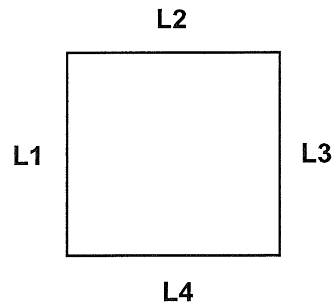
Perimeter / Circumference

Square or Rectangle:

Perimeter = L1 + L2 + L3 + L4



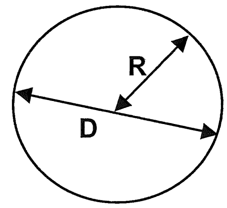
Circle:

Circumference = πD

or

Circumference = $\pi \times (2R)$

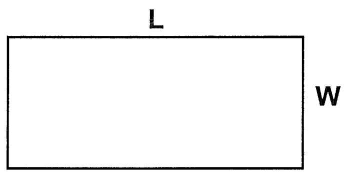
Where $\pi = 3.14$



Area

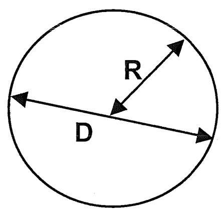
Square or Rectangle:

$A = L \times W$



Circle:

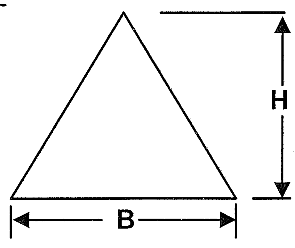
$A = \pi R^2$ **or** $A = 0.785\, D^2$



Where $\pi = 3.14$

Triangle:

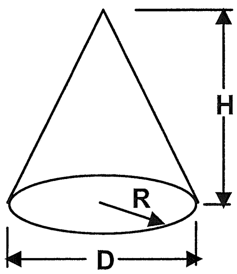
$A = \dfrac{B \times H}{2}$



Volume

Cone:

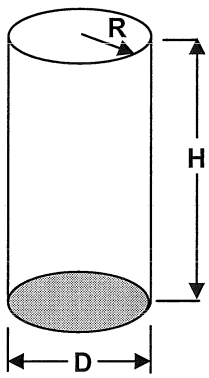
$$V = \frac{\pi R^2 H}{3} \quad \textbf{or} \quad V = \frac{0.785\, D^2 H}{3}$$



Where π = 3.14

Cylinder:

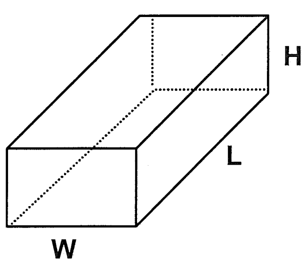
$$V = \pi R^2 H \quad \textbf{or} \quad V = 0.785\, D^2 H$$



Where π = 3.14

Cube:

$$V = L \times W \times H$$



Formula/Conversion Table for Wastewater Treatment and Wastewater Collection Exams

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

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

Area of Circle $= (0.785) \times (\text{Diameter}^2)$ *OR* $(\pi) \times (\text{Radius}^2)$

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

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

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

Area of Rectangle = (Length) × (Width)

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

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

Average (geometric mean) $= (x_1 \times x_2 \times x_3 \times x_4 \times x_n)^{1/n}$ The *n*th root of the product of *n* numbers.

Biochemical Oxygen Demand (unseeded), mg/L $= \dfrac{(\text{Initial DO,mg/L}) - (\text{Final DO,mg/L})}{\dfrac{\text{Sample Volume,mL}}{\text{Final Diluted Volume,mL}}}$

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

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

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

Composite Sample Single Portion $= \dfrac{\text{Instantaneous Flow} \times \text{Total Sample Volume}}{\text{Number of Portions} \times \text{Average Flow}}$

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

Degrees, Celsius (°C) $= (\text{Degrees, Fahrenheit} - 32) \times \left(\frac{5}{9}\right)$ *OR* $\dfrac{(°F - 32)}{1.8}$

Degrees, Fahrenheit (°F) $= (\text{Degrees, Celsius}) \times \left(\frac{9}{5}\right) + 32$ *OR* $(°C) \times (1.8) + 32$

Detention Time $= \dfrac{\text{Volume}}{\text{Flow}}$ Note: Units must be compatible.

Electromotive Force (E.M.F or $\mathcal{E}$), volts = (Current, amps) × (Resistance, ohms) *OR* $\mathcal{E} = IR$

Feed Rate, lbs/day = $\frac{(\text{Dosage,mg/L}) \times (\text{Capacity,MGD}) \times (8.34\,\text{lbs/gal})}{(\text{Purity, decimal percentage})}$

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

Filter Backwash Rise Rate, in/minute = $\frac{(\text{Backwash Rate,GPM/sq ft}) \times (12\ \text{in/ft})}{(7.48\ \text{gal/cu ft})}$

Filter Yield, lbs/hr/sq ft = $\frac{(\text{Solids Loading, lbs/day}) \times (\text{Recovery,\% / 100\%})}{(\text{Filter Operation, hr/day}) \times (\text{Area, sq ft})}$

Flow Rate, cfs = (Area, sq ft) $\times$ (Velocity, ft/sec) or Q = AV Where: Q = flow rate, A = area, V= velocity

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

Force, pounds = (Pressure, psi) $\times$ (Area, sq in)

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

Hardness, as mg $CaCO_3$/L = $\frac{(\text{Titrant Volume, mL}) \times (1{,}000)}{\text{mL of Sample}}$ Only when the titration factor is 1.00 of EDTA.

Horsepower, Brake (bhp) = $\frac{(\text{Flow, gpm}) \times (\text{Head, ft})}{(3{,}960) \times (\text{Decimal Pump Efficiency})}$

Horsepower, Motor (mhp) = $\frac{(\text{Flow, gpm}) \times (\text{Head, ft})}{(3{,}960) \times (\text{Decimal Pump Efficiency}) \times (\text{Decimal Motor Efficiency})}$

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

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

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

Mass, lbs = (Volume, MG) $\times$ (Concentration, mg/L) $\times$ (8.34 lbs/gal)

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

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

MCRT or SRT, days = $\frac{(\text{Volume of Aeration Basins,MG}) \times (\text{MLVSS,mg/L})}{\{(\text{Influent Flow,MGD}) \times (\text{Effluent SS,mg/L})\} + \{(\text{Waste Sludge Flow,MGD}) \times (\text{Waste Sludge SS,mg/L})\}}$

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

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

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

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

$$\text{Organic Loading Rate} = \frac{\text{Organic Load, lbs BOD}_5\text{/day}}{\text{Volume}} = \frac{(\text{BOD}_5\text{, mg/L}) \times (\text{Flow, MGD}) \times (8.34\text{ lbs / gal})}{\text{Volume}}$$

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

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

$$\text{Organic Loading Rate – Pond} = \frac{(\text{BOD}_5\text{, mg/L}) \times (\text{Flow, MGD}) \times (8.34\text{ lbs / gal})}{\text{Area, acres}}$$

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

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

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

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

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

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

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

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

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

$$\text{Sludge Age, days} = \frac{\text{Mixed Liquor Solids, lbs}}{\text{Primary Effluent Solids, lbs/day}} \ \underline{OR} \ \frac{\text{Solids Under Aeration, lbs}}{\text{Solids Added, lbs/day}}$$

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

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

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

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

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

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

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

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

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

Three Normal Equation = (N_1 x V_1) + (N_2 x V_2) = (N_3 x V_3), where $V_1 + V_2 = V_3$

Two Normal Equation = N_1 x V_1 = N_2 x V_2, where N = concentration, V = volume or flow

$$\text{Velocity, ft/sec} = \frac{\text{Flow Rate, cu ft/sec}}{\text{Area, sq ft}} \ \underline{OR} \ \frac{\text{Distance, ft}}{\text{Time, sec}}$$

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

$$\text{Volume of Cone} = \left(\frac{1}{3}\right) \times (0.785) \times (\text{Diameter}^2) \times (\text{Height})$$

$$\text{Volume of Cylinder} = (0.785) \times (\text{Diameter}^2) \times (\text{Height})$$

$$\text{Volume of Rectangular Tank} = (\text{Length}) \times (\text{Width}) \times (\text{Height})$$

$$\text{Waste Milliequivalent} = (\text{mL}) \times (\text{Normality})$$

$$\text{Watts (DC circuit)} = (\text{Volts}) \times (\text{Amps})$$

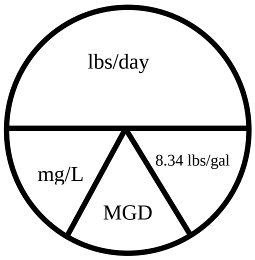
$$\text{Watts (AC circuit)} = (\text{Volts}) \times (\text{Amps}) \times (\text{Power Factor})$$

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

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

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

Davidson Pie Diagram: Dosage Formula



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

Conversion Factors:

1 acre = 43,560 square feet
1 acre foot = 326,000 gallons
1 cubic foot = 7.48 gallons
1 cubic foot = 62.4 pounds
1 cubic foot per second = 0.646 MGD = 448.8 gpm
1 foot = 0.305 meters
1 foot of water = 0.433 psi
1 gallon = 3.79 liters
1 gallon = 8.34 pounds
1 grain per gallon = 17.1 mg/L
1 horsepower = 0.746 kW or 746 watts or 33,000 ft. lbs/min
1 million gallons per day = 694 gallons per minute
1 million gallons per day = 1.55 cubic feet per second
1 mile = 5,280 feet
Population Equivalent, hydraulic = 100 gallons/person/day
Population Equivalent = 0.17 lbs BOD/person/day
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

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
in	inches
kW	kilowatt
lbs	pounds
mg/L	milligrams per liter
MCRT	mean cell residence time
MGD	million gallons per day
mL	milliliter
MLSS	mixed liquor suspended solids
MLVSS	mixed liquor volatile suspended solid
OCR	oxygen consumption rate
ORP	oxygen reduction potential
OUR	oxygen uptake rate
ppb	parts per billion
ppm	parts per million
psi	pounds per square inch
PE	population equivalent
Q	flow
RAS	return activated sludge
RBC	rotating biological contactor
SDI	sludge density index
SRT	solids retention time
SS	suspended 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