International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-5, January 2020

Radiation Exposure to Pregnant Woman using Mobile Phone Inside Metallic Enclosure

T. Anita Jones Mary, Shanthini Pandiyaraj, J. Janish Blessy

Abstract: ***This paper explores the basic absorption rate (SAR) assessment of pregnant women from wireless communication devices inside the metal enclosure. The mobile phone antenna was modeled as a PIFA (Planar Inverted F Antenna) working at a distance of 10 mm from the head at 900MHz. Processed results show that when compared to free space, the average SAR induced for a pregnant woman inside the metal enclosure is increased by 2.5 times. Results have showed that inside the enclosure the child standing near her often causes different levels of SAR values. Compared to free space, the induced SAR is 1.37 times greater inside the enclosure.***

Index Terms: FEKO, SAR, PIF, RF.

I. INTRODUCTION

Today, cell phones are becoming inevitable on the planet. In the human head region, portable handsets are used. Remote mobile administration's continuous growth has restricted the versatile handset manufacturers to think about the prevalent communication between the mobile terminals and the human body[1]. It is found that the human head consumes the piece of the electromagnetic wave transferred by the receiving antenna. Using Specific Absorption Rate (SAR), electromagnetic interaction with humans can be evaluated. Specific absorption rate (SAR) is a percentage of the body's rate of consumption of vitality when it is presented with radio Frequency (RF). It has units of Watts per kilogram (W / kg) and is distinguished by the energy maintained per tissue mass. The associated condition (1) may dictate the SAR (W / kg) at any time.

$$SAR = \frac{\sigma |E|^2}{\rho} \text{ (W/Kg)} \quad (1)$$

Where E is the electrical field inward (V / m), the SAR is the basic level of absorption (W / kg), the tissue is the conductivity (S / m) and the tissue is the mass density (kg / m3). It is possible to communicate the SAR values in excess of 1 gram or 10 gram mass and is called 1 g or 10 g spatial SAR. Confinements on the radiation sizes of customer products were thus established. These include the non-ionizing foreign Radiation Protection Commission (ICNIRP) and IEEE-1528.

Enclosures, automobiles and air ship lodges are spoken to as electrically huge metallic enclosures. Unlike the fenced in area, airplanes and autos have seats which go about as dielectric stacking, though an enclosure with no high dielectric stacking in this way prompting reflection and reverberation impacts [2-5]. These impacts could expand the electric field quality inside the metallic walled in area and furthermore the dimension of human introduction. It is discovered that the electromagnetic ingestion is expanded greatly inside a shut enclosure. PLANAR INVERTED–F-ANTENNA (PIFA), talked about in this paper is broadly utilized in versatile handset application in light of its position of safety and basic structure. It very well may be effectively covered up into the lodging of the portable. In reverse radiation is less in PIFA and has diminished electromagnetic wave assimilation (SAR) towards the human head. This paper will in this way center around the effect of cell phone radiation on the SAR when utilized by the pregnant woman inside the walled in area is researched.

II. CONFIGURATION OF MODELING

A. PIFA Inside Metallic Enclosure

Figure 3 shows the radiation pattern of PIFA. It is observed that backward radiation is minimised in PIFA. Because of reduced backward radiation, PIFA is widely used as internal antennas.

A scenario in which a passenger head exposed to a mobile handset inside an enclosure made of steel is considered. Sinceenclosures do not have any chance of dielectric loading like seats in cars, they greatly favour resonance and reflection effects [6-10]. Enclosure made of steel with conductivity 1e7 is considered in this paper. Evaluation of SAR inside enclosure is done at 900MHz. Due to the complexity in the design, the dimensions of the enclosure is scaled down by a factor of 4:1 than its original value for the ease of simulation. The design parameters are shown in Table 1. The geometry of the enclosure is shown in Figure 1.

Manuscript published on January 30, 2020.
* Correspondence Author
T Anita Jones Mary Pushpa*, Department of Electronics and Communication Engineering, Karunya Institute of Technology and Scinences, Coimbatore, Tamilnadu, India
Shanthini Pandiaraj, Department of Electronics and Communication Engineering, Karunya Institute of Technology and Scinences, Coimbatore, Tamilnadu, India
J Janish Blessy, Department of Electronics and Communication Engineering, Velammal Institute of Technology, Chennai, Tamilnadu, India

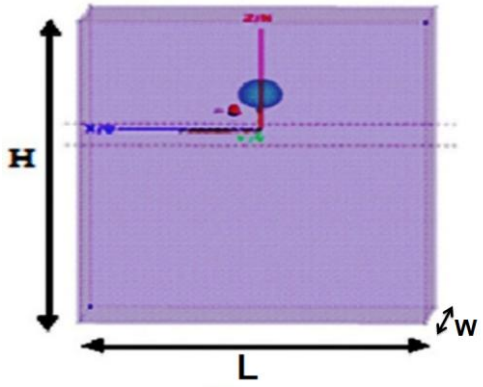

Figure 1. Metallic enclosure made of steel

Table1Design parameters of metallic Enclosure

Metallic enclosure	For 900 MHz in meters
Length (L)	0.4
Width (W)	0.3
Height (H)	0.4
Steel (σ)	1e7

The human head model consists of a sphere with averaged electrical properties of a real human head. That is, a density of 1030kg/m3, a relative permittivity of 43.7 and an electrical conductivity of .84s/m.The radius of the sphere is 95mm and is placed at 10mm apart from PIFA emitting at 900MHz.

B. Antenna Design

PIFA is designed to operate at 900 MHz based on the formula,[11]

$$L1+L2= \lambda/4 \qquad (2)$$

The simulated PIFA is shown in Figure 2 Where L1 is the length of PIFA,L2 is the width of PIFA,W is the width of shorting post; H is the height of shorting pin and D is the distance of the feed from the shorting post. The simulation parameters for the proposed PIFA are shown in Table 2.

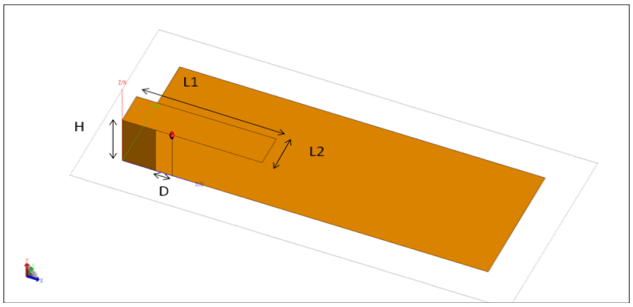

Figure 2.PIFA

Table2.Design parameters of PIFA

Parameters	900MHz(m)
L1	.09
L2	.06
H	.03
D	.013
W	.003

III. RESULTS AND DISCUSSIONS

A. Antenna Performance

Figure 3 shows the radiation pattern of PIFA. It is observed that backward radiation is minimised in PIFA. Because of reduced backward radiation, PIFA is widely used as internal antennas.

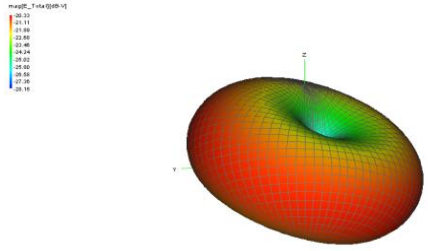

Figure 3 shows the radiation pattern of PIFA.

B. Evaluation Of Sar Inside Enclosure

The radiation pattern of a human head exposed to PIFA inside metallicenclosure made of steel isshown in Figure4. From the radiation pattern it is seen that metallic enclosure greatly favours SAR.[12-14]

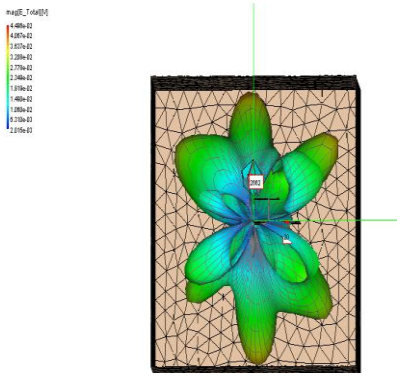

Figure 4. Far field pattern inside enclosure

SAR (1g) is calculated for human head exposed to mobile phone loaded with PIFA inside an electrically large metallic enclosure. From the tabulations shown in Table 3,it is seen that SAR is increased 7 times for 900 MHz compared to the limit specified by IEEE-1528.A concern for human safety is raised because of the “hot spots” that occur inside the enclosure due to the increase of field intensity.

Table 3. SAR at 900 MHz

Frequency MHz	1g SAR(W/Kg)
733.33	18.26
800	14.01
866.667	14.42
933.33	12.18
1000	12.95
1067	12.54
1200	12.73

C. RADIATION EXPOSURE TO PREGNANT WOMAN AND CHILD INSIDE ENCLOSURE

As shown in Figure 5, a pregnant woman with a child standing next to her inside the enclosure is considered. The simulation parameters are set as shown in Table 4. From the pattern of radiation found in Figures 6 and 7, it is seen that the radiation from mobile phone used by pregnant woman affects the fetus inside her womb and also the child standing nearby her to a large extent in free space and also inside enclosure. The distance between pregnant woman and child is kept constant as 75mm.

Table 4. Electromagnetic Properties of Fetus

Properties of tissue	At 900 MHz
Dielectric permittivity (ε)	45.8 (woman) 41.5(child) 65(fetus)
Conductivity σ (S/m)	0.77
Mass density (kg/m^3)	1030

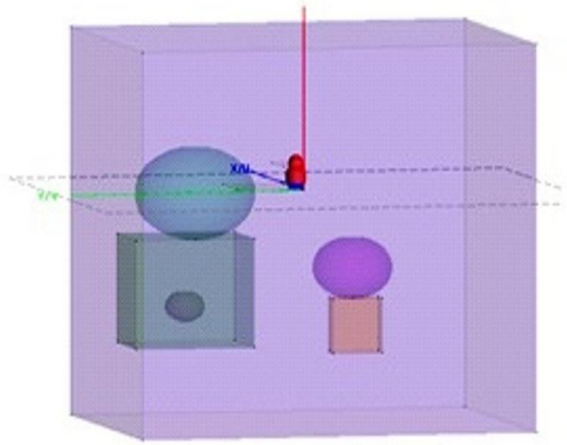

Figure 5 Pregnant woman and child inside enclosure

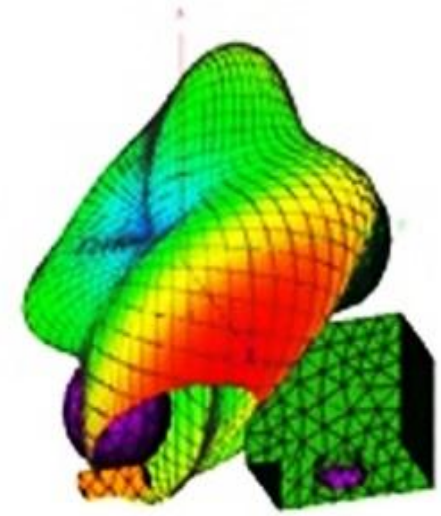

Figure 6 Radiation patterns of pregnant woman, fetus and child in free space

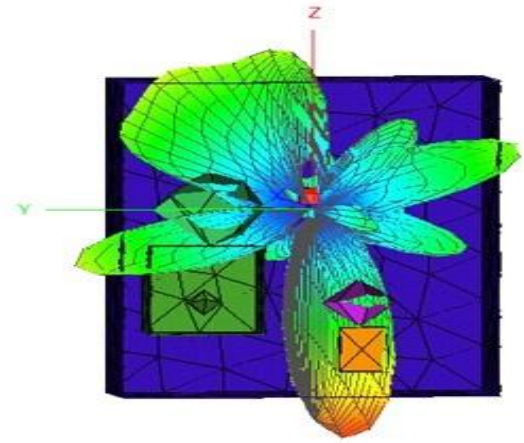

Figure 7 Radiation patterns of pregnant woman, fetus and child inside enclosure

D. Results and Discussions

From the simulated result shown in Figures 8to 11, it is seen that the radiation to baby inside mother's womb is 2.5 times greater inside enclosure compared to free space and also child standing nearby mother is also affected by radiation of 1.37 times greater inside enclosure compared to free space and also exceeds the limit specified by IEEE-1528. The results are tabulated in Tables 5 and 6.

Table 5. SAR induced in free space for pregnant woman, fetus and child

Frequency (MHz)	SAR(W/Kg) in Baby inside mother's womb	SAR(W/Kg) in child	SAR(W/Kg) in woman
700	0.0301034	0.24792	1.74311
762	0.03042	0.254976	1.67465
824	0.034402	0.249128	1.67669
917	0.030289	0.2641155	1.533008
980	0.040619	0.29254	1.4558

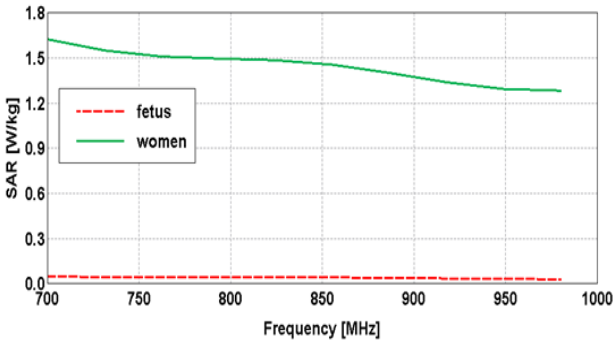

Figure 8 SAR comparison in free space for pregnant woman and fetus

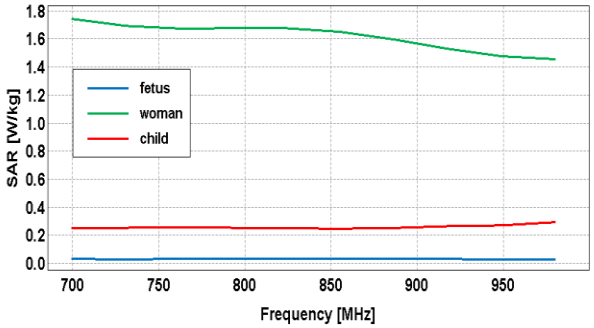

Figure 9 SAR comparisons in free space for pregnant woman, fetus and child

Table 6. SAR induced inside enclosure

Frequency (MHz)	SAR(W/Kg) in Fetus	SAR(W/Kg) in child	SAR(W/Kg) in woman
700	0.251771	0.188185	16.35
722	0.198678	0.304781	38.461
766	0.149214	0.17743	68.635
811	0.114563	0.303015	65.9199
833	0.223	0.33194	42.737
855	0.25413	0.15016	37.738
877	0.3202	0.26385	26.449
900	0.25175	0.432966	23.356

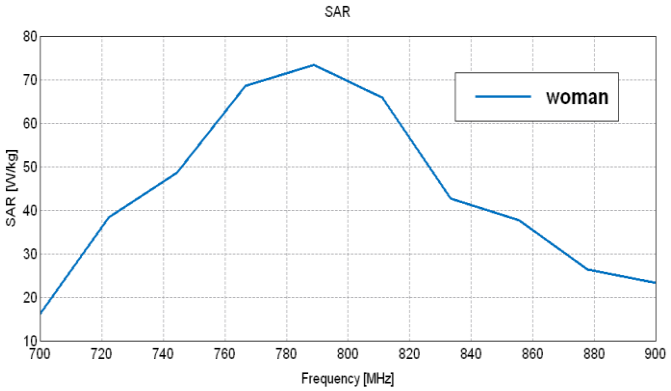

Figure 10 SAR for pregnant woman inside enclosure

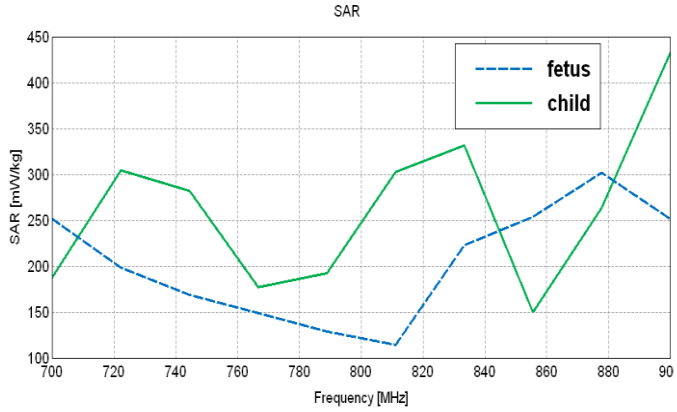

Figure 11SAR comparisons inside enclosure for child and fetus

IV. CONCLUSION

SAR research was carried out in pregnant women due to EM mobile phone radiation inside the enclosure. Results indicated that the total SAR value caused by a pregnant woman using a mobile phone inside the enclosure was 2.5 times greater than that of a pregnant woman using a mobile phone in free space. Studies also clearly indicate that the use of mobile phones inside the enclosure has an effect on the fetus inside the uterus of the mother as well as on the infant near her. In this document, the pregnant woman is issued an alert of health awareness using a mobile phone inside the enclosure.

REFERENCES

1. Corbett Rowell and Edmund Y. Lam," Mobile-Phone Antenna Design,"IEEE Antennas and Propagation Magazine, Vol. 54, No. 4, August 2012
2. Christopoulou, M., S. Koulouridis, and K. S. Nikita, "Parametric study of power absorption patterns induced in adult and child head models by small helical antennas," Progress In Electromagnetics Research, Vol. 94, 49-67, 2009.
3. Hirata, A., K. Shirai, and O. Fujiwara, "On averaging mass of SAR correlating with temperature elevation due to a dipole antenna," Progress In Electromagnetics Research, Vol. 84, 221-237, 2008.
4. Mahmoud, K. R., M. El-Adawy, S. M. M. Ibrahem, R. Bansal,and S. H. Zainud-Deen, "Investigating the interaction between a human head and a smart handset for 4G mobile communicationsystems," Progress In Electromagnetics Research C, Vol. 2, 169-188, 2008.
5. Kouveliotis, N. K. and C. N. Capsalis, "Prediction of the SARlevel induced in a dielectric sphere by a thin wire dipoleantenna,"Progress In Electromagnetics Research, Vol. 80, 321-336, 2008.
6. Ebrahimi-Ganjeh, M. A. and A. R. Attari, "Interaction of dualband helical and PIFA handset antennas with human head andhand," Progress In Electromagnetics Research, Vol. 77, 225-242,2007.
7. IEEE standard -1528, "IEEE Recommended Practice for. Determining the Peak Spatial-Average. Specific Absorption Rate (SAR) in the. Human Head from Wireless," December 2003.
8. Erren TC,"A meta-analysis of epidemiologic studies of electric and magnetic fields andbreast cancer in women and men", Bioelectromagnetics Supplement 5: S105-S119,2001
9. Feychting M, Jonsson F, Pedersen NL and Ahlbom A," Occupational magnetic fieldexposure and neurodegenerative disease", Epidemiology 14: 413-419,2003
10. Foliart DE Pollock BH Mezei G Iriye R Silva JM Epi KL Kheifets L Lind MP Kavet R "Magnetic field exposure and long-term survival among children with leukemia". British Journal of Cancer 94 161-164,2006
11. L. C. Kuo, and H. R. Chuang, "Design of a 900/1800MHz Dual-Band Loop Antenna Mounted on A Handset Considering the Human Hand and Head Effects," IEEE Antennas and Propagation Society International Symposium,June 2003.
12. T. Anita Jones Mary, T. Joyce Selva Hephzibah and C.S.Ravichandran," SAR on Human head modeling with Inverted F Antenna in Cylindrical Enclosures,"2011
13. T. Anita Jones Mary, S.Jemimah Priyadarshini and C.S.Ravichandran,"Analysis of SAR on Human head model in Metal Enclosures,"Dec 2010
14. T. Anita Jones Mary, S.Jemimah Priyadarshini and C.S.Ravichandran,"Effects of Metal Slab on SAR effects in Mobile Antenna for Dual Band Frequency,"Dec.2010
15. www.bioinitiative.org/report/docs/section_17.pdf .