ABC & C_2EP Formula/Conversion Table for Wastewater Treatment, Industrial, Collection, & Laboratory Exams

$$\text{Alkalinity, as mg } CaCO_3/L = \frac{(\text{Titrant Volume, mL})(\text{Acid Normality})(50{,}000)}{\text{Sample Volume, mL}}$$

$$\text{Amps} = \frac{\text{Volts}}{\text{Ohms}}$$

*Area of Circle $= (.785)(\text{Diameter}^2)$

$= (\pi)(\text{Radius}^2)$

$$\text{Area of Cone (lateral area)} = (\pi)(\text{Radius})\sqrt{\text{Radius}^2 + \text{Height}^2}$$

$$\text{Area of Cone (total surface area)} = (\pi)(\text{Radius})\left(\text{Radius} + \sqrt{\text{Radius}^2 + \text{Height}^2}\right)$$

Area of Cylinder (total exterior surface area) = [Surface Area of End #1] + [Surface Area of End #2] + [(π) (Diameter) (Height or Depth)]

*Area of Rectangle = (Length) (Width)

$$\text{*Area of a Right Triangle} = \frac{(\text{Base})(\text{Height})}{2}$$

$$\text{Average (arithmetic mean)} = \frac{\text{Sum of All Terms}}{\text{Number of Terms}}$$

Average (geometric mean) $= [(X_1)(X_2)(X_3)(X_4)(X_n)]^{1/n}$ *The* n*th root of the product of* n *numbers*

$$\text{Biochemical Oxygen Demand (unseeded), mg/L} = \frac{[(\text{Initial DO, mg/L}) - (\text{Final DO, mg/L})][300\text{mL}]}{\text{Sample Volume, mL}}$$

$$\text{Chemical Feed Pump Setting, \% Stroke} = \frac{\text{Desired Flow}}{\text{Maximum Flow}} \times 100\%$$

$$\text{Chemical Feed Pump Setting, mL/min} = \frac{(\text{Flow, MGD})(\text{Dose, mg/L})(3.785\text{ L/gal})(1{,}000{,}000\text{ gal/MG})}{(\text{Liquid, mg/mL})(24\text{ hr/day})(60\text{ min/hr})}$$

Circumference of Circle $= (\pi)(\text{Diameter})$

$= 2(\pi)(\text{Radius})$

$$\text{Composite Sample Single Portion} = \frac{(\text{Instantaneous Flow})(\text{Total Sample Volume})}{(\text{Number of Portions})(\text{Average Flow})}$$

$$\text{Cycle Time, min} = \frac{\text{Storage Volume, gal}}{\text{Pump Capacity, gpm} - \text{Wet Well Inflow, gpm}}$$

*Pie Wheel format for this equation is available at the end of this document.

Degrees Celsius $= (\text{Degrees Fahrenheit} - 32)\ (^5/_9)$

$$= \frac{(°F - 32)}{1.8}$$

Degrees Fahrenheit $= (\text{Degrees Celsius})\ (^9/_5) + 32$

$$= (\text{Degrees Celsius})\ (1.8) + 32$$

Detention Time $= \dfrac{\text{Volume}}{\text{Flow}}$ *Units must be compatible*

Dose = Demand + Residual

*Electromotive Force (EMF), volts = (Current, amps) (Resistance, ohms) *or* E = IR

$$\text{*Feed Rate, lbs/day} = \frac{(\text{Dosage, mg/L})(\text{Capacity, MGD})(8.34\ \text{lbs/gal})}{\text{Purity, \% expressed as a decimal}}$$

$$\text{Filter Backwash Rise Rate, in/min} = \frac{(\text{Backwash Rate, gpm/ft}^2)\ (12\ \text{in/ft})}{7.48\ \text{gal/ft}^3}$$

$$\text{Filter Flow Rate or Backwash Rate, gpm/ft}^2 = \frac{\text{Flow, gpm}}{\text{Filter Area, ft}^2}$$

$$\text{Filter Yield, lbs/hr/ft}^2 = \frac{(\text{Solids Loading, lbs/day})\ (\text{Recovery, \% expressed as a decimal})}{(\text{Filter Operation, hr/day})\ (\text{Area, ft}^2)}$$

*Flow Rate, cfs = (Area, ft^2) (Velocity, ft/sec) *or* Q = AV *Units must be compatible*

$$\text{Food/Microorganism Ratio} = \frac{\text{BOD}_5\text{, lbs/day}}{\text{MLVSS, lbs}}$$

*Force, lbs = (Pressure, psi) (Area, in^2)

$$\text{Gallons/Capita/Day} = \frac{\text{Volume of Water Produced, gpd}}{\text{Population}}$$

$$\text{Hardness, as mg CaCO}_3\text{/L} = \frac{(\text{Titrant Volume, mL})\ (1{,}000)}{\text{Sample Volume, mL}}$$ *Only when the titration factor is 1.00 of EDTA*

$$\text{Horsepower, Brake (bhp)} = \frac{(\text{Flow, gpm})\ (\text{Head, ft})}{(3{,}960)\ (\text{Pump Efficiency, \% expressed as a decimal})}$$

Horsepower, Motor (mhp) =

$$\frac{(\text{Flow, gpm})(\text{Head, ft})}{(3{,}960)(\text{Pump Efficiency, \% expressed as a decimal})(\text{Motor Efficiency, \% expressed as a decimal})}$$

$$\text{*Horsepower, Water (whp)} = \frac{(\text{Flow, gpm})\ (\text{Head, ft})}{3{,}960}$$

$$\text{Hydraulic Loading Rate, gpd/ft}^2 = \frac{\text{Total Flow Applied, gpd}}{\text{Area, ft}^2}$$

*Pie Wheel format for this equation
is available at the end of this document.

$$\text{Leakage, gpd} = \frac{\text{Volume, gallons}}{\text{Time, days}}$$

*Mass, lbs = (Volume, MG) (Concentration, mg/L)(8.34 lbs/gal)

*Mass Flux, lbs/day = (Flow, MGD) (Concentration, mg/L) (8.34 lbs/gal)

$$\text{Mean Cell Residence Time (MCRT) or Solids Retention Time (SRT), days} = \frac{\text{Aeration Tank TSS, lbs} + \text{Clarifier TSS, lbs}}{\text{TSS Wasted, lbs/day} + \text{Effluent TSS, lb/day}}$$

Milliequivalent = (mL) (Normality)

$$\text{Molarity} = \frac{\text{Moles of Solute}}{\text{Liters of Solution}}$$

$$\text{Motor Efficiency, \%} = \frac{\text{Brake hp}}{\text{Motor hp}} \times 100\,\%$$

$$\text{Normality} = \frac{\text{Number of Equivalent Weights of Solute}}{\text{Liters of Solution}}$$

$$\text{Number of Equivalent Weights} = \frac{\text{Total Weight}}{\text{Equivalent Weight}}$$

$$\text{Number of Moles} = \frac{\text{Total Weight}}{\text{Molecular Weight}}$$

$$\text{Organic Loading Rate, lbs BOD}_5\text{/day/ft}^3 = \frac{\text{Organic Load, lbs BOD}_5\text{/day}}{\text{Volume, ft}^3}$$

$$\text{Organic Loading Rate-RBC, lbs BOD}_5\text{/day/1,000 ft}^2 = \frac{\text{Organic Load, lbs BOD}_5\text{/day}}{\text{Surface Area of Media, 1,000 ft}^2}$$

$$\text{Organic Loading Rate-Trickling Filter, lbs BOD}_5\text{/day/1,000 ft}^3 = \frac{\text{Organic Load, lbs BOD}_5\text{/day}}{\text{Volume, 1,000 ft}^3}$$

$$\text{Oxygen Uptake Rate or Oxygen Consumption Rate, mg/L/min} = \frac{\text{Oxygen Usage, mg/L}}{\text{Time, min}}$$

$$\text{Population Equivalent, Organic} = \frac{\text{(Flow, MGD) (BOD, mg/L) (8.34 lbs/gal)}}{\text{BOD/day/person, lbs}}$$

$$\text{Recirculation Ratio-Trickling Filter} = \frac{\text{Recirculated Flow}}{\text{Primary Effluent Flow}}$$

$$\text{Reduction in Flow, \%} = \left(\frac{\text{Original Flow - Reduced Flow}}{\text{Original Flow}}\right) \times 100\%$$

$$\text{Reduction of Volatile Solids, \%} = \left(\frac{\text{In} - \text{Out}}{\text{In} - (\text{In} \times \text{Out})}\right) \times 100\%$$ *All information (In and Out) must be in decimal form*

$$\text{Removal, \%} = \left(\frac{\text{In} - \text{Out}}{\text{In}}\right) \times 100\%$$

*Pie Wheel format for this equation is available at the end of this document.

$$\text{Return Rate, \%} = \frac{\text{Return Flow Rate}}{\text{Influent Flow Rate}} \times 100\%$$

$$\text{Return Sludge Rate-Solids Balance} = \frac{\text{(MLSS) (Flow Rate)}}{\text{Return Activated Sludge Suspended Solids} - \text{MLSS}}$$

$$\text{Slope, \%} = \frac{\text{Drop or Rise}}{\text{Distance}} \times 100\%$$

$$\text{Sludge Density Index} = \frac{100}{\text{SVI}}$$

$$\text{Sludge Volume Index (SVI), mL/g} = \frac{(\text{SSV}_{30}\text{, mL/L) (1,000 mg/g)}}{\text{MLSS, mg/L}}$$

$$\text{Solids, mg/L} = \frac{\text{(Dry Solids, grams) (1,000,000)}}{\text{Sample Volume, mL}}$$

$$\text{Solids Concentration, mg/L} = \frac{\text{Weight, mg}}{\text{Volume, L}}$$

$$\text{Solids Loading Rate, lbs/day/ft}^2 = \frac{\text{Solids Applied, lbs/day}}{\text{Surface Area, ft}^2}$$

Solids Retention Time (SRT): *see* Mean Cell Residence Time (MCRT)

$$\text{Specific Gravity} = \frac{\text{Specific Weight of Substance, lbs/gal}}{\text{Specific Weight of Water, lbs/gal}}$$

$$\text{Specific Oxygen Uptake Rate or Respiration Rate, (mg/g)/hr} = \frac{\text{OUR, mg/L/min (60 min)}}{\text{MLVSS, g/L (1 hr)}}$$

$$\text{Surface Loading Rate or Surface Overflow Rate, gpd/ft}^2 = \frac{\text{Flow, gpd}}{\text{Area, ft}^2}$$

Three Normal Equation $= (N_1 \times V_1) + (N_2 \times V_2) = (N_3 \times V_3)$ *Where* $V_1 + V_2 = V_3$

Two Normal Equation $= N_1 \times V_1 = N_2 \times V_2$ *Where N = normality, V = volume or flow*

$$\text{Velocity, ft/sec} = \frac{\text{Flow Rate, ft}^3\text{/ sec}}{\text{Area, ft}^2} \quad or \quad \frac{\text{Distance, ft}}{\text{Time, sec}}$$

$$\text{Volatile Solids, \%} = \left(\frac{\text{Dry Solids, g} - \text{Fixed Solids, g}}{\text{Dry Solids, g}}\right) \times 100\%$$

*Volume of Cone = (1/3) (.785) (Diameter^2) (Height)

= (1/3) [(π) (Radius^2) (Height)]

*Volume of Cylinder = (.785) (Diameter^2) (Height)

= (π) (Radius^2) (Height)

*Volume of Rectangular Tank = (Length) (Width) (Height)

*Pie Wheel format for this equation is available at the end of this document.

Watts (AC circuit) = (Volts) (Amps) (Power Factor)

Watts (DC circuit) = (Volts) (Amps)

$$\text{Weir Overflow Rate, gpd/ft} = \frac{\text{Flow, gpd}}{\text{Weir Length, ft}}$$

$$\text{Wire-to-Water Efficiency, \%} = \frac{\text{Water Horsepower, hp}}{\text{Power Input, hp or Motor hp}} \times 100\%$$

$$\text{Wire-to-Water Efficiency, \%} = \frac{(\text{Flow, gpm})(\text{Total Dynamic Head, ft})(0.746\ \text{kW/hp})}{(3{,}960)(\text{Electrical Demand, kW})} \times 100\%$$

Abbreviations:

BOD	biochemical oxygen demand
CBOD	carbonaceous biochemical oxygen demand
cfs	cubic feet per second
COD	chemical oxygen demand
DO	dissolved oxygen
ft	feet
F/M ratio	food to microorganism ratio
g	grams
gpd	gallons per day
gpg	grains per gallon
gpm	gallons per minute
hp	horsepower
hr	hour
in	inches
kW	kilowatt
lbs	pounds
mg/L	milligrams per liter
MCRT	mean cell residence time
MGD	million gallons per day
min	minute
mL	milliliter
MLSS	mixed liquor suspended solids
MLVSS	mixed liquor volatile suspended solid
OCR	oxygen consumption rate
ORP	oxidation reduction potential
OUR	oxygen uptake rate
ppb	parts per billion
ppm	parts per million
psi	pounds per square inch
PE	population equivalent
Q	flow

Abbreviations(continued):

RAS	return activated sludge
RBC	rotating biological contactor
SDI	sludge density index
SRT	solids retention time
SS	settleable solids
SSV_{30}	settled sludge volume 30 minute
SVI	sludge volume index
TOC	total organic carbon
TS	total solids
TSS	total suspended solids
VS	volatile solids
WAS	waste activated sludge

Conversion Factors:

1 acre = 43,560 square feet
1 acre foot = 326,000 gallons
1 cubic foot = 7.48 gallons
= 62.4 pounds
1 cubic foot per second = 0.646 MGD
1 foot = 0.305 meters
1 foot of water = 0.433 psi
1 gallon = 3.79 liters
= 8.34 pounds
1 grain per gallon = 17.1 mg/L
1 horsepower = 0.746 kW
= 746 watts
= 33,000 foot lbs/min
1 mile = 5,280 feet
1 million gallons per day = 694 gallons per minute
= 1.55 cubic feet per second (cfs)
1 pound = 0.454 kilograms
1 pound per square inch = 2.31 feet of water
1 ton = 2,000 pounds
1% = 10,000 mg/L
π or pi = 3.14159

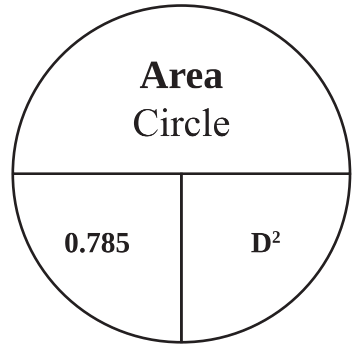
*Pie Wheel format for this equation is available at the end of this document.

***Pie Wheels:**

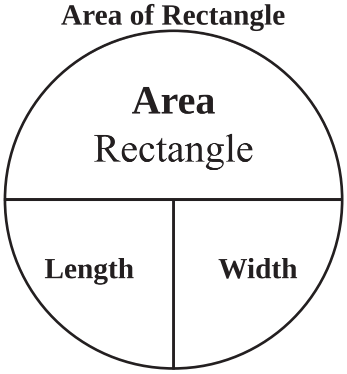
- To find the quantity above the horizontal line: multiply the pie wedges below the line together.
- To solve for one of the pie wedges below the horizontal line: cover that pie wedge, then divide the remaining pie wedge(s) into the quantity above the horizontal line.

Given units must match the units shown in the pie wheel.

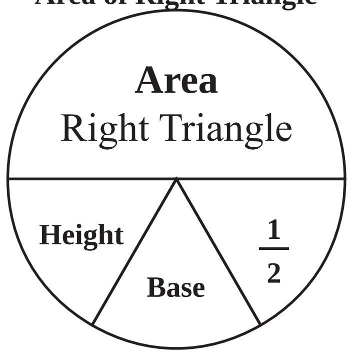
Area of Circle



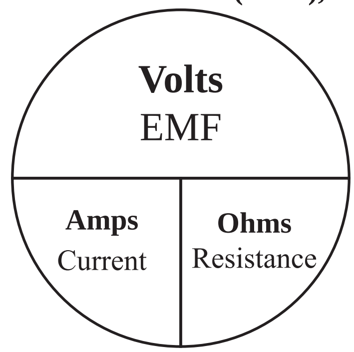
Area of Rectangle



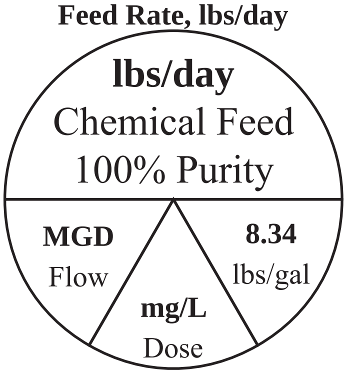
Area of Right Triangle



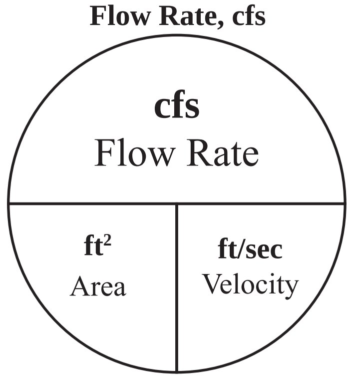
Electromotive Force (EMF), volts



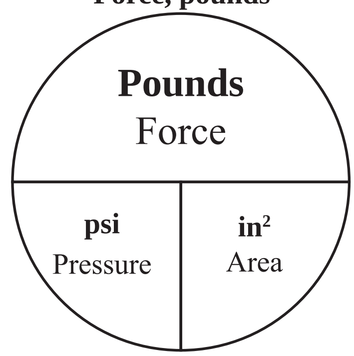
Feed Rate, lbs/day



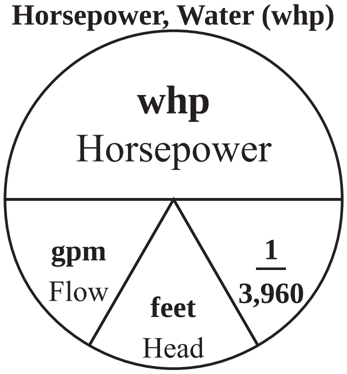
Flow Rate, cfs



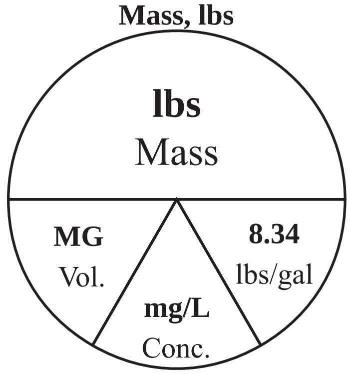
Force, pounds



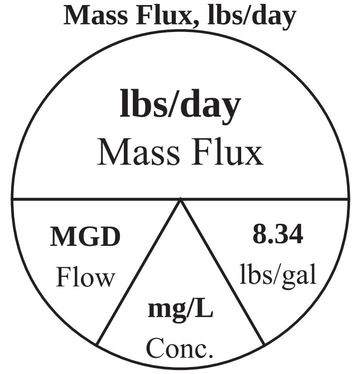
Horsepower, Water (whp)



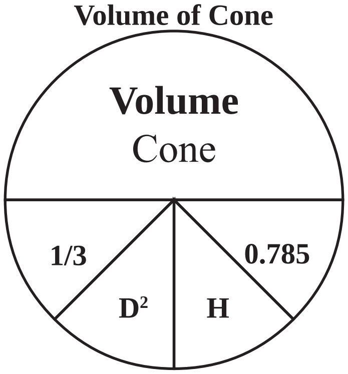
Mass, lbs



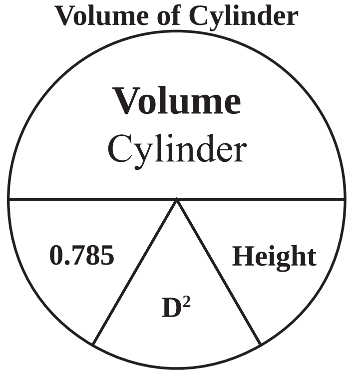
Mass Flux, lbs/day



Volume of Cone



Volume of Cylinder



Volume of Rectangular Tank