



Division of Drinking and Ground Waters

APPLIED WASTEWATER MATH FORMULA SHEET AND CONVERSION FACTORS

Table of conversion factors: 12 in = 1 ft, 27 cu ft = 1 cu yd, 1,000 mg = 1 gm, 60 sec = 1 min, 3 ft = 1 yd, 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 pi = 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 x W Triangle: A = 1/2 B x H Circle: Area = piR^2

VOLUME

Cylinder: V = piR^2H Rectangle: V = L x W x H Cone: V = 1/3piR^2H

VELOCITIES and FLOW RATES

1. Velocity = distance / time

2. Q = v x A

DETENTION TIME

Detention Time = V / Q

PARTS PER MILLION / POUNDS

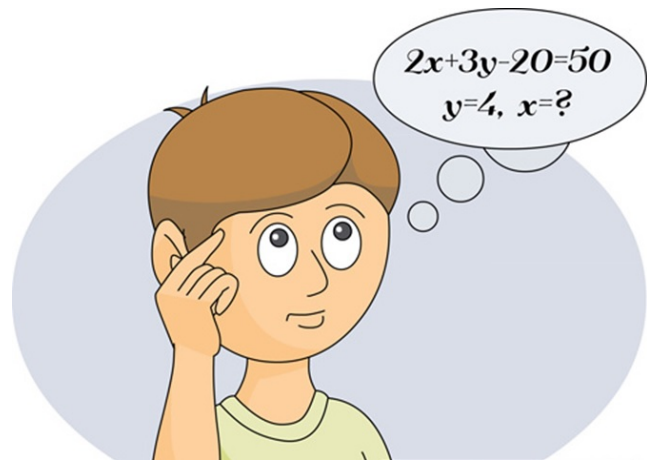
lbs = 8.34 lbs / gal x mg/L x MG x SG

SEDIMENTATION AND LOADINGS

1. Weir overflow rate = total flow / length of weir

2. Surface overflow rate = Influent flow / surface area

3. Solids Loading rate = solids applied / surface area



## **SEDIMENTATION AND LOADINGS (continued)**

4. Efficiency, % =  $\frac{(\text{in}) - (\text{out})}{(\text{in})} \times 100\%$
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 =  $\frac{Q \times \text{run time}}{\text{run time} + \text{skim time}}$

## **ACTIVATED SLUDGE**

1. SVI =  $\frac{30 \text{ min settling, ml/L} \times 1,000 \text{ mg}}{\text{MLSS, mg/L} \text{ gram}}$
2. SDI =  $\frac{100}{\text{SVI}}$
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 =  $\frac{\text{solids inventory}}{[\text{effluent solids} + \text{WAS solids}]}$
7. Change, WAS rate, MGD =  $\frac{(\text{current solids inventory, lbs}) - (\text{desired solids inventory, lbs})}{\text{WAS, mg/L} \times 8.34 \text{ lbs / gal}}$
8. Return sludge rate, MGD =  $\frac{(\text{settleable solids, mL}) \times Q}{(1,000 \text{ mL}) - (\text{settleable solids, mL})}$

## **SLUDGE DIGESTION**

1. Dry solids, lbs =  $\frac{(\text{sludge, gal}) \times (\text{sludge, \% solids}) \times (8.34 \text{ lbs / gal}) \times \text{SG}}{100\%}$
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 =  $\frac{Q(\text{gpm}) \times 8.34 \text{ lbs / gal} \times \text{head (ft)}}{33,000 \text{ ft-lbs / min}}$
2. Break HP =  $\frac{\text{Water HP}}{\text{pump efficiency}}$
3. Motor HP =  $\frac{\text{BHP}}{\text{motor efficiency}}$
4. Upward force =  $62.4 \text{ (lbs / ft}^3\text{)} \times \text{height (ft)} \times \text{area (ft}^2\text{)}$
5. Side wall force =  $31.2 \text{ (lbs / ft}^3\text{)} \times \text{volume (ft}^3\text{)}$
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.  $\frac{\text{Polymer solution \%}}{100\%} = \frac{\text{dry polymer (lb)}}{\text{Vol of solution (gal)} \times 8.34 \text{ (lbs / gal)}}$

## **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