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ENERGY CHARACTERISTICS AND THE DIRECTED PROPERTIES OF ANTENNAS IN PEKERIS WAVE GUIDE

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Work of the antenna in Pekeris wave guide is investigated. Calculation of radiation resistance of the antenna in a wide range of frequencies is executed. Features of radiation in the lower semi sphere are investigated. The vertical cylindrical antennas submitted as monopole and quarapole source, forming the directed radiation in semi sphere are analyzed.

Many researches [1-5] are devoted to the behavior of directed antennas in Pekeris waveguide. It is known that Pekeris model is successfully applied to the analysis of behavior of specific antennas.

The field of the radiator in a wave guide will be presented by the discrete sum of normal waves of all types resolved by the dispersive equation. Three sets of roots of the dispersive equation and three sets of normal waves are distinguished: normal waves, quasinormal - the basic components of the total sound field in wave guide and flowing. In the latter case constant distributions are complex and normal waves expotentionaly fade in a direction of distribution. They describe process of energy transfer from the source of wave guide to lower semi sphere.

Following the definition of resistance of radiation accepted earlier, we have [4]

$$Z_R = \frac{Z_R}{\rho_1 \cdot c_1 \cdot S} = \frac{2 \cdot l}{h} \cdot k_1 \cdot \sum_n \frac{\varphi_n^2(Z_q) \cdot \Phi_n^2}{\xi_n \cdot E_n \cdot H_1^{(2)}(\xi_n \cdot a)} \cdot \varepsilon_n \cdot i \cdot H_0^{(2)}(\xi_n \cdot a), \tag{1}$$

where S - a surface of a radiator, a - radius of the antenna, l - the aperture, h - thickness of a wave guide, Φ_n^2 - partial diagram of n-direction a normal wave; ξ_n - a constant of distribution, $\varphi_n(z)$ - proper functions corresponding to all three types of waves.

Distinguishing normal waves with real constant of distribution $n(1)$, $n(2)$ - type and the flowing wave's $n(3)$ - type, we receive

$$\begin{aligned}
&Z'_{12} = r'_{12} + i \cdot x'_{12} = \\
&= \frac{2 \cdot \ell}{h} \cdot \kappa_1 \cdot \sum_n^{N^- + N^+} \frac{\varphi_n^2(z_q) \cdot \Phi_n^2}{\xi_n \cdot E_n \cdot \left|H_1^{(2)}(\xi_n \cdot a)\right|^2} \cdot i \cdot H_0^{(2)}(\xi_n \cdot a) \cdot H_1^{(1)}(\xi_n \cdot a); \\
&r'_{12} = \frac{2 \cdot \ell}{h} \cdot \frac{2}{\pi} \cdot (\kappa_1 \cdot h) \cdot \sum_n^{N^- + N^+} \frac{\varphi_n^2(z_q) \cdot \Phi_n^2}{\xi_n \cdot a \cdot \xi_n \cdot h \cdot \left|H_1^{(2)}(\xi_n \cdot a)\right|^2 \cdot E_n}; \\
&x'_{12} = \frac{2 \cdot \ell}{h} \cdot \kappa_1 \cdot \sum_n^{N^- + N^+} \frac{\varphi_n^2(z_q) \cdot \Phi_n^2}{\xi_n \cdot E_n \cdot \left|H_1^{(2)}(\xi_n \cdot a)\right|^2} \times \\
&\times \left[J_0(\xi_n \cdot a) \cdot J_1(\xi_n \cdot a) + N_0(\xi_n \cdot a) \cdot N_1(\xi_n \cdot a)\right]. \\
&Z'_3 = r'_3 + i \cdot x'_3 = \frac{2 \cdot \ell}{h} \cdot \kappa_1 \cdot \sum_{n(3)} \frac{\varphi_n^2(z_q) \cdot \Phi_n^2}{\bar{\xi}_n \cdot E_n \cdot H_1^{(2)}(\bar{\xi}_n \cdot a)} \cdot i \cdot \varepsilon_n \cdot H_0^{(2)}(\bar{\xi}_n \cdot a).
\end{aligned} \tag{2}$$

The component r_{12} full resistance of radiation characterizes transfer of capacity to a wave guide, and component r_3 - to the lower semi sphere.

Resistance Z_{12} is divided into the components connected to normal waves of the set $n(1)$ and quasinormal waves of the set $n(2)$

$$Z'_{12} = (r_{12}^+ + r_{12}^-) + i \cdot (x_{12}^+ + x_{12}^-),$$

Where signs (-), (+) concern to normal and quasinormal to waves accordingly.

As an example monopole and the four-element vertical antenna are considered. The overall dimension of radiator quadropole type accepts the same values, as for the radiator of monopole type.

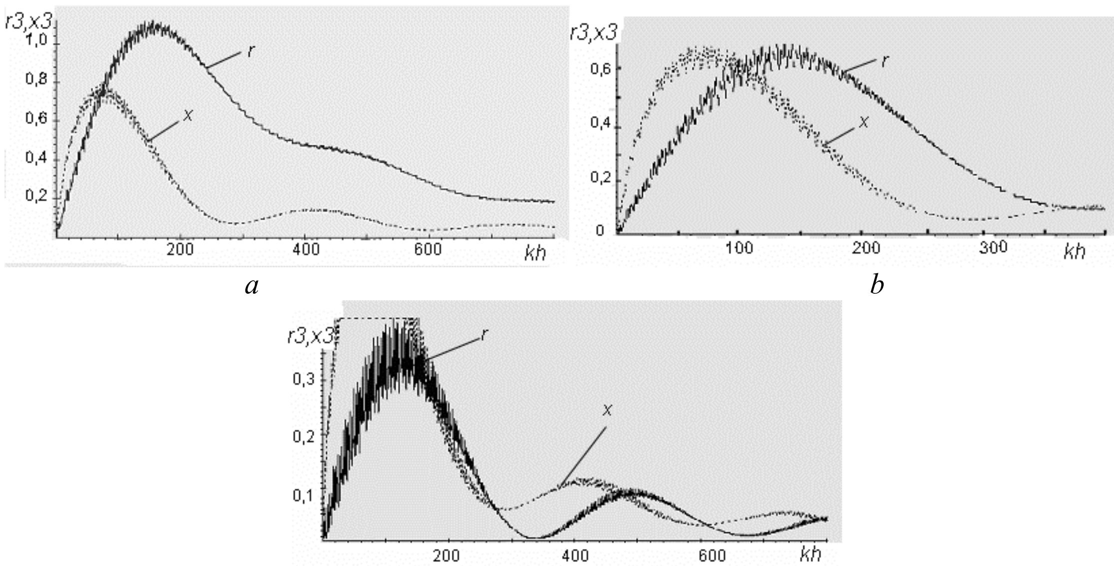

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Fig. 1. Dependence of radiation resistance of the antenna (monopole) on type of ground in Pekeris wave guide. Following waves, *l*=0,01; *a*=0,005; Z_0=0,5;

a - $\rho_{12} = 1/1{,}5; c_{12} = 1{,}5/1{,}55$; *b* - $\rho_{12} = 1/1{,}6; c_{12} = 1{,}5/1{,}75$;

c - $\rho_{12} = 1/2; c_{12} = 1{,}5/2{,}5$

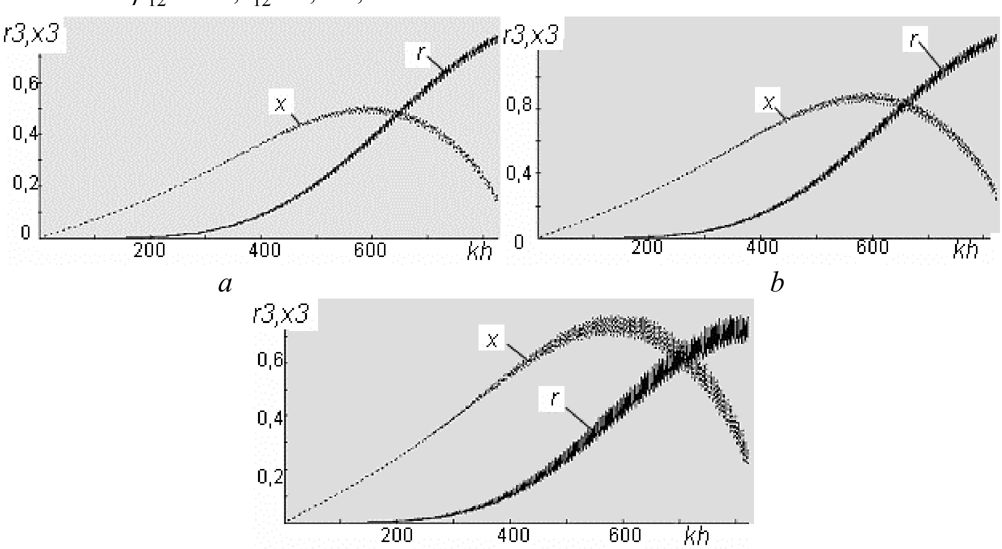

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Fig. 2. Dependence of radiation resistance of the antenna (quadrapole) from type of ground in Pekeris wave guide. Following waves, *l*=0,01; *a*=0,005; Z_0=0,5;

a - $\rho_{12} = 1/1{,}5; c_{12} = 1{,}5/1{,}55$; *b* - $\rho_{12} = 1/1{,}6; c_{12} = 1{,}5/1{,}75$; *c* - $\rho_{12} = 1/2; c_{12} = 1{,}5/2{,}5$

Calculation is made on the ratio (2) for various parameters of the ground. The numerical analysis of radiation resistance allows estimate the capacity radiated in the wave guide and in the bottom, thus parameters of the ground render essential influence on character of the following waves describing radiation in semi sphere. Parameters of a ground vary, remaining corresponding to impedance border. Three types of the ground deposits corresponding to the bottom of continental shelf are considered: sea sand, clay, alevrit sand. The antenna works in the center of a wave guide. It is shown on the fig. 1, 2 that for quadropole active and reactive components achieve the limiting values on higher frequencies.

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