Journal of Advances in Science and Technology

Vol. VII, Issue No. XIV, August-2014, ISSN 2230-9659

"BIOLOGICAL EFFECTS OF ELECTROMAGNETIC AND RF MICROWAVE SIGNALS"

AN INTERNATIONALLY INDEXED PEER REVIEWED & REFEREED JOURNAL

www.ignited.in

Journal of Advances in Science and Technology
Vol. VII, Issue No. XIV, August-2014, ISSN 2230-9659

"Biological Effects of Electromagnetic and RF Microwave Signals"

Nimbalkar

Research Scholar, Singhania University, Jhunjhunu, Rajasthan

Abstract – ***In this paper we present the most apparent biological effects of RF energy to living cells are due to heating. While it is not certain that RF radiation generally poses any risks to human health, some reasons exist for being concerned about human health effects from the cellular phones themselves. These concerns exist because the antennas of these phones deliver much of their RF energy to small portions of the user's head.***

Keywords: ***Radiofrequency, Electromagnetic, Biological Effect, Frequency Spectrum.***

----------♦----------

INTRODUCTION

Radiofrequency (RF) electromagnetic waves may interrelate with biological tissue through a number of mechanisms. It has not been established though that any of those proposed so far could result in adverse health effects at radiation levels below guidelines. Indeed Adair [2003], in a recent appraisal, noted that the interactions were all weak compared with the endogenous interactions and concluded that it was most unlikely that RF fields of intensity less than 100 W/m2 incidents on humans could affect physiology significantly.

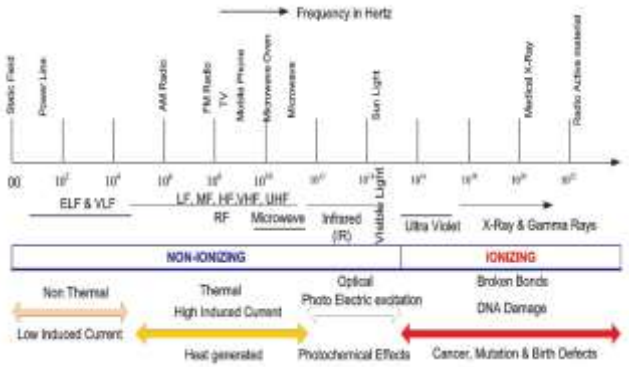
However, there also seems consensus that the possibility remains open that there could be health effects from exposure to RF fields below guidelines [e.g., AGNIR, 2003] and that more research is needed. This suggests a continuing need to consider new proposals for interaction mechanisms. The aim of the present study is to give a qualitative discussion of some of the more recently published work.

ELECTROMAGNETIC OCCURRENCE RANGE

Wireless communication links have been used worldwide for many years as solutions for connectivity in point-to-point and point to multipoint applications. The most common wireless solutions include AM and FM radio, television broadcast stations, mobile and cellular phones, radar and microwave systems.

The electromagnetic (EM) spectrum contains an array of electromagnetic waves increasing in frequency from Extremely Low Frequency and Very Low Frequency (ELF/VLF), through Radio Frequency (RF) and Microwaves, to Infrared (IR) light, Visible Light, Ultraviolet (UV) light, X-rays, and Gamma rays.

Below Figure is a graphical representation of the spectrum of electromagnetic energy or radiation in ascending frequency (decreasing wavelength). The general nature of the effects is noted for different ranges.



CHARACTERISTICS OF ELECTROMAGNETIC FIELDS

The power of each field source and the field strength it produces at the location of interest. Relevant considerations are whether the source uses adaptive power control, produces intermittent transmissions, and whether it can produce multiple carriers.

- The modulation of the signal; that is, the time-dependent amplitude and frequency (or phase) changes of each carrier.
- Multipath propagation, wave contributions from the same source arriving at the measurement position via different reflected paths and adding constructively or

destructively according to the path length in relation to the wavelength.

- Fading of the signal, as statistical variations in its amplitude over time due to multipath propagation between the source and measurement position.

- The radiation pattern generated by the source, which is the spatial distribution of the EM field with respect to the source. In the near-field, angular field distributions change greatly as a function of distance from the source. In the far-field, there should be no significant change in the angular field pattern with distance from the source, but reflecting objects in the far-field often make this assumption incorrect.

The frequency spectrum of the source(s), as energy may be distributed over several decades of frequency. The latest ultra wideband (UWB) sources have energy spread over ranges as great as 3.1-10.6 GHz.

- The impedance of the field, which describes the amount of energy associated with the electric versus the magnetic field at each point of interest in space.

- The polarization of the field, which for a single frequency field, is the direction of the electric field vector and/or the magnetic field vector. The polarization may be constant in a particular direction (linear polarization) or rotating (elliptical polarization).

- The direction of propagation for a far-field source.

- The spatial distribution of fields as a function of location from the RF source.

- The physical environment between the source and measurement location, including the ground and other reflecting objects.

RF EXPOSURE AND COUPLING INTO BIOLOGICAL SYSTEMS

When a radio frequency electromagnetic field in air impinges on a biological body it is reflected, transmitted, refracted or scattered by the biological body; the refracted and scattered fields may proceed in directions different from that of the incident RF field. These phenomena are described and governed by the well-known Maxwell's equations of electromagnetic theory. The transmitted and refracted fields from the RF exposure induce electric and magnetic fields in the biological systems that interact with cells and tissues in a variety of ways, depending on the frequency, waveform, and strength of the induced fields and the energy deposited or absorbed in the biological systems. Thus, to achieve a biological response, the electric, magnetic or electromagnetic field must couple into and exert its influence on the biological system in some manner, regardless of what mechanism may be accountable for the response.

Mechanism responsible for a given observed biological effect is of scientific interest because:

(1) They facilitate understanding of the phenomenon

(2) They help in analyzing relationships among various observed biological effects in different experimental models and subjects

(3) They serve as guides for comparison and extrapolation of experimental results from tissue to tissue, from tissue to animal, from animal to animal, from animal to human and from human to human undergoing RF exposure.

Therefore, it is important in assessing the health and safety risk of RF energy to determine not only the fields induced in biological tissues, but also the mechanisms underlying its biological interactions with cells, tissues and the human body.

BIOLOGICAL MACROMOLECULES

Bohr and Bohr have performed a series of experiments on globular proteins, particularly β lacto globulin. RF was applied for 5 s in a microwave oven at 2.45 GHz and 800 W, causing a ~0.3°C temperature increase in the protein solution. In the first publication (Bohr and Bohr 2000a) using optical rotational dispersion, the authors showed that exposure accelerated conformational changes of the protein and in a second paper (Bohr and Bohr 2000b) they reported an enhancement of folding and denaturation of the protein. These observations were interpreted as evidence of coherent RF excitation of irrational or torsional modes leading to altered conformation of the protein molecules. However, their discussion did not consider the difficulty of direct excitation of irrational modes by RF nor the effects of damping (Adair 2002; Challis 2005).

The hypothesis of an alteration of the conformation of proteins through transient heating resulting from pulsed RF exposure was suggested by Laurence et al (2000). However, the maximum temperature rise produced by the RF heating depends on the heat capacity of the heated volume and the rate at which it diffuses away. The authors had used an incorrect value of the heat capacity and the temperature rises became extremely small when the correct figure was used (Laurence et al 2003).

CONCLUSION:

In this paper we analyzed the most apparent biological effects of RF energy to living cells are due

to heating. While it is not certain that RF radiation generally poses any risks to human health, some reasons exist for being concerned about human health effects from the cellular phones themselves. These concerns exist because the antennas of these phones deliver much of their RF energy to small portions of the user's head.

RF exposure on human subjects is the thermoregulatory responses of the cardiovascular system to RF-induced heating, increasing heat loss from the skin through increased skin blood flow and evaporative heat loss from sweat. Children are known to thermo regulate as well as adults in response to exercise and/or hot environments, but may be more vulnerable to dehydration.

REFERENCES:

- Zamanian and CY Hardiman Fluor Corporation, Industrial and Infrastructure Group, Electromagnetic Radiation and Human Health: A Review of Sources and Effects b July 2005
- Bohr H, Bohr J. Microwave enhanced kinetics observed in Optical Rotational Dispersion studies of a protein. Bio electromagnetics 21:68-72; 2000a.
- Bohr H, Bohr J. Microwave enhanced folding and denaturation of globular proteins. Phys Rev E61:4310– 4314; 2000b.
- Adair RK. Vibrational resonances in biological systems at microwave frequencies. Biophys J 82:1147-52; 2002.
- Challis L J. Mechanisms for interaction between RF fields and biological tissue. Bio electromagnetic 7:98-106; 2005.
- Laurence JA, French PW, Lindner RA, McKenzie DR. Biological effects of electromagnetic fields mechanisms for the effects of pulsed microwave radiation on protein conformation. J Theor Biol 206(2):291-298; 2000.
- Laurence JA, McKenzie DR, Foster KR. Application of the heat equation to the calculation of temperature rises from pulsed microwave exposure. J Theor Biol 222(3):403-405; 2003.
- Adair ER, Mylacraine KS, Allen SJ. Thermo physiological consequences of whole body resonant RF exposure (100 MHz) in human volunteers. Bio electromagnetics 24(7):489-501; 2003.
- AGNIR. Health effects from radiofrequency electromagnetic fields. Report of an Independent Advisory Group on Non-ionizing Radiation. Docs NRPB 14(2), Chilton, NRPB; 2003.