ACTA TECHNICA CORVINIENSIS
– Bulletin of Engineering
Tome X [2017]
Fascicule 3 [July – September]
ISSN: 2067 – 3809

[1.] Ján ZBOJOVSKÝ, [2.]Iraida KOLCUNOVÁ, [2]Marek PAVLÍK,
[1.]Marek ČEŠKOVIČ, [1.]František ADAMČÍK, [1.]Martin KRCHŇÁK

MODEL OF ANECHOIC CHAMBER FOR EVALUATING THE SHIELDING EFFECTIVENESS OF ELECTROMAGNETIC FIELD

[1.] Technical University of Košice, Faculty of Aeronautics, Department of Avionics, Kosice, SLOVAKIA
[2.] Technical University of Košice, Faculty of Electrical Engineering and Informatics, Department of Electric Power Engineering, Košice, SLOVAKIA

Abstract: Over the last years occurred a rapid growth in the utilization of technology, in which is creating electromagnetic radiation of different frequencies. At first it was the high-voltage lines, transformers and electrical installations in houses. To these sources of field had been included also wireless network to the internet, telecommunications and navigation connection. Due to this it is necessary to pay attention and research it, while modeling belongs to a fundamental ways of developing and analyzes the propagation of field through various materials. This paper deals with model of anechoic chamber created in ANSYS HFSS. Model is created for evaluating the shielding effectiveness of materials with different properties. In that case it is possible to optimize the shielding effectiveness of materials with changing of its properties. Model works for frequency range from 1 to 10 GHz.
Keywords: shielding effectiveness, electromagnetic field, frequency, anechoic chamber, ANSYS

INTRODUCTION

Over the last century occurred a huge technological development in the world. Over time, humanity passed through the creation of simple devices and equipments to creating a variety of innovative devices, which are higher quality and technically complicated as previously. This caused an increase of sources of electromagnetic field, and it is almost impossible to avoid their activity at the present.

Electromagnetic field is created either from natural radiation, or is artificially created from electrical devices. Some devices are used directly in order to form of this field, while in some devices is formed as by-product of their operation.

At first it was the high-voltage lines, transformers and electrical installations in houses. To these sources of field had been included also wireless network to the internet, telecommunications and navigation connection. [1][2]

Due to this it is necessary to pay attention and research it, while modeling belongs to a fundamental ways of developing and analyzes the propagation of field through various materials. [3][4]

IMPACT OF ELECTROMAGNETIC FIELD TO THE BIOLOGICAL ORGANISM

Electromagnetic field can be described by Maxwell's equations:

$$\text{rot } H = J + \frac{\partial D}{\partial t} \quad (1)$$

$$\text{rot } \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \quad (2)$$

$$\text{div } \mathbf{D} = \rho \qquad \text{div } \mathbf{D} = \rho \quad (3)$$

$$B = \mu H \qquad D = \varepsilon E \quad (4)$$

Over the last years occurred a rapid growth in the utilization of technology, in which is creating electromagnetic radiation of different frequencies. Besides the positive results arising the impact of electromagnetic field are also negative.

Is much more difficult to determine it, since the testing on the human organism is not possible and thus cannot be exactly determined and discuss about diseases

caused primary by these field. But electromagnetic field can have a negative impact on individual from its state of health, thus worsening of its condition, or outbreaks of the disease. The discovery, that the electromagnetic field could have direct negative impact on the emergence of diseases like a cancer, organ damage etc., could negatively affect the contemporary lifestyle dependent on electricity.

Various organizations are working to research and tests, which are trying to find impact of electromagnetic field on living organisms. In Slovakia, the protection of population currently provides decree of Healthcare Ministry of the Slovak Republic number 534/2007 Z.z. (Collections of laws) about details and requirements on sources of electromagnetic radiation and limits of exposure of the population to electromagnetic radiation in the environment. [2][5]

CALCULATION OF SHIELDING EFFECTIVENESS

As it was mentioned above, one of the ways of protection against the harmful effects is the shielding. Shielding effectiveness can be expressed by the following equations, these equations is for case, if the value of the transmitted signal is set in logarithmic unit:

$$SE = |E_1| - |E_2| \quad (5)$$

$$SE = |H_1| - |H_2| \quad (6)$$

where E_1, H_1, represents the magnitude of electric and magnetic field impinging on a shielding material (barrier) and E_2, H_2 represents the magnitude of electric and magnetic field at some specific point of shielded area. [7]

MODEL OF THE ANECHOIC CHAMBER

The frequency-dependent simulation of electro-magnetic field is created in the program HFSS (high frequency structural simulator).

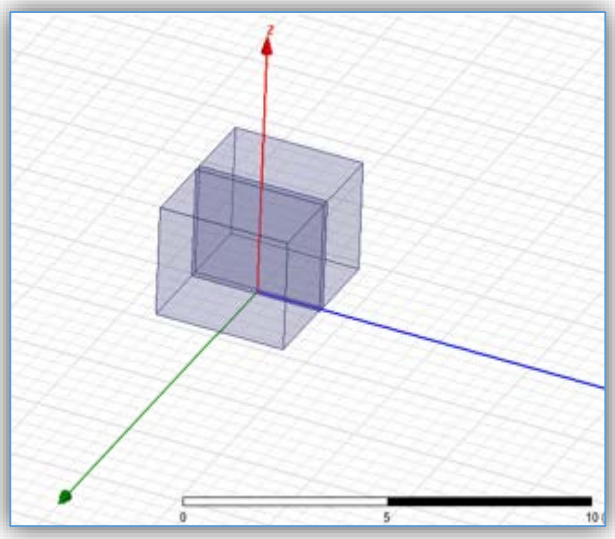

Figure 1. Model of anechoic chamber

The created model is an anechoic chamber, located at the Department of Electric Power Engineering at the Technical University of Košice. Frequency range is from 1 GHz to 10 GHz. The following figure shows the model of chamber, for evaluate of shielding effectiveness material "brick" was chosen. [9] [10]

Figure 2 shows the propagation of electromagnetic wave in chamber. In the middle material "brick" is located. It can be seen the deformation of the waves at the interface of the materials.

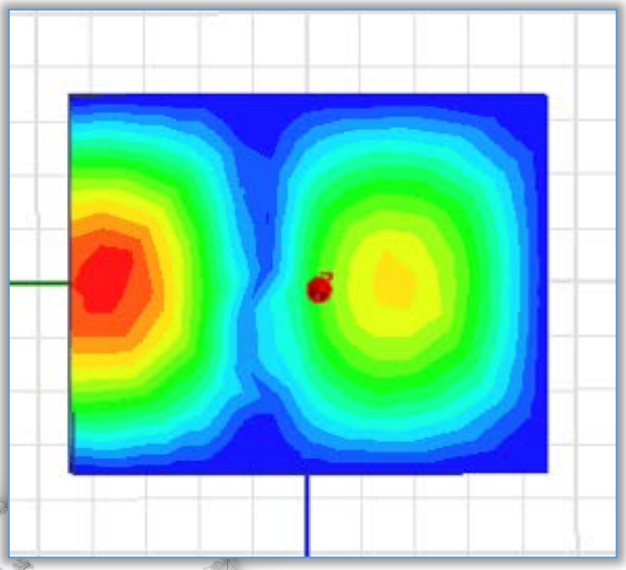

Figure 2. The wave propagation inside the model

RESULTS

Obtained from simulations were then calculated shielding effectiveness. With increasing frequency we had a better values of shielding effectiveness. The maximum value reached at a frequency of 5.8 GHz, and it was 7.165436254 dB. In the following table is a comparison of the shielding effectiveness for the frequencies used in the range of 1-10 GHz.

Table 1. The shielding effectiveness for compared frequencies

Freq [GHz]	Utilization	Shielding effectiveness [dB]
1,8	Mobile network (2G)	2,719510795
2,1	Mobile network (3G)	3,89742965
2,4	WiFi	4,759421802
2,6	Mobile network (4G LTE)	4,31603198
5	WiFi	6,636557869
5,8	Satelite signal (VSAT)	7,165436254
6,7	Satelite signal (VSAT)	7,092218711
7	Analog TV	7,056538597

CONCLUSION

Humanity is almost exposed to electromagnetic field radiation. Given that the electromagnetic field is not observed by human eye, people do not realize that they are constantly exposed to its action. Organizations such as the World Health Organization or the European Union are making efforts on research into the impact of electromagnetic fields. Problem occurs also in ensuring proper functioning of electrical equipment, which are sensitive to electromagnetic fields.

The paper was aimed to create conditions and get closer in simulation of electromagnetic field to the fair values obtained from measurements performed in an anechoic chamber at the Department of Electric Power Engineering FEI TU Košice. The advantage of simulation compared to measurement is the possibility of modeling the material which reports adequate shielding effectiveness by a suitable choice of its electrical properties. At same it is possible to further optimize the model according to the characteristics of an anechoic chamber at the Department of Avionics, Faculty of Aeronautics TU, and perform comparative measurements and simulations.

Acknowledgements

This work is the result of the project implementation: Protection of the population of the Slovak Republic from the effects of electromagnetic fields, ITMS: 26220220145, Activity 2.1 supported by the Research & Development Operational Programme funded by the ERDF. This work was supported by project VEGA SR No.1/0132/15. This work was supported by project: Convergence, Regional Competitiveness and Employment ITMS: 26210120002, 26230120002.

References

[1] VECCHIA P, et al: Exposure to high frequency elektromagnetic fields, biological effects and health consequences (100 kHz to 300 GHz), INCIRP 16/2009

[2] Dolník, B.: Electromagnetic compatibility. (Elektromagnetická kompatibilita). TU of Košice, dec. 2013, monography. ISBN 978-80-8086-221-3.

[3] Liptai, P.: Meranie elektromagnetického tienenia kombinovaného materiálu a možnosti jeho využitia. Fyzikálne faktory prostredia. Roč. 5, č. 2 (2015), s. 45-48. ISSN 1338-3922.

[4] YOSHINO, Y., SHOTA, I., MICHIHIKO, K., MASAO, T., Assessment of human exposure to electromagnetic field from an intra-body communication device using intermediate frequency electric field, International Symposium on Electromagnetic Compatibility

[5] Liptai, P.: Metodika merania a hodnotenia vysokofrekvenčných elektromagnetických polí základňových staníc mobilných operátorov v obývaných oblastiach. Ukraine – EU. Modern Technology, Business and Law. Chernihiv National University of Technology, 2016 pp. 306-309. ISBN 978-966-7496-71-5.

[6] LORRAIN, Paul et al.: Electromagnetic fields and waves. Third edition New York City 1988. 754s. ISBN 0-716-71823-5

[7] Únal, E. - Gőkcen, A. - Kutlu, Y.: Effective Electromagnetic Shielding, IEEE Microwave magazine, 2006 s. 48 – 54. ISSN 1527-3342

[8] Celozzi, S. - Araneo, R. - Lovat, G.: Electromagnetic Shielding, Electrical Engineering Department La Sapienza University Rome, Italy, IEEE Press.

[9] CUINAS I., SÁNCHEZ GARCÍA M.: Permittivity and Conductivity Measurements of Building Materials at 5.8 GHz and 41.5 GHz, Wireless Personal Communications 20, 2002, 93-100s

[10] Whamid Al-Shabib: Simulation vs. measurement of polyaniline for electromagnetic interference shielding. School of Engineering, Edith Cowan University, Western Australia, 2014. ISBN 978-1-4799-3351-8/14

ISSN:2067-3809