Design Curves for Waveguide Absorbers

Normalized curves are presented for the design of waveguide absorbers consisting of thin uniformly spaced sheets of resistive material. An analysis of absorption in rectangular waveguides containing parallel sheets of resistive material uniformly spaced across the waveguide was carried out by Witt *et al.*[1] A conclusion of this work was that when the operating frequency is in excess of about 1.5 to 2 times the cutoff frequency for the TE_{10} mode in the unloaded waveguide and the number of sheets exceeds three or four, then then the loaded waveguide solutions closely approach the solutions that apply to an infinite array of parallel resistive sheets. Thus, provided that these conditions are satisfied, the infinite array theory can be used to design waveguide absorbers.

The infinite array geometry is depicted in Fig. 1. The dispersion equation for modes having the electric field vector parallel to the sheets, and for which the center planes of the sheets are planes of infinite impedance is

$$-j\frac{k_x c}{2}\tan\frac{k_x c}{2} = \frac{kc}{2}\frac{\eta}{R_s} \tag{1}$$

where

c is the spacing between sheets,
R_s is the ohms per unit square value of the resistive sheets,
$\eta=\sqrt{\mu/\epsilon}$ is the wave impedance in the medium between the sheets,
$k=\omega\sqrt{\mu\epsilon}$ is the wave number in the medium between the sheets, and
jk_x is the x-directed propagation constant.

The z-directed propagation constant is given by

$$\gamma = \alpha + j\beta = \sqrt{k_x^2 - k^2}. \tag{2}$$

Finite thickness sheets convert to infinitely thin sheets by the relation $R_s = 1/\sigma\delta$, where δ is the sheet thickness and σ is the conductivity. If we let

$$\frac{k_x c}{2} = \theta$$

then (1) and (2) become

$$\theta \tan\theta = j\frac{\pi}{2}\frac{c}{\lambda}\frac{\eta}{R_s} \tag{3}$$

and

$$\alpha c + j\beta c = 2\sqrt{\theta^2 - \left(\frac{\pi c}{\lambda}\right)^2}. \tag{4}$$

Equation (3) must be solved for the allowed values of θ and then the attenuation and phase shift are obtained from (4). Suetake and Griemsmann found approximate solutions by conformal mapping techniques.[2] In this work a digital computer was used to obtain solutions. The results are depicted in Fig. 2. The design curves give normalized attenuation αc versus normalized sheet spacing c/λ with normalized surface resistance R_s/η as a parameter.

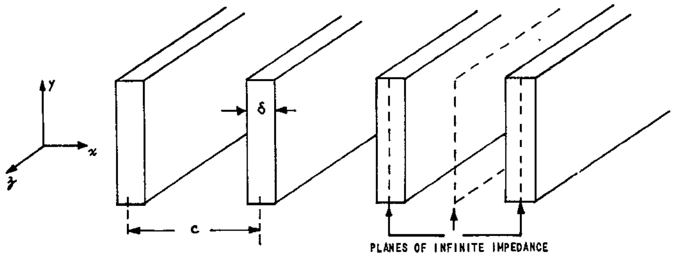

Fig. 1. Array of resistive sheets.

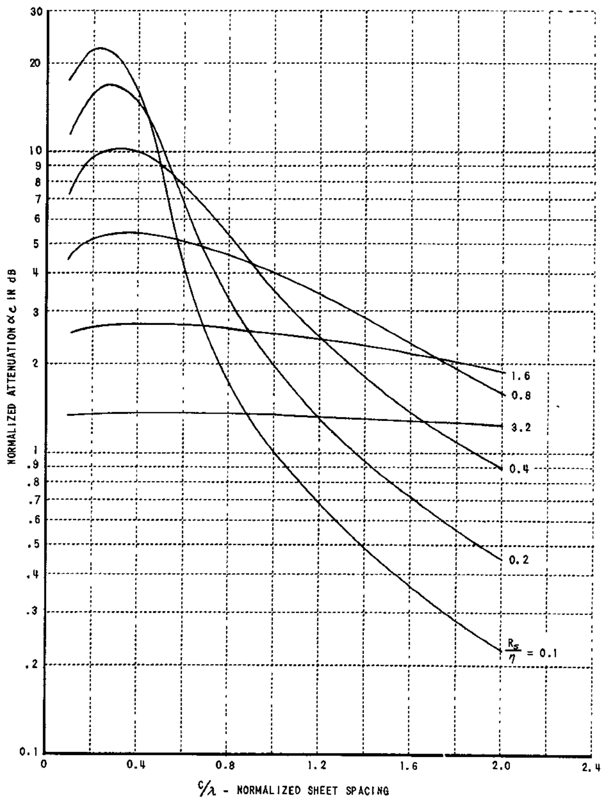

Fig. 2. Design curves for resistive absorbers.

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[1] H. R. Witt, E. L. Price, and R. E. Biss, "Propagation constants of a waveguide containing parallel sheets of finite conductivity," *IEEE Trans. Microwave Theory and Techniques*, vol. MTT-15, pp. 232–239, April 1967.

[2] K. Suetake and J. W. E. Griemsmann, "Absorbing material using parallel resistance sheets," Polytechnic Institute of Brooklyn Brooklyn, N. Y., Rept. PIBMRI-1060-62, August 14, 1962.