INDUSTRIAL MATH FORMULAS

1. Surface Area, ft^2 [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.]
   B [pie] = 3.14; D = diameter [distance across the tank]; $D^2 = (D)(D)$;
   r [radius] = ½ D; $r^2 = (r)(r)$

   (1) Area [sq ft] = $(B)(r^2)$ Or $A = (3.14)(r^2)$

   (2) Area [sq ft] = $(0.785)(D^2)$

   C. Ponds
   43,560 ft^2 = 1 acre

   A = (43,560)(number of acres)

2. Volume, ft^3 [volume in cubic feet]

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

   Volume, $ft^3 = (l)(w)(h)$

   B. Circle

   (1) Volume, $ft^3 = (3.14)(r^2)(h)$

   (2) Volume, $ft^3 = (0.785)(D^2)(h)$

   C. Ponds

   Volume, ft^3 = (43,560)(acres)(depth)

3. Volume, gallons = $(ft^3)(7.48)$

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

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

6. 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:
$$\text{concentration, mg/L} = \frac{(\text{lbs})\ \frac{\%\ \text{concentration}}{100\%}}{(\text{Flow [MGD]})(8.34)}$$

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

8. BOD

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

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

9. COD

A= mls titrated in blank
B= mls titrated in sample
C= mls titrated in standard
M= 0.1 for low concentrations; 1.0 for high concentrations

$$\text{COD [mg/l]} = \text{A} - \text{B}\ \frac{(2{,}000)(\text{M})}{\text{C}}$$

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

11. 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]

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

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

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

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

16. Flow velocity formulas: Where Q = flow [cfs], V = velocity [ft/sec], A = area [ft^2]

    A. $Q = AV$

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

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

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

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

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

20. Temperature conversions:

    A. °C to °F: ((°C)(1.8)) + 32 = °F

    B. °F to °C: (°F - 32) ÷ 1.8 = °C

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

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

    ^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]

23. Chemical Feed Rate [lbs/day]

    A. Full strength chemicals:

    lbs/day chemical = (Concentration [mg/l])(Flow [MGD])(8.34)

    B. Less than full strength chemicals:

    $$lbs/day\ chemical = \frac{(Concentration\ [mg/l])(Tank\ volume\ [MG])(8.34)}{\frac{\%\ concentration}{100\%}}$$

24. Percent Strength of Solutions

    A. Dry Chemicals:

    $$\%\ Strength = \frac{Chemicals\ [lbs]}{water\ [lbs] + chemical\ [lbs]}\ (100)$$

    B. Liquid Chemicals:

    $$(Liquid\ Poly\ [lbs])\frac{(\%\ Strength)}{100} = (Poly\ Solution\ [lbs])\frac{(\%\ Strength)}{100}$$

25. Mixing Solutions of Different Strengths:

A. % Strength of Mixture = $\frac{\text{lbs chemical [solution 1] + lbs chemical [solution 2]}}{\text{lbs solution 1} + \text{lbs solution 2}}$ (100)

B. % Strength of Mixture = $\frac{\frac{(\text{lbs solution 1})(\%\text{ strength})}{100} + \frac{(\text{lbs solution 2})(\%\text{ strength})}{100}}{\text{lbs solution 1} + \text{lbs solution 2}}$

26. Solution Chemical Feeder Setting [GPD]

Concentration [mg/l] (Flow [MGD])(8.34) = (Solution [mg/l])(MG)(8.34)

27. Chemical Feed Pump [% Stroke Setting]

% Setting = $\frac{\text{Required Feed Pump [GPD]}}{\text{Maximum Feed Pump [GPD]}}$ (100)

28. Solution Chemical Feeder Setting [mls/minute]

A. First calculate the GPD setting using the formula:

Chemical [lbs/day] = (Chemical Dosage [mg/L])(Flow [MGD])(8.34)

GPD = $\frac{\text{lbs/day}}{\text{Chemical Dosage [mg/L]}}$

(MG)(1,000,000) = GPD

B. Using the GPD flow, determine the mls/min setting:

Chemical [mls/min] = $\frac{\text{Flow [GPD](3785 [ml/gal])}}{\text{1440 [min/day]}}$

29. Dry Chemical Feeder Calibration

Chemical Feed Rate [lbs/day] = $\frac{\text{Chemical used [lbs]}}{\text{Application time [days]}}$

30. Solution Chemical Feeder Calibration [Given mls/min flow]

A. Convert ml/min flow to GPD flow:

$$GPD = \frac{\text{Flow [mls/min] (1440 [min/day])}}{\text{3785 [mls/gal]}}$$

B. Calculate chemical dosage [lbs/day]:

Chemical [lbs/day] = Chemical [mg/L] (Flow [MGD])(8.34)

31. Solution Chemical Feeder Calibration (Given drop in solution tank level)

A. $$\text{Flow [GPM]} = \frac{\text{Volume pumped [gals]}}{\text{Duration of test [min]}}$$

OR

B. $$\text{Flow [GPM]} = \frac{0.785\ (D^2)(\text{drop [ft]})(7.48)}{\text{Duration of test [min]}}$$

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

33. Sludge Volume Index [SVI]:

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

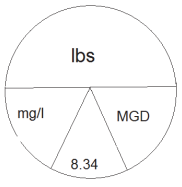
B. $$SVI = \frac{\text{(Set Sol [\%]) (1,000)}}{\text{MLSS [mg/L]}}$$

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/ft ^{3}
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. B [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 ft^3/hr
32. 1 MGD = 92.8 ft^3/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



Revised 0316