Motor Application Formulae

Calculating Horsepower

Once the machine torque requirement is determined, horsepower can be calculated using the formula:

$$HP = \frac{T \times N}{5{,}250}$$

where,

HP = Horsepower
T = Torque (ft-lb)
N = Base speed of motor (rpm)

If the calculated horsepower falls between standard available motor ratings, select the higher available horsepower rating. It is good practice to allow some margin when selecting the motor horsepower.

For many applications, it is possible to calculate the horsepower required without actually measuring the torque required. The following useful formulae will help:

Conveyors

$$HP\ (\text{Vertical}) = \frac{\text{Weight (lb)} \times \text{Velocity (FPM)}}{33{,}000}$$

$$HP\ (\text{Horizontal}) = \frac{\text{Weight (lb)} \times \text{Velocity (FPM)} \times \text{Coefficient of Friction}}{33{,}000}$$

Web Transport Systems and Surface Winders

$$HP = \frac{\text{Tension (lb)} \times \text{Velocity (FPM)}}{33{,}000}$$

Note: The tension value used in this calculation is the actual web tension for surface winder applications. For sectional drives, it is the tension differential: downstream tension – upstream tension.

Center Winders (Control to Base Speed Only)

$$HP = \frac{\text{Tension (lb)} \times \text{Line Speed (FPM)} \times \text{Buildup}}{33{,}000 \times \text{Taper}}$$

Center Winders (Field Control)

If Taper x Field Range $\geq$ Buildup, then,

$$HP = \frac{\text{Tension (lb)} \times \text{Line Speed (FPM)}}{33{,}000}$$

If Taper x Field Range $\leq$ Buildup, then,

$$HP = \frac{\text{Tension (lb)} \times \text{Line Speed (FPM)} \times \text{Buildup}}{33{,}000 \times \text{Taper} \times \text{Field Range}}$$

NOTE: The preceding formulae for calculating horsepower do not include any allowance for machine function windage or other factors. These factors must be considered when selecting a drive for a machine application.

Fans and Blowers

$$HP = \frac{\text{CFM} \times \text{Pressure (lb/ft}^2)}{33{,}000 \times \text{Efficiency of Fan}}$$

Effect of Speed on HP:

$HP = K_1 (RPM)^3$ — Horsepower varies as the 3rd power of power of speed.

$T = K_2 (RPM)^2$ — Torque varies as the 2nd power of speed

$Flow = K_3 (RPM)$ — Flow varies directly as the speed

$$HP = \frac{\text{CFM} \times \text{Pressure (lb/in}^2)}{229 \times \text{Efficiency of Fan}}$$

$$HP = \frac{\text{CFM} \times \text{Inches of Water Gauge}}{6356 \times \text{Efficiency of Fan}}$$

Pumps

$$HP = \frac{\text{GPM} \times \text{Head (ft)} \times \text{Specific Gravity}}{3960 \times \%\ \text{Efficiency of Pump}}$$

Specific Gravity of Water = 1.0
1 ft^3 per sec. = 448 GPM
1 PSI = A head of 2.309 ft for water weighing 62.36 lb/ft^3 at 62°F

Constant Displacement Pumps

Effect of Speed on HP:

$HP = K (RPM)$ — Horsepower and capacity vary directly as the speed.

Displacement pumps under constant head require approximately constant torque at all speeds.

Centrifugal Pumps

Effect of Speed on HP:

$HP = K_1 (RPM)^3$ — Horsepower varies as the 3rd power of speed.

$T = K_2 (RPM)^2$ — Torque varies as the 2nd power of speed.

$Flow = K_3 (RPM)$ — Flow varies directly as the speed.

Efficiency:

500 to 1,000 gal/min	= 70% to 75%
1,000 to 1,500 gal/min	= 75% to 80%
Larger than 1,500 gal/min	= 80% to 85%

Displacement pumps may vary between 50% and 80% efficiency, depending on size of pumps.