EFFECT OF SIZE OF HUMAN HEAD ON ELECTROMAGNETIC FIELDS ABSORPTION

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ABSTRACT *– In this paper the effect of size of subject under exposure on SAR, E-Field strength and H-Field strength are simulated. The head model of a normal human (IEC 66209 standard) as an adult are simulated. Also a dipole antenna as an exposure source is simulated. On the next step to evaluate the effect of size, the size of head is reduced to* $\frac{1}{2}$ *. Also to validate the results the simulations are done at to frequencies i.e. 835 and 1900MHz. These two frequencies are for mobile telecommunication as a useable but with probable hazardous effect for human body technology. The simulations are done by HFSS.*

Key words: children, human head, IEC66209, frequency

INTRODUCTION

With the growth of use of portable devices in mobile telecommunication such as cell phones with portable antenna, the interactions between such devices become an important subject. Many experiments and studies the entire world has been done to dedicate these probable effects [1]. The biological effects have been described by many scientists the entire world. Human body has dielectrical properties which vary with frequency [2]. For more information references [3-6] can be seen. Also the EM (Electromagnetic) fields are useful for medical applications and play an important role in medical treatments such as hyperthermia to treat cancers. Many parameters affect the value of EM absorption in human tissues Such as frequencies, exposure sources and tissue sizes[7-8].

In the real world the expriment on human body with the electromagnetic source exposure is not possible duo to probable biological effects. Because of it the standards company model the human body and exposure sources to evaluate and simulate the interaction between human body and exposure sources [9].

Specific Absorption Rate

The specific absorption rate is defined

$$SAR = \frac{\sigma_E}{2\rho}|E^2| = c\frac{dT}{dt} \qquad (1)$$

Where E is the induced electric field vector, c is the specific heat capacity, σ_E is electric conductivity, ρ is the mass density of the tissue and $\frac{dT}{dt}$ is temperature increase in the tissue. The unit of SAR is Watt per Kilogram [10].

The SAR value depends on frequency, exposure source, geometry of tissue and etc. Dielectric properties of tissues are ε, μ and σ. Because of these properties EM fields can interact with human body.

For example the dielectric properties of skin have been shown in Fig1 and 2 [11].

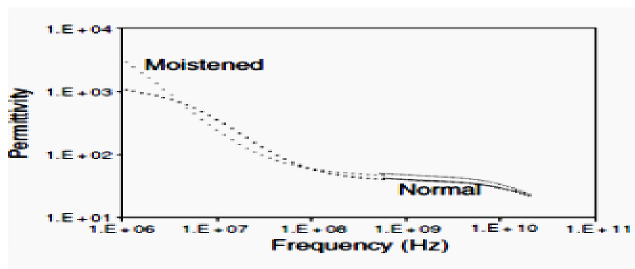
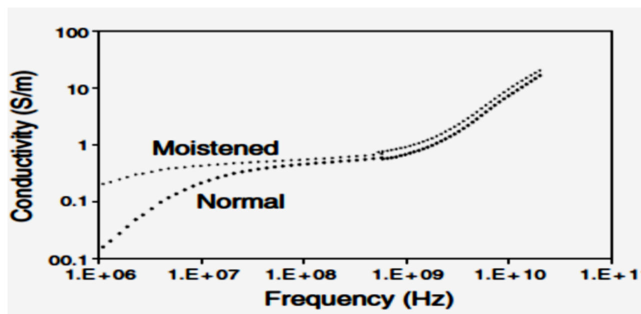


Figure 1 - permittivity of skin



Models and simulations

In this part an antenna and a human head model has been introduced. The properties of model are according to refrences [10] , [12].

The models for human head simulations are various. For example spherical, qubic, etc. we used from spherical model with sizes in IEC66209[10]. In real systems there are a shell with low loss as a human body model (phantoms). The equvalent human body matterial (in liquid or jell) put in it and a dipole antenna as an exposer source situates in for example 5mm (according to IEC66209) of it. Then a electric or magnetic probe measurs the E or H field strenth and finally with equation 1 the SAR is calculated. Figure 1 shows the model.

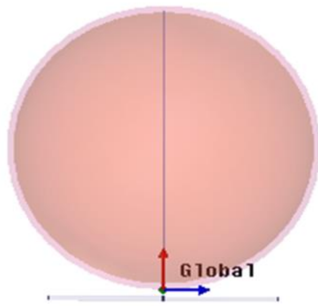


Figure 3-a-adult head and dipole antenna model

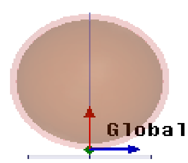


Figure 3-b- child head and dipole antenna model

The human head equavalent material properties and dipole antenna lengh are in table 1 and table 2.

Table1. the properties of human head model

	835MHz		1900MHz	
	ε_r	σ	ε_r	σ
Head matterial	41.5	0.9	40	1.4
Shell	4.6	0	4.6	0

Table2. the dipole charactristics(power=1watt)

Frequency (MHz)	Lengh(mm)	Diameter(mm)
835	161	3.6
1450	89.1	3.6

RESULTS

Figure 4 to 9 show the E and H and SAR simulations in human head model as an adult and $\frac{1}{2}$ human head model as a child at 835MHz.

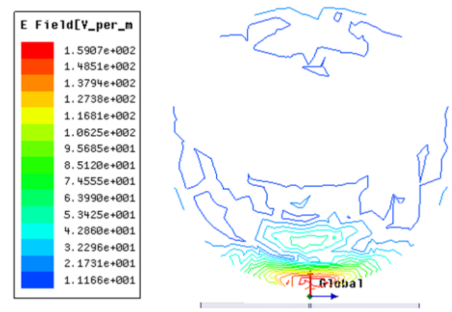


Fig4. E-field strength in adult head at 835MHz

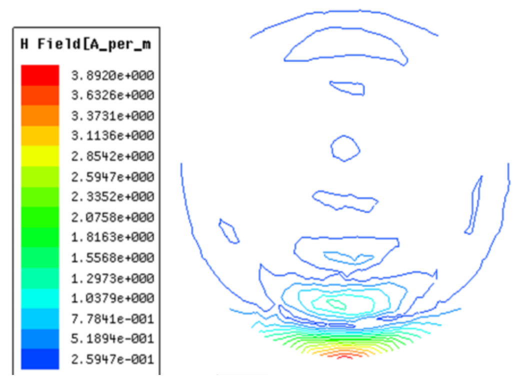


Fig5. H-field strength in adult head at 835MHz

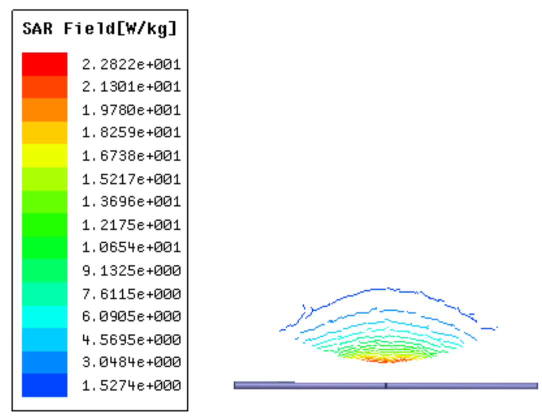


Fig6. SAR in adult head at 835MHz

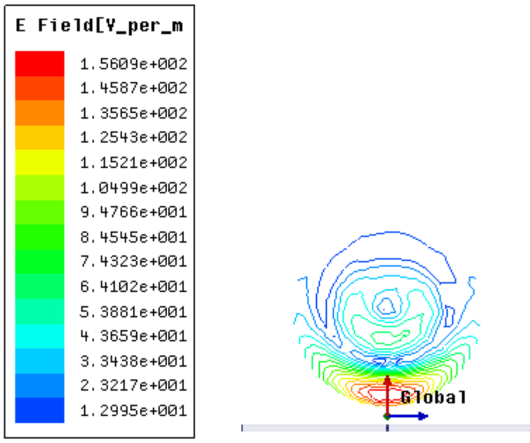


Fig7. E-field strength in child head at 835MHz

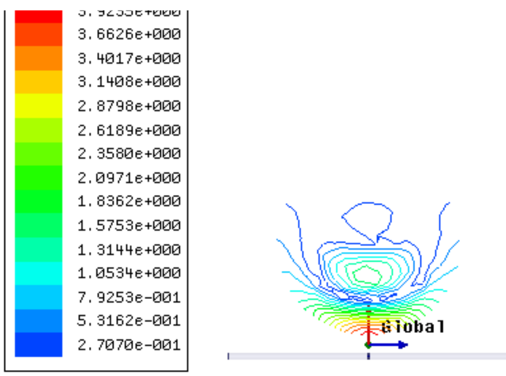


Fig8. H-field strength in child head at 835MHz

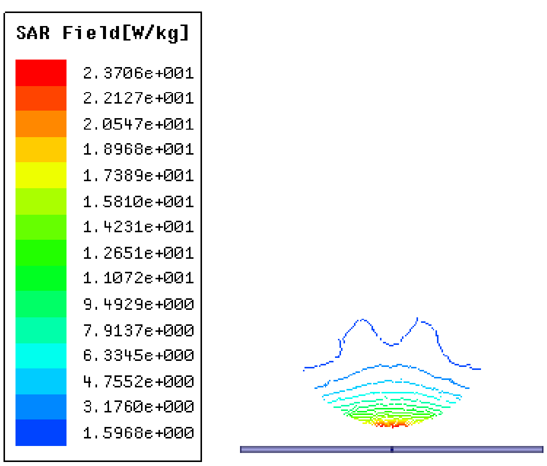


Fig9. SAR in child head at 835MHz

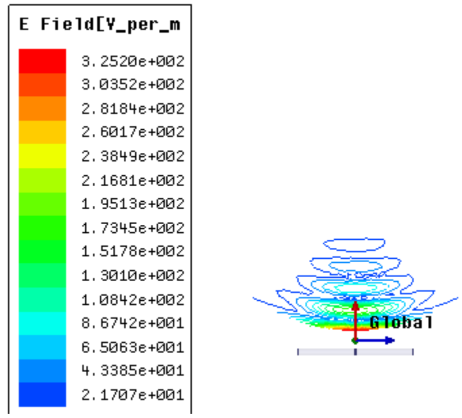


Fig10. E-field strength in adult head at 1900MHz

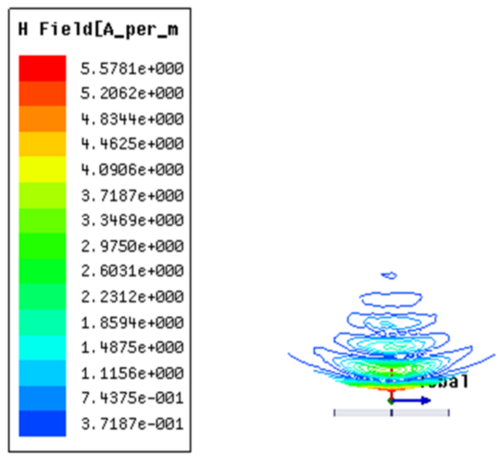


Fig11. H-field strength in adult head at 1900MHz

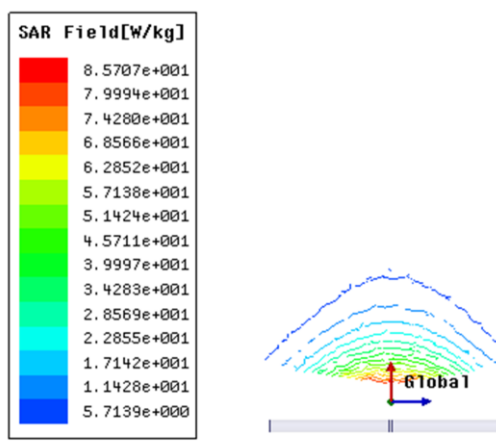


Fig12. SAR in adult head at 1900MHz

 ISSN 1013-5316; CODEN: SINTE 8 Sci.Int.(Lahore),27(5),4001-4005,2015

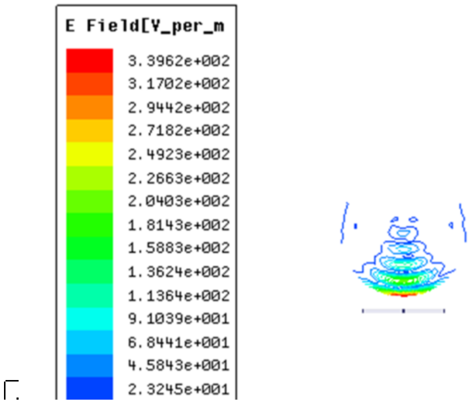


Fig13. E-field strength in child head at 1900MHz

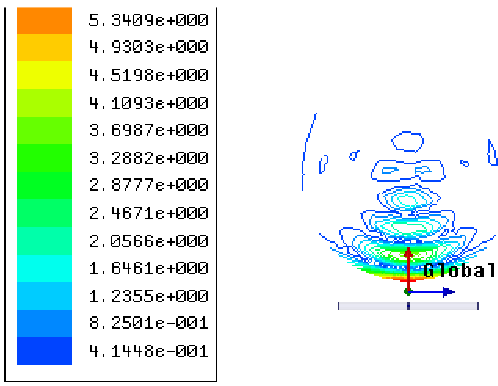


Fig14. H-field strength in child head at 1900MHz

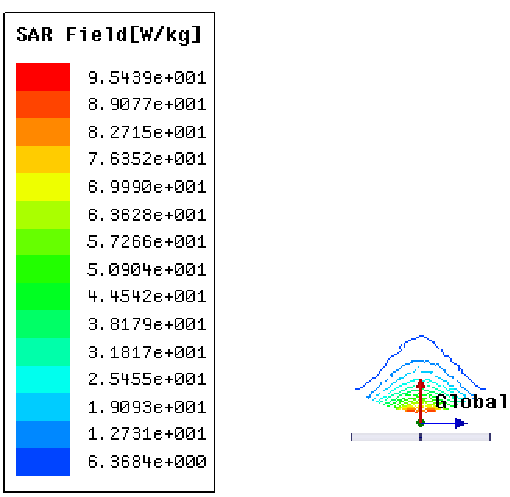


Fig15.SAR in child head at 1900MHz

To validate the results the simulations repeat for higher frequency i.e. 1900MHz. Figure 10 to 15 show the E and H and SAR simulations in human head model as an adult and $\frac{1}{2}$ human head model as a child at 1900MHz.

RESULTS

Table3. Comparison between absorption in adult and child head do to exposure to dipole antenna

	Adult		child	
	835MHz	1900MHz	835MHz	1900MHz
SAR	22.8	85.7	23.7	95.4
E-field strength	159	325	156	339
H-field strength	3.89	5.57	3.92	6.16

All of the simulations have done to compare the EM absorption in human head of adult and children.

The summery of the result has been shown in Table3.

As it can be seen all of the values for the adult and child both at 835 and 1900MHz show that in the same conditions, the absorption of E and H field strength and SAR in children's head is larger than adults (about 2 times). So the children need more protection against the EM fields because their bodiy tissues specially brain are growing.

Also by the increasing in frequency the effects have been increased.

The other subject is real conditions. This model is a commercial model in standard but cannot show the good model of human head because the head includes many tissues with various Ɛ and σ. So the better model should design to better and accurate results.

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