WASTEWATER FORMULA & CONVERSION CARD

PUMPS & PUMPING

1. Pumping: Water Hp = \( \frac{GPM \times \text{Head, ft}}{(3,960)} \)

\[ \text{Brake Hp} = \frac{GPM \times \text{Head, ft}}{(3,960) \times \text{% Eff, GPM}} \]

Head, ft = \( \frac{\text{Brake Hp} \times (3,960) \times \text{% Eff, GPM}}{\text{Head, ft}} \)

Vol, GPM = \( \frac{(0.785) \times \text{Stroke, ft} \times \text{Gallons/min}}{(3,960) \times \text{Head, ft}} \)

Gals = \( \frac{(0.785) \times \text{Stroke, ft} \times \text{Gallons/min}}{(3,960) \times \text{Head, ft}} \)

Cost per day = \( \frac{(\text{Brake Hp}) \times (0.746 \text{ Kw/Hp})}{\text{Operating Time, Hrs.}} \times (\text{C Kw/Hr}) \)

GPM = \( \frac{\text{Volume, gals}}{\text{Pumping Time, min}} \)

3. Time, min = \( \frac{\text{Volume, gallons}}{\text{Pumping Rate, GPM}} \)

4. Supply, Hrs = \( \frac{\text{Storage Volume, gallons}}{\text{Flow In, GPM} - \text{Flow Out, GPM}} \times 60 \text{ min/hr} \)

5. Chemical Feed Pumps:
   \[ \text{GDP} = \frac{(\text{Required Lbs./Day Feed})}{(\text{mg/L} \times 8.34 \text{ Dry Lbs/Gal})} \]

6. Chemical Feed rate:\n   \[ \text{GDP} = \frac{(\text{GDP} \text{ ml/min}) \times 1.440}{(1 \text{ min/24 Hrs})} \]

7. \% % Eff, Chemical in = \( \frac{(\text{Dry Chemical Lbs.)}}{(\text{Vol. gals} \times 8.34 \text{ lbs/gal}) + (\text{Dry chem/lbs}) \times 100} \)

8. Solution from Dry Stock:
   \[ \frac{\text{Vol. gals} \times 8.34 \text{ lbs/gal} + (\text{Dry chem/lbs})}{\text{Vol. gals} \times 8.34 \text{ lbs/gal}} \]

9. Mixture Strength, %:\n   \[ \frac{(\text{Vol 1})}{(\text{Conc. 1})} = \frac{(\text{Vol 2})}{(\text{Conc. 2})} \]

10. Speed, RPM (N) = \( \frac{N}{D} \)

11. Hydraulics:
    \[ \text{Head, ft} = \frac{(2.31 \text{ ft/s})}{(\text{V})} \times (\text{Head, ft}) \]

Sedimentation Tanks & Clarifiers:

1. Detention Time, Hrs. = \( \frac{(\text{Volume, gals})}{(24 \text{ Hrs.})} \)

2. Total Flow, GDP = \( \frac{\text{Volume, gals}}{(24 \text{ Hrs.}) \times \text{Detention Time, Hrs.}} \)

3. Surface Loading Rate, GDP/sq. ft. = \( \frac{\text{Total Flow, GDP}}{(\text{Surface Area, sq. ft.})} \)

4. Recirculation Ratio = \( \frac{(\text{Recirculation Flow, Q})}{(\text{Average Inflow, Q})} \)

5. Total Flow = \( (\text{Recirc. flow, Q}) + (\text{Average Inflow, Q}) \)

Ponds & Lagoons:

1. Organic Loading Rate, Lbs/day/acre = \( \frac{(\text{BOD In} \times \text{lbs/day})}{(\text{Pond Area, acres})} \)

2. Pond Area, Acres = \( \frac{(\text{BOD In} \times \text{lbs/day})}{(\text{Pond Area, acres})} \)

3. Detention Time, Days = \( \frac{(\text{Volume, Acre-ft})}{(\text{Flow, Acre-ft/day})} \)

4. Surface Area, Acres = \( \frac{(\text{Flow, MGD}) \times (\text{BOD conc, mg/l})}{(8.34 \text{ lbs/gal})} \)

5. Hydraulic Loading = \( (\text{Pond Depth, Inches}) \times (\text{Uptake Rate, Inches/day}) \)

6. Time, Hrs. = \( (43,560 \text{ sq. ft/acre}) \)

7. Volume, Acre-ft = \( (\text{Area, acre}) \times (\text{Depth, ft}) \)

8. Flow Rate = \( (\text{Flow into Pond, GPD}) \times (\text{Acre-
   
Evaporation & Percolation Rates:

1. Inches Day = \( \frac{\text{Volume Lost, Gallons}}{\text{Day}} \)

2. Vol. gals = \( (\text{Acre, sq.ft}) \times (\text{Evap. Rate, inches/day}) \times 7.48 \text{ gals/cf} \)

3. TRICKLING FILTERS:

1. Organic Loading = \( \frac{(\text{BOD, Lbs/Day})}{(\text{Rate, Lbs/Day/1,000 cu. ft.})} \)

2. Hydraulic Loading = \( \frac{\text{GPM}}{(\text{Rate, GPM/sq. ft.})} \)

3. Hydraulic Loading = \( \frac{(\text{GPM} \times 1,440 \text{ min/day})}{(\text{Rate, GPD/sq. ft.})} \)

4. Recirculation Ratio = \( \frac{\text{Recirculation Flow, Q}}{(\text{Average Inflow, Q})} \)
ROTATING BIOLOGICAL CONTACTORS:

1. Organic BOD = (Soluble BOD applied, lbs BOD / day)
   Loading Rate, (Media Surface area / 1,000 sq. ft.)
   Lbs/Day/1,000 sq.ft.

2. Hydraulic Loading = (GPM)
   Rate, GPM = (Surface area, sq. ft.)
   Rate, GPD/0.0007 = (Surface area, sq. ft.)

3. Hydraulic Loading = (Total flow, GPD) Including Recirculation
   Rate, GPD/0.0007 = (Surface area, sq. ft.)

4. BOD Applied = (Flow, mgd) x (Soluble BOD, mg/L) x Lbs/Day
   (8.34 lbs/gal)

5. Soluble BOD, mg/L = Total BOD, mg/L - Suspended BOD, mg/L
   OR (Total BOD, mg/L) - (K x Suspended solids, mg/L)

6. Suspended BOD, mg/L = (K x Suspended Solids, mg/L)
   (K = 0.5 - 0.7 for most domestic wastewaters)

OXIDATION DITCHES:

1. F/M = (BOD, lbs/day / MLVSS, lbs)

2. BOD Loading Rate, Lbs/Day/1,000 Cu Ft. = (Ditch Volume, in 1,000 Cu. Ft.)

3. Ditch Detention = (Ditch Vol. MG) x 24 Hours / Day

4. Determine Sludge Age:
   Aeration Solids, lbs = (Vol, MG) x (MLSS, mg/L) x (8.34 lbs/gal)
   Solids added, lbs/day = (Vol, MG) x (Int. SS, mg/L) x (8.34 lbs/gal)
   Sludge age, days = (Solids under Aeration, lbs)
   Solids Added, lbs/day

5. Calculate Ditch Volume:
   Average width, ft = (Bottom, ft) + (Depth, ft)
   (Slope)

6. Area Determination
   Area, sq. ft = Width, ft x Depth, ft
   OR
   Area, sq. ft = (B. Width, ft + T. Width, ft)
   (2)
   End, Lengths, ft = (2 x R.) x Radius, ft
   Total Length, ft = Ends lengths, ft + (2 Lengths, ft)

7. Volume, Cu. ft = (Length, ft) x (Area, sq. ft)

ACTIVATED SLUDGE

1. F/M Ratio = (BOD in Primary Effluent, lbs/day)
   (Lbs of mixed liquor VSS in the Aeration)

2. Mean Cell Residence Time (TSS Wasted, days) = (Aeration Tank, TSS, lbs)
   + (Clarifier TSS, lbs)
   Days, (MCRT)

3. TSS Wasted = (Aer. Tank SS, lbs) + (Clar. TSS, lbs) - Effluent TSS, lbs
   (MCRT, Days)

4. MCRT, Days = (Aer. Tank SS, lbs) + (RAS, lbs)
   + (Effluent TSS, lbs)

5. Sludge Volume = (Settled Volume, ml/L) / (1,000,000)
   Index (SVI), ml/g

6. Solids Index (SVI) = (MLSS, mg/L)
   (1,000,000)
   MLSS, mg/L = (1,000,000)

7. Sludge Density = (100) / SVI

8. Sludge to Waste, lbs/day = (Secondary SS, lbs) - Effluent SS, lbs/day
   (MCRT, Days)

9. Sludge Age, Days = (Aeration Tank TSS, lbs)
   (Refer to MCRT)
   (Primary Clarif. Eff. TSS, lbs / day)

10. Return Sludge Rate, MG = (Aerator Flow, MG) x (Settling Solids, %)

11. Desired MLSS = (Desired MLSS in Aerator, lbs)
    mg/L = (Aerator Vol., MG) x (8.34 lbs/gal)

12. Cu. ft. Air/ Lbs = (Air, cu. ft)
    (MCRT, Days)
    BOD Removed = (Primary Eff, lbs BOD - Secondary Eff, lbs BOD)

ANAEROBIC DIGESTERS:

1. Volatile Solids = (Feed Sludge VS, lbs/day)
   Loading, lbs
   (Digester Volume, cu. ft)
   VS / Day / Cu. ft

2. Detention Time, Days = (Digester Volume, Gallons)
   (Sludge Feed, GPD)

   (SRT) = (TSS Removed, lbs/day)

4. Volatile Solids = (VS In - VS Out) / 100
   Reduced, %
   (VS In) - (VS, In x VS, Out)

5. Gas Production = (Gas Produced, Cu. ft/day)
   Cu. ft/lb. VS Reduced = (VS, Fed, lbs/day) / (Reduction/100)

6. Oxygen Uptake Rate, OUR = (mg of O2 consumed)
   (minute)

7. VA/Alk Ratio = (Volante Acids, mg/l)
   (Alkalinity, mg/l)

8. VS Loading = (VS In, lbs)
   (Digester Vol, Cu. ft)

TERTIARY FILTRATION:

1. Filter Flow Rate, GPM = (Filter Area, sq. ft.) / (GPM / sq. ft.)

2. Filter Backwash:
   Backwash, gals = (Filter Area, sq. ft.) x (Backwash Rate, GPM) x Time, min
   Backwash Rate, gpm/sq.ft = (Backwash Volume, GPM)
   gpm/sq.ft
   Backwash gals = (Filter Area, sq. ft.) x (rise/ fall, ft/min) / (7.48 gals/cu.ft)

LAND APPLICATION:

1. Required Acres = (Total Volume of sludge, tons / year)
   (Limit, tons per acre)

2. Sludge Application, Lbs. = (Gall. of Sludge) x (8.34 lbs/gal) / (% Solids in Sludge)

WATERWAYS DISCHARGE:

Diluted Concentration, mg/l = (Stream Conc. 1 x Stream, Q) + (waste Conc. 2 x Waste, Q)
or (Steam, Q + Waste, Q)

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