

Study of the Effects of RF/MW Radiations on Humans

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ABSTRACT

Electronic devices have become a very important part of everyone's life, as these devices give some benefits of use on the other hand they are risky in their use. These devices emit radiations which are harmful for the human beings as well as for the environment. In this paper we have discussed about the sources of electromagnetic radiations, tolerable level of radiations, some effects that can be caused by electromagnetic radiations and the effect on the environment. Also some precautions are discussed which can reduce the effect of radiations to some extent. At the end of the paper we found out that the electromagnetic radiations produced from cell phones, computers and related equipment, microwave ovens, radio and TV transmitters and other electrical and electronic appliances are analogous to the cigarettes of 21th century.

Keywords - EM Radiations, Electromagnetic spectrum, Electromagnetic radiations (EMR). Electromagnetic pollution.

I. INTRODUCTION

The various equipments which generate electromagnetic radiations such as wireless phones various electrical equipments etc. have now become a very important part of life. Life cannot be imagined without these equipments. These electromagnetic devices have various uses in domestic, industries and medical technology. Induction heating is used in industries, MRI and CT scan are used to find out the abnormal conditions in human body and hyperthermia technique is used to treat cancer and tumors. In spite of all usefulness the electromagnetic fields impose a great danger to the human body. Electromagnetic pollution (or EMF pollution) is a term given to all the man made electromagnetic fields (EMF) of various frequencies, which fill homes, workplaces and public space.

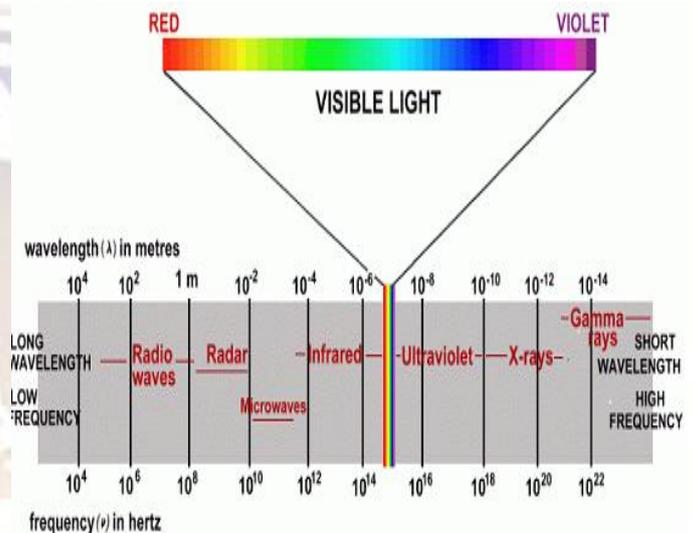


Figure.1 Electromagnetic Spectrum

The Electromagnetic spectrum consists of all frequency domains increasing in frequency from lowest frequency(10⁴) to highest frequency(10²²) through Radio wave, Radar, Microwave, Infrared, Ultraviolet, X-ray, Gamma rays .

II. CLASSIFICATION:

The Electromagnetic radiation can be classified into ionizing radiations and non-ionizing radiations, based on whether they are capable of ionizing atoms and breaking covalent bonds. Ultra violet and higher frequencies, such as X-rays or gamma rays are ionizing. These pose their own special hazards. Non-ionizing radiations are associated with two major potential hazards: electrical and biological. Additionally, induced electric current caused by radiation can generate sparks and create a fire or explosive hazard. The electromagnetic spectrum includes several different classes of radiation: low frequency, radio waves, microwaves, infrared, visible light, ultraviolet light, x-rays and gamma rays. Wave frequency is what differentiates one class of radiation from another. Figure 1 shows the electromagnetic spectrum [1].

Electromagnetic pollution is due to frequencies below (oscillating slower than) visible light waves. Of course, x-rays and gamma rays (which oscillate faster than visible light) are highly dangerous but homes and workplaces are not filled with these rays. Electromagnetic pollution is everywhere.

A. SOURCES OF ELECTROMAGNETIC/RADIO WAVES RADIATIONS

Here's a short list of the main culprits:

- a) Cell (and other mobile) phones
- b) Computers and related equipments
- c) Microwave ovens
- d) Radio and TV transmitters
- e) Electrical and electronic appliances
- f) House-wiring
- g) High and low voltage power lines
- h) Information Networks
- i) Cars, Motor cycles, Buses, Trains, Aero planes.

Level of radiation that is safe:

Various standards and guidelines have been developed by organizations and countries over the past several decades. Safety factors are then incorporated to arrive at specific levels of exposure to provide sufficient protection for various segments of the population. Not all standards and guidelines throughout the world have recommended the same limits for exposure. This philosophy is inconsistent with the approach taken by most other standards-setting bodies which base limits on levels where recognized hazards may occur and then incorporate appropriate safety margins to ensure adequate protection.

In the United States, although the Federal Government has never itself developed RF/MW exposure standards, the FCC has adopted and used recognized safety guidelines for evaluating RF/MW environmental exposure since 1985. Federal health and safety agencies, such as the Environmental Protection Agency (EPA), the Food and Drug Administration (FDA), the National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) have also been actively involved in monitoring and investigating issues related to RF/MW exposure. The Institute of Electrical and Electronics Engineers (IEEE) and the National Council on Radiation Protection and Measurements (NCRP). The ANSI committee on RF exposure standards (Standards Coordinating Committee 28) became a committee of the IEEE, and revised its earlier standard and issued its own two-tiered standard that had been developed over a period of several years. The ANSI/IEEE standards have been widely used and cited and have served as the basis for similar standards in the United States and in other countries[2].

B. What biological effect can be caused by RF/MW radiations?

There are studies showing frequency-specific biological effects, and studies demonstrating that a high frequency signal modulated at certain low frequencies, or a signal

that is pulsed, has more harmful effects than an unmodulated, steady carrier. These so-called 'window effects' greatly complicate any attempt to understand the relationship between electromagnetic radiation and health. [5][6]

Some of the most known effects of RF/MW radiations are given below:

- Blood Brain Barrier
- DNA damage
- Risk to children
- Effect on skin
- Tinnitus and Ear damage
- Effect on Eye/ melanoma.

Increase in cancer risk

C. Biological Effect on environment:

(1) Farm animals:

- Dairy cows – Decreased milk production, spontaneous abortions, reproductive and developmental problems, and General declines in overall health.
- Sheep, dogs, cats, rabbits living near base stations are also affected by EM radiations.

(2) Birds:

- Interfere with navigation, reproduction, thinning of egg shells.
- In India and London - 75% fall sparrow population due to EM radiation. Sparrows are "Red List" of endangered avian species due to EM radiations.
- Prolonged EM radiation exposure in pigeons, swans, white stork and rock dove reduces their immunity and causes many diseases such as bird flu which in turn affects the humans.

III. SPECIFIC ABSORPTION RATE (SAR) AND CELL PHONE USE TIME LIMIT

The specific absorption rate (SAR) is the rate at which radiation is absorbed by human body, measured in units of watts per (w/kg) which is actually for 6 minutes. In has a safety margin of 3 to 4, so a person should not use cell phone for more than 18 to 24 minutes per day. This information is not commonly known to Indian people.

Cell phones and SAR value

Manufactures	Model	SAR Output (W/Kg)
Motorola	V 195	1.6
Motorola	Rival	1.59
Sony Ericsson	Satio	1.56
Nokia	E71X & X6	1.53
BlackBerry	Curve 8330	1.54
Samsung	Blue earth	0.196
Samsung	S3650corby	0.75
Samsung	Sgh-g800	0.23
LG	Rumor	1.51
SAR is expressed in Watts per Kilogram		
Current UK Standard = 1.0W/Kg		
Current US Standard = 1.6W/Kg		

A San Francisco Govt. has made it mandatory for the industry to display SAR value for each phone (USA today 14 July, 2010)

IV. FACT OF CLOTHING

It is known that RF/MW radiated energy will be absorbed by the tissue of the human body. The depth of energy penetration into the tissue depends primarily on the wavelength of the incident radiation and the water content of the tissue [3] [4]. Clothing can act as an impedance matching transformer for RF/MW radiation. In 1986, Gandhi and Riazi [4] reported that the coupling efficiency of clothing may be as high as 90-95 percent for incident radiation in the millimeter-wave band. They determined that the thickness of the clothing and frequency of the incident radiation are important factors in the coupling condition. The relationship between

clothing thickness and coupling efficiency as a function of frequency is shown below

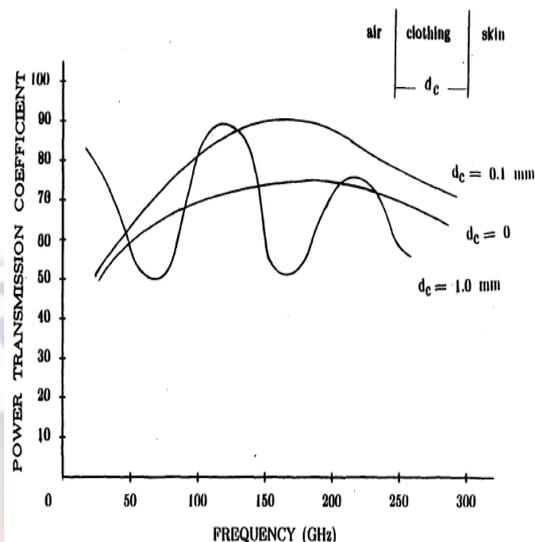


Figure: Comparison of transmission coefficient with and without clothing with no air gap between skin and exterior clothing[4].

The water content in the human tissue will influence the depth of energy penetration into the body. Millimeter-wave radiation is reported by Gandhi and Riazi [4] to penetrate less than 2 mm into the body because of the "Debye relaxation of the water molecules" in the tissue [4]. The Debye Effect was observed by a Dutch physicist named Peter Debye. He discovered that EM waves are absorbed by a dielectric because of molecular dipoles present in the dielectric material. Water molecules are essentially dipoles constructed from atoms of hydrogen and oxygen. Hence, these dielectrics are rich in molecular dipoles and are able to quickly absorb millimeter-wave radiation. High frequency radiation emission are not expected to penetrate deeply into the human body [4]

V. DEPTH OF PENETRATION

Energy emitted in the millimeter-wave band is not likely to penetrate to more the about 1 or 2 mm into the tissue [4]. Essentially, PF/MW energy radiated at wavelengths less than 3 centimeters will be captured in the outer skin surface. RF/MW wavelengths from 3 to 10 centimeters will penetrate to a depth of about 1 to 10 mm. The greatest depth of penetration into the body will occur at wavelengths between 25 to 200 centimeters. At these wavelengths RF/MW radiated energy can directly affect internal body organs and cause serious injury. The human body is reported to be transparent to RF/MW radiated energy emitted at wavelengths greater than 200 centimeters. Also, at frequencies above 300 MHz it has been observed that the depth of energy penetration fluctuates rapidly with changes in frequency. In general, the

depth of energy penetration into the body will decline as the frequency of the incident radiation increases. At 10 GHz, the absorption of RF/MW energy will be similar to IR radiation [3]. These figures were published by the U. S. Department of Health, Education and Welfare [3].

VI. HOW WE CAN PROTECT OUR SELF FROM EM POLLUTION.

- Cell phones with a lower specific absorption rate (SAR) should be used. That means SAR value of a cell phone must one of the most important criterion while buying a new Handset
- Making and receiving the calls should be done quickly so that the radiation exposure time is minimal.
- If a person cannot avoid talking for longer durations on the cell phone then it is recommended to use a wired headset because a Bluetooth paired headset will have its own EM radiation Envelope.
- Stricter radiation norms must be enforced in India. This can only be done when people have the knowledge about the dangers of EM radiations.
- Calls should not be made when the network Signal is low because the cell phone emits more EM radiations to compensate for the low network signal.
- Use of cell phones by the children should be discouraged otherwise it should be limited to bare minimum.
- Mobile base stations should be located far away from residential areas. This can only be done by passing strict laws and safety norms.

VII. CONCLUSION

1) After the study it can be concluded that the radiations from Mobile base station towers, cell phones, computers, laptops, TV & FM towers and microwave ovens etc are very harmful for us and can have adverse effect on human body depending on the intensity and frequency of the electromagnetic radiation. It is always a good idea to avoid the unnecessary exposure to electromagnetic fields whenever possible. This does not mean that we have to stop living near the towers. We all know that automobiles create air pollution. Instead of avoiding them we came up with unleaded petrol, CNG driven vehicles, and hybrid vehicles etc similarly the solution to avoid excess radiation is to use the radiation shield.

2) Mobile companies should not be in the denial mode and accept that radiation pose serious health problems. They should invest some

portion of their huge profits for R&D on eliminating the hazards posed by the EM Radiations. Only then people all over the world will carry out research to come out with solution.

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