CV3015 2013-2014 Sem I

1a. Electroneutrality : The sum of meq/L of cations (positive radicals) equals the sum of anions (negative radicals)

Constituents	MW	EW	mg/l	meq/L	
Ca^{2+}	40	20	40.	2	
Mg^{2+}	24	12	36	3	
Na^{+}	23	23	23	1	
K^{+}	39	39	19.5	0.5	$\Sigma = 6.5$
HCO_3^-	61	61	122	2	
SO_4^{2-}	96	48	168	3.5	
Cl^-	35.5	35.5	35.5	1	$\Sigma = 6.5$

Total hardness = 250 mg/L as $CaCO_3$ = 5 meq/L.

$Ca^{2+} + Mg^{2+}$ = 5 meq/L

Ca^{2+} = 2 meq/L.

Total Alkalinity = 100 mg/L as $CaCO_3$ = 2 meq/L.

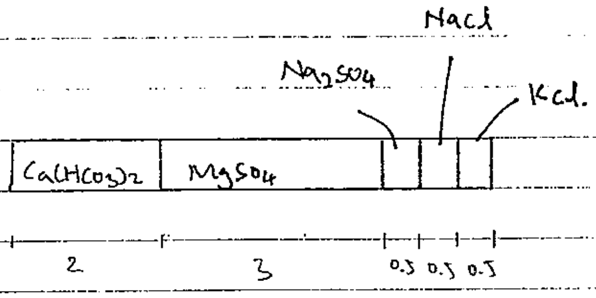
HCO_3^- = 2 meq/L.

Σ cation = $HCO_3^- + SO_4^{2-} + Cl^-$

$6.5 = 2 + 1 + SO_4^{2-}$

SO_4^{2-} = 3.5 meq/L

Compound.	meq/L
$Ca(HCO_3)_2$	2
$MgSO_4$	3
Na_2SO_4	0.5
NaCl	0.5
KCl	0.5.



b. Carbonate Hardness : CO_3^{2-} and HCO_3^- of Me^{x+}.

Non-carbonate Hardness: other anions e.g. SO_4^{2-}, NO_3^-

Total Hardness = Carbonate Hardness + Non carbonate Hardness.

250mg/L = 100mg/L + 150mg/L.

c. Final alkalinity = initial + added − reacted. (Mu) = Mol units.

$120/100 = 100/100 + 28/56$ − reacted.

1.2 = 1 + 0.5 − reacted.

reacted = 0.3 (mu)

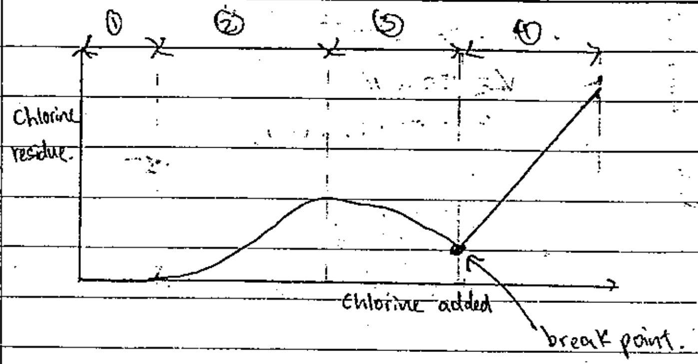
1 mol $Al_2(SO_4)_3 \cdot 14H_2O$ reacts with 3 mol $Ca(HCO_3)_2$.

0.3 mu reacts with 0.1 (mu) $Al_2(SO_4)_3 \cdot 14H_2O$.

0.1 × 594 = 59.4mg/L.

Yes, U Can!

2a).



① chlorine demand - amount of chlorine used up when reacting with compounds in water, producing no chlorine residual.

② chloramines formation - amount of chlorine needed to react with all dissolved ammonia in water forming combined residue or chloramines.

⑤ destruction of some chloramines - further addition of chlorine breakdowns chloramines in water thus lowering chlorine residual.

④. Break point and formation of free chlorine - when these demands are met, chlorine "break point" is reached. chlorine added beyond breakpoint reacts with water and forms HOCl in direct proportion to the amount of chlorine added and available as a free chlorine.

Significance; chlorine Dosage direct proportionate to free chlorine formed after breakpoint.

Yes, U Can!

Anthracite.

$Re = \frac{\varphi d v}{\nu}$

$\nu = 0.893 \times 10^{-6}$

$v = 150 \, m/d$

$= 0.001736 \, m/s$

$\therefore = \frac{0.9 \times 0.001 \times 0.001736}{0.893 \times 10^{-6}}$

$= 1.75$

$CD = \frac{24}{1.75} + \frac{3}{\sqrt{1.75}} + 0.34 = 16.3.$

$\frac{h}{L} = \frac{1.067 \times 16.3 \times 0.001736^2}{0.9 \times 9.81 \times 0.001 \times 0.45^4}$

$\frac{h}{0.5} = 0.1448$

$h = 0.0724.$

Sand.

$Re = \frac{0.75 \times 0.0005 \times 0.001736}{0.893 \times 10^{-6}}$

$= 0.729.$

$CD = \frac{24}{0.729} = 32.9.$

$\frac{h}{0.3} = \frac{1.067 \times 32.9 \times 0.001736^2}{0.75 \times 9.81 \times 0.0005 \times 0.4^4}$

$\frac{h}{0.3} = 1.123$

$h = 0.334.$

Head loss total $= 0.334 + 0.724$

$= 0.406$

ii) $f_{mixed} = \frac{0.3}{0.3+0.5} \times 0.45 + \frac{0.5}{0.3+0.5} \times 0.4$

$= 0.42.$

$\frac{L_e}{L} = \frac{1-0.42}{1-f_e} = 1.5$

$f_e = 0.613$

$V_b = V_s (0.613)^{4.5}$

$V_b = 0.12 (0.613)^{4.5}$

$= 0.0133 \text{ m/s}.$

iii). $d_2 = d_1 \left(\frac{S_{s1}-1}{S_{s2}-1}\right)^{2/3}$

$= 0.0005 \left(\frac{2.65-1}{1.55-1}\right)^{2/3}$

$= 1.04 \times 10^{-3} > d = 0.001$ ∴ intermixing have no possibility of occurring.

c. $t = 30s$. population = 20,000 Lpcd = 500.

$Q = 20000 \times 500 \times 10^{-3}$

$= 10000 \text{ m}^3/d.$

$P = 1000^2 \times 0.893 \times 10^{-3} \times 3.47$

$= 3099 \text{ w}.$

∴ $\frac{V}{t} = Q.$

$V = Qt$

$= \frac{10000}{24 \times 3600} \times 30$

$= 3.47 \text{ m}^3.$

$P = 3 \times 1000 \times n^3 \times 1^5$

$3099 = 3 \times 1000 \times n^3 \times 1^5$

$n = 1.01 \text{ rps}.$

Yes, U Can!

3a). i). Aeration → $V/Q = 3000 \div 10000 \times 24 = 7.2 hr.$

ii) $\frac{F}{m} = \frac{10000 m^3/d (195 mg/L)}{3000 m^3 (300 mg/L)(0.8} = 0.27.$

iii). $VLR = \frac{10000 m^3/d (195 mg/L)}{3000 m^3} = 0.65 Kg/m^3 d.$

iv) mean cell residence time $= \frac{VrX}{Qwxr}.$

$$\theta c = \frac{3000 m^3 (3000 mg/L)(0.8)}{100 m^3/d (1\% \times 10^6 mg/L)(0.8)}$$

$= 9$ days.

v). returned sludge flow rate $= \frac{4286}{10000} = 0.4286$

$(Q + Qr) X = Qr X_r$

$(10000 + Qr) 3000 = Qr (10000)$

$Qr = 4286.$

b) Primary: solid (5%) + Water (95%) ; VS (60%) + FS (40%).

$\frac{1}{\rho s} = \frac{0.4}{2.8} + \frac{0.6}{1.0}$ $\rho s = 1.34.$

$\frac{1}{\rho_{S1}} = \frac{0.95}{1} + \frac{0.05}{1.34}$ $\rho_{S1} = 1.01.$

activated sludge: Solid (1%) + water (99%). , VS (80%) + FS (20%).

$\frac{1}{\rho s} = \frac{0.2}{2.8} + \frac{0.8}{1}$ $\rho s = 1.15$

$\frac{1}{\rho_{S1}} = \frac{0.99}{1} + \frac{0.01}{1.15}$ $\rho_{S1} = 1.00.$

Vol of pri sludge $= \frac{10000 m^3/d \times 300 mg/L \times 0.6 \times 10^{-3}}{1.01 \times 10^3 \times (5\%)} = 35.6 m^3/d.$

Vol of activated sludge $= \frac{10000 mg/L \times 100 m^3/d \times 10^{-3}}{1 \times 10^3 \times (1\%)} = 100 m^3/d.$

Total $= 135.6 m^3/d$

Yes, U Can!

3c. This is a design question.

20000 m³/d (3 mg/L) + 5000 m³/d (eff. BOD) = 25000 m³/d (10 mg/L)

eff BOD → 38 mg/L.

BOD after primary treatment = 400 × 65% = 260 mg/L.

eff of trickling filter → $\frac{260-38}{260}$ = 85.4%.

Loading = 20000 m³/d (260 mg/L) = 5200 Kg BOD/d.

assume rr = 2.

$F = \frac{1+2}{(1+0.1(2))^2} = 2.08$.

$85.4 = \frac{100}{1+0.448\sqrt{\frac{5200}{V(2.08)}}}$, $V = 171.67 m^3$.

assume depth = 2.

$V = \frac{D^2}{4}\pi \times d$, $171.67 = \frac{D^2}{4}\pi \times 2$, $D = 10.45 m$

Yes, U Can!

4a) Day 1.

O_3 & CO.

O_3 : $\frac{0.15-0.12}{0.2-0.12} = \frac{PSI-100}{200-100}$ PSI = 137.5.

CO : $\frac{12-9}{15-9} = \frac{PSI-100}{200-100}$ PSI = 150 #.

Day 2.

PM10 : $\frac{385-350}{420-350} = \frac{PSI-200}{300-200}$ PSI = 250 #.

Day 3.

CO : $\frac{14-9}{15-9} = \frac{PSI-100}{200-100}$ PSI = 183.3 #.

4b. 10^6 kJ produce 0.5kg SO_2.
26000kJ produce 0.013kg SO_2.

0.013kg SO_2 contains 0.065kg s.
% S = $\frac{0.065}{1}$ = 0.65%.

c). $4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$

- CH_4 does not produce NO_x air polution as N is not present in the compound.
- NO_x polution can only occur with compound with N present.