3) Basic Engineering Information

The following engineering information will help solve technical problems frequently encountered in designing and selecting power transmission components and systems.

Torque:

$$T = FR \qquad (1)$$

where:

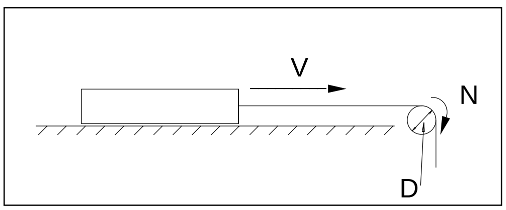
T = Torque (lb·ft)
F = Force (lb)
R = Radius, or distance that the force is from the pivotal point (ft)

Linear to rotary motion:

$$N = \frac{V}{0.262D} \qquad (2)$$

where:

N = Speed of shaft rotation (rpm)
V = Velocity of material (fpm)
D = Diameter of pulley or sprocket (in)



Horsepower:

- Rotating objects:

$$P = \frac{TN}{5250} \qquad (3)$$

where:

P = Power (hp)
T = Torque (lb·ft)
N = Shaft speed (rpm)

- Objects in linear motion:

$$P = \frac{FV}{33000} \qquad (4)$$

where:

P = Power (hp)
F = Force (lb)
V = Velocity (fpm)

Accelerating torque and force:

- Of rotating objects:

$$T = \frac{(WK^2)\,\Delta N}{308t} \qquad (5)$$

where:

T = Torque required (lb·ft)
WK^2 = Total inertia of load to be accelerated (lb·ft^2) See formulas 7, 8, 9 and 10
ΔN = Change in speed (rpm)
t = Time to accelerate load (sec)

- Objects in linear motion:

$$F = \frac{W\,\Delta V}{1933t} \qquad (6)$$

where:

F = Force required (lb)
W = Weight (lb)
ΔN = Change in velocity (fpm)
t = Time to accelerate load (sec)

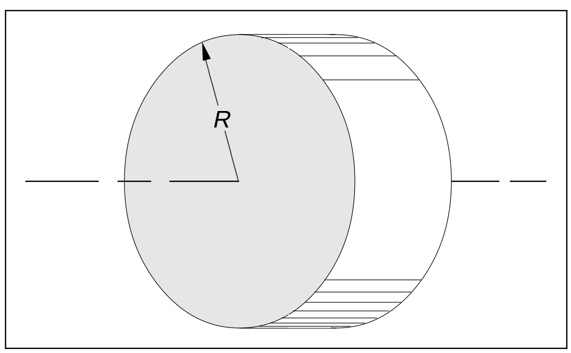
Moment of Inertia

- Solid cylinder rotating about its own axis

$$WK^2 = \frac{1}{2} WR^2 \qquad (7)$$

where:

WK^2 = Moment of inertia (lb·ft^2)
W = Weight of object (lb)
R = Radius of cylinder (ft)



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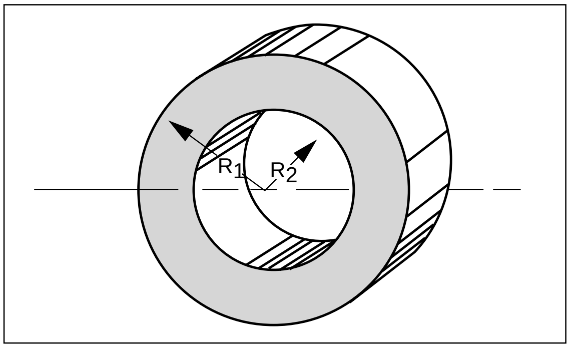
- Hollow cylinder rotating about its own axis:

$$WK^2 = \frac{1}{2} W(R_1^2 + R_2^2) \quad (8)$$

where:
WK^2 = Moment of inertia (lb·ft²)
W = Weight of object (lb)
R_1 = Outside radius (ft)
R_2 = Inside radius (ft)



- Material in linear motion with a continuous fixed relation to a rotational speed, such as a conveyor system:

$$WK_L^2 = W\left(\frac{V}{2\pi N}\right)^2 \quad (9)$$

where:
WK_L^2 = Linear inertia (lb·ft²)
W = Weight of material (lb)
V = Linear velocity (fpm)
N = Rotational speed of shaft (rpm)

- Reflected inertia of a load through a speed reduction means — gear, chain, or belt system:

$$WK_R^2 = \frac{WK_L^2}{R_r^2} \quad (10)$$

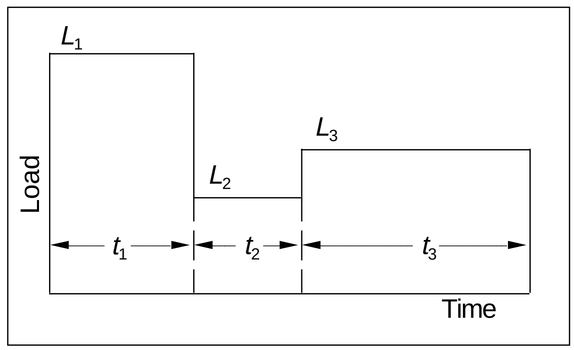
where:
WK_R^2 = Reflected inertia (lb·ft²)
WK_L^2 = Load inertia (lb·ft²)
R_r = Reduction ratio

Duty cycle calculation

The RMS (root mean squared) value of a load is one of the quantities often used to size PT components.

$$L_{RMS} = \sqrt{\frac{L_1^2 t_1 + L_2^2 t_2 + \ldots + L_n^2 t_n}{t_1 + t_2 + \ldots t_n}} \quad (11)$$

where:
L_{RMS} = RMS value of the load which can be in any unit — hp, amp, etc.
L_1 = Load during time period 1
L_2 = Load during time period 2, etc.
t_1 = Duration of time period 1
t_2 = Duration of time period 2, etc.



Modulus of elasticity

$$E = \frac{PL}{A\Delta d} \quad (12)$$

where:
E = Modulus of elasticity (lb/in²)
P = Axial load (lb)
L = Length of object (in)
A = Area of object (in²)
Δd = Increase in length resulting from axial load (in)