MOTOR APPLICATION FORMULAS

Calculating Horsepower

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

$$HP = \frac{T \times N}{5250}$$

Where,

HP = Horsepower

T = Torque (lb-ft)

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 formulas will help:

For Conveyors

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

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

For Web Transport Systems and Surface Winders

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

Note that the tension value used in this calculation is the actual web tension for surface winder applications, but it is the tension differential (downstream tension - upstream tension) for sectional drives.

Center Winders (Armature Control Only)

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

Center Winders (Field Control)

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

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

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

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

NOTE: The preceding formulas 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.

For Fans and Blowers

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

Effect of Speed on HP

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

T = $k^1\ (RPM)^2$—Torque varies as the 2nd power of speed.

Flow = k_3 (RPM)—Flow varies directly as the speed.

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

$$HP = \frac{CFM \times (Inches\ of\ Water\ Gauge)}{6356 \times (Eff.\ of\ Fan)}$$

For Pumps

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

Specific Gravity of Water = 1.0

1 ft3 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 & 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 1000 gal/min	= 70 to 75%
1000 to 1500 gal/min	= 75 to 80%
Larger than 1500 gal/min	= 80 to 85%

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