Frequency Properties of Electrical Fields of Cylindrical Sonar Antenna with a Flat Baffle in the Diametral Plane

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Abstract—By means of method of coupled fields we obtain analytical relations describing electrical fields of cylindrical piezoceramic antennas with flat baffles in diametral plane. Numerical experiment results of frequency characteristics of antennas' electrical fields dependently on parameters of antenna elements and embodiment are presented.

Cylindrical energy converters are widely applied in current-technology devices of echolocation. Antennas arrays, developed at their basis, are the main elements of hydrolocation stations of different purpose. In contrast to radio location antennas, their specificities lie in hydrolocation antennas realize not only shaping of radiated or received energy in the environment, but conversion of one energy type into another one. In particular, it is a conversion of electrical energy into acoustic one in radiation mode. It results to necessity of match of output characteristics of the station generator section with antenna input parameters. But definition of the lasts is enough complicated problem in case of, for example, antenna fabrication on a basis of piezoceramic elements.

These problems are related to conversion of electrical energy into acoustic one is realized in piezoceramic antenna due to interaction of electric, mechanic and acoustic fields. In mathematical aspect rigid solution of this problem is enough complicated, in this connection definite numerical solution of electrical fields are practically absent in literature. Existent data [1, 2] are enough scant and they are obtained with approximate method of equivalent electromechanic circuits [3].

The purpose of this paper is problem solution for electric fields properties of piezoceramic cylinder antennas with flat baffle in diametral plane. Based on obtained analytical relationships the numerical investigations of frequency characteristics of this antenna were carried out.

PROBLEM STATEMENT

We define electric field of cylinder piezoceramic antenna with a baffle in diametral plane. The normal cross-cut of antenna is represented in Fig. 1. The antenna consists of cylinder piezoceramic radiating element *1* with circumferential polarization and rear baffle *2*. Internal cavity of piezoceramic cover of the radiating element of the thickness h can be vacuumized, filled with gas or liquid with a density of ρ_1 and sound speed of c_1.

Horizontal polarization is realized by means of cover building from inflexibly glued N piezoceramic prismatic solids, which are connected in parallel. Prisms electrodes are fed by harmonic oscillating electric voltage $\psi = \psi_0 e^{-i\omega t}$ with frequency ω, where "i" is imaginary unit. Thin rear baffle of the antenna is realized of acoustically soft material. Antenna is placed into medium with density ρ and sound speed c.

Assuming antenna height is greater than 5–7 wavelengths [4] in case of introduced coordinates systems (Fig. 1) electrical field of the antenna considered is defined from mutual solution of

– equation of forced static electricity for piezoceramics: