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### Conversion Factors

<table>
<thead>
<tr>
<th>Unit Conversion</th>
<th>Equivalent</th>
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<tr>
<td>1 acre</td>
<td>43,560 ft²</td>
</tr>
<tr>
<td>1 foot of head</td>
<td>0.433 psi</td>
</tr>
<tr>
<td>1 psi</td>
<td>2.31 feet of head</td>
</tr>
<tr>
<td>1 yd³</td>
<td>27 ft³</td>
</tr>
<tr>
<td>1 gal</td>
<td>3.785 Liters</td>
</tr>
<tr>
<td>1 gallon of water</td>
<td>8.34 lbs</td>
</tr>
<tr>
<td>1 cubic foot of water</td>
<td>7.48 gallons</td>
</tr>
<tr>
<td>1 lb</td>
<td>453.6 grams</td>
</tr>
<tr>
<td>1 mile</td>
<td>5280 feet</td>
</tr>
<tr>
<td>1%</td>
<td>10,000 mg/L</td>
</tr>
</tbody>
</table>

### Converting \( \frac{mg}{mL} \) to \( \frac{lb}{gal} \)

\[
\begin{align*}
\text{lgs} & \quad 453.6 \quad \text{gram} \quad 1000 \quad \text{mg} \\
\text{gal} & \quad 3.785 \quad \text{Liter} \quad 1000 \quad \text{mL}
\end{align*}
\]

To use this diagram: First, find the box that coincides with the beginning units (i.e. mg/mL). Then, find the box that coincides with the desired ending units (i.e. lbs/gal). The numbers between the starting point and ending point are the conversion factors. When moving from a smaller box to a larger box, multiply by the factor between them. When moving from a larger box to a smaller box, divide by the factor between them. For final number, divide top number by bottom number.
Distribution System Formulas

**Area**

- **Rectangle:** Area, $\text{ft}^2 = (\text{length, ft})(\text{width, ft})$
- **Circle:** Area, $\text{ft}^2 = (0.785)(\text{Diameter, ft})^2$
- **Triangle:** Area, $\text{ft}^2 = (0.5)(\text{base, ft})(\text{height, ft})$

**Volume**

- **Rectangle:** Volume, $\text{ft}^3 = (\text{length, ft})(\text{width, ft})(\text{depth, ft})$
- **Cylinder:** Volume, $\text{ft}^3 = (0.785)(\text{Diameter, ft})^2(\text{depth or length, ft})$
- **Cone:** Volume, $\text{ft}^3 = \frac{(0.785)(\text{Diameter, ft})^2(\text{height, ft})}{3}$

Volume, gallons = $(\text{volume, ft}^3)(7.48 \text{ gal/ft}^3)$

**Temperature**

- $^\circ\text{C} = \frac{5}{9}(^\circ\text{F} - 32)$
- $^\circ\text{F} = \frac{9}{5}(^\circ\text{C}) + 32$

**Flow**

- $Q = AV$
- $Q = (\text{Area})(\text{Velocity})$
- $Q$ (channel), $\text{cfs} = (\text{width, ft})(\text{depth, ft})(\text{Velocity, fps})$
- $Q$ (pipeline), $\text{cfs} = (0.785)(\text{Diameter, ft})^2(\text{Velocity, fps})$
- Velocity, fps = $\frac{\text{Distance, ft}}{\text{Time, sec}}$
- Average Flow, MGD = $\frac{\text{sum of daily flows, MGD}}{\text{Number of daily flows}}$

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Distribution System Formulas
Distribution System Formulas

Flow Conversions

To use this diagram:  First, find the box that coincides with the beginning units (i.e. gpm).  Then, find the box that coincides with the desired ending units (i.e. cfs).  The numbers between the starting point and ending point are the conversion factors.  When moving from a smaller box to a larger box, multiply by the factor between them.  When moving from a larger box to a smaller box, divide by the factor between them.
Dosage

\[
\text{Dosage, mg/L} = \frac{\text{(grams/min)(1,000 mg/gram)}}{\text{(flow, gpm)(3.785 L/gal)}}
\]

\[
\text{Dosage, mg/L} = \frac{\text{chemical feed, lbs/day}}{\text{(flow, MGD)(8.34 lbs/gal)}}
\]

Chemical Feed, lbs

\[
\text{Chemical Feed, lbs} = \frac{(\text{dose, mg/L})(\text{volume, MG})(8.34 \text{ lbs/gal})}{\text{(% chemical purity, expressed as decimal)}}
\]

Feed Rate, lbs/day

\[
\text{Feed Rate, lbs/day} = \frac{(\text{dose, mg/L})(\text{flow, MGD})(8.34 \text{ lbs/gal})}{\text{(% chemical purity, expressed as decimal)}}
\]

\[
\text{Feed Rate, lbs/day} = \frac{(\text{conc., mg/L})(\text{vol. pumped, mL})(1440 \text{ min/day})}{\text{(time pumped, min)(1000 mL/L)(1000 mg/g)(453.6 g/lb)}}
\]

Power

1 Horsepower

\[
1 \text{ Horsepower} = 746 \text{ watts or 0.746 kilowatts}
\]

Power, watts

\[
\text{Power, watts} = \frac{(\text{volts})(\text{amps})}{746}
\]

Amps, single-phase

\[
\text{Amps, single-phase} = \frac{(746)(\text{horsepower})}{(\text{volts})(\% \text{ efficiency, as decimal})(\text{power factor})}
\]

Amps, three-phase

\[
\text{Amps, three-phase} = \frac{(746)(\text{horsepower})}{(1.732)(\text{volts})(\% \text{ efficiency, as decimal})(\text{power factor})}
\]

Horsepower

\[
\text{Horsepower} = \frac{(\text{volts})(\text{amps})}{746}
\]

Kilowatts, single-phase

\[
\text{Kilowatts, single-phase} = \frac{(\text{volts})(\text{amps})(\text{power factor})}{1000}
\]

Kilowatts, three-phase

\[
\text{Kilowatts, three-phase} = \frac{(\text{volts})(\text{amps})(\text{power factor})(1.732)}{1000}
\]

Power Factor

\[
\text{Power Factor} = \frac{\text{watts}}{(\text{volts})(\text{amps})}
\]
Pumps

\[ \text{Pumping Rate, gpm} = \frac{\text{volume, gal}}{\text{time, min}} \]
\[ \text{Pumping Rate, gpm} = \frac{(\text{length, ft})(\text{width, ft})(\text{depth, ft})(7.48 \text{ gal/ft}^3)}{\text{time, min}} \]
\[ \text{Pumping Rate, gpm} = \frac{(0.785)(\text{Diameter, ft})^2(\text{depth, ft})(7.48 \text{ gal/ft}^3)}{\text{time, min}} \]
\[ \text{Time to fill, min} = \frac{\text{tank volume, gal}}{\text{flow rate, gpm}} \]
\[ \text{Water hp} = \frac{(\text{flow, gpm})(\text{head, ft})}{3960} \]
\[ \text{Brake hp} = \frac{(\text{flow, gpm})(\text{head, ft})}{(3960)(\text{pump efficiency, as decimal})} \]
\[ \text{Motor hp} = \frac{(\text{flow, gpm})(\text{head, ft})}{(3960)(\text{pump efficiency, as decimal})(\text{motor efficiency, as decimal})} \]
\[ \text{Brake hp} = \frac{\text{water hp}}{\text{pump efficiency, as decimal}} \]
\[ \text{Motor hp} = \frac{\text{brake hp}}{\text{motor efficiency, as decimal}} \]
\[ \% \text{ Motor Efficiency} = \left( \frac{\text{brake hp}}{\text{motor hp}} \right) \times 100 \]
\[ \% \text{ Pump Efficiency} = \left( \frac{\text{water hp}}{\text{brake hp}} \right) \times 100 \]
\[ \% \text{ Efficiency} = \left( \frac{\text{hp output}}{\text{hp supplied}} \right) \times 100 \]
\[ \% \text{ Efficiency, overall} = \left( \frac{\text{water hp}}{\text{motor hp}} \right) \times 100 \]
\[ \text{Wire-to-water Efficiency, \%} = (\% \text{ pump eff., as decimal})(\% \text{ motor eff., as decimal})(100) \]
**Pumps, cont**

- **Static Head, ft** = suction lift, ft + discharge head, ft
- **Static Head, ft** = discharge head, ft – suction head, ft
- **Friction Loss, ft** = (0.1)(static head, ft) **use this formula in absence of other data**
- **Total Dynamic Head, ft** = static head, ft + friction losses, ft
- **Cost, $/hr** = (motor hp)(0.746 kW/hp)(cost, $/kW-hr)

**Metric Conversions**

Primary Unit

```
<table>
<thead>
<tr>
<th>mega (M)</th>
<th>kilo (k)</th>
<th>hecto (h)</th>
<th>deka (da)</th>
<th>no prefix</th>
<th>deci (d)</th>
<th>centi (c)</th>
<th>milli (m)</th>
<th>micro (µ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000,000</td>
<td>1,000</td>
<td>100</td>
<td>10</td>
<td>1</td>
<td>1/10</td>
<td>1/100</td>
<td>1/1,000</td>
<td>1/1,000,000</td>
</tr>
</tbody>
</table>
```

- meter – linear measurement
- liter – volume measurement
- gram – weight measurement

**Disinfection**

- **Cl₂, lbs** = (dosage, mg/L)(volume, MG)(8.34 lbs/gal)
- **HTH, lbs** = (dosage, mg/L)(volume, MG)(8.34 lbs/gal)
  % chemical purity, expressed as decimal
- **Bleach, gal** = (dosage, mg/L)(volume, MG)
  % concentration, bleach, expressed as decimal
- **Bleach, gal (dilution)** = (% desired conc., expressed as decimal)(desired volume, gal)
  % concentration, bleach, expressed as decimal
- **HTH, lbs (solution mix)** = (% desired conc., expressed as decimal)(desired vol, gal)(8.34 lbs/gal)
  % available HTH, expressed as decimal
Distribution System Formulas

Pressure, psi = \frac{\text{pressure head, ft}}{2.31 \text{ ft/psi}}

Pressure, psi = (\text{pressure head, ft})(0.433 \text{ psi/ft})

Pressure head, ft = (\text{pressure, psi})(2.31 \text{ ft/psi})

Pressure head, ft = \frac{\text{pressure, psi}}{0.433 \text{ psi/ft}}

C Factor = \frac{\text{flow, gpm}}{(193.75)(\text{diameter, ft})^{2.63}(\text{slope})^{0.54}}

Slope = \frac{\text{energy loss, ft}}{\text{distance, ft}}

Slope = \frac{\text{head loss, ft}}{\text{distance, ft}}

Slope = \frac{(\text{pressure drop, psi})(2.31 \text{ ft/psi})}{\text{distance, ft}}

Meter accuracy, % = \frac{(\text{volume of water registered, gal})(100)}{\text{actual volume, gal}}

Flow from hydrant, gpm = \frac{(2.83)(\text{diameter, in})^{2}(\text{length, in})}{\sqrt{\text{height}}}

Flow from hydrant, gpm = (27)(\text{nozzle ID, in})^{2}(\sqrt{\text{pitot pressure, psi}})

Uplift force, lbs = (\text{area, ft}^{2})(\text{pressure, lbs/ft}^{2})

Pressure, lbs/ft^{2} = (62.4 \text{ lbs/ft}^{3})(\text{height, ft})

Uplift force, lbs = (62.4 \text{ lbs/ft}^{3})(\text{volume, ft}^{3})
Ductile Iron
Allowable leakage, gph

\[ L = \frac{SD\sqrt{P}}{133,200} \]

Where:
- \( L \) = allowable leakage, gph
- \( S \) = length of pipe tested, ft
- \( D \) = diameter of pipe, in
- \( P \) = average test pressure, psig

PVC Pipe
Allowable leakage, gph

\[ L = \frac{ND\sqrt{P}}{7400} \]

Where:
- \( L \) = allowable leakage, gph
- \( N \) = number of joints in the length of pipeline tested
- \( D \) = diameter of the pipe, in
- \( P \) = average test pressure, psig

Number of joints = \( \frac{\text{pipeline length, ft}}{\text{pipe section, ft/joint}} \)