Formula Reference Sheet

Convert pressure to head

$$h=\frac{p}{ρ∙g}$$

Where:

h = head, feet or meters

p = pressure, psi (Pa)

ρ = liquid density, lbm/ft3 (kg/m3)

g = Acceleration due to gravity, ft/s2 (m/s2)

Convert pressure (psi) to head in feet



1 meter (m) = 3.281 feet (ft)

Calculation of velocity head



Where:

*h*v = velocity head, ft (m)

*v* = flow velocity, ft/s (m/s)

g = acceleration constant due to gravity

Gravitational acceleration constants



Pump affinity rules with respect to impeller diameter



Where:

*Q* = flow rate

*H* = total head

P = pump input power

D = impeller diameter

Pump affinity rules with respect to pump speed



Where

*Q* = flow rate

*H* = total head

P = pump input power

n = pump rotational speed

Calculation of Net Positive Suction Head Available (NPSHA)

NPSHA = hatm + hgs + hvs + zs − hvp

Where

hatm = atmospheric pressure head, ft (m)

hgs = suction gauge head, ft (m)

hvs = suction velocity head, ft (m)

zs = elevation from the suction gauge centerline to datum, ft (m)

hvp = liquid vapor pressure head, ft (m)

Calculation of Net Positive Inlet Pressure Available (NPIPA)

$$NPIPA=p\_{s,absolute}-p\_{vp,abs}$$

Where

$p\_{s,absolute}$ = Total suction pressure absolute

$p\_{vp,abs}$= Liquid vapour pressure absolute

Calculation of electrical input power



Where

I = current in amperes (A) (meter reading)

V = volts (meter reading)

PF = power factor (motor curve or measured)

C = 1 for single-phase current

 = 2 for two-phase four-wire control

 = 1.73 for three-phase current

Calculation of power

Hydraulic Power as a function of Head

*hydraulic power*also known as Water Horsepower (WHP, Pw) when water is the pumped fluid

Hydraulic power*pu* hp (horsepower)

Head (H) feet

Flow (Q) gpm

Specific gravity (s) dimensionless

3960 is a constant that incorporates two conversions: (1) convert flow (gpm) to pounds/minute, and (2) convert the product of mass flow  head (pound-foot/minute) to horsepower

$$P\_{u}= \frac{Q×H×ρ×g}{1000}(kW)$$

Where:

*Pu* = Hydraulic power (kW)

*Q* = Flow rate (m3/s)

*H* = Head (m)

*ρ* = Density of fluid (kg/m3)

*g* = Acceleration due to gravity (9.81 m/s2)



Where:

*Pu* = Hydraulic power (kW)

Head (H) meters (m)

Flow (Q) m3/s

Specific gravity (s) dimensionless

0.1022 is metric units conversion to provide power in kilowatt (kW)

Hydraulic power as a function of total differential pressure

$$P\_{u}\left(kW\right)=\frac{Q\left(\frac{m^{3}}{h}\right)×Δp\left(kPa\right)}{3600 (\frac{s}{h})}=Q\left(\frac{m^{3}}{s}\right)×Δp\left(kPa\right)$$

$$P\_{u}(hp)=\frac{Q(gpm)×Δp(psi)}{1714}$$

*Pump Power Input*also known as shaft power or Brake Horsepower (BHP)

Where:

*Pu* = Hydraulic power (kW)

Pump Efficiency (*η*)

*Power* (*kW*) = 0.746 × *Horsepower*

**Area of pipe**

$$A=π×r^{2}$$

Where:

A= crossection area of the pipe inside diameter, ft2 (m2)

r = radius of the pipe inside diameter, ft (m)

Velocity (v) in pipe



$$v\left(\frac{ft}{s}\right)=\frac{0.4085×gpm}{pipe ID^{2} (inches)}$$

**Resistance to flow in pipes and fittings**



Where

*hf* = frictional resistance in head

*f* = piping friction factor

*l* = length of pipe, ft (m)

*d* = average ID of piping, ft (m)

*v* = average velocity, ft/s (m/s)

*g* = acceleration due to gravity

$$h\_{f}=k×\frac{v^{2}}{2g}$$

Where

*hf* = frictional resistance in head

*k* = resistance coefficient for valve or fitting

*v* = average velocity, ft/s (m/s)

*g* = acceleration due to gravity