

CALCULATION OF MAGNETIC FLUX DENSITY USING Maxwell 3D VERSION 10

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Abstract: Present knowledge limits magnitude of quantities of electrical and magnetic fields. This fact is also considered by government of many countries including BiH throughout law. So we must be prepared to offer solutions for actual construction sites that will be correspondent later to measurement upon finishing actual facilities. One way is to use existing software solutions.

Keywords: Numerical computations, Magnetic flux density

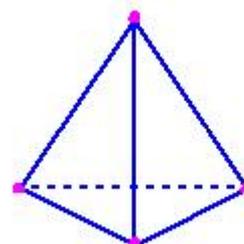


Fig. 1 - Tetrahedron

INTRODUCTION

Problem that I was solving in this paper is a problem that I faced on my working place. I had to calculate current that will flow through a three phase cable that connects distribution cabinet and main switchgear cabinet of one building. My calculation determined value:

$$\begin{aligned} i_{L1}(t) &= 295 \cdot (\cos \omega \cdot t) [A] \\ i_{L2}(t) &= 295 \cdot \left(\cos \omega \cdot t + \frac{2\pi}{3} \right) [A] \\ i_{L3}(t) &= 295 \cdot \left(\cos \omega \cdot t + \frac{4\pi}{3} \right) [A] \end{aligned} \quad (1)$$

Position of cable is inside a building and near future working places. So my desire was to establish a value of magnetic flux density in a presence of human body, more exactly inside human body. Limits posed by law sets that value below $100 \mu T$.

MODELING

Description of software package

Maxwell 3D is an interactive package for analyzing electric and magnetic fields in three-dimensional structures. Software finite element based field solvers enable us to simulate electric and magnetic fields in any type of device.

To represent an electrical or magnetic field over a large, irregularly-shaped region, Maxwell 3D divides the region into many tetrahedra – figure 1 (pyramid-shaped sub-regions).

The collection of tetrahedral is referred to as the finite element mesh – or simpler, the mesh. To obtain a precise description of the field, the system must size each tetrahedron so that it is small enough for the field to be adequately interpolated from the nodal values. The accuracy of the solution depends on how small each of the individual elements are. The optimal mesh for a structure is one that contains enough tetrahedral to accurately represent a field solution but not so many that the available computing resources are overwhelmed. Program can use three ways to make sure that tetrahedral are placed wisely: adaptive mesh refinement, manual mesh refinement and combination. I used first principle. During solution process, software iteratively refines the mesh in regions where error is high. This allows the simulator to target mesh refinement to the areas that need it, optimizing computing resources.

Geometrical modelling and solving of problem

First we have to define geometrical bodies, that will represent cable and human body. Both models are placed in vacuum, and vacuum has similar properties as air. As a model of a cable I used three conductors, whose properties are set to represent copper. This is option which you can set inside a program.

Conductor is shaped as cylindrical object, with $r = 5,5mm$, $H = 5000mm$ that r represent radius of basis of cylinder and H represent height of conductor. This value is an approximation of a cable with a conductors that are used inside of building ($4 \cdot 95 mm^2$). As I mentioned before, it is very easy to set properties in this simple case. The conductors are placed in close vicinity between each other. As you can notice there are no insulation on these conductors.

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Body is also shaped as actual body. This form is combination of 4 different figures that are unite in one. Fig. 2 shows window for drawing geometrical bodies and my models represented in planes (2D) and space (3D).

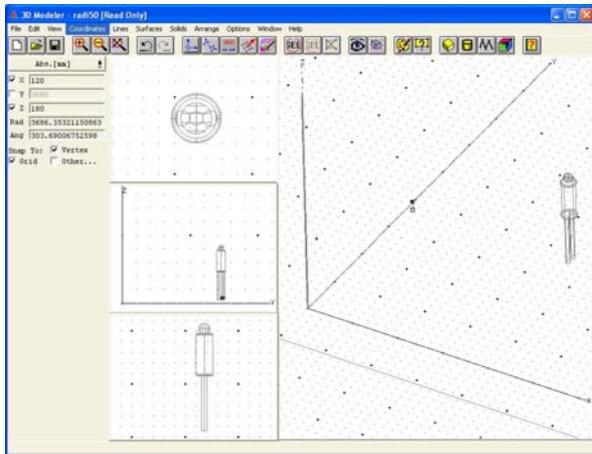


Fig. 2 – Drawing of objects in 3D

Properties of a body are set like in next figure (Fig.3):

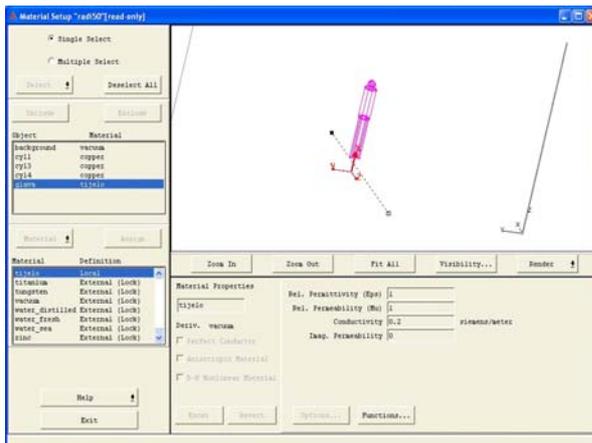


Fig. 3- Properties of object

Next step is to define sources or boundary conditions. Due to my problem, logical solution was to pick a source. At next figure, number 4, you can observe this.

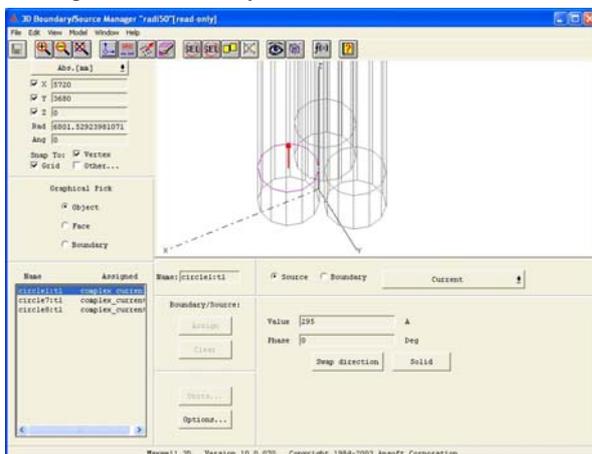


Fig. 4 – Definition for current source

With a finishing of this process, you can start a simulation. You can very easy set percent of refinement at each pass, a number of passes and percent error. I set percent error at 1%, but I achieved 5,2% after 10 passes. After 10 passes, he made around 134000 tetrahedra (Fig.5)

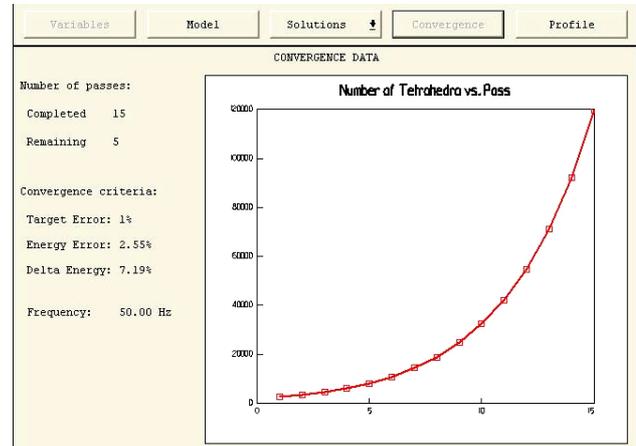


Fig. 5 – Graph tetrahedra=f(number of pass)

Finally, results are obtained after approximately one hour from the beginning of simulation. They are represented at next figure (Fig.6).

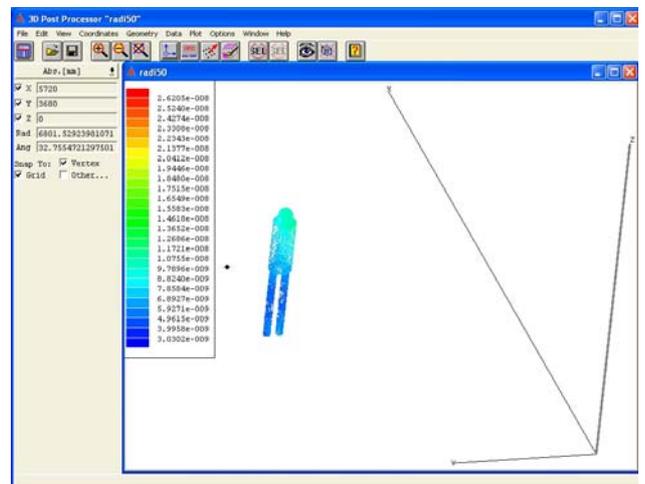


Fig. 6 – Results of simulation

As you can see, upper values are around $0,018 \mu T$, and they are much below values that are concerning for human health.

Of course, main issue lays in fact that software is not with open source, so we must relay that a proper design of software lies behind our results. Also I used the simplest way to model cable and human body. But engineers are known as a people that tries to find the simplest solution.

CONCLUSION

I tried in this simple way to show in the easiest way possible, through a picture in 3D way, how you can explain to others values of Magnetic flux density. Lawmakers in this region predicts possibility of calculation of quantities of fields, together with a actual measurement on sites. So we should encourage production of software packages with their academic background. Also these packages do not need to be large, and they could be formed as modules. This is a way how we can inside our universities make an enterprise that could benefit to everybody, from a young researchers that will be better paid to the needful economic income for development in a new environment.

REFERENCES

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Dr. Mićo Gaćanović was born in 1952. He is recognized and known internationally as a scientist in the field of applied electrostatics, where he has given his contribution through original solutions, which are patented in 136 countries throughout the world and applied in production.

He received many prestigious world-known awards and certificates for his creative work. Hence, he is included in the work of world groups of creativity, research and new technology in Brussels, Moscow, Pittsburgh and other world cities. He is also involved in research projects from the field of theoretical electrical engineering in Germany, Belgium and Russia.

