Division of Drinking and Ground Waters

APPLIED WASTEWATER MATH FORMULA SHEET AND CONVERSION FACTORS

12 in = 1 ft	27 cu ft = 1 cu yd	1,000 mg = 1 gm	60 sec = 1 min
3 ft = 1yd	7.48 gal = 1 cu ft	1,000 gm = 1 kg	60 min = 1 hour
5,280 ft = 1 mi	8.34 lbs = 1 gal water	1,000 ml = 1 liter	1,440 min = 1 day
144 sq in = 1ft^2	62.4 lbs = 1 ft^3 water	2.31 ft water = 1 psi	10,000 mg/L = 1%
43,560 ft^2 = 1 acre	746 watts = 1hp	0.433 psi = 1 ft water	454 gm = 1 lb

L = Length B = Base π = 3.14 W = Width H = Height R = Radius

Q = Flow Rate A = Area V = Volume v = velocity SG = Specific Gravity

Chlorine Demand (mg/L) = dosage (mg/L) – residual (mg/L)

AREA

Rectangle: $A = L \times W$

Triangle: $A = \frac{1}{2} B \times H$

Circle: Area = πR^2

VOLUME

Cylinder: $V = \pi R^2 H$

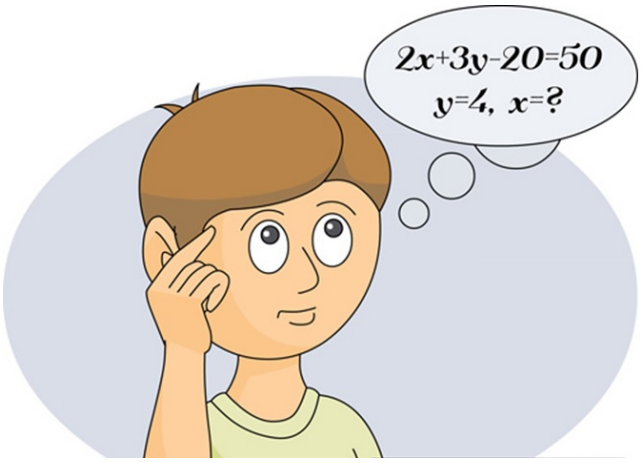
Rectangle: $V = L \times W \times H$

Cone: $V = 1/3 \pi R^2 H$

VELOCITIES and FLOW RATES

1. Velocity = $\frac{\text{distance}}{\text{time}}$

2. $Q = v \times A$



DETENTION TIME

Detention Time = $\frac{V}{Q}$

PARTS PER MILLION / POUNDS

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

SEDIMENTATION AND LOADINGS

1. Weir overflow rate = $\frac{\text{total flow}}{\text{length of weir}}$

2. Surface overflow rate = $\frac{\text{Influent flow}}{\text{surface area}}$

3. Solids Loading rate = $\frac{\text{solids applied}}{\text{surface area}}$

SEDIMENTATION AND LOADINGS (continued)

4. Efficiency, % = $\frac{\text{(in) – (out)}}{\text{(in)}} \times 100\%$

5. Organic loading rate (activated sludge) = $\frac{\text{CBOD applied}}{V}$

6. Hydraulic loading rate = $\frac{Q}{A}$

7. Centrifuge hydraulic loading: hydraulic loading rate = $\frac{Q \times \text{run time}}{\text{run time + skim time}}$

ACTIVATED SLUDGE

1. SVI = $\frac{\text{30 min settling, ml/L}}{\text{MLSS, mg/L}} \times \frac{\text{1,000 mg}}{\text{gram}}$

2. SDI = $\frac{100}{SVI}$

3. Solids inventory, lbs = (Tank volume, MG) x (solids concentration, mg/L) x (8.34 lbs / gal)

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

5. F/M = $\frac{\text{CBOD applied}}{\text{Organic solids under aeration}}$

6. MCRT = $\frac{\text{solids inventory}}{\text{[effluent solids + WAS solids]}}$

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

8. Return sludge rate, MGD = $\frac{\text{(settleable solids, mL) x Q}}{\text{(1,000 mL) – (settleable solids, mL)}}$

SLUDGE DIGESTION

1. Dry solids, lbs = $\frac{\text{(sludge, gal) x (sludge, \% solids) x (8.34 lbs / gal) x SG}}{100\%}$

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

3. Seed Sludge, gal = $\frac{\text{seed sludge (lbs volatile solids)}}{\text{seed sludge (lbs / gal)} \times \frac{\text{(solids \%)}}{100\%} \times \frac{\text{(volatile solids \%)}}{(100\%)}}$

4. Digested sludge removed = Total sludge in – volatile solids destroyed

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

SLUDGE DIGESTION (continued)

6. Percent volatile solids reduction = $\frac{(\text{in} - \text{out}) \times 100\%}{\text{in} - (\text{in} \times \text{out})}$

7. VS destroyed, lbs / day / cu ft = $\frac{\text{volatile solids added (lbs / day)} \times \text{volatile solids reduction (\%)}}{\text{digester volume (ft}^3\text{)} \times 100\%}$

8. Gas production (cu ft / lb VS) = $\frac{\text{gas produced (ft}^3\text{ / day)}}{\text{VS destroyed (lbs / day)}}$

HORSEPOWER, FORCE, CHEMICAL PUMPS

1. Water HP = $\frac{\text{Q(gpm)} \times 8.34 \text{ lbs / gal} \times \text{head (ft)}}{33{,}000 \text{ ft-lbs / min}}$

2. Break HP = $\frac{\text{Water HP}}{\text{pump efficiency}}$

3. Motor HP = $\frac{\text{BHP}}{\text{motor efficiency}}$

4. Upward force = 62.4 (lbs / ft^3) x height (ft) x area (ft^2)

5. Side wall force = 31.2 (lbs / ft^3) x volume (ft^3)

6. Chemical solution, lbs / gal = $\frac{(\text{solution \%}) \times 8.34 \text{ lbs / gal)}}{100\%}$

7. Feed pump flow, gal / day = $\frac{\text{chemical feed (lbs / day)}}{\text{Chemical solution (lbs / gal)}}$

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

9. Total Dynamic Head = Static Head + Friction Losses

10. Static Head = Suction Lift + Discharge Head

11. $\frac{\text{Polymer solution \%}}{100\%} = \frac{\text{dry polymer (lb)}}{\text{Vol of solution (gal) x 8.34 (lbs / gal)}}$

LAB PROCEDURES AND MEASUREMENTS

1. TSS, mg/L = $\frac{(\text{RDD} - \text{DD}) \times 1\text{M}}{\text{sample vol (mL)}}$
2. VSS, mg/L = $\frac{(\text{RDD} - \text{FDD}) \times 1\text{M}}{\text{sample vol (mL)}}$

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

LAB PROCEDURES AND MEASUREMENTS (continued)

3. VSS, % = $\frac{\text{volatile solids (mg/L)}}{\text{total suspended solids (mg/L)}} \times 100\%$

4. CBOD sample size (mL) = $\frac{1{,}200}{\text{estimated CBOD (mg/L)}}$

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

6. CBOD, mg/L = $\frac{[(\text{Initial D.O.} - \text{Final D.O.}) - \text{seed correction factor}] \times \text{bottle volume (mL)}}{\text{sample volume (mL)}}$

7. Initial D.O. = $\frac{(\text{mL sample} \times \text{D.O. sample}) + (\text{mL dilution water} \times \text{D.O. dilution water})}{\text{bottle volume (mL)}}$

8. Temperature Conversion: Temperature, F = (temperature C)(1.8) + 32