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Theme: Magnetic field Under Overhead Power Lines

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Abstract

With the development of electrical energy networks, environmental impact assessment in the neighbourhood and high voltage overhead power lines caused public concern. This paper presents a simulation methodology for analyze the distribution of the magnetic field generated by high voltage overhead transmission line. The effect of sag due to the weight of the line on the values of the magnetic field on ground level has also been discussed. The analytical results of the calculation of a 400 KV line based on image method using MATLAB numerical software which makes it possible to better analyze and to represent the transverse profile of the magnetic field under the power line.

Keywords: overhead power line, high voltage, magnetic field, sag, simulation.

1. Introduction

very low frequency electromagnetic fields generated by electric power transmission lines have been widely studied by the scientific community due concerns existed by government agencies, non-governmental and energy utilities electric on their possible biological effects on health and the environment [1], [2]. HV overhead power lines and THT generate magnetic fields which can reach an intensity of 0.4µT at a distance of 100 m (400kV) or 30 m (225 kV). These power lines engender electric and magnetic fields, and therefore advanced serious questions about the potential health and environmental effects related with high levels of intensity of these fields around these lines. In the last decades, many requests have been put forward about the possibility of potential health hazards from low frequency electric and magnetic fields. The interferences of these fields with the human body may affect the functioning of the living cells due to the induced currents which flow inside the organisms [3]. These currents result from the electric and magnetic in!!duced fields in body humans submit to high voltage electric and magnetic fields. The limits of exposure to electromagnetic fields (EMF) are derived from the International Commission on Non-Ionizing Radiation Protection (ICNIRP). At Low Frequency 50 Hz, the reference levels for general public exposure are 100µT, 500µT for occupational exposure (magnetic induction) and 5kV/m applied to the public and 10kV/m for professionals (electric field) [4]. respectively, the reference levels for occupational exposure are 1mT and 10kV/m. These limit values are sometimes approached in areas close to huge transmission lines. With the increase power demand, the power transmission utilities are increasing the transmission voltage levels for effective magnitude power transmission. The interference of these low frequency (50 Hz) electromagnetic fields with human organisms (working personnel and general public) may cause a menace on human health and the environment. This assumption has been the subject and discussed in several researches projects over the last few decades [5] .The results of some studies confirmed the possibility the negative effects from human exposure to low frequency electromagnetic fields. The purpose of this paper is to examine the created magnetic field by overhead power line (400KV) horizontal straight parallel to a flat ground, in order to calculate and plot the 2D transverse profile of the magnetic field intensity.

2. Calculation of magnetic field under three phase overhead power line

2.1. Principle of image method

Quasi-static analysis of electromagnetic problem at industrial frequencies requires that the magnetic field analysis is carried out separately from the analysis of the electric field, the magnetic field of overhead power transmission line is generated only by the current flow. A simple application of the law of Ampere allows calculating the intensity value of magnetic field around a simple conductor, and then applying superposition theorem of the three partial fields get the total magnetic field. To calculate the magnetic field at ground level in the vicinity of a transmission power line, we consider an overhead power line traveled by an electric current and the conductors are cylindrical, the ray of conductors is weak in relation to its length and its height above ground. The magnetic field is given by the formula:

$$H = \frac{I}{2.\pi.r} \quad (1)$$

An electric current intensity (I) at the point (xi,yi), created in point P(xj,yj) of space a magnetic field, the magnetic induction is defined by the relation:

$$B = \mu_0.H = \frac{\mu_0.I}{2.\pi.r} \quad (2)$$

Where μ_0: is the magnetic permeability of the air (N/A^2).

The image method is helpful to take into account the impacts of the presence of a conducting ground. The alternating magnetic field that the line generates induces return currents in the ground, at the same time generate a magnetic field that is composed to that produced by the line. The components of magnetic flux density due to a conductor are given by the two components vertical and horizontal in the equations above:

$$\left.\begin{aligned} B_{xj} &= -\frac{\mu_0}{2.\pi}.\sum_{j=1}^{3.n.m} I_j.\left[\frac{y_i - y_j}{r_{ij}^{\,2}} - \frac{y_i + y_j + D_{erc}}{r_{ij}'^{\,2}}\right] \\ B_{yj} &= \frac{\mu_0}{2.\pi}.\sum_{j=1}^{3.n.m} I_j\left[\frac{x_i - x_j}{r_{ij}^{\,2}} - \frac{x_i - x_j}{r_{ij}'^{\,2}}\right] \end{aligned}\right\} \quad (3)$$

Where, (x_i, y_i) and (x_j, y_j) are the coordinates of the observation point and location of simulation line current, respectively; r_{ij} is the distance between each conductor and observation point above ground; r'_{ij} is the distance between each image conductor and observation point (see Fig. 1).
For magnetic field calculation, the image of a filamentary current for a sub –conductor is located at depth different from the real sub -conductor height above ground is called the depth of penetration; it can be expressed as follows [6]:

$$D_{erc} = 658.87.\sqrt{\frac{\rho_s}{f}} \quad (4)$$

Where, ρ_s is the electrical resistivity of the earth expressed as Ω.m; f is the frequency of the source current in Hz.

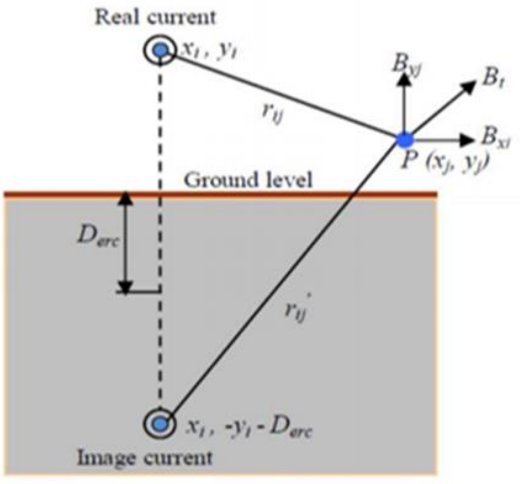


Fig.1. Magnetic field generated by a real current and its image in an observation point.

The magnetic field of transmission line can be written in adding the components of the given field for each conductor:

$$\left.\begin{aligned} Bxj &= \sum_{n=1}^{N} Bxj \\ Byj &= \sum_{n=1}^{N} Byj \end{aligned}\right\} \qquad (5)$$

The magnitude of the total magnetic induction at any desired point P is calculated by the summation of the horizontal and vertical components:

$$Bt = \sqrt{B_{xj}^{2} + B_{yj}^{2}} \qquad (6)$$

2.2. Geometric and characteristics of the line study

We consider a high voltage three-phase overhead power line having the arrangement and the geometric coordinates, reported shown in figure (2). Its characteristics are listed in Table 1.model of a very high voltage power transmission line.

Table 1. Characteristics of the very high voltage line

The height between the phase and the ground (m)	26
Conductor diameter (m)	232.10^{-3}
The distance between the phases (m)	12
The height of the guard cable (m)	36
The span line (m)	300
Voltage(KV)	400

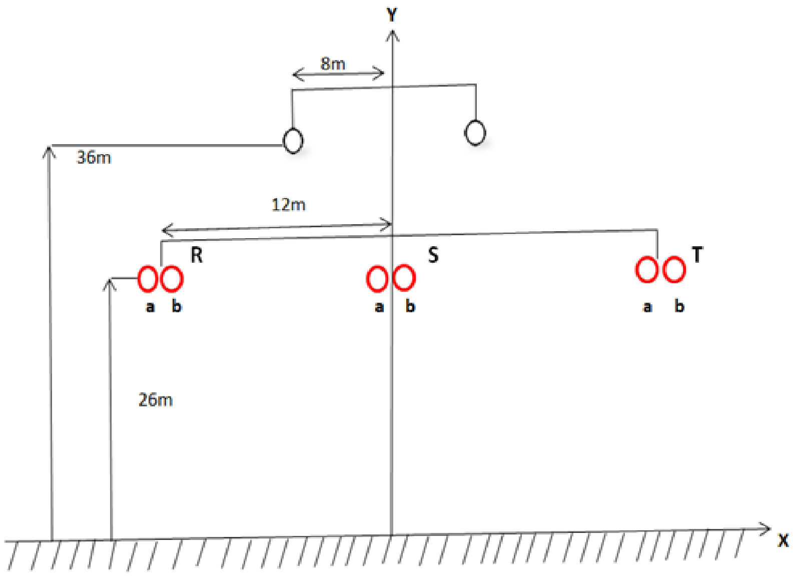
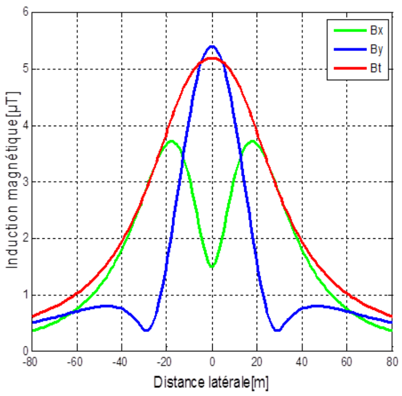


Fig.2. Geometry of the three-phase line in a horizontal configuration.

3. Results and Discussion

Figure 3 shows the curve of the magnetic field at 1m above the ground .The maximum value of the magnetic induction is B_{max} = 05.19μT, and decrease laterally in a continuous manner, in figure 4 represent the link between the intensity of the magnetic field and the effective intensity of the electric current flowing through the conductor .it see a significant linear relationship between the magnetic induction and current. More the current is higher, the magnetic field is intense, it is proportional to the current intensities that pass them.



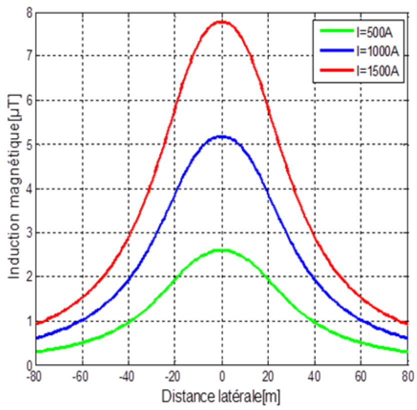


Fig.3. Magnetic field at 1m above the ground for 400 kV line configuration horizontal

Fig. 4. Relationship between the intensity of the magnetic field and the current flowing in the conductor**.**

4. Conclusion

In this paper, approximation approach based on GARSON Method performed from Matlab for plot the magnetic field in the vicinity of HV three-phase overhead power line 1m above the ground , from this result ,it is clear that the in the mid-span the induction magnetic value is higher, and then decreases with increase in the lateral distance . the magnetic field is proportional to the current of the three-phase overhead power line.

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