FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Wastewater Treatment Formulas/Conversion Table

Measurement Conversion	Measurement Conversion	Measurement Conversion
12 in= 1 ft	27 cu. ft. = 1 cu. yd.	1000 mg = 1 gm
3 ft= 1 yd	7.48 gal= 1 cu. ft.	1000 gm = 1 kg
5280 ft= 1 mi	8.34 lbs= 1 gal	1000 ml = 1 liter
144 sq. in. = 1 sq. ft.	62.4 lbs= 1 cu. ft.	2.31 ft water = 1 psi
43,560 sq. ft.= 1 acre	1 grain / gal= 17.1 mg/L	0.433 psi = 1 ft water
43,560 cu. ft.= 1 acre-ft	454 gm = 1 lb.	1.133 ft of water = 1 in. Mercury
60 sec = 1 min	10,000 mg/L = 1%	1 hp= 0.746 kW
60 min = 1 hour	1mg/l = 1ppm	1 hp = 33,000 ft lbs/min
1440 min = 1 day		

L = Length B = Base W = Width H = Height R = Radius D = Diameter $\pi\pi = 3.14$

Activated Sludge

Change, WAS rate, MGD = $\frac{\text{(current solids inventory, lbs) - (desired solids inventory, lbs)}}{\text{(WAS, mg/L)(8.34 lbs / gal)}}$

Food to Microorganism Ratio or F/M = $\frac{\text{(influent CBOD, mg/L) (Flow, MGD) (8.34 lbs / gal)}}{\text{(Aeration tank cap, MG) (MLVSS, mg/L) (8.34 lbs / gal)}}$

Mean Cell Residence Time or MCRT, days = $\frac{\text{solids inventory, lbs}}{\text{(Effluent solids, lbs) + (WAS solids, lbs)}}$

Return Sludge Rate, MGD = $\frac{\text{(Settleable Solids, ml) (flow, MGD)}}{\text{(1,000 ml) - (Settleable Solids, ml)}}$

Sludge Age, days = $\frac{\text{solids under aeration, lbs}}{\text{solids added, lbs / day}}$

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

Sludge Volume Index or SVI = $\frac{\text{30 min settling, ml/L}}{\text{Mixed Liquor Suspended Solids, mg/L}}$ (1,000)

Solids Inventory, lbs = (Tank capacity, MG) (MLSS, mg/L) (8.34 lbs / gal)

Waste Activated Sludge or WAS flow, MGD = $\frac{\text{WAS, lbs/day}}{\text{(WAS, mg/L) (8.34 lbs / gal)}}$

WAS, lbs / day = $\frac{\text{(Solids inventory, lbs) - (Solids lost in effluent, lbs / day)}}{\text{MCRT, days}}$

Area, Circumference, and Volume

Area, sq ft.

Circle: $A = \pi \times R^2$ or $A = 0.785 \times D^2$

Cylinder (total outside surface area): $A = [(2 \times 0.785 \times D^2) + (\pi \times D \times H)]$ or $[(2 \times \pi \times R^2) + (\pi \times D \times H)]$

Rectangle: $A = L \times W$

Triangle: $A = ½B \times H$

Circumference, ft

Circle, $ft = \pi \times D$

Rectangle, $ft = (2 \times L) + (2 \times W)$

Volume, cu ft

Cone: $V = \pi/3 \times R^2 \times H$ or $V = {}^1/_3 \times 0.785 \times D^2 \times H$

Cylinder: $V = \pi \times R^2 \times H$ or $V = 0.785 \times D^2 \times H$

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

$$\text{Average (Arithmetic Mean)} = \frac{\text{Sum of all Terms or Measurements}}{\text{Number of Terms or Measurements}}$$

$$\text{Annual Running Average} = \frac{\text{Sum of all averages}}{\text{Number of averages}}$$

Chemical Feed

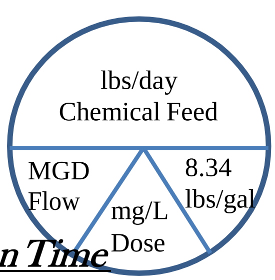
Chemical solution, lbs/gal = (solution, as a decimal) (8.34 lbs / gal)

$$\text{Feed pump flow, gal/day} = \frac{\text{chemical feed, lbs/day}}{\text{chemical solution, lbs/gal}}$$

$$\text{Scale setting, \%} = \frac{(\text{desired flow, gal / day})\ (100\ \%)}{\text{maximum feed rate, gal / day}}$$

Feed Rate

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



Davidson Pie Chart

- To find the quantity above the horizontal line: multiply the pie wedges below the line together and divide by the purity, as a decimal (i.e., 65% = 0.65).
- To solve for one of the pie wedges below the horizontal line: cover that pie wedge then divide the remaining pie wedges into the quantity above the horizontal line and multiply by the purity, as a decimal (i.e., 65% = 0.65).
- The given units must match the units shown in the pie wheel.

Detention Time

$$\text{Detention Time, (days)} = \frac{\text{Volume, gallons}}{\text{Flow, gpd}}$$

Note: For detention time in hours multiply by 24hr/day and for detention time in minutes multiply by 1440 min/day

Disinfection

Chlorine Demand, mg/L = Chlorine Dosage, mg/L – Chlorine Residual, mg/L

Chlorine Dosage, mg/L = Chlorine Demand, mg/L + Chlorine Residual, mg/L

Chlorine Residual, mg/L = Chlorine Dosage, mg/L – Chlorine Demand, mg/L

Horsepower & Force

$$\text{Water HP} = \frac{(\text{flow, gal / min}) \times (\text{head, ft})}{3{,}960}$$

$$\text{Brake Horse Power, BHP} = \frac{(\text{flow, gal/min}) \times (\text{head, ft.})}{(3{,}960 \times \text{Pump Efficiency, as a decimal})}$$

$$\text{Motor HP} = \frac{(\text{flow, gal/min}) \times (\text{head, ft})}{(3{,}960)\ (\text{Pump Efficiency, as a decimal})\ (\text{Motor Efficiency, as a decimal})}$$

Upward Force, lbs = (62.4 lbs/cu. ft.) (ground water height over tank bottom, ft) (area, ft^2 of tank bottom)

Side Wall Force, lbs = (31.2 lbs / cu. ft.) $(\text{height, ft})^2$ (length, ft)

$$\text{Brake Horsepower, Hp} = \frac{(\text{Power to electric Motor, KW})\ (\text{Motor Efficiency, \%})}{0.746\ \text{kw/Hp}}$$

$$\text{Pump Efficiency, \%} = \frac{\text{Water Horsepower, Hp} \times 100\%}{\text{Brake Horsepower, Hp}}$$

Kilowatt- hr/day = (Motor, HP) x 24 hr/Day x 0.746/HP

Cost, $/day = Kilowatt-hr/day x cost, $/kWh

Total Dynamic Head, ft. = Static Head, ft. + Friction Losses, ft.

Static Head = Suction Lift, ft. + Discharge Head, ft.

Laboratory Procedures & Measurements

RDD =dried residue + dish + disc (filter), grams
DD = dish + disc, grams
FDD = fired residue + dish + disc, grams
1 M = 1,000,000

Total Suspended Solids, TSS, mg/l = $\frac{\text{(RDD - DD)}}{\text{sample volume, ml}}$ x 1 M

Volatile Suspended Solids, VSS, mg/l = $\frac{\text{(RDD - FDD)}}{\text{sample volume, ml}}$ x 1 M

Volatile Suspended Solids, VSS, % = $\frac{\text{Volatile Solids, mg/L}}{\text{Total Suspended Solids, mg/L}}$ x 100%

Carbonaceous Biochemical Oxygen Demand, **CBOD** sample size, ml = $\frac{\text{1,200}}{\text{estimated CBOD, mg/L}}$

Seed Correction, mg/L, for 1 ml seed = $\frac{\text{seed initial D.O. - seed final D.O.}}{\text{ml seed added}}$

CBOD, mg/L = $\frac{\text{[(initial DO - Final DO) - seed correction factor] x (bottle volume, ml)}}{\text{Sample volume, ml}}$

Parts per Million (ppm) & Pounds (lbs)

mg/L = ppm = $\frac{\text{pounds of chemical}}{\text{(8.34 lbs / gal x MG)}}$

lbs = 8.34 lbs/gal x mg/L x MG

Sedimentation & Loadings

Weir Overflow, gal/day /ft = $\frac{\text{total flow, gal /day}}{\text{length of weir, ft.}}$

Solids Loading, lbs/day/ft^2 = $\frac{\text{solids applied, lbs / day}}{\text{surface area, ft}^2}$

Efficiency, % = $\frac{\text{(in) - (out)}}{\text{(in)}}$ x 100%

Hydraulic or Surface Loading, gal/day/ft^2 = $\frac{\text{flow rate, gal / day}}{\text{surface area, sq. ft.}}$

Trickling Filter Organic loading, lbs CBOD/day /1000 ft^3 = $\frac{\text{CBOD applied, lbs/day}}{\text{volume of media in 1000 ft}^3}$

Soluble CBOD, mg/L = total CBOD, mg/L - (K x suspended solids, mg/L)
(K = 0.5 to 0.7 for most domestic wastewaters)

RBC Organic Loading, lbs CBOD/day/1000 ft^2 = $\frac{\text{soluble CBOD applied, lbs/day}}{\text{Surface area of media, 1000 ft}^2}$

Sludge Digestion

Dry solids, lbs = $\frac{\text{(raw sludge, gal) (raw sludge, \% solids)(8.34 lbs /gal)}}{\text{100 \%}}$

Volatile Solids pumped, lbs/day =

$$\frac{\text{(ret. sludge, gal/day) (ret. sludge solids, \%)}}{(100\%)} \times \frac{\text{(ret. sludge vol., \%) (8.34 lbs / gal)}}{(100\%)}$$

Seed Sludge, lbs volatile solids = $\frac{\text{VS pumped, lbs VS/day}}{\text{loading factor, lbs VS/day/lb VS in digester}}$

Seed Sludge, gal = $\frac{\text{seed sludge, lbs volatile solids}}{\text{(seed sludge, lbs / gal) x (solids, as a decimal) x (VS, as a decimal)}}$

Lime required, lbs = (sludge, MG) (volatile acids, mg/L) (8.34 lbs / gal)

Reduction of Volatile Solids, % = $\frac{\text{(in - out) x 100\%}}{\text{in - (in x out)}}$

Volatile Solids destroyed, lbs/day/ft^3 = $\frac{\text{(VS added, lbs / day) (VS reduction, \%)}}{\text{(digester volume, ft}^3\text{) (100\%)}}$

Gas production, ft^3/lb Volatile Solids = $\frac{\text{gas produced, cu. ft. / day}}{\text{VS destroyed, lbs / day}}$

Temperature Conversions

Degrees Celsius = [(°F – 32)(5/9)] or [(°F – 32)(0.555) or $\frac{(°F - 32)}{1.8}$

Degrees Fahrenheit = [(°C)(9/5) + 32] or [(°C)(1.8)+32]

Velocities & Flow Rates

Velocity, fps = $\frac{\text{distance, ft}}{\text{time, min}}$ or $\frac{\text{Flow rate, cfs}}{\text{Area, ft}^2}$

Flow rate, cfs = velocity, ft/sec. x area, ft^2 or (Q = V x A)

Flow rate, gpm = (Area, ft^2)(Velocity, ft/sec)(7.48 gal/ft^3)(60 sec/min) or Q = V x A x 7.48 x 60

Abbreviations:

Abbreviations	Measurement Types	Abbreviations	Measurement Volumes
BOD	Biochemical Oxygen Demand	kWh	Kilowatt-hour
cfs	Cubic feet per second	m	Meter
CBOD	Carbonaceous Biochemical Oxygen Demand	mg	Milligrams
DO	Dissolved oxygen	mg/L	Milligrams per liter
ft	Feet	lbs	Pounds
fps	Feet per second	MGD	Million gallons per day

Abbreviations	Measurement Types	Abbreviations	Measurement Volumes
GFD	Gallons per day per square foot	mL	Milliliter
gm	Grams	ppb	Parts per billion
gpd	Gallons per day	ppm	Parts per million
gpg	Grains per gallon	psi	Pounds per square inch
gpm	Gallons per minute	Q	Flow
gph	Gallons per hour	SS	Settleable solids
gr	Grains	TTHM	Total trihalomethanes
hp	Horsepower	TOC	Total organic carbon
in	Inch	TSS	Total suspended solids
kg	Kilogram	VS	Volatile solids
kW	Kilowatt	W	Watt