P4-14: Compensation of Wave H_{01} Reflection from a Dielectric Window on to the Horn Aperture

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Abstract: *With use developed before methods and the program of calculation symmetric H waves in an irregular round wave guide with dielectric inserts [3] calculations of factor of reflection of a horn with a dielectric window on the aperture are executed. Conditions at which at the expense of a correct choice of parametres of a horn full indemnification of reflection is realised are found.*

Keywords: horn, dielectric window, reflection factor, mathematical model operation

Introduction

Usually from the generator of big capacity the MICROWAVE radiation deduce through a horn, which basic purpose the coordination of a wave guide with open space, and maintenance of the minimum reflection with it at an energy conclusion, and also maintenance of the demanded diagramme of an orientation. The dielectric diaphragm isolating vacuum space of powerful source the MICROWAVE is located on the horn aperture.

Not always probably to pick up the thickness of a diaphragm corresponding to the minimum reflection at certain values of dielectric permeability ε. In this case the research problem of possibility of selection of such parametres of a horn (Fig.1) is actual for $\mu_{01} < b_0 < \mu_{02}$, at which indemnification of reflection from a diaphragm would be realized. Research of physical features of such indemnification - is a problem of the given report.

Statement of a problem and decision method

On Fig. 1. the geometry of a solved problem is presented.

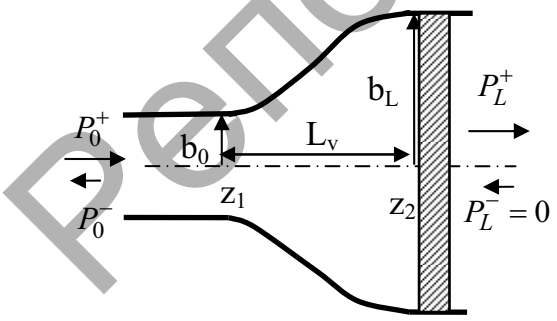

Figure 1. Horn with a dielectric window

On an input of a horn in radius b_0 moves symmetric H_{01} wave capacities P_0^+ ($A_0^+ = 1$). Radius aperture is b_L.

Forming a horn at $z_1 < z < z_2$ it was set in the form of a parabola having smooth interface to regular wave guides on an input and the aperture

$$b(z) = b_0 + (b_L - b_0) * P_5\left[(z - z_1)/(z_2 - z_1)\right],\ P_5[x] = x^3\left(10 - 15x + 6x^2\right).$$

Parametres of horn $L_v = z_2 - z_1$ also b_L - stole up from a condition of the minimum reflection in the presence of a dielectric window in the thickness D_ε with dielectric permeability ε.

For performance of calculations the method and the program developed earlier for similar problems [1-3] was used. The reflection factor on capacity H_{0l} – waves in a horn with a dielectric window paid off under formula $K = 1 - P_L^+ / P_0^+$, where P_0^+, P_L^+ - submitted on an input and passing capacities. Below geometrical sizes are resulted in terms of $\lambda/2\pi$.

Results of calculations

For a typical monotonous horn without a dielectric window with entrance radius $b_0 = 5$ it has been established, that at $b_L = 9 \div 10$ and $L_v = 10 \div 15$ the factor of reflection K does not surpass 0.003. At fixed $b_{L0} = 10$ and increase $L_v \geq 10$ the reflection factor fluctuates in range $K = 0,0023 \div 0,003$, and first minimum K=0.0023 is reached at $L_v = 12.4$. From Fig. 2. it is visible, that on an exit of a horn size of amplitudes of the higher partial waves H_{02}, H_{03} thus makes ≈50 % and 5 % from amplitude of basic wave H_{01}.

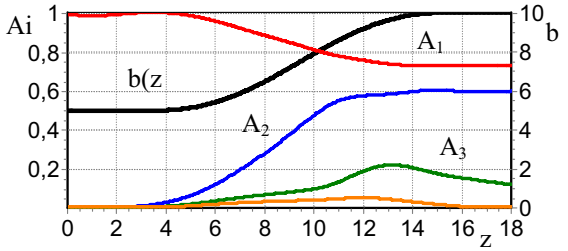

Figure 2. Amplitudes A_i waves H_{0i} in horn without a dielectric window b_0=5, b_L=10, L_v=12.4, K=0.0023

As is known [3], the wave passes without reflection through a diaphragm with a thickness, a multiple half of length of a wave in dielectric $D_\varepsilon^k = 0.5k\Lambda_\varepsilon^{H_{0i}}$,

$\Lambda_{\varepsilon}^{H_{0i}} = 2\pi / \sqrt{\varepsilon - (\mu_{0i}/b)^2}$. At $b_0 > 8$ for H_{01} waves a thickness such "transparent" of diaphragm $D_{\varepsilon}^{1} \approx \pi/\sqrt{\varepsilon}$. However, if D_{ε} does not satisfy to this condition, the reflection factor K has the maximum value at $D_{\varepsilon} \approx (0.5+k)D_{\varepsilon}^{1}$, which reaches considerable size - 20% at $\varepsilon = 2.5$, 40% at $\varepsilon = 5$. Thus wave passage through a dielectric window is not accompanied by excitation of the higher partial waves [3].

Calculations have shown, that at a premise "transparent" for H_{01} diaphragm waves in aperture a horn (with parametres Fig. 2) there is small, approximately twice an increase in factor of reflection *K*, explained by reflection from a diaphragm of waves raised in a horn to higher index. By optimisation of parametres b_L, L_v it is possible to reduce factor of reflection to values corresponding to a horn without a dielectric window. Characteristic distribution of amplitudes $A_i(z)$ in a horn in the presence of a dielectric "transparent" window ($D_{\varepsilon} = D_{\varepsilon}^{1}$) to and after optimization it is presented on Fig. 3.

In the presence of reflection before a diaphragm on peak curves are visible characteristic for superposition of direct

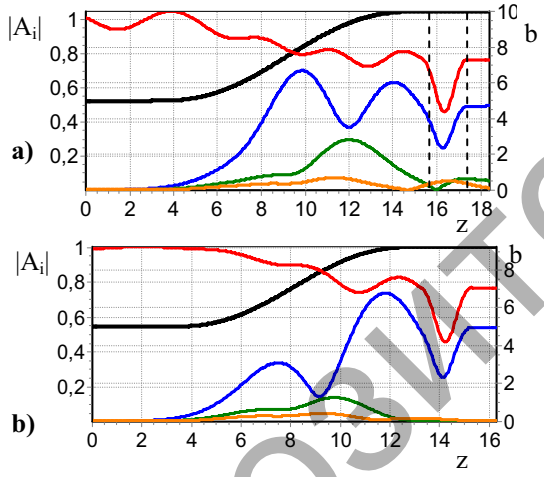

Figure 3. Horn with a "transparent" window b_0=5, ε=2.5
a) before optimisation b_L=10, L_v=12.4, D_{ε} =2, K=0.0051,
b) after optimisation b_L=9.2, L_v=10.3, D_{ε} =2, K=0.0023

and return waves of palpation. After diaphragms of amplitude of a passing wave are constant, that corresponds to the full coordination.

It is natural, that at a premise in having opened a horn of a "reflecting" diaphragm ($D_{\varepsilon} \neq D_{\varepsilon}^{1}$) the factor of reflection of a horn will correspond to factor of reflection from such diaphragm. Calculations have shown what to compensate reflection from a dielectric window it is possible at the expense of a corresponding choice of parametres b_L, L_v a horn, providing a minimum of factor of reflection *K*.

On Fig.4 distribution of amplitudes in a horn with a "reflecting" diaphragm ($D_{\varepsilon} = 0.5D_{\varepsilon}^{1}$) before optimisation is presented.

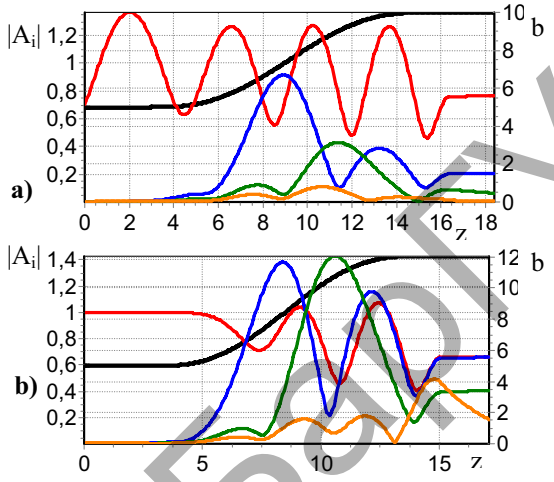

Figure 4. Horn with a "reflecting" window b_0=5, ε=2.5
a) before optimisation b_L=10, L_v=12.4, D_{ε} =1, K=0.14,
b) after optimisation b_L=12.04, L_v=11.09, D_{ε} =1, K=0.0023

The factor of reflection of wave H_{01} from such diaphragm is equal 0.22. The factor of reflection of a horn with such diaphragm a little bit more low also is equal 0.14. As we see from Fig. 4a the basic reflection tests in this case H_{01} wave. As a result of optimisation of parametres the reflection factor appears not big than at a horn without a diaphragm. Apparently from Fig. 4b in a horn with such parametres there is a reflection of waves between a diaphragm and an irregular site of a waveguide. As a result the system "horn-diaphragm" represents the half-wave transformer through which the wave passes without reflection.

Conclusion

As a result of computing experiment it is shown, that the reflection factor in a horn with a dielectric window can reach 20-60 % at $\varepsilon = 2-10$. At a corresponding choice of parametres system «a horn-dielectric the window» represents the half-wave transformer and practically full indemnification of reflection is reached**.**

References

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