Sealed Enclosure Design Formulas

Tim Starr

February 27, 2005

Here are the basic sealed enclosure equations. See "Intro to Sealed Enclosures" for the definitions of each variable. In an effort to make this accessible to the broadest audience as possible, I'll refrain from making simplifications or using notation that isn't in general use (meaning the non-math/science/engineering public!). I don't mean to insult anyone's intelligence but we all get our symbols mixed up now and then. As a reminder $x^{\frac{1}{2}}$ is the same as $\sqrt{x}$.

$$f_{\mathrm{c}} = \frac{Q_{\mathrm{tc}} \cdot f_c}{Q_{\mathrm{ts}}} \tag{1}$$

Both f_{xmax} and f_{gmax} are given as ratios of f_{c}. Thus, to find the actual frequency you must multiply by f_{c}!

$$f_{\mathrm{xmax}} = \sqrt{1 - \frac{1}{2Q_{\mathrm{tc}}^2}} \tag{2}$$

$$f_{\mathrm{gmax}} = \frac{1}{f_{\mathrm{xmax}}} = \frac{1}{\sqrt{1 - \frac{1}{2Q_{\mathrm{tc}}^2}}} \tag{3}$$

So to find the frequency at which f_{xmax} actually occurs at, call it F_{xmax}, you would have

$$F_{\mathrm{xmax}} = f_{\mathrm{xmax}} \cdot f_{\mathrm{c}}$$

This goes for f_{gmax} as well, to find the frequency at which f_{gmax} occurs, call it F_{gmax}

$$F_{\mathrm{gmax}} = f_{\mathrm{gmax}} \cdot f_{\mathrm{c}}$$

$$\text{Peak dB} = 20 \cdot \log_{10} \sqrt{\frac{Q_{\mathrm{tc}}^4}{Q_{\mathrm{tc}}^2 - 0.25}} \tag{4}$$

$$\alpha = \left(\frac{Q_{\mathrm{tc}}}{Q_{\mathrm{ts}}}\right)^2 - 1 \tag{5}$$

$$f_3 = \left(\frac{\left(\frac{1}{Q_{\mathrm{tc}}^2} - 2\right) + \sqrt{\left(\frac{1}{Q_{\mathrm{tc}}^2} - 2\right)^2 + 4}}{2}\right)^{\frac{1}{2}} \cdot f_{\mathrm{c}} \tag{6}$$

$$V_{\mathrm{b}} = \frac{V_{\mathrm{as}}}{\alpha} \tag{7}$$

Free-air reference efficieny as a percentage is given by

$$\eta_0 = \frac{K\left(f_{\mathrm{s}}^3 V_{\mathrm{as}}\right)}{Q_{\mathrm{es}}} \cdot 100 \tag{8}$$

where the constant

$$K = \begin{cases} 9.64 \times 10^{-10} & \text{for } V_{\mathrm{as}} \text{ in liters} \\ 9.64 \times 10^{-7} & \text{for } V_{\mathrm{as}} \text{ in cubic meters} \\ 2.70 \times 10^{-8} & \text{for } V_{\mathrm{as}} \text{ in cubic feet} \end{cases}$$

SPL at $\frac{\mathrm{1Watt}}{\mathrm{1meter}}$, in decibels may also be calculated by

$$\mathrm{dB} = 112 + 10 \cdot \log_{10}\left(\eta_0\right) \tag{9}$$

Driver efficiency in an enclosure, as a percentage, may also be calculated by

$$\eta_{0\mathrm{f_c}} = \frac{K f_{\mathrm{c}}^3 V_{\mathrm{as}} V_{\mathrm{b}}}{Q_{\mathrm{ec}}\left(V_{\mathrm{as}} + V_{\mathrm{b}}\right)} \cdot 100 \tag{10}$$