

## INDUSTRIAL MATH FORMULAS

### 1. Surface Area, ft<sup>2</sup> [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.]

$\pi$  [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 ft<sup>2</sup> = 1 acre

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

### 2. Volume, ft<sup>3</sup> [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 = (ft<sup>3</sup>)(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. 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. Removal Efficiency, % = 
$$\frac{\text{In} - \text{Out}}{\text{In}} (100)$$

8. BOD

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

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

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

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

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<sup>2</sup>] =  $\frac{\text{Flow [gpd]}}{\text{Surface area [ft}^2\text{]}}$
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<sup>2</sup>]
- A.  $Q = AV$
  - B.  $V = \frac{Q}{A}$
  - C.  $A = \frac{Q}{V}$
17. WHP [water horsepower] =  $\frac{(\text{gpm})(\text{ft of head})}{3960}$
18. BHP [brake horsepower] =  $\frac{(\text{gpm})(\text{ft of head})}{(3960)(\text{pump efficiency})}$
19. Pump efficiency =  $\frac{\text{WHP}}{\text{BHP}}$

20. Temperature conversions:

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

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

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

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

<sup>^</sup>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:

$$\text{lbs/day chemical} = (\text{Concentration [mg/l]})(\text{Flow [MGD]})(8.34)$$

B. Less than full strength chemicals:

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

24. Percent Strength of Solutions

A. Dry Chemicals:

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

B. Liquid Chemicals:

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

25. Mixing Solutions of Different Strengths:

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

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

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

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:

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

B. Calculate chemical dosage [lbs/day]:

$$\text{Chemical [lbs/day]} = \text{Chemical [mg/L]} (\text{Flow [MGD]})(8.34)$$

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

# 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<sup>3</sup>
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.  $\pi$  [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<sup>3</sup>/hr
32. 1 MGD = 92.8 ft<sup>3</sup>/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) = ft<sup>2</sup> [square feet] or area
4. (ft)(ft)(ft) = ft<sup>3</sup> [cubic feet] or volume

