Optimization of grounding electrode systems

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1. Abstract

The behaviour of the grounding system in electrical installations is fundamental for the safety persons and for the correct operation of the electrical equipment
The fundamental elements of the grounding system are:

- The geometry and dimensions of the electrode.
- The behaviour of the land.

In this paper the finite element technology has been used to model the behaviour of simple ground systems in opposite to typical phase-earth defect sine wave excitations and opposite to stroke excitations including ionization effect in the area around of the electrode.

Palabras clave:grounding electrodes, fem, soil characteristics, high frecuency.

2. Introduction

The grounding electrodes have different behaviour according to the excitation type and the type of land (resistivity, dielectric constant). These two variables take us to results different from the awaited ones:

- Effective electrode length. For every current there is an effective electrode length, not for much to increase the dimensions obtains a reduction of the value of the electrical resistance of ground electrode system.
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- For someone current (stroke type or high frequency type) the great electric field in the land area around of electrode, that there are reached values that ionization of the area is done, turning the land area into a conductor and consequently diminishing the impedance of grounding electrode system.

3. Models

The model is realized using the finite elements analysis, beginning for a simple electrode (goad electrode) to model his behaviour for sine wave excitation that verify the formula [1]

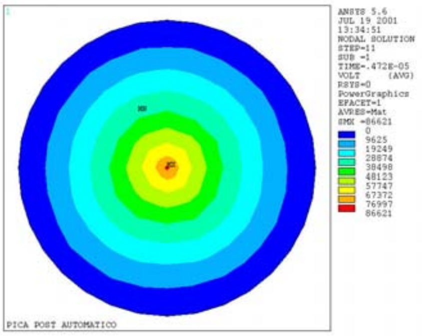
$$R_{1-rod} = \frac{\rho}{2\pi l}\left[\ln\left(\frac{4l}{a}\right)-1\right] - l\rangle\rangle a$$

where ρ is the resisitivity of the land area in ohms·meter, l is the goad electrode length in meters and a is the goad electrode radius in meters.
As soon as the model was verified, one is going to increase the length of the electrode to determine the validity of the model and to obtain the minimal length that minimizes the value of the resistance of grounding electrode system.
The used technology for a simple model is going to be applied to high frequency excitations where there for is waited a RLC behaviour [2] of the grounding electrode system, taking as a limit the critical value of the electric field that ionizes the land area around of electrode.

The article ends which a model proposed that includes the RLC behavior where there is included the ionizaición of the land area, not of explicit form [3] but there is included the equation that has developed in [5].

$$E_c = 8.6083 \cdot k_g^{-0.0103} + \sigma_g^{-0.1526}$$

Where k_g is the dielectric constant of the soil, and σ_g is the conductivity of the land area.



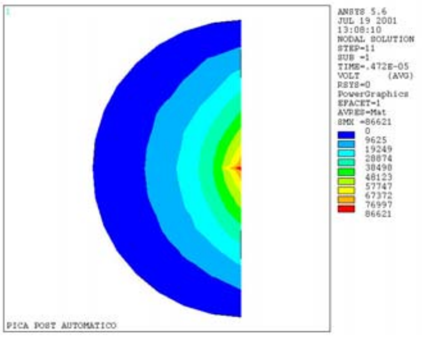


Figure 1 and 2. Goad electrode behaviour at high frequency excitation.

4 Conclusion

The obtained results allow the electrode optimization for all type of excitations, taking in account the maximum length of electrode and the possible ionization effect of the soil.

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