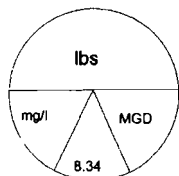


WASTEWATER MATH CONVERSION FACTORS

1. 1 acre = 43,560 sq ft
2. 1 acre = 2.47 hectares
3. 1 cu ft [of water] = 7.48 gallons
4. 1 cu ft [of water] = 62.4 lbs/ft³
5. Diameter = radius plus radius, $D = r + r$
6. 1 foot = 12 inches or 0.305 meters
7. 1 ft [of water] = 0.43 PSIG or 0.88 inches of Mercury (Hg)
8. 1 gallon [of water] = 8.34 lbs
9. 1 gallon = 3.785 liters
10. Gallons = (volume)(7.48)
11. 1 gram, liter, etc. = 1,000 milligrams, milliliter, etc.
12. 1 hp = 746 watts (W) or 0.746 kilowatts (kW)
13. 1 inch = 25.4 millimeters
14. 1 Kilogram, liter, etc. = 1,000 grams, liters, etc.
15. 1 Kilogram (kg) = 2.2 lbs
16. 1 mile = 1.609 kilometers or 5,280 feet
17. 1 milligram, liter, etc. = 1/1,000 or 0.001 gram, liter, etc.
18. 1 MGD [million gallons per day] = 694.4 gpm [gallons per minute]
19. gpm [gallons per minute] = (CFS)(448.8)
20. MGD [million gallons per day] = (CFS)(0.646)
21. CFS [cubic feet per second] = (MGD)(1.547)
22. CFS = (gpm)(0.00223)
23. GPD [gallons per day] = (GPM)(1440)
24. 1 oz [ounce] = 28.35 grams
25. 1% [percent] = 10,000 mg/L
26. π [Pi] = 3.14 [approximate]
27. 1 lb [pound] = 453.6 grams [approximate]
28. 1 PSIG = 2.31 ft or 27.72 inches [of water] or 2.04 inches of Hg
29. 1 quart = 0.946 liters
30. 1 yard = 3 feet
31. 1 MGD = 5570 ft³/hr
32. 1 MGD = 92.8 ft³/min
33. 3957 = number of gallons of water to weigh 33,000 lbs.

Notes:

1. Standard rounding procedure: round to the nearest hundredth [two places]
2. ft + ft = ft 3. (ft)(ft) = ft² [square feet] or area
4. (ft)(ft)(ft) = ft³ [cubic feet] or volume



BASIC MATH FORMULAS - CLASS I

1. Surface Area, ft² [area in feet squared]

A. Rectangle [clarifiers, ponds]

l = length; w = width; A = area; area in square ft [sq ft]

$$A = (l)(w)$$

B. Circle [clarifiers, pipes, manholes, etc.]

π [pie] = 3.14; D = diameter [distance across the tank]; $D^2 = (D)(D)$;
r [radius] = $\frac{1}{2} D$; $r^2 = (r)(r)$

$$(1) \text{ Area [sq ft]} = (\pi)(r^2) \text{ Or } A = (3.14)(r^2)$$

$$(2) \text{ Area [sq ft]} = (0.785)(D^2)$$

C. Ponds

$$43,560 \text{ ft}^2 = 1 \text{ acre}$$

$$A = (43,560)(\text{number of acres})$$

2. Volume, ft³ [volume in cubic feet]

A. Rectangle l = length; w = width; h = height or depth of water in tank

$$\text{Volume, ft}^3 = (l)(w)(h)$$

B. Circle

$$(1) \text{ Volume, ft}^3 = (3.14)(r^2)(h)$$

$$(2) \text{ Volume, ft}^3 = (0.785)(D^2)(h)$$

C. Ponds

$$\text{Volume, ft}^3 = (43,560)(\text{acres})(\text{depth})$$

3. Volume, gallons = (ft³)(7.48)

4. Percent

$$\text{Percent, \%} = \frac{\text{part}}{\text{whole}} (100)$$

5. Velocity, ft/sec = $\frac{\text{Distance traveled, ft}}{\text{Time, seconds}}$

6. Pounds [lbs] formula - used to calculate lbs of BOD, solids, etc.
 Note: Flow must be expressed as MGD [million gallons per day]
 Wt of one gallon of water = 8.34 lbs.; 1440 minutes = (24 hours)(60 minutes)

Formula when the concentration contains 100% available chemical:

A. lbs per day = (concentration, mg/L)(Flow [MGD])(8.34)

Formula when the concentration is less than 100% available chemical:

B. lbs per day = $\frac{(\text{concentration, mg/L})(\text{Flow [MGD] })(8.34)}{\frac{\% \text{ concentration}}{100\%}}$

7. Concentration [mg/L]

- A. Formula when the concentration is 100% available chemical:

$$\text{concentration, mg/L} = \frac{\text{lbs}}{(\text{Flow (mgd)} \times 8.34)}$$

- B. Formula when the concentration is less than 100% available chemical:

$$\text{concentration, mg/L} = \frac{(\text{lbs}) \frac{\% \text{ concentration}}{100\%}}{(\text{Flow [mgd] })(8.34)}$$

8. Population Equivalency = $\frac{(\text{BOD})(\text{Flow [MGD] })(8.34)}{0.17}$

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

10. BOD

DO = Dissolved Oxygen; P = mls of sample added/300 mls [should be a decimal number]

$$\text{BOD mg/L} = \frac{\text{Initial DO} - \text{Final DO}}{P}$$

11. Detention Time, hrs = $\frac{(\text{Volume, gals of tank})(24)}{\text{Flow [gpd]}}$

CLASS II WASTEWATER MATH FORMULAS

(Also use Class I formulas and Conversion sheet)

12. Chlorine Calculations:

A. Dosage [mg/L] = Demand [mg/L] + Residual [mg/L]

B. Demand [mg/L] = Dosage [mg/L] - Residual [mg/L]

C. Residual [mg/L] = Dosage [mg/L] - Demand [mg/L]

13. Circumference of a circle [ft] = (3.14)(Diameter [ft])

14. Weir overflow rate [gpd/ft] = $\frac{\text{Flow [gpd]}}{\text{Weir length [ft]}}$

15. Surface loading rate [gpd/ft²] = $\frac{\text{Flow [gpd]}}{\text{Surface area [ft}^2\text{]}}$

16. Pumping rate [gpm] = $\frac{\text{Volume [gal]}}{\text{Time [minutes]}}$

17. Solids loading rate [lbs/day/ft²] = $\frac{\text{Solids applied [lbs/day]}}{\text{Surface area [ft}^2\text{]}}$

18. Organic loading [lbs BOD/ac/day] = $\frac{(\text{BOD [mg/L]})(\text{flow [MGD]})(8.34)}{\text{Acres}}$

19. CFS = $\frac{\text{gpm}}{(60)(7.48)}$

20. Flow velocity formulas: Where Q = flow [cfs], V = velocity [ft/sec], A = area [ft²]

A. $Q = AV$

B. $V = \frac{Q}{A}$

C. $A = \frac{Q}{V}$

21. WHP [water horsepower] = $\frac{(\text{gpm})(\text{ft of head})}{3960}$

22. BHP [brake horsepower] = $\frac{(\text{gpm})(\text{ft of head})}{(3960)(\text{pump efficiency})}$

23. Pump efficiency = $\frac{\text{WHP}}{\text{BHP}}$

24. Temperature conversions:

A. °C to °F: $((\text{°C})(1.8)) + 32 = \text{°F}$

B. °F to °C: $(\text{°F} - 32) \div 1.8 = \text{°C}$

25. Capacity [tank volume in ft³] = $(5570)(\text{flow [MGD]})(\text{detention time [hrs]})$

26. Measurement of water from a horizontal pipe:

Flow [gpm] = $(\text{Area [ft}^2\text{] of pipe})(\text{distance [in inches to point where water drops 12"]})$
[If flowing full]

CLASS III WASTEWATER MATH FORMULAS

(Also use Class I and II formulas and Conversion sheet)

$$27. \quad F/M = \frac{(\text{BOD [mg/L]}) (\text{Flow [MGD]}) (8.34)}{(\text{MLVSS [mg/L]}) (\text{Aer Vol [MG]}) (8.34)} = \frac{\text{lbs BOD}}{\text{lbs MLVSS}}$$

$$28. \quad \text{Desired MLVSS [lbs]} = \frac{\text{lbs BOD}}{F/M}$$

$$29. \quad \text{MCRT or SRT [days]} = \frac{(\text{MLSS [mg/L]}) (\text{Aer Vol}^* [\text{MG}]) (8.34) + (\text{CCSS}^{\wedge} [\text{mg/L}]) (\text{Final Clarifier Vol [MG]}) (8.34)}{(\text{WAS SS [mg/L]}) (\text{Waste Rate [MG]}) (8.34) + \text{Sec Eff SS [mg/L]}) (\text{Flow [MGD]}) (8.34)}$$

[^]Clarifier Core SS concentration of the entire water column sampled by a core sampler

*If secondary clarifier Vol [MG] is known, add to Aer Vol [MG]

$$30. \quad \text{Sludge age [days]} = \frac{(\text{MLSS [mg/L]}) (\text{Aer Vol [MG]}) (8.34)}{(\text{Primary Effluent SS [mg/L]}) (\text{Flow [MGD]}) (8.34)}$$

[Note: #29 & 30 are outdated concepts that are not utilized by most operators at present] [See page 250 for #29 and page 246 for #30 in Price's Applied Math]

$$31. \quad \text{Desired MLSS [mg/L]} = (\text{Sludge age [days]}) (\text{solids added [lbs/day]})$$

$$32. \quad \text{Desired MLSS [mg/L]} = \frac{\text{Desire MLSS [lbs]}}{(\text{Aer. Vol. [MG]}) (8.34)}$$

$$33. \quad \text{Return Sludge Rate [MGD]} = \frac{(\text{Set Sol}^* [\text{ml}]) (\text{Flow [MGD]})}{1,000 \text{ ml} - \text{Set Sol [ml]}}$$

*Set Sol = 30 minute settling test results expressed in ml/L

$$34. \quad \text{Return Sludge Rate [gpm]} = \frac{\text{Return Rate [gpd]}}{1,440}$$

$$35. \quad \text{Change in WAS pump [MG]} = \frac{\text{Actual MLSS [lbs]} - \text{Desired MLSS [lbs]}}{(\text{WAS conc [mg/L]}) (8.34)}$$

$$36. \quad \text{New WAS pump [gpm]} = \text{Current WAS pump [gpm]} + \text{change in WAS pump [gpm]}$$

$$37. \quad \text{WAS pump [MGD]} = \frac{\text{WAS [lbs/day]}}{(\text{WAS SS [mg/L]}) (8.34)}$$

$$38. \text{ Dry solids [lbs]} = \frac{(\text{Raw Sludge [gal]}) (\text{Raw Sludge [\%]}) (8.34)}{100}$$

$$39. \text{ Volatile Solids [lbs]} = \frac{(\text{Dry Solids [lbs]}) (\text{Raw Sludge [\% VS]})}{100}$$

$$40. \text{ \% Reduction VS} = \frac{\text{In}^* - \text{Out}^*}{\text{In} - ((\text{In})(\text{Out}))} (100)$$

*All % expressed as the decimal fractions

$$41. \text{ Digester Loading [lbs VS/day/ft}^3\text{]} = \frac{\text{Volatile Solids added [lbs/day]}}{\text{Digester Volume [ft}^3\text{]}}$$

42. Sludge Volume Index [SVI]:

$$A. \text{ SVI} = \frac{(\text{Set Sol [ml/L]}) (1,000)}{\text{MLSS [mg/L]}}$$

$$B. \text{ SVI} = \frac{(\text{Set Sol [\%]}) (1,000)}{\text{MLSS [mg/L]}}$$

$$43. \text{ Concentration Factor [cf]} = \frac{\text{Thickened Sludge Concentration [\%]}}{\text{Influent Sludge Concentration [\%]}}$$

$$44. \text{ Sludge Volume [gal]} = \frac{\text{lbs dry solids}}{\frac{(8.34) \% \text{ solids}}{100}}$$

$$45. \text{ Lime required [lbs]} = (\text{lbs lime/ton sludge}) \frac{\text{lbs sludge}}{2000}$$

46. Solids loading rate [lbs] for gravity filter:

$$\text{lbs SS/hr/ft belt width} = \frac{(\text{WAS flow [gpm]}) (60) (8.34) (\% \text{ solids}/100)}{\text{Belt width [ft]}}$$