Radioelectronics and Communications Systems
Vol. 47, No. 2, pp. 42–47, 2004

Izvestiya VUZ. Radioelektronika
Vol. 47, No. 2, pp. 58–65, 2004
UDC 621.371:510.62 + 551

CHARACTERISTICS OF THE ELECTROMAGNETIC FIELD STRUCTURE AND WAVE PROCESS PARAMETERS IN THE SEA TROPOSPHERIC WAVEGUIDE

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The paper considers the characteristics of the beam method used for calculation of amplitude distribution of the fundamental wave field inside the sea tropospheric waveguide (TWG) and of the wave process parameters. Expressions are derived making it possible to determine the maximum wavelength of the fundamental mode and of higher modes propagating over TWG. The results of theoretical and experimental investigations are supplemented with a formula for calculation of the "angle of feeding" of natural TWG. The knowledge of this angle contributed to the practical application of such wave-guiding formations.

The intensive development of ecology, hydrometeorology, hydrography, and other applied sciences is accompanied by investigations on the facilities and technologies used for studying the sea surface and boundary layers of the atmosphere. The measurement results obtained in these inquiries, such as *M*-profiles of the troposphere, can be used for determination of parameters of sea tropospheric waveguides (TWG) to be used, for example, in radar and communications. For efficient application of TWG, arising regularly over southern seas and over the Black Sea in particular, we have to know the maximal wavelength of a particular TWG — by analogy with the critical wavelength of metal waveguide, and the amplitude distribution of the radio wave field inside the TWG — and to estimate the opportunity of its "feeding" (energy take-off) with some radio equipment, for example, with the aid of a radar. This work is devoted to resolving these problems.

Analysis of the electromagnetic field in a sea TWG will be performed based on the beam representation [1]. The beam method, using the Brillouin concept, is often employed in calculations of the electromagnetic field and parameters of dielectric waveguides, strip lines, and various microwave components and devices on their basis [2], i.e., for directed systems with "rigid" borders between media. However, the sea TWG differs from such systems.

Let the Poynting vector $\overline{\Pi}$ of a plane wave, propagating in a TWG with its height h_1 (Fig. 1), forms with the coordinate axes $0x$, $0y$, and $0z$ the angles equal, respectively, to θ_{xx}, θ_{yx}, and θ_{zx}, which depend on the coordinate x in a certain way. The direction cosines of these angles are related to each other as $\cos^2\theta_{xx} + \cos^2\theta_{yx} + \cos^2\theta_{zx} = 1$.

As follows from [3], for the evaporation waveguides and for near-water TWG arising over the Black Sea, the height h_1 may vary from several to several tens of meters depending on the season and on the mechanism of their formation. At the same time, the dimensions of the sea wave-guiding structures in the horizontal plane (the 0y axis) may be as large as tens of hundreds of kilometers. This feature of the sea TWG permits reflections from side walls to be neglected. Consequently, we may set $\theta_{yx} = 90°$, and $\cos\theta_{yx} = 0$ and $|\cos\theta_{xx}| = |\sin\theta_{zx}|$. Then the TGW takes the form presented in Fig. 2.

Here we shall consider the conditions for generation of a wave process in TWG along the $0z$ axis. The "faces" of this waveguide are, from one side, the sea surface with parameters ε_3, μ_3, σ_3 (the waves falling on the sea surface at some sharp

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9 September 2003