Effect of Communication Frequency on Specific Absorption Rate of Electromagnetic Radiations in Human Body

Amarjeet Kaur, Himani Malik, Asha Lather, V. K. Lamba

Abstract: In this paper a novel approach for analyzing penetration of electromagnetic radiations in human tissue at different frequency is presented. Moreover, we concentrated our work on analyzing the other related factors describing system performance like return loss& Voltage Standing Wave Ratio (VSWR). consider We use different communication frequencies to simulate antenna for analyzing variation in Specific Absorption Rate (SAR) of electromagnetic radiations (produced by handheld communication devices) in Human tissues at different communication frequencies.

Index Terms— Electromagnetic Interaction, Electromagnetic radiations, EM waves, Return Loss, Specific Absorption Rate, SAR, VSWR, XFDTD

I. INTRODUCTION

Mobile phone industry has significantly gained the market in last few decades. People are in so much habit of keeping mobile phone with them in their daily life, that they call it as “Artificial Limb” also. Mobile phones are two way radio that use radio frequency for transmission and reception of voice and data. As the number of mobile phone users is increasing rapidly, it has become main concern to focus on the effect of radio frequency electromagnetic radiations produced by mobile phone responsible for establishing electromagnetic interaction between human body and mobile phone.

At communication frequency, human body behaves as a lossy dielectric and the EM radiation generated by mobile phone are able to penetrate through semisolid substances like living tissues and meat etc. to distance depending on its power density. Specific Absorption Rate (SAR) is the parameter for determining absorption of electromagnetic energy by human tissues.

In this paper, we have simulated tissue at different frequencies for analyzing the effect of frequency variation on SAR values & other important factors.

II. GEOMETRY USED FOR SIMULATION

Using software XFDTD 7.2.3, we have created geometry of tissue with a dipole antenna in close proximity. Geometry comprises of three parts i.e. Flat phantom, Phantom shell and a Dipole. Flat Phantom represents tissue simulating liquid which is being used for SAR measurement. Flat Phantom is a rectangular extrusion of dimension 220 X 150 mm with an extrusion in the +Z direction of 150mm. Flat Phantom is assigned the properties of tissue simulating liquid i.e. electrical properties as isotropic, magnetic properties as free space. The conductivity, relative permittivity and density are set as 0.9 S/m, 41.5 & 1000Kg/m^3 respectively.

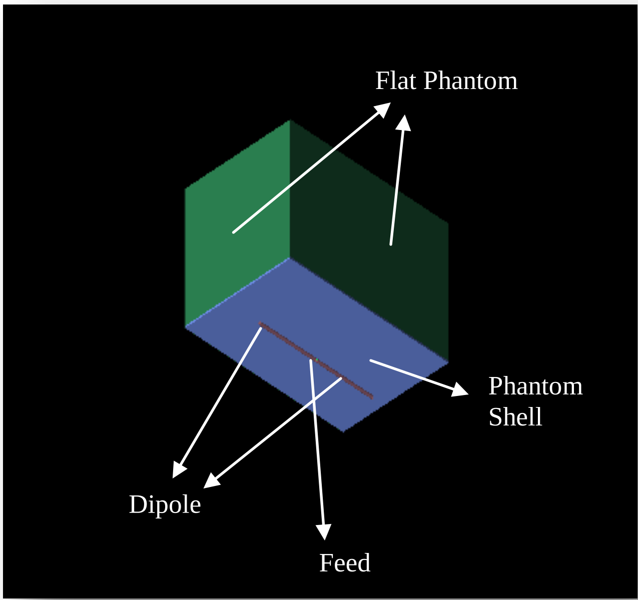

Figure1. Basic geometry of tissue being simulated in close proximity with dipole antenna

Whereas, Phantom Shell is a plastic vessel that will hold the simulating liquid (Flat Phantom). For our simulation, we require only add the bottom of Phantom shell that separates the liquid from dipole source. We have kept this shell size same as that of Flat Phantom in X, Y dimensions and have a thickness of 2mm. We have assigned the electrical properties to Phantom shell as isotropic & magnetic properties as free space. The conductivity & relative permittivity are set as 0S/m& 3.7 respectively. After creating the geometry of tissue, we have designed a simple dipole antenna which comprises of two cylinder extrusions of radius 1.8mm and a length 161mm with a gap, where a voltage source of 50 ohm voltage source.

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We have assigned electric and magnetic properties as perfect electric conductor & free space respectively. We have added SAR sensors for collecting the values of 1g and 10g average SAR data.

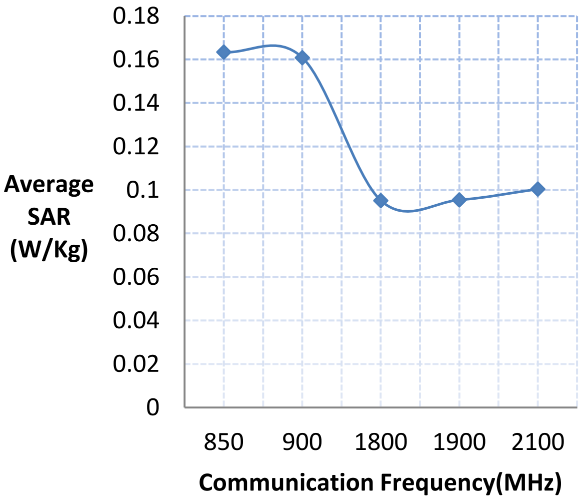
III. RESULTS

We have measured average SAR values achieved at different communication frequencies for the tissue model we have designed. Table1 shows the results we have measured for this tissue model.

Table1. Simulation results for different operating frequencies

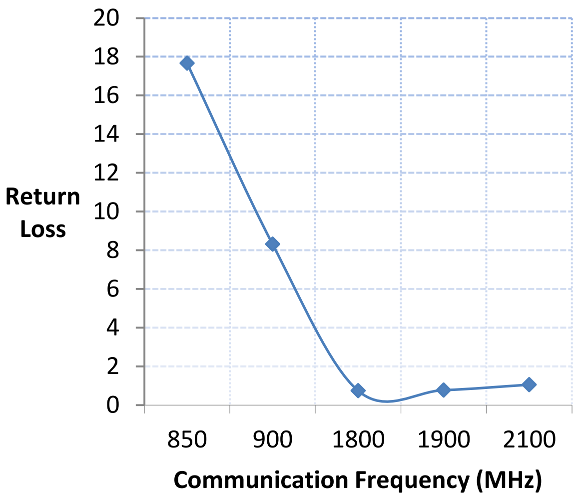
Frequency (MHz)	Average SAR (W/Kg)	Reflection coefficient	VSWR	Return Loss (dB)
850	0.1634	1.017	1.301	17.67
900	0.1608	0.3837	2.245	8.32
1800	0.09511	0.9138	23.187	0.75
1900	0.09542	0.9138	22.201	0.78
2100	0.1004	0.8849	16.369	1.06

As shown in graph 1, SAR values achieved by simulating tissue at 850MHz& 900 MHz are 0.1634& 0.1608 W/Kg respectively. While SAR values achieved at frequency 1800, 1900 & 2100 are 0.09511, 0.09542& 0.1004 W/Kg. The lowest SAR value is achieved at 1800 MHz communication frequency. It shows that It is better to use mobile phones operating at or more than 1800MHz communication frequencies.



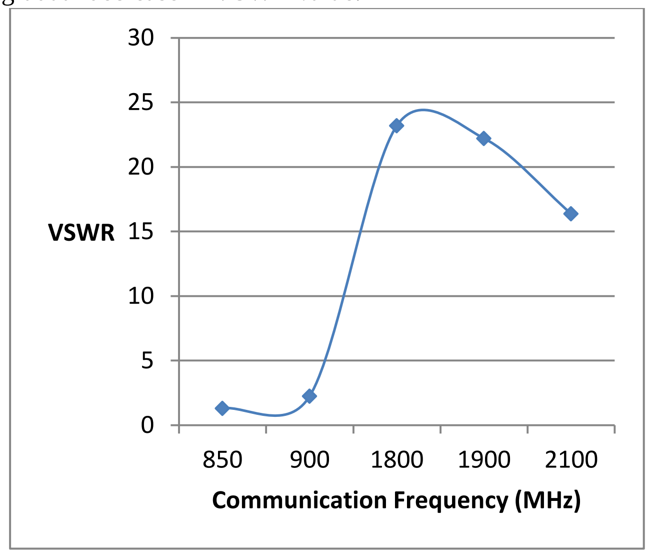
Graph1. Variation in SAR with varying frequencies

Graph 2 shows the variation in return loss with changing operating frequency. Graph shows that highest return loss of 17.67dB is achieved at 850 MHz operating frequency. The lowest return loss value is achieved at 1800 MHz frequency, which is approximately 0.75, while that in case of 1900& 2100 MHz is about 0.78 and 1.06 respectively.



Graph2. Variation in Return Loss with varying frequencies

Graph 3 shows the variation in values of VSWR with varying communication frequency. For the tissue model we have used for simulation, at 850 MHz frequency we got lowest VSWR value. While highest VSWR values are achieved at 1800 MHz. At frequencies more than 1800 MHz, It shows a gradual decrease in VSWR value.



Graph3. Variation in VSWR with varying frequencies

IV. CONCLUSION

The conclusion comes out from here is that at 1800 MHz communication frequency, lowest SAR value is achieved in comparison with that achieved at other four frequencies which are commonly used for communication. Moreover, lowest Return loss & highest VSWR value are achieved at 1800 MHz frequency. It concludes that with health and safety point of view it will be safer to use mobile phones operating at 1800 MHz communication frequency. Moreover, better performance can also be gained at this frequency with highest VSWR and lowest return loss.

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