

**Conversion Factors**

1 ft <sup>3</sup>	= 7.48 gallons
1 gallon of H <sub>2</sub> O	= 8.34 lbs.
1 mg/L	= 1 ppm
1 mile	= 5280 feet
1 acre	= 43560 ft <sup>2</sup>
1 psi	= 2.31 feet of head
1 horsepower	= 0.746 kilowatts
1 ppb	= 1 ug/L
1 gallon	= 8 pints

**Conversion Factors**

1 feet of head	= 0.433 psi
1 ft <sup>3</sup> of water	= 62.4 lbs
1 inch	= 2.54 centimeters
1 grain per gallon	= 17.12 mg/L
1 horsepower	= 33,000 ft. lbs./min.
1 yard <sup>3</sup>	= 27 ft <sup>3</sup>
1 kilogram	= 2.2 lbs
1 lbs	= 454 grams
1 ton	= 2000 lbs

**Temperature**

Fahrenheit (°F)	= (1.8x°C) + 32
Celsius (°C)	= 0.56 x (°F-32)

**Flow and Velocity**

Q	= V x A
Q	= Flow
V	= Velocity
A	= Area

**Area**

Rectangle	= length x width
Circle	= 0.785 x Diameter <sup>2</sup>
Circle	= π x radius <sup>2</sup>
Triangle	= 0.5 x base x height
Sphere	= 4 x π x radius <sup>2</sup>
Cylinder	= (2 x π x r x h) + (2 x π x r <sup>2</sup> )

L = Length  
B = Base  
W = Width  
H = Height

**Volumes**

Cone: V	= 1/3 x 0.785 x D <sup>2</sup> x H
Cone: V	= 1/3 x π x R <sup>2</sup> x H
Cylinder: V	= π x R <sup>2</sup> x H
Cylinder: V	= 0.785 x D <sup>2</sup> x H
Rectangular Prism: V	= L x W x H
Pyramid: V	= L x W x (1/3)H
Sphere: V	= 4/3(πr <sup>3</sup> )

V = Volume  
R = Radius  
D = Diameter  
π = 3.14

**WATER-BRAKE-MOTOR HORSEPOWER**

$$WHP = \frac{GPM \times \text{Total Head (ft)}}{3960}$$

$$BHP = \frac{GPM \times \text{Total Head (ft)}}{3960 \times E_p}$$

$$MHP = \frac{GPM \times \text{Total Head (ft)}}{3960 \times E_p \times E_m}$$

E<sub>p</sub> = Pump Efficiency (%)  
E<sub>m</sub> = Motor Efficiency (%)

**Total Dynamic Head, ft** = Static Head, ft + Discharge Head, ft + Friction Losses, ft

**Alkalinity**

Phenolphthalein Alkalinity, as mg CaCO<sub>3</sub>/L =  $\frac{(\text{Titrant Volume A, ml})(\text{Acid Normality})(50,000)}{\text{Sample Volume, ml}}$

Total Alkalinity, as mg CaCO<sub>3</sub>/L =  $\frac{(\text{Titrant Volume B, ml})(\text{Acid Normality})(50,000)}{\text{Sample Volume, ml}}$

Alkalinity Relationships: Alkalinity, mg/l as CaCO<sub>3</sub>

Result of Titration	Hydroxide Alkalinity as CaCO <sub>3</sub>	Carbonate Alkalinity as CaCO <sub>3</sub>	Bicarbonate Concentration as CaCO <sub>3</sub>
P = 0	0	0	T
P < ½ T	0	2P	T - 2P
P = ½ T	0	2P	0
P > ½ T	2P - T	2(T - P)	0
P = T	T	0	0

Key: P – phenolphthalein alkalinity; T – total alkalinity

**Common Compounds in Water**

Hydrated Alum	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 14 H <sub>2</sub> O	Sodium Hydroxide	NaOH	Sodium Hypochlorite	NaOCl
Calcium Chloride	CaCl <sub>2</sub>	Sodium Carbonate	Na <sub>2</sub> CO <sub>3</sub>	Hydrofluorosilic Acid	H <sub>2</sub> SiF <sub>6</sub>
Hydrochloric Acid	HCl	Hypochlorous Acid	HOCl	Sulfuric Acid	H <sub>2</sub> SO <sub>4</sub>
Ferric Chloride	FeCl <sub>3</sub>	Calcium Hydroxide	Ca(OH) <sub>2</sub>	Calcium Carbonate	CaCO <sub>3</sub>
Calcium Bicarbonate	Ca(HCO <sub>3</sub> ) <sub>2</sub>	Chloramine	NH <sub>2</sub> Cl	Peroxide	H <sub>2</sub> O <sub>2</sub>
Ferric Sulfate	Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	Calcium Oxide (Dry Lime)	CaO	Phosphoric Acid	H <sub>3</sub> PO <sub>4</sub>
Chlorine Gas	Cl <sub>2</sub>	Ozone	O <sub>3</sub>	Carbon Dioxide	CO <sub>2</sub>
Calcium Hypochlorite (HTH)	Ca(OCl) <sub>2</sub>	Alum	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	Sodium Fluoride	NaF

## Miscellaneous Formulas

**Leakage Formula:**

$$L = \frac{S \times D \times \sqrt{P}}{148,000}$$

Where:

L = allowable leakage (gallons per hour)

S = Length of pipe tested (feet)

D = pipe diameter (inches)

$\sqrt{P}$  = square root of the pressure (P expressed in psi)

$$\text{Pumping Rate, GPM} = \frac{\text{Volume, gal}}{\text{Time, min}}$$

$$\text{Power Output, horsepower} = \frac{(\text{Power Input, kilowatts})(\text{Efficiency, \%})}{(0.746 \text{ kilowatt/horsepower})(100\%)}$$

**Bernoulli's Equation**

$$\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + Z_2 + H_L$$

$$\text{Friction Head Loss} = \frac{\text{Friction Factor} \times \text{Length} \times \text{velocity}^2}{\text{Diameter} \times 2 \times \text{Gravity}}$$

$$\text{Langlier Index} = \text{pH} - \text{pH}_s$$

$$\text{Circumference} = \pi \times \text{diameter or } 2 \times \pi \times r$$

**Dilution Equation**

$$C_1V_1 = C_2V_2$$

**Chlorine Dosage**

$$= \text{Demand} + \text{Residual}$$

**PPM**

$$= \frac{\text{lbs. of chemical}}{\text{Million lbs. of H}_2\text{O}}$$

**Detention Time**

$$= \frac{\text{Volume}}{\text{Flow}}$$

**C\*T** = Chlorine Residual (mg/L) x time(minutes)

**Velocity**

$$= \frac{\text{Distance (Ft)}}{\text{Time (Sec)}}$$

**Filtration Rate**

$$(\text{gpm/ft}^2) = \frac{\text{Flow (gpm)}}{\text{Surface Area (ft}^2\text{)}}$$

**Hardness, grains/gallon**

$$= \frac{(\text{Hardness, mg/L})(1 \text{ grain/gallon})}{17.1 \text{ mg/l}}$$

**Total Hardness, mg/L as CaCO<sub>3</sub>** = Calcium Hardness, mg/L as CaCO<sub>3</sub> + Magnesium Hardness, mg/L as CaCO<sub>3</sub>

**Gravity Constant** = 32.2 ft/sec<sup>2</sup>

### List of Elements (Name-Symbol-Atomic Mass in grams)

Actinium	Ac	227.00g	Erbium	Er	167.26g	Mercury	Hg	200.6g	Scandium	Sc	44.96g
Aluminum	Al	26.98g	Europium	Eu	151.96g	Molybdenum	Mo	95.94g	Seaborgium	Sg	266.00g
Americium	Am	243.00g	Fermium	Fm	257.00g	Neodymium	Nd	144.4g	Selenium	Se	78.96g
Antimony	Sb	121.76g	Fluorine	F	19.00g	Neon	Ne	20.20g	Silicon	Si	28.10g
Argon	Ar	39.95g	Francium	Fr	223.00g	Neptunium	Np	237.00g	Silver	Ag	107.87g
Arsenic	As	74.92g	Gadolinium	Gd	157.25g	Nickel	Ni	58.69g	Sodium	Na	23.00g
Astatine	At	210.00g	Gallium	Ga	69.72g	Niobium	Nb	92.90g	Strontium	Sr	87.62g
Barium	Ba	137.33g	Germanium	Ge	72.64g	Nitrogen	N	14.01g	Sulfur	S	32.06g
Berkelium	Bk	247.00g	Gold	Au	196.97g	Nobelium	No	259.00g	Tantalum	Ta	180.95g
Beryllium	Be	9.01g	Hafnium	Hf	178.50g	Osmium	Os	190.23g	Technetium	Tc	98.00g
Bismuth	Bi	208.98g	Hassium	Hs	277.00g	Oxygen	O	16.00g	Tellurium	Te	127.60g
Bohrium	Bh	264.00g	Helium	He	4.00g	Palladium	Pd	106.42g	Terbium	Tb	158.93g
Boron	B	10.80g	Holmium	Ho	164.93g	Phosphorous	P	30.97g	Thallium	Tl	204.38g
Bromine	Br	79.90g	Hydrogen	H	1.01g	Platinum	Pt	195.07g	Thorium	Th	232.04g
Cadmium	Cd	112.40g	Indium	In	114.82g	Plutonium	Pu	244.00g	Thulium	Tm	168.93g
Calcium	Ca	40.09g	Iodine	I	126.90g	Polonium	Po	209.00g	Tin	Sn	118.71g
Californium	Cf	251.00g	Iridium	Ir	192.22g	Potassium	K	39.10g	Titanium	Ti	47.87g
Carbon	C	12.01g	Iron	Fe	55.85g	Praseodymium	Pr	140.90g	Tungsten	W	183.84g
Cerium	Ce	140.12g	Krypton	Kr	83.80g	Promethium	Pm	145.00g	Uranium	U	238.03g
Cesium	Cs	132.90g	Lanthanum	La	138.90g	Protactinium	Pa	231.04g	Vanadium	V	50.94g
Chlorine	Cl	35.50g	Lawrencium	Lr	262.00g	Radium	Ra	226.00g	Xenon	Xe	131.30g
Chromium	Cr	52.00g	Lead	Pb	207.20g	Radon	Rn	222.00g	Ytterbium	Yb	173.04g
Cobalt	Co	58.93g	Lithium	Li	6.94g	Rhenium	Re	186.20g	Yttrium	Y	88.90g
Copper	Cu	63.55g	Lutetium	Lu	174.97g	Rhodium	Rh	102.90g	Zinc	Zn	65.39g
Curium	Cm	247.00g	Magnesium	Mg	24.30g	Rubidium	Rb	85.47g	Zirconium	Zr	91.22g
Dubnium	Db	262.00g	Manganese	Mn	54.94g	Ruthenium	Ru	101.00g			
Dysprosium	Dy	162.50g	Meitnerium	Mt	268.00g	Rutherfordium	Rf	261.00g			
Einsteinium	Es	252.00g	Mendelevium	Md	258.00g	Samarium	Sm	150.36g			

**Table of Softening Mass Conversions**

<b>Source of Demand*</b>	<b>Chemical Dose Required</b>	
	<b>Lime (mg/L as CaO)</b>	<b>Soda Ash (mg/L as Na<sub>2</sub>CO<sub>3</sub>)</b>
CO <sub>2</sub> (mg/L as CO <sub>2</sub> )	1.27	-
Ca <sup>++</sup> Carbonate Hardness	0.56	-
Mg <sup>++</sup> Carbonate Hardness	1.12	-
Mg <sup>++</sup> NCH	0.56	1.06
Ca <sup>++</sup> NCH	-	1.06
Excess Lime	0.56	
Excess Soda Ash		1.06

*\*all units are 'as CaCO<sub>3</sub>' unless specified*