Possibilities of Modelling Overvoltage Protection Systems in Electrical Networks

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INTRODUCTION

Overhead lines are one of the key elements in electrical network. These lines require the use of appropriate protective systems due to lightning threats. Increasing the strength of these lines can be ensured by using overvoltage protection systems. These devices have many different types as it is shown in [1]. To assess the effectiveness of individual types, start with the simulation stage. Performing a simulation in a given case is aimed at [2]:

- analysis of the electrostatic field and the distribution of electric field intensity for various cases,
- analyzing the processes occurring as a result of making modifications to improve the characteristics of the device.

IMPLEMENTATION OF SIMULATION

The simulation is started at the initial stage in a static system. The dynamic system requires more precision when creating a numeric model. On the basis of the simulation stage, you can go to the laboratory tests stage and on the overhead line. To perform the simulation, the numerical model should be properly constructed. Based on the information contained in [2], [3], [4], the way of creating and methods of analyzing such a model can be determined (Fig. 1).

In technical issues, one of the basic methods of solving boundary tasks is the finite element method (FEM). The main idea of FEA is to convert any continuous size into a discrete model. The resulting model is based on a limited number of nodes that define a limited number of finite elements [5], [6].

In the case of simulation, the following stage should be used, while controlling the level of these finite elements, which may eventually allow simulation (Fig. 2):

- preparation of geometry,
- assignment of physical properties,
- determination of boundary conditions,
- simulation implementation.

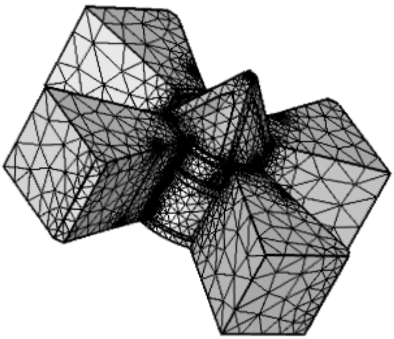
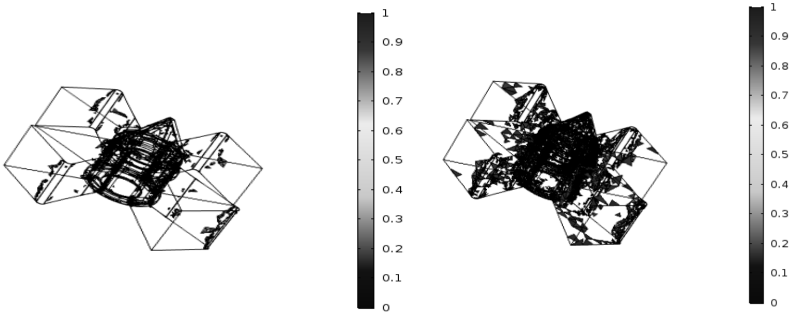


Fig. 1. 3D model grid of element of the surge protection system.



a) b)

Fig. 2. The number of the worst elements (10% (a) and 25% (b) from the total amount) of the 3D mesh of the element model of the surge protection system.

In the Comsol program, the modeled electrostatic issue described by the Laplace equation (Eqs. (1) and (2)) and using the Dirichlet condition.

$$E = -\nabla V \tag{1}$$

$$\nabla \cdot (\epsilon_0 \epsilon_R E) = \rho_V \tag{2}$$

Grids of different densities are used in simulations, also controlling the effect of changing the mesh density on the results. The grid in the most interesting parts of the analysis area is made much denser than for the rest of the model. In this case, the effect of discretization of the model on the results of calculations can be observed. Therefore, special attention should be paid to the selection of the type of finite elements.

CONCLUSIONS

The article presents a preliminary assessment of the feasibility of an exemplary numerical model and simulation of surge protection systems in electrical network. An exemplary simulation is presented based on the model created in Comsol. The article were presented the assumptions for creating such a model and the stage of implementation of the simulation. The authors indicate that in order to increase the efficiency of devices and to compare their properties, a simulation based on the finite element method can be used. This variant is cheaper and faster and helpful before the implementation of the practical part of laboratory tests.

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