FLARE ANGLE CHANGES ANTENNA OF THE MILLIMETER WAVE BAND

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ABSTRACT - A pyramidal horn with flare-angle changes was designed at millimeter wave band with using of the S. Cohn's method of antenna pattern shaping. Results of the investigation show an assemblage of good properties are resticted to this kind of antennas (if take into account such parameters as: form of beam, level of sidelobe and crosspolarization, microwave loss and radiation coefficient away from main lobe).

INTRODUCTION. There is generality of requirements for a features of the horns as antennas or feeds with using of ones in radio astronomy, radiolocation, etc. The axial symmetry of beam and suppressed sidelobes, broad band performance, low microwave and dissipation loss fall into the requirements.

There are many ways to design horn antennas with corrected pattern. Generally multimode horn structures are used to obtain the required pattern. S. B. Cohn proposed the technique for controlling the E-plane radiation pattern of a pyramidal or conical horn by means of higher modes are excited by one or more small changes of flare angle within the horn [1]. As a result of the mode excitation, the number, the rate of the flare-angle change and relative position of the
flare-angle change points and the throat of the horn determine the E-plane aperture distribution and thereby determine the E-plane radiation pattern of the horn.

It is known a pyramidal horn with square aperture has the sidelobe levels are 23dB (in the H-plane) and 13dB (in the E-plane) below the peak of the main beam and a theoretical ratio of H-plane to E-plane 3dB beamwidth equal to 1.35. Since the H-plane pattern already satisfactory, a means was sought for introducing E-plane aperture taper in order to increase the beamwidth and reduce the sidelobes of the E-plane pattern. The design formulas proposed in [1] were used for calculation of the pyramidal horn dimensions.

**DESIGN CALCULATION AND FEATURES MEASUREMENT OF THE HORN ANTENNA.** A small flare-angle change within the horn causes the conversion of part of the TE10 mode energy to higher modes, namely TE/TM12, TE/TM14, TE/TM16, etc., where TE/TM denotes TE/TM pairs. The higher modes have a substantial effect on the E-plane pattern, and that on the H-plane may be neglected in practical design. The TE/TM1n - mode amplitudes relative to the TE10 can be found from the following equations [1]:

\[ A_0 = 1; \quad A_2 = \frac{2a_0(\theta_1 - \theta_2)}{3\lambda}; \quad A_4 = -\frac{1}{5}A_2; \quad A_6 = \frac{3}{35}A_2 \ldots \] (1)

where \( A \) represents complex amplitudes of the TE/TM12, TE/TM14, etc., relative to the TE10. \( \theta_1 \) is the aperture height and width at the flare-change point, \( \theta_1 \) is the flare angle ahead of the flare change point, \( \theta_2 \) is the same at that point, \( \lambda \) is the guide wave length of the TE10 horn mode, \( j \) is unit imaginary number.

A length of horn introduces a differential phase shift between the TE10 mode and TE/TM1n. The phase shift \( \psi_n \) of TE/TM1n modes in square pyramidal horn may be obtained in radians from the following equation[1]:

\[ \psi_n = \frac{\pi}{\theta_2} \left\{ \frac{a_0^2}{\lambda} \sqrt{1 - (1 + n^2)(2a_0/\lambda)^2} - \frac{a_0}{\lambda} \sqrt{1 - (1 + n^2)(\lambda/2a_0)^2} + 0.5 \frac{\lambda}{\sqrt{1 + n^2}} \right\} \] (2)