The equation for determining the maximum flux density of a given toroidal core is as follows:

$$B_{max} = \frac{E \times 10^8}{4.44 \times A_e \times N \times F}$$

E_{pk} = applied RMS volts

A_e = cross-sect. area (cm^2)

N = number of wire turns

F = frequency (Hertz)

The safety factor may be increased by using the peak AC voltage in the equation. This is a standard practice among many RF engineers who design broadband RF power transformers.

The above equation may be changed as shown below to make it more convenient during calculations of B_{max} at radio frequencies.

$$B_{max} = \frac{E \times 10^2}{4.44 \times A_e \times N \times F}$$

E_{pk} = applied RMS volts

A_e = cross-sect. area (cm^2)

N = number of wire turns

F = frequency (MHz)

The sample calculation below is based on a frequency of 7 MHz, a peak voltage of 25 volts and a primary winding of 15 turns. The cross-sectional area of the sample core is 0.133 cm^2. From previous guidelines we know that the maximum flux density at 7 MHz should be not more than 57 gauss.

$$B_{max} = \frac{25 \times 100}{4.44 \times 0.133 \times 15 \times 7} = 40.3 \text{ gauss}$$

This hypothetical toroid core will have a flux density of 40 gauss according to the above formula and when operated under the above conditions. This is well within the guidelines as suggested above.

Temperature rise can be the result of using an undersized wire gauge for the amount of current involved as well as magnetic action within the core. Both will contribute to the overall temperature rise of the transformer. This can be calculated with the following equation:

$$\text{Temperature Rise (°C)} = \left[\frac{\text{Total Power Dissipation (Milliwatts)}}{\text{Available Surface Area (cm}^2\text{)}}\right]^{.833}$$

If the operating temperature (ambient temperature + temperature rise) is more than 100°C when used intermittently, or more than 75°C if used continuously, a larger size core and/or a heavier gauge wire should be selected.