Basic Water Treatment Math Formulas for Surface and Well Exams

These formulas are intended to serve as a general resource and are not intended to be an all-inclusive list.

AREA

Rectangle: A, ft^2 = L * W

Circle: A, ft^2 = 0.785 * D^2

VOLUME

Rectangular Tank: V, ft^3 = L * W * H

Circular Pipe or Tank: V, ft^3 = 0.785 * D^2 * H

FORCE

Force, lbs = Area, Sq. Inches x PSI

DOSAGE (Pounds Formula)

Lbs = mg/L * MGD * 8.34

$$\text{Mg/L} = \frac{\text{lbs}}{\text{MGD} * 8.34}$$

FLUORIDATION

AFI = Molecular Weight of Fluoride/Total Molecular Weight of Chemical * (100)

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

$$\text{Feed Rate, gpd} = \frac{\text{Feed Rate, lbs/day}}{\text{Chemical Solution, lbs/gal}}$$

Feed Dose, mg/L = Desired Dose, mg/L – Actual Concentration, mg/L

$$\text{Mixture Strength, \%} = \frac{\text{(Tank, gal)(Tank, \%)+(Vendor, gal)(Vendor, \%)}}{\text{Tank, gal + Vendor, gal}}$$

For Saturator

$$\text{Feed Rate, gpd} = \frac{\text{Capacity, gpd * dose, mg/L}}{\text{18,000 mg/L}}$$

FILTRATION

$$\text{Filtration Rate (gpm/ft}^2\text{)} = \frac{\text{flow, gpm}}{\text{Surface Area ft}^2}$$

Backwash Water, (gal) = (Backwash Flow, gpm)(Backwash Time, min)

Backwash Flow, (gpm) = (Filter Area sq. ft.)(Backwash Rate, gpm/sq ft.)

$$\text{Backwash \%} = \frac{\text{(Total Backwash, gal)(100\%)}}{\text{Totaled Filtered, gal}}$$

$$\text{Rate of Rise, (ft/min)} = \frac{\text{Backwash Rate, gpm/ft2}}{\text{7.48 gals/ft3}}$$

PUMPS AND MOTORS

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

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

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

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

Cost = Motor, hp * .746 kW * Cost * Hrs. * Days

DISINFECTION

Well Disinfection

Chlorine Required/gallon = $\frac{\text{(Casing Volume, gal)(Desired Dose, mg/L)}}{\text{Chlorine Solution, mg/L}}$

Dose (mg/L) = Demand (mg/L) + Residual (mg/L)

Chlorine Demand (mg/L) = Chlorine Dose (mg/L) – Chlorine Residual (mg/L)

Residual (mg/L) = Dosage (mg/L) – Demand (mg/L)

Chlorine lbs. = (Hypochlorite, gal)(8.34 lbs/gal)$\frac{\text{(Hypochlorite, \%)}}{100\%}$

Hypochlorite strength, % = $\frac{\text{(Chlorine required, lbs/day)(100\%)}}{\text{(Hypochlorinator Flow, gal/day)(8.34 lbs/gal)}}$

Water Added, gal to hypochlorite solution = $\frac{\text{(Hypo, gal)(Hypo, \%)-(Hypo, gal)(Desired Hypo, \%)}}{\text{Desired Hypo, \%}}$

DETENTION TIME (Minutes)

$\frac{\text{(Basin Vol, gal)(24 hr/day)(60 min/hr)}}{\text{Flow, gal/day}}$

MEMBRANE TREATMENT PROCESS

Efficiency, % = $\frac{\text{(Mass In – Mass Out)(100\%)}}{\text{Mass In}}$

Recovery, % = $\frac{\text{(Product Flow, MGD)(100\%)}}{\text{Feed Flow, MGD}}$

Mineral Rejection, % = 1 - $\frac{\text{Product TDS, mg/L}}{\text{Feed TDS, mg/L}}$ (100%)

ION EXCHANGE

$$\text{Grains/gallon} = \frac{\text{Total Hardness, mg/L}}{17.1 \text{ mg/L/Grain}}$$

$$\text{Hardness, mg/L} = \frac{(\text{Hardness, grains/gal})(17.1 \text{ mg/L})}{1 \text{ grain/gal}}$$

Exchange Capacity, grains = (Media Volume, ft^3)(Removal Capacity, grains/ft^3)

$$\text{Water Treated, gal} = \frac{\text{Exchange Capacity, grains}}{\text{Hardness Removed, grains/gal.}}$$

$$\text{Bypass Water, gal} = \frac{(\text{Softener Capacity, gal})(\text{Bypass Flow, gpd})}{\text{Softener Flow, gpd}}$$

Total Hardness, mg/L as $CaCO_3$ =
Calcium Hardness, + Magnesium Hardness
(mg/L as $CaCO_3$) (mg/L as $CaCO_3$)

COAGULATION and FLOCULATION

$$\text{Polymer, lbs} = \frac{(\text{Polymer solution, gal})(8.34 \text{ lbs./gal})(\text{Polymer, \%})(\text{Sp Gr})}{100\%}$$

$$\text{Polymer, \%} = \frac{(\text{Dry Polymer, lbs.})(100\%)}{(\text{Dry Polymer, lbs} + \text{Water, lbs.})}$$

$$\text{Liquid Polymer, gals} = \frac{(\text{Polymer Solution, \%})(\text{ Volume of Solution, gal})}{(\text{Liquid polymer, \%})}$$

VELOCITY

$Q = A * V$ $V = Q / A$ $A = Q / V$

TEMPERATURE

Temperature, $^oC = (^oF - 32\,^oF) / 1.8$

Temperature, $^oF = (1.8 * {}^oC) + 32\,^oF$

CONSTANTS

1. 2.54 centimeters = 1 inch
2. 3.28 feet = 1 meter
3. 43,560 square feet = 1 acre
4. 640 acres = 1 square mile
5. 7.48 gallons = 1 cubic foot
6. 1.0 gallon of water = 8.34 lbs
7. 1.0 liter = 1,000 cubic centimeters
8. 1.0 liter = 1,000 milliliter (ml)
9. 1.0 gallon = 3.785 liters
10. 1.0 pound = 7,000 grains
11. 1.0 pound = 453.5 grams
12. 1.0 grain per gallon = 17.1 parts per million (p.p.m.)
13. 1.0 grain - 0.0648 grams
14. 1.0 p.p.m. = 8.34 lbs. per million gallons of water
15. 1.0 cubic foot of water weighs 62.4 pounds
16. 1.0 gram = 15.43 grains
17. 1.0 ounce = 28.35 grams
18. 1.0 ounce = 29.57 milliliter (ml)
19. 1.0 quart = 0.9464 liters
20. 1.0 foot of water = .433 psi
21. 1.0 psi = 2.31 feet of water
22. 1.0 inch of mercury = 1.13 feet of water
23. 1.0 Horsepower = 33,000 ft. lbs. per minutes
24. 1.0 Horsepower = 746 watts
25. 1.0 million gallons per day = 1.55 cubic feet per second
26. 1.0 million gallons per day 694 gallon per minute
27. 1 day = 1440 minutes
28. π = 3.14
29. 1 meter = 100 centimeters
30. 1.0 kilograms = 2.205 lbs
31. 1 mile = 5,280 ft.