2. MATERIAL AND METHODS

2.1 ELECTRIC FIELD SURROUNDING THE MOBILE PHONES BASE STATION

The mobile phone transmission towers transmit electromagnetic fields in the microwave frequency range. The intensity of these fields is maximum near the transmission towers and reduces with distance as it is inversely proportional to the square of distances. The value of electric field, \( E_0 \), at a distance, \( r \), from vertical transmitting antenna of power, \( P \), is given by Polk⁵:

\[
P/4\pi r^2 = E_0^2 \epsilon_0 \sigma/2
\]

\[
E_0 = (P/2\pi r^2 \epsilon_0 \sigma)^{1/2}
\]

Where, \( \epsilon_0 \) is permittivity of free space; and \( \sigma \), speed of light. The electric field, \( E_0 \), at a distance, \( r \), from vertical transmitting antenna of effective radiated power (ERP) of 50 W (ref. 6) is

\[
E_0 = 54.76/r \text{ V/m}
\]

Thus, the electric field varies inversely proportional to the distances from the transmission tower.

2.2 PENETRATION OF ELECTRIC FIELD INSIDE HUMAN BODY

When the radiated field falls on a human body, the penetration of the field depends on the frequency of radiation. Thus, the field at a depth, \( z \), due to incident electric field, \( E_0 \), on the surface is given as⁶:

\[
E_z = E_0 \exp(-z/\delta)
\]

Where, \( \delta \), is the skin depth, whose value depends upon the frequency of radiation for biological body and is given by:

\[
\delta = 1/\omega \mu \epsilon
\]

\[
q = [\mu \epsilon ((1+p^2)^{1/2} - 1)/2]^{1/2}
\]

\[
p = \sigma/\omega \epsilon
\]

Where, \( \omega \), is radian frequency of radiations; \( \epsilon \), the permittivity of tissue material; \( \mu \), its permeability; and \( \sigma \), conductivity⁷.

2.3 SPECIFIC ABSORPTION RATE

The SAR is defined as the time derivative of the incremental energy (\( dw \)) absorbed by or dissipated in an incremental mass (\( dm \)) contained in a volume element (\( dV \)) of a given density (\( \rho \)). It is given by (ref 8):

\[
\text{SAR} = d/dt (dw/dm)
\]
\[ \frac{d}{dt} \left( \frac{dw}{\rho dV} \right) \]
\[ = \sigma E_i^2 / \rho \]

where, \( E_i \) is the electric field inside the materials. The density of fat and skeletal muscles of human body is given by Stuchly\(^9\). This relation represents the rate at which the electromagnetic energy is converted into heat through well established interaction mechanism. It provides a valid quantitative measurement of all interaction mechanisms that are dependent on the intensity of the internal electric field\(^{10} \). At this point, some additional information may be relevant. For instance, some effects of radio waves modulated in amplitude at extremely low frequency (ELF) are dependent on the electric field intensity\(^{11} \). Specific interactions mechanism is better understood if they would be expressed in term of Specific absorption rate and modulation characteristics, even though the interaction mechanism may not necessarily be thermal. The value of Specific absorption rate in human body tissues due to home appliances at various frequencies is calculated by Kumar et al.\(^{12} \).

### 3. RESULTS AND DISCUSSION

The calculated values of Specific absorption rate in fat and skeletal muscle of human body from mobile phone base station are given in Tables 1 and 2. It is found that the harmful values of SAR for fat are up to a distance of 10 cm from the base station and for skeletal muscles these values are up to 4000 cm from the base station. There are standards by international bodies on exposure to the occupational and general public. The guidelines and regulations governing the safe use of RF/microwave radiations are given by the International Commission on Non-ionizing Radiation Protection (ICNIRP, 1998), the Institute of Electrical and Electronics Engineers (IEEE, 2001), National Council on Radiation Protection and Measurement (NCRP, 1986), The Australian Radiation Protection and Nuclear Safety Agency Standard (ARPANSA, 2002), etc. All these agencies have set the safe limits of whole body Specific absorption rate as 1.6 W/kg.

### 4. CONCLUSION

It may be concluded that no transmission tower should be located near to the populated area. It is also suggested that nobody should reach near (4.0 m distance) to the transmission tower.

### ACKNOWLEDGMENTS

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#### Table 1 — Variation of Specific absorption rate inside FAT at different depth

<table>
<thead>
<tr>
<th>S No</th>
<th>Distance from tower, cm</th>
<th>Specific absorption rate (W/kg)</th>
<th>1 cm</th>
<th>2 cm</th>
<th>3 cm</th>
</tr>
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<td>Incident electric field (E(_i), V)</td>
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<td></td>
</tr>
<tr>
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<td>10</td>
<td>548.7</td>
<td>10.10</td>
<td>3.9</td>
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<tr>
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<td>40</td>
<td>162.4</td>
<td>0.99</td>
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<td>0.238</td>
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<td>70</td>
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<td>0.101</td>
<td>0.038</td>
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#### Table 2 — Variation of Specific absorption rate inside skeletal muscle at different depth

<table>
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<th>S No</th>
<th>Distance from tower, cm</th>
<th>Specific absorption rate (W/kg)</th>
<th>1 cm</th>
<th>2 cm</th>
<th>3 cm</th>
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<td>0.365</td>
<td>0.348</td>
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</tbody>
</table>

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