The Influence of Suspension Towers on the Directional Energy Flux Density along a Transmission Route

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Abstract **The paper deals with the influence of suspension towers on the directional energy flux density (Poynting vector) along a transmission route. The computation of an electromagnetic field along a power overhead line is performed by means of an integral method in the 3D arrangement.**

Keywords **Poynting vector, power overhead line, suspension towers, integral equations.**

I. INTRODUCTION

From a general point of view, the directional energy flux density (Poynting vector) along a transmission route has the same direction as a power overhead line. However, the Poynting vector around a suspension tower is influenced by the tower.

II. FORMULATION OF THE PROBLEM

The investigated case is depicted in Fig. 1, showing the suspension tower with 2 x 110 kV overhead line and the rectangular area of dimensions 21 x 11 m selected for the computation of the Poynting vector. This area is coplanar to the ground plane at the height of 1.8 m above the ground. The maximum possible value of the current passing though the phase conductors is 1240 A.

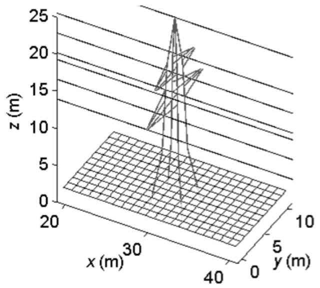

Fig. 1. Suspension tower and computation area

III. MATHEMATICAL MODEL

This time-dependent problem was solved three-dimensionally in the Cartesian coordinate system *x*, *y*, *z*. The magnetic field strength $\boldsymbol{B}$ produced by the line at point Q is determined by means of an integral equation (Biot-Savart law)

$$\boldsymbol{B}(Q) = \frac{\mu_0 I}{4\pi} \int_c \frac{\mathrm{d}\boldsymbol{l} \times \boldsymbol{r}_{PQ}}{r_{PQ}^3} \quad (1)$$

where μ_0 is the permeability of air, $\mathrm{d}\boldsymbol{l}$ is an element of the length of the conductor at general point P, and $\boldsymbol{r}_{PQ}$ is a radius vector that begins at point P and ends at point Q. The symbol I denotes the current passing through the conductor. The electric field strength $\boldsymbol{E}$ is determined by means of the integral equation

$$\boldsymbol{E}(Q) = \frac{1}{4\pi\varepsilon_0} \int_S \frac{\sigma(P) \cdot \boldsymbol{r}_{PQ}}{r_{PQ}^3} \mathrm{d}S \quad (2)$$

where σ is the surface charge density. The distribution of the Poynting vector $\boldsymbol{N}$ was calculated using the formula

$$\boldsymbol{N} = \boldsymbol{E} \times (\boldsymbol{B} / \mu_0) \quad (3)$$

IV. RESULTS OBTAINED

Figure 2 demonstrates the Poynting vector in the selected rectangular area. The maximum value of the Poynting vector 24861 W/m^2 is only valid at the individual nodes of the grid in which the set distance between two adjacent nodes was 0.25 m.

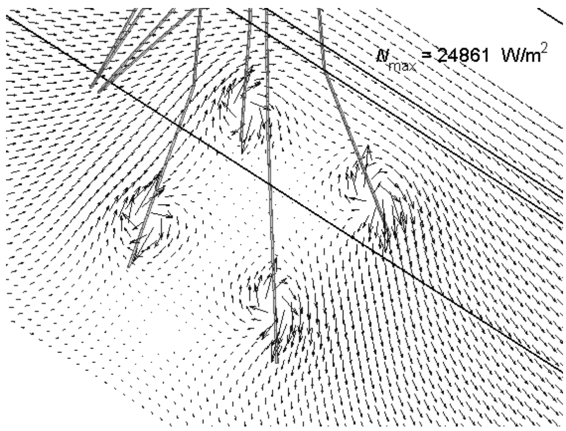

Fig. 2. Poynting vector in the selected rectangular area for the time $t = 0$

V. CONCLUSION

The aim of this paper was to calculate the Poynting vector along a transmission route around a suspension tower. The results clearly show that suspension towers significantly affect the directional energy flux density.

VI. ACKNOWLEDGEMENTS

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VII. REFERENCES

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