Beryllium X-Ray Window Thickness Guidelines

Beryllium radiation windows frequently operate with atmospheric pressure on one side and vacuum on the other side. The following equations are suggested to compute the stress on the radiation window for a given set of conditions.

The design strength of the foil should be taken as 40,000 psi. An appropriate safety factor should also be employed. The maximum stress for a chosen thickness as computed by the equations should be compared with the 40,000 psi design strength decreased by the chosen safety factor. Repetitive computation will establish the proper thickness. The analysis considers the x-ray window to be a simply supported flat plate, with, for example, an adhesive-bonded edge.

This procedure is valid for windows that undergo small deflections only. The design procedure is as follows:

a) Compute the deflection at the center of the window.

b) If the deflection at the center of the window is less than half the thickness of the window, follow the procedure described below.

c) If the deflection at the center of the window exceeds half the thickness of the window, this procedure is not valid. An analysis technique that includes large deflection (geometric non-linearity) must be used.

d) Alternatively, if the deflection at the center of the window exceeds half the thickness of the window, increase the thickness of the window and recompute deflection. When deflection is less than half the thickness, proceed with stress computation.

FOR CIRCLES:

Edges Simply Supported, Uniform Load Across Area

$$= \frac{3W(m-1)(5m+1)a^2}{16\pi E m^2 t^3}$$

Deflection at the Center of the Window

$$= \frac{3W(3m+1)}{8\pi m t^2}$$

At Center:
Maximum Stress (Radial)

<u>Where</u>:

W	=	*Total force* on window (Pressure x Area)
t	=	Thickness of Window
m	=	Inverse of Poisson's Ratio (1/n)
		For Beryllium m = 10.0
E	=	Young's Modulus (42 x 10^6 psi for Be)
a	=	Radius of Window

$$= \alpha \frac{wb^4}{Et^3}$$

FOR RECTANGLES:

Deflection at Center of Window

$$= \beta \frac{wb^2}{t^2}$$

Maximum Stress

<u>Where</u>:

w	=	Applied *pressure* (psi)
a	=	Length of Long Side
b	=	Length of Short Side
E	=	Young's Modulus (42x10^6 psi for Be)
t	=	Thickness
a, b	=	As Defined Below

a b	1	1.2	1.4	1.6	1.8
β	0.2431	0.3348	0.4170	0.4865	0.5435
α	0.0483	0.0671	0.0842	0.0987	0.1107

a b	2	3	4	5	∞
β	0.5892	0.7066	0.7389	0.7473	0.7500
α	0.1203	0.1453	0.1523	0.1541	0.1547

Intermediate ratios may be interpolated.
These equations are taken from: <u>Formulas for Stress and Strain</u> by Raymond J. Roark. 4th Edition. (1965) McGraw-Hill.

Brush Wellman Inc.
Electrofusion Products
44036 South Grimmer Blvd. • Fremont, CA 94538
800-4Be-FOIL • 510-623-1500 • FAX 510-623-7600