

## ABC Formula/Conversion Table for Wastewater Treatment, Industrial, Collection and Laboratory Exams

$$\text{Alkalinity, as mg CaCO}_3/\text{L} = \frac{(\text{Titrant Volume, mL})(\text{Acid Normality})(50,000)}{\text{Sample Volume, mL}}$$

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

$$\text{Area of Circle} = (0.785) (\text{Diameter}^2) \text{ or } (\Pi) (\text{Radius}^2)$$

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

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

$$\text{Area of Cylinder (total outside surface area)} = [\text{Surface Area of End \#1}] + [\text{Surface Area of End \#2}] + [(\Pi) (\text{Diameter}) (\text{Height or Depth})]$$

$$\text{Area of Rectangle} = (\text{Length}) (\text{Width})$$

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

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

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

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

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

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

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

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

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

$$\text{Degrees Celsius} = (\text{Degrees Fahrenheit} - 32) (\frac{5}{9}) \text{ or } \frac{(\text{F} - 32)}{1.8}$$

$$\text{Degrees Fahrenheit} = [(\text{Degrees Celsius}) (\frac{9}{5}) + 32] \text{ or } [(\text{Degrees Celsius}) (1.8) + 32]$$

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

Electromotive Force (E.M.F), volts = (Current, amps) (Resistance, ohms) or  $E = IR$

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

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

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

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

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

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

Force, pounds = (Pressure, psi) (Area, sq in)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Two Normal Equation =  $N_1 \times V_1 = N_2 \times V_2$ , where N = concentration (normality), V = volume or flow

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

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

Volume of Cone =  $(1/3) (0.785) (\text{Diameter}^2) (\text{Height})$

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

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

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

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

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

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

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

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

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**Conversion Factors:**

|   |  |
|---|--|
| 1 acre = 43,560 square feet                               | 1 horsepower = 0.746 kW or 746 watts or 33,000 ft. lbs./min. |
| 1 acre foot = 326,000 gallons                             | 1 million gallons per day = 694 gallons per minute           |
| 1 cubic foot = 7.48 gallons                               | 1 million gallons per day = 1.55 cubic feet per second       |
| 1 cubic foot = 62.4 pounds                                | 1 mile = 5,280 feet  |
| 1 cubic foot per second = 0.646 MGD                       | 1 pound = 0.454 kilograms                                    |
| 1 foot = 0.305 meters                                     | 1 pound per square inch = 2.31 feet of water                 |
| 1 foot of water = 0.433 psi                               | 1 ton = 2,000 pounds   |
| 1 gallon = 3.79 liters                                    | 1% = 10,000 mg/L   |
| 1 gallon = 8.34 pounds                                    | $\Pi$ or pi = 3.14   |
| 1 grain per gallon = 17.1 mg/L                            |  |
| Population Equivalent, hydraulic = 100 gallons/person/day |  |
| Population Equivalent = 0.17 lbs BOD/person/day           |  |

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**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                | settleable solids                      |
| SSV <sub>30</sub> | 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                 |