

Flywheel Formulas



Flywheels are occasionally used on a few machines, such as air compressors, to even out load pulsations. These formulas are useful in designing entire flywheel rims. It is also possible to use V-Belt sheaves as a flywheel thus eliminating the need for a separate flywheel in the system. Consult *Martin* with specific requirements.

Formulas for Entire Flywheel

- W = weight (pounds)
- R = radius of gyration (feet)
- N = speed (RPM)
- t = time to change from N₁ to N₂ (seconds)
- F = face of rim (inches)
- D = outside diameter of rim (inches)
- d = inside diameter of rim (inches)
- P = weight per cubic inch of material (pounds)

where N₂ = final RPM and N₁ = initial RPM
 Velocity at outside diameter (feet per minute) = 0.2618 ND

*WR² = flywheel effect (pounds x feet²). See table below for WR² of rims. Ordinarily the WR² of the rim only is considered. In unusual instances the relatively small WR² values of the hub and arms or web can be added directly to the WR² of the rim if desired. To find the WR² of a hub or web use the WR² formula for rims, substituting the hub or web outside diameter, inside diameter, and width for D, d, and F respectively. When arms are used instead of a web an approximate WR² value of the arms is the total weight of the arms in pounds times the square of the radius in feet from the shaft center line to the mid-point of the arms between hub and rim.

Kinetic energy of rotation of a flywheel (foot pounds) = .0001705 N²(WR²)*.

Torque to accelerate or decelerate a flywheel uniformly = $\frac{.03908(N_2 - N_1)(WR^2)^*}{t}$ (pound inches)

Formulas for Flywheel Rims

Property	Cast Iron Rim (Based on .26 lbs per cubic inch)	Steel Rim Rim (Based on .283 lbs per cubic inch)	Rim of any Material Weighing P Pounds per cubic inch
Volume (Cubic Inches)	.7854F(D ² - d ²)	.7854F(D ² - d ²)	.7854F(D ² - d ²)
W Weight (Pounds)	.2042F(D ² - d ²)	.2223F(D ² - d ²)	.7854FP(D ² - d ²)
R Radius of Gyration (Feet)	$\sqrt{\frac{.8681(D^2 + d^2)}{1000}}$	$\sqrt{\frac{.8681(D^2 + d^2)}{1000}}$	$\sqrt{\frac{.8681(D^2 + d^2)}{1000}}$
WR ² Wt. x Sq. of Radius of Gyration (Lbs. x Ft. ²)	$\frac{.1773F(D^4 - d^4)}{1000}$	$\frac{.1929F(D^4 - d^4)}{1000}$	$\frac{.6818FP(D^4 - d^4)}{1000}$
Ts Tensile Load in Rim (Lbs.)	$\frac{.3078FN^2(D^3 - d^3)}{1,000,000}$	$\frac{.3350FN^2(D^3 - d^3)}{1,000,000}$	$\frac{1.184PFN^2(D^3 - d^3)}{1,000,000}$

▲ Centrifugal force causes this tensile load at each and every section of the rim. Thus on rims split into two or more sections, the fastening at each joint should be designed to take the full load as calculated from the formula below.

Centrifugal Force

R = Distance from the axis of rotation to the center of gravity of the body (feet)

N = Revolutions per minute (RPM)

v = Velocity of the center of gravity of the body (feet per second)

g = Acceleration due to gravity (32.16 commonly)

$$F = \frac{Wv^2}{gR} = \frac{WRN^2}{2933} = .000341 WRN^2$$

F = Centrifugal force tending to move the body outward from the axis of rotation (pounds)

W = Weight of body (pounds)