Formulas & Conversion Factors

Miscellaneous Formulas

OHMS Law

Ohms = Volts/Amperes (R = E/I)
Amperes = Volts/Ohms (I = E/R)
Volts = Amperes x Ohms (E = IR)

Power—A-C Circuits

$$\text{Efficiency} = \frac{746 \times \text{Output Horsepower}}{\text{Input Watts}}$$

$$\text{Three-Phase Kilowatts} = \frac{\text{Volts} \times \text{Amperes} \times \text{Power Factor} \times 1.732}{1000}$$

$$\text{Three-Phase Volt-Amperes} = \text{Volts} \times \text{Amperes} \times 1.732$$

$$\text{Three-Phase Amperes} = \frac{746 \times \text{Horsepower}}{1.732 \times \text{Volts} \times \text{Efficiency} \times \text{Power Factor}}$$

$$\text{Three-Phase Efficiency} = \frac{746 \times \text{Horsepower}}{\text{Volts} \times \text{Amperes} \times \text{Power Factor} \times 1.732}$$

$$\text{Three-Phase Power Factor} = \frac{\text{Input Watts}}{\text{Volts} \times \text{Amperes} \times 1.732}$$

$$\text{Single-Phase Kilowatts} = \frac{\text{Volts} \times \text{Amperes} \times \text{Power Factor}}{1000}$$

$$\text{Single-Phase Amperes} = \frac{746 \times \text{Horsepower}}{\text{Volts} \times \text{Efficiency} \times \text{Power Factor}}$$

$$\text{Single-Phase Efficiency} = \frac{746 \times \text{Horsepower}}{\text{Volts} \times \text{Amperes} \times \text{Power Factor}}$$

$$\text{Single-Phase Power Factor} = \frac{\text{Input Watts}}{\text{Volts} \times \text{Amperes}}$$

$$\text{Horsepower (3 Ph)} = \frac{\text{Volts} \times \text{Amperes} \times 1.732 \times \text{Efficiency} \times \text{Power Factor}}{746}$$

$$\text{Horsepower (1 Ph)} = \frac{\text{Volts} \times \text{Amperes} \times \text{Efficiency} \times \text{Power Factor}}{746}$$

Power —D-C Circuits

Watts = Volts x Amperes (W = EI)

$$\text{Amperes} = \frac{\text{Watts}}{\text{Volts}} \quad (I = W/E)$$

$$\text{Horsepower} = \frac{\text{Volts} \times \text{Amperes} \times \text{Efficiency}}{746}$$

Miscellaneous Formulas (cont.)

Speed—A-C Machinery

$$\text{Synchronous RPM} = \frac{\text{Hertz} \times 120}{\text{Poles}}$$

$$\text{Percent Slip} = \frac{\text{Synchronous RPM} - \text{Full-Load RPM}}{\text{Synchronous RPM}} \times 100$$

Motor Application

$$\text{Torque (lb.-ft.)} = \frac{\text{Horsepower} \times 5250}{\text{RPM}}$$

$$\text{Horsepower} = \frac{\text{Torque (lb.-ft.)} \times \text{RPM}}{5250}$$

Time for Motor to Reach Operating Speed (seconds)

$$\text{Seconds} = \frac{WK^2 \times \text{Speed Change}}{308 \times \text{Avg. Accelerating Torque}}$$

$$\text{Average Accelerating Torque} = \frac{[(FLT + BDT)/2] + BDT + LR1}{3}$$

WK^2 = Inertia of Rotor + Inertia of Load (lb.-ft.^{2})

FLT = Full-Load Torque   BDT = Breakdown Torque

LRT = Locked Rotor Torque

$$\text{Load } WK^2 \text{ (at motor shaft)} = \frac{WK^2 \text{ (Load)} \times \text{Load RPM}^2}{\text{Motor RPM}^2}$$

$$\textbf{Shaft Stress (P.S.I.)} = \frac{\text{HP} \times 321{,}000}{\text{RPM} \times \text{Shaft Dia.}^3}$$

Change in Resistance Due to Change in Temperature

$$R_C = R_H \times \frac{(K + T_C)}{(K + T_H)}$$

$$R_H = R_C \times \frac{(K + T_H)}{(K + T_C)}$$

K = 234.5 - Copper
= 236 - Aluminum
= 180 - Iron
= 218 - Steel

R_C = Cold Resistance (OHMS)

R_H = Hot Resistance (OHMS)

T_C = Cold Temperature (°C)

T_H = Hot Temperature (°C)

Formulas & Conversion Factors

Miscellaneous Formulas (cont.)

Vibration

D = .318 (V/f) — D = Displacement (Inches Peak-Peak)

V = π(f) (D) — V = Velocity (Inches per Second Peak)

A = .051 $(f)^2$ (D) — A = Acceleration (g's Peak)

A = .016 (f) (V) — f = Frequency (Cycles per Second)

Volume of Liquid in a Tank

Gallons = 5.875 x D^2 x H

D = Tank Diameter (ft.)

H = Height of Liquid (ft.)

Centrifugal Applications

Affinity Laws for Centrifugal Applications:

$$\frac{Flow_1}{Flow_2} = \frac{RPM_1}{RPM_2}$$

$$\frac{Pres_1}{Pres_2} = \frac{(RPM_1)^2}{(RPM_2)^2}$$

$$\frac{BHP_1}{BHP_2} = \frac{(RPM_1)^3}{(RPM_2)^3}$$

For Pumps

$$BHP = \frac{\text{GPM x PSI x Specific Gravity}}{\text{1713 x Efficiency of Pump}}$$

$$BHP = \frac{\text{GPM x FT x Specific Gravity}}{\text{3960 x Efficiency of Pump}}$$

For Fans and Blowers

$$\text{Tip Speed (FPS)} = \frac{D(in) \times RPM \times \pi}{720}$$

Temperature: $°F = °C\left(\frac{9}{5}\right) + 32$ $°C = (°F - 32)\,\frac{5}{9}$

$$BHP = \frac{\text{CFM x PSF}}{\text{33000 x Efficiency of Fan}}$$

$$BHP = \frac{\text{CFM x PIW}}{\text{6344 x Efficiency of Fan}}$$

$$BHP = \frac{\text{CFM x PSI}}{\text{229 x Efficiency of Fan}}$$

1 ft. of water = 0.433 PSI

1 PSI = 2.309 Ft. of water

Specify Gravity of Water = 1.0