# HYDRONIC FORMULAS & PUMP LAWS

### PUMP LAW #1 – FLOW vs. SPEED

*Note: RPM, FPM, CFM, GPM, Frequency (Hz) and Dia. (Sheave/Impeller) are all interchangeable.*

$$\frac{\mathrm{RPM_2}}{\mathrm{RPM_1}} = \frac{\mathrm{GPM_2}}{\mathrm{GPM_1}} \qquad \mathrm{RPM_2} = \mathrm{RPM_1\ x}\left(\frac{\mathrm{GPM_2}}{\mathrm{GPM_1}}\right) \qquad \mathrm{GPM_2} = \mathrm{GPM_1\ x}\left(\frac{\mathrm{RPM_2}}{\mathrm{RPM_1}}\right)$$

### PUMP LAW #2 – FLOW vs. PRESSURE (*$\Delta P$, $\Delta H$, SP, & Density)*

$$\frac{\Delta\mathrm{P_2}}{\Delta\mathrm{P_1}} = \left(\frac{\mathrm{GPM_2}}{\mathrm{GPM_1}}\right)^2 \qquad \Delta\mathrm{P_2} = \Delta\mathrm{P_1\ x}\left(\frac{\mathrm{GPM_2}}{\mathrm{GPM_1}}\right)^2 \qquad \mathrm{GPM_2} = \mathrm{GPM_1\ x}\sqrt{\frac{\Delta\mathrm{P_2}}{\Delta\mathrm{P_1}}}$$

### PUMP LAW #3 – FLOW vs. ENERGY (*BHP & Amps*)

$$\frac{\mathrm{BHP_2}}{\mathrm{BHP_1}} = \left(\frac{\mathrm{GPM_2}}{\mathrm{GPM_1}}\right)^3 \qquad \mathrm{BHP_2} = \mathrm{BHP_1\ x}\left(\frac{\mathrm{GPM_2}}{\mathrm{GPM_1}}\right)^3 \qquad \mathrm{GPM_2} = \mathrm{GPM_1\ x}\sqrt[3]{\frac{\mathrm{BHP_2}}{\mathrm{BHP_1}}}$$

### STATIC EFFCIENCY:

$$PumpBHP = \frac{GPM\ x\ TDH}{3960\ x\ Eff} \qquad PumpEff = \frac{GPM\ x\ TDH}{3960\ x\ BHP}$$

### HEAD:

$$\text{Total Dynamic Head} = \mathrm{Discharge_{TH}} - \mathrm{Suction_{TH}}$$

$$\text{Total Dynamic Head} = (\mathrm{Discharge_{SH}} + \mathrm{Discharge_{VH}}) - (\mathrm{Suction_{SH}} + \mathrm{Suction_{VH}})$$

$$\mathrm{NPSHA} = \mathrm{Inlet_{PSIG}} + \text{Inlet VP}_{\mathrm{PSI}} + 14.7_{\mathrm{PSI}} - \text{Vapor Pressure}_{\mathrm{PSI}}$$

### FLOW STATIONS:

$$\mathrm{GPM} = \mathrm{C_v\ x}\sqrt[2]{\Delta\mathrm{P_{PSI}}} \qquad \mathrm{C_v} = \frac{\mathrm{GPM}}{\sqrt[2]{\Delta P_{PSI}}} \qquad \Delta\mathrm{P_{PSI}} = \left(\frac{\mathrm{GPM}}{\mathrm{C_v}}\right)^2$$

### COOLING TOWERS:

$$\text{Tower Approach} = \mathrm{LWT} - \mathrm{EATwb}$$

$$\text{Tower Range} = \mathrm{EWT} - \mathrm{LWT}$$

$$\text{Coefficient of Perfomance} = \frac{\mathrm{BTUH}}{\text{Watts x } 3.41}$$

# HEAT TRANSFER

### WATER:

$$\mathrm{GPM} = \frac{\mathrm{BTUH}}{500\ \mathrm{x}\ \Delta\mathrm{T}} \qquad \Delta\mathrm{T} = \frac{\mathrm{BTUH}}{500\ \mathrm{x\ GPM}} \qquad \mathrm{MBH} = \frac{\mathrm{BTUH}}{1000}$$

$$\mathrm{BTUH} = \mathrm{GPM\ x}\ 500\ \mathrm{x}\ \Delta\mathrm{T}$$