

MODELING OF ELECTRIC FIELD AROUND DIELECTRIC CYLINDER IN ANSYS MAXWELL

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In this article distribution of electric field around the dielectric cylinder is considered. For modeling simulation software package ANSYS Maxwell is used. A model of the electric field around the cylinder is obtained. In article, the detailed algorithm of creation of electric field in ANSYS Maxwell is considered. Presented algorithm can be used for further solving of more complex modeling problems. The model gives an opportunity to study distribution of electric field of objects of any complexity, made from different materials.

Introduction

Recently, application of computer design aids became widespread. This led to development of programs for modeling of various processes and phenomena, in particular electric and magnetic fields. Modeling is aimed at simplification of activity of a developer of the electrotechnical equipment. Modeling allows spending less time for realization of the solution.

An electromagnetic field (also EMF or EM field) is a physical field produced by electrically charged objects. It affects the behavior of charged objects in the vicinity of the field. The electromagnetic field extends indefinitely throughout space and describes the electromagnetic interaction.

The field can be considered as the combination of an electric field and a magnetic field. The electric field is produced by stationary charges, while the magnetic field by moving charges (currents); these charges are often described as the sources of the field. The way, which determines now charges and currents interact with the electromagnetic field, is described by Maxwell's equations and the Lorentz force law.

The electric field is a component of the electromagnetic field. It is a vector field, and it is generated by electric charges or time-varying magnetic fields as described by Maxwell's equations. The concept of an electric field was introduced by Michael Faraday.

ANSYS Maxwell is software for modeling of electromagnetic fields used for design and research of two-dimensional and three-dimensional models, type of engines, sensors, transformers and other electric and electromechanical devices of various applications. ANSYS Maxwell is based on a Finite Element Method - FEM and precisely counts static, harmonious electromagnetic and electric fields, and also transition processes in field tasks. The library of properties of materials increases speed of the considered software package.

For creation of a field of evenly charged long cylinder, the software package described above was used.

Modeling of electric field around dielectric cylinder in ANSYS Maxwell

For modeling, it was assumed that a cylinder of radius R is charged evenly. The volume density of a charge is $10\,000\text{ A/m}^3$. From reasons of symmetry it follows that lines of intensity will be directed along radiuses of circular sections with identical density relationally to a cylinder axis. As a closed surface the charged parallelepiped with height l , square basis with the side length a , was constructed (Fig. 1).

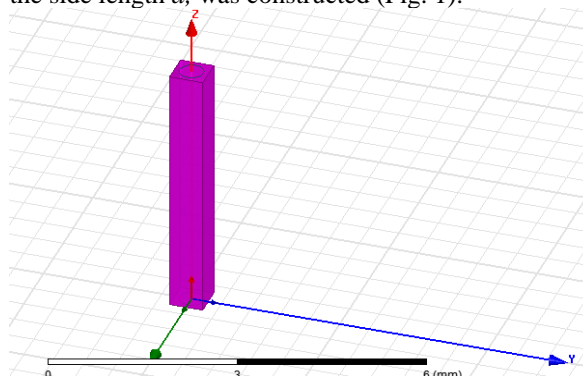


Figure 1 - The cylinder limited to a rectangular parallelepiped

The detailed algorithm of modeling of electric field is given further. Algorithm consists of nine main stages. Further in the text ANSYS Maxwell's function is written by italic font. On the first stage, the program is started, and the mode of designing of 3D models is turned on (*insert Maxwell 3d design*). A field (grid) of construction appears. As further construction will be connected with electric field, on the second stage, it is necessary to go to the *Project manager* tab, choose *Maxwell 3d design* in the opened *solution type* window (decision type) and select *electrostatic* (electrostatics). On the third stage, in the *Maxwell 3D design* window one should choose one of functions (*draw cylinder*) offered by the function panel. After that the cylinder is built. Then, on the fourth stage, appropriate material is assigned to the object (*assign material* → *diamond*). On the fifth stage, boundary conditions are set, by means of special function *Create region*. On the sixth step, to set the volume current density for the object, in a tree of designing one should choose *Cylinder* → *assign excitation* → *by volume charge density excitation* → *value* = $10\,000\text{ A/m}^3$. On the seventh stage, parameters (*Assign Parameters* → *to Force* → *by Virtual* → *Parameters* → *Force1*) are established,

thus the force vector is determined. For carrying out the analysis and identification of mistakes, on the eighth stage, the following actions are implemented:

a. in the *Project Manager* tab → *Analysis* → *Add Solution Setup* → *Convergence* → *Refinement Per Pass of =10%*.

b. *Project Manager* → *Analysis* → *Analyze All* → *Save*.

Analysis results can be observed on the monitor. If the program detects errors, they need to be corrected; missing actions have to be taken into account. The analysis has to be made anew. On the ninth stage, the resulting electromagnetic field is displayed on the screen if the following steps has been executed: in a tree of designing *Planes* → all three planes are allocate: *Global: XY*, *Global: XZ*, *Global: YZ* → *Project Manager* → *Field overlays* → *Fields* → *E* → *E_Vector* → *Cylinder*. Modeled electric field around the cylinder is presented in Fig.2.

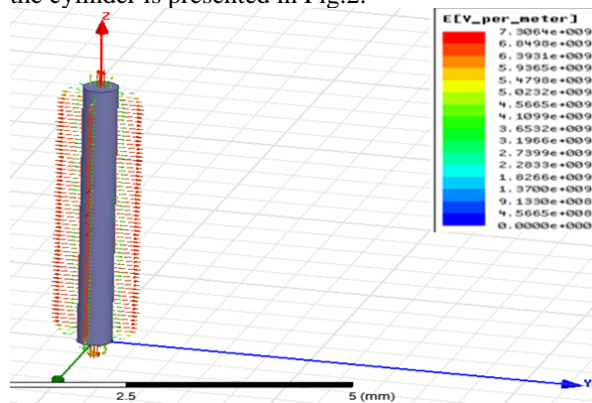


Figure 2 - Electric field around the cylinder

Such arrangement of vectors (Fig. 1) is caused by the fact that the vector of intensity is perpendicular to an equipotential surface in each its point.

- The *Show overlade visualization in active view* function is applied for better visibility of representation of electric field (Fig.3).

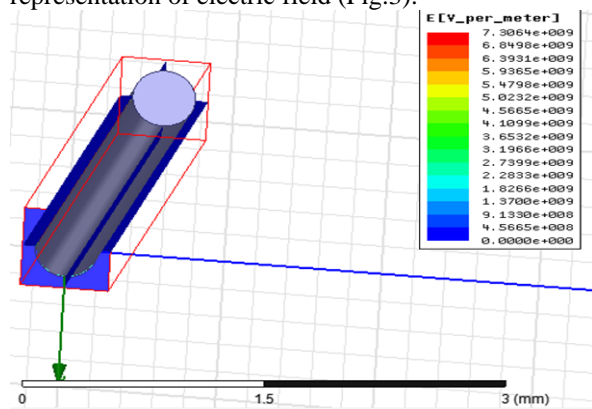


Figure 3 - Electric field around the cylinder without *Show overlade visualization in active view* function application

Specifying the value of current density of 10000 A/m³ to cylinder volume (cylinder material - diamond,

with dielectric permeability 16.5), and putting voltage equal 10000 V to surface of the parallelogram, it is possible to observe a picture of distribution of electric field intensity in the cylinder. Electric conductivity in vacuum is infinitely small, therefore, between the cylinder and the walls of a parallelogram there is no intensity (this area is illustrated by blue color). The color card shows distribution of the chosen physical quantity. The color card is accompanied by the color scale showing compliance between the color and the value of a physical quantity. One can adjust the color card, changing amount of color gradation and a range of the quantity. The color card can be represented in the form of gradation of gray color. Electric field can be also represented in the form of vectors of different colors (Fig. 4).

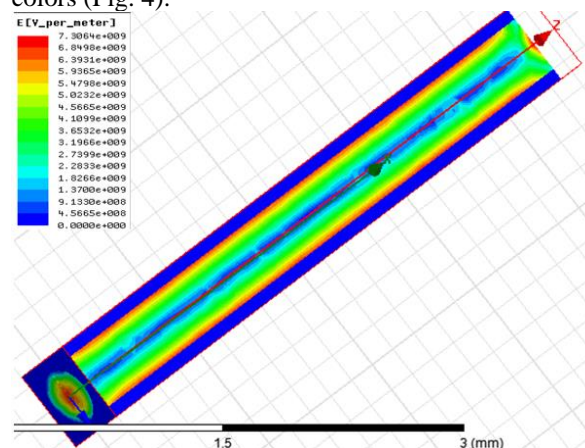


Figure 4 - Electric field around the cylinder with the color card

Conclusion

The detailed algorithm of electric field modeling, presented in the article, can be used for design of models with other parameters (material, geometric, medium properties). Opportunity of visual research of the electric field distribution makes the design process more clear and simple. The received results can be used by educational institutions in the students training course.

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