University Of Technology
Building and Construction Eng. Dept.
Final Exam-First Attempt–2014/2015

Branch :Structural Eng. **Class: Third**
subject : Sanitary Engineering **Time : 3 Hours**
Examiner : Lec. Rana J. Kadhim **Date : 10/6/2015**

Answer <u>Four</u> questions only

Q1:-A/ Design an activated sludge process to yield an effluent BOD_5 of 20 mg /l and suspended solids of 25 mg /l. The influent BOD_5 following primary clarification is 160 mg/l . Assume Y=0.65, k_d=0.05, and θ_c= 10 days. The waste flow is 10 m^3/min, MLVSS=2500 mg/l, under flow suspended solid concentration= 1.5% and BOD_5 of the effluent solids =0.63(S.S.) concentration.

(13 marks)

B/ Explain briefly the following terms:

1- The types and sources of water impurities.
2- The characteristics of sand and gravel used in filter media.
3- The methods used for population forecastings.

(12marks)

Q2:- A/ A stream with a flow of 0.7 m^3/s and BOD 4 mg/l is saturated with DO 9.17 mg /l at 20°C. It receives an effluent discharge of 0.3 m^3 /s, BOD 25 mg/l and DO 5 mg /l. Determine the DO deficit at a point 35 km downstream if the average velocity of flow is 0.2 m /s. Assume temperature is 20°C throughout, k_1 for effluent / water mixture 0.1 / day, k_2 for stream 0.4 / day. (13marks)

B/ Define only the following terms:
1- Zeta potential.
2- Coagulation and Flocculation.
3- Breakpoint chlorination.

(12marks)

Q3:-A/ The design flow for a water treatment plant is 3.8 * 10^3 m^3/d. The rapid mixing tank will have a mechanical mixer and the average alum dosage will be 30 mg/l. The theoretical mean hydraulic detention time of the tank will be 1 min.. Determine :-

1-the quantity of alum needed in kg/d.
2- the dimensions of the tank in meters for a tank with equal length,width, and depth.
3-the power input for a G of 900/sec for a water temperature of 10 °C (μ=1.307*10^{-3} kg/m.s),express the answer in KW.

(13marks)

B/ Draw a sketch showing the method of filtration and back washing of filters (R.S.F.) (12 marks)

Q4:- A/ Rapid sand filter L= 9m, W= 4.5 m after filtering 20000 m^3/d in 24 hr period, the filter is backwash at a rate 0.6 m/ min for 15 min. The filter is designed with 4 troughs Find:-

1- Filtration rate.
2- Quantity of wash water flow in each trough.
3- Dimensions of trough of square cross section.

(13marks)

B/ Write short notes on the following:-

1- The Factors that must be considered in the location of water intakes.

2- The common methods used for disinfection of water.

(12marks)

Q5:-A/ Find the diameter (mm) of the smallest particle to be 100% removed in a sedimentation tank of depth = 5m , detention time 3.5 hr , $\mu = 1.027 * 10^{-3}$ Ns/m^2 , $\rho_s = 1200\ Kg/m^3$, $\rho_w = 1000 Kg/m^3$.

(13marks)

B/ Draw a sketch showing physical and biological processes (units) of conventional waste water treatment plant and describe the benefits of each unit.

(12marks)

Useful information:-

$$D_t = \frac{k1\ la}{k2-k1}\ (10^{-K1*t} - 10^{-K2*t}) + D_a\ 10^{-K2*t} \qquad r = \frac{Q_r}{Q}$$

$$T_c = \frac{1}{K_2 - K1} \text{Log}\{ \frac{K_2}{K_1} (1 - \frac{D_a\ (K_2-K1)}{K_1\ La}) \} \qquad G = (\frac{P}{\mu\ V})^{0.5}$$

$$D_c = \frac{K_1}{K_2} L_a * 10^{-K1\ Tc} \qquad y = 1.73 \sqrt[3]{\frac{Q_b^2}{g\ b^2}}$$

$$XV = \frac{Y\ Q\ \theta_c\ (S_o - S)}{1 + K_d\ \theta_c} \qquad \text{vol. of air required} = \frac{wt.of\ O_2}{0.232\ (1.2)}$$

$$\frac{dX}{dt} = \frac{xV}{\theta_c}$$

$$O_{2\ demand} = 1.47\ (S_o - S)\ Q - 1.14\ X_r\ Q_w \qquad Q_w = \frac{Solid\ production}{X_r}$$

$$Q_r = \frac{Q\ X}{X_r - X} \qquad V_s = \frac{1}{18}\frac{g}{\mu}(\rho_s - \rho_w)d^2$$

حلول اسئلة امتحان الدور الاول - الدور الاول 2014-2015

فرع الهندسة المدنية

المادة: الهندسة البيئية المرحلة: الثالثة

Q1: A/ BOD_5 effluent $= 0.63(SS) = 20 - 0.63(25) = 4$ mg

$$XV = \frac{0.65(10^4 \times 1440)(10)(160-4)}{1 + 0.05(10)}$$

$$= 9.73 \times 10^9 \text{ mg}$$

Assume MLVSS $= 2500$ mg/l

$$V = \frac{9.73 \times 10^9}{2500} = 3.894 \times 10^6 \text{ l} = 3894 \text{ m}^3$$

$$\frac{dx}{dt} = \frac{XV}{\theta_c} = \frac{9.73 \times 10^9}{10} = 973.5 \text{ kg/day}$$

Assume solids $= 80\%$ volatile $= \frac{973.5}{0.8} = 1217$ kg/day

assume $X_r = 15000$ mg/l

$$Q_w = \frac{1217 \times 10^6 \text{ mg/day}}{15 \times 10^3 \text{ mg/l}} = 81.1 \text{ m}^3/\text{day}$$

$$Q_r = \frac{QX}{X_r - X} = \frac{10(2500)}{12500} = 2 \text{ m}^3/\text{min}$$

$$r = \frac{Q_r}{Q} = 0.2$$

$$t = \frac{V}{Q} = \frac{3.894 \times 10^3}{1440} = 0.27 \text{ days} = 6.5 \text{ hrs}$$

$$O_2 \text{ demand} = 1.47(160-4)(144 \times 10^6) - 1.14(15000)(81100)$$

$$= 1.915 \times 10^9 \text{ mg/day}$$

$$= 1915 \text{ kg/day}$$

Vol. of air required = O2 demand / 0.232 (1-2)

$Q_{air} = \frac{1915}{0.275} = 6856\ m^3/day$

Actual air required $\frac{6856}{0.7} = 68\ m^3/min$

The air volume required per unit of BOD_5 removed is thus equal to = 97934 / (160-4)(14.4) = 43.6 m^3/kg

Q1 = B/

1-

- suspended
  - Bacteria
  - Algae
  - protozoa
  - viruses
  - silt, clay
  - colloids
- dissolved
  - Salts
    - cations: Ca^{+2}, Mg^{+2}, Na^{+1}, K^{+1}
    - anions: HCO_3^-, CO_3^-, SO_4^-, Cl^-
  - organics
    - color
    - odor
    - taste
    - toxicity
  - gases
    - O_2
    - CO_2
    - H_2S
    - NH_3

Q1:- B/

2- Sand

أرخص مادة كوسط للترشيح , تستخدم بنطاق واسع
يجب ان يكون خالي من الاطيان , صلب , مقاوم
للذوبان , يجب أن لا يفقد أكثر من 5 % من الوزن
بعد وضعه في حامض HCl بنسبة 40 % لمدة
24 ساعة

عمق الرمل 60-70 cm

e.f 0.45-0.55 mm

$1.2 \leq U \leq 1.7$

الفحم يوضع بخمس أو ست طبقات حيث تكون الطبقات
العليا حاوية على الفحم الأصغر , صلب , مدور , مقاوم
الوزن النوعي 1600 كغم/م٣ , خالي من الشوائب
قطع رقيقة وطويلة , غير حاوي على الاطيان , الرمال
التراب الطيني , مواد عضوية

3-

- Arithmetic method (based upon the hypothesis that the rate of increase is constant

$$\frac{dP}{dt} = k_a$$

$$P_t = P_o + k_a t$$

- constant percentage Growth rate method (based upon the hypothesis of constant percentage or geometric growth rate assum

that the rate increase is proportional to population)

$$\ln P - \ln P_2 = k_p (t - t_2)$$

Q2: A/ Sol.

$$BOD)_{mix} = \frac{0.7(4) + 0.3(25)}{0.7 + 0.3} = 10.3 \text{ mg/l}$$

$$DO)_{mix} = \frac{0.7(9.17) + 0.3(5)}{0.7 + 0.3} = 7.919 \text{ mg/l}$$

$$D_a = 9.17 - 7.919 = 1.25 \text{ mg/l}$$

$$t = \frac{35000}{0.2} = 175000 \text{ s} = 2 \text{ days}$$

$$L_a = \frac{BOD)_{mix}}{1 - 10^{-k_1 t}} = \frac{10.3}{1 - 10^{-0.1 \times 5}} = 15.065 \text{ mg/l}$$

$$D_2 = \frac{0.1(15)}{0.4 - 0.1}\left(10^{-0.1(2)} - 10^{-0.4(2)}\right) + 1.25 \times 10^{-0.4(2)}$$

$$= 2.358 + 0.198$$

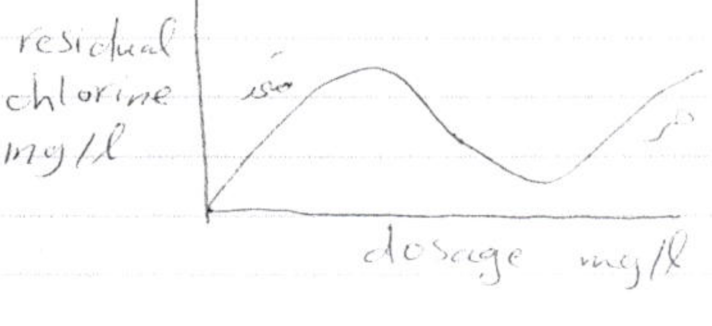
$$= 2.556 \text{ mg/l}$$

Q2 = B/

1- Zeta potential: When a charged is placed in an electric field, it will migrate to the pole of opposite charge. This movement is called electrophoresis, The electric potential between the shear plane and the bulk solution is called the Zeta potential.

2- Coagulation = Destabilization colloids by
Flocculation = Aggregation of destabilized colloids
When combined with subsequent physical removal It chieves removal of turbidity, remove infectious agents. toxic compounds.

3- Breakpoint chlorination:
هي النقطة التي يتحد بها الكلور الحر وبعدها يبقى كلور حر
تستخدم في حالة وجود مواد عضوية كثيرة في الماء ومادة
التعقيم بها



Q3: A/ Sol.

1- The quantity of alum needed = $Q \times dose$

$= 3.8 \times 10^3 \times 30 \times \frac{10^3}{10^6}$

$= 114$ kg/d

2- $V = Q \times t$

$= 3.8 \times 10^3 \times 1 / 1440$

$= 2.64\ m^3$

$V = L \times W \times H = 2.64\ m^3$

$L = W = H$

$V = X^3 = 2.64\ m^3$

$\therefore X = 1.4\ m$

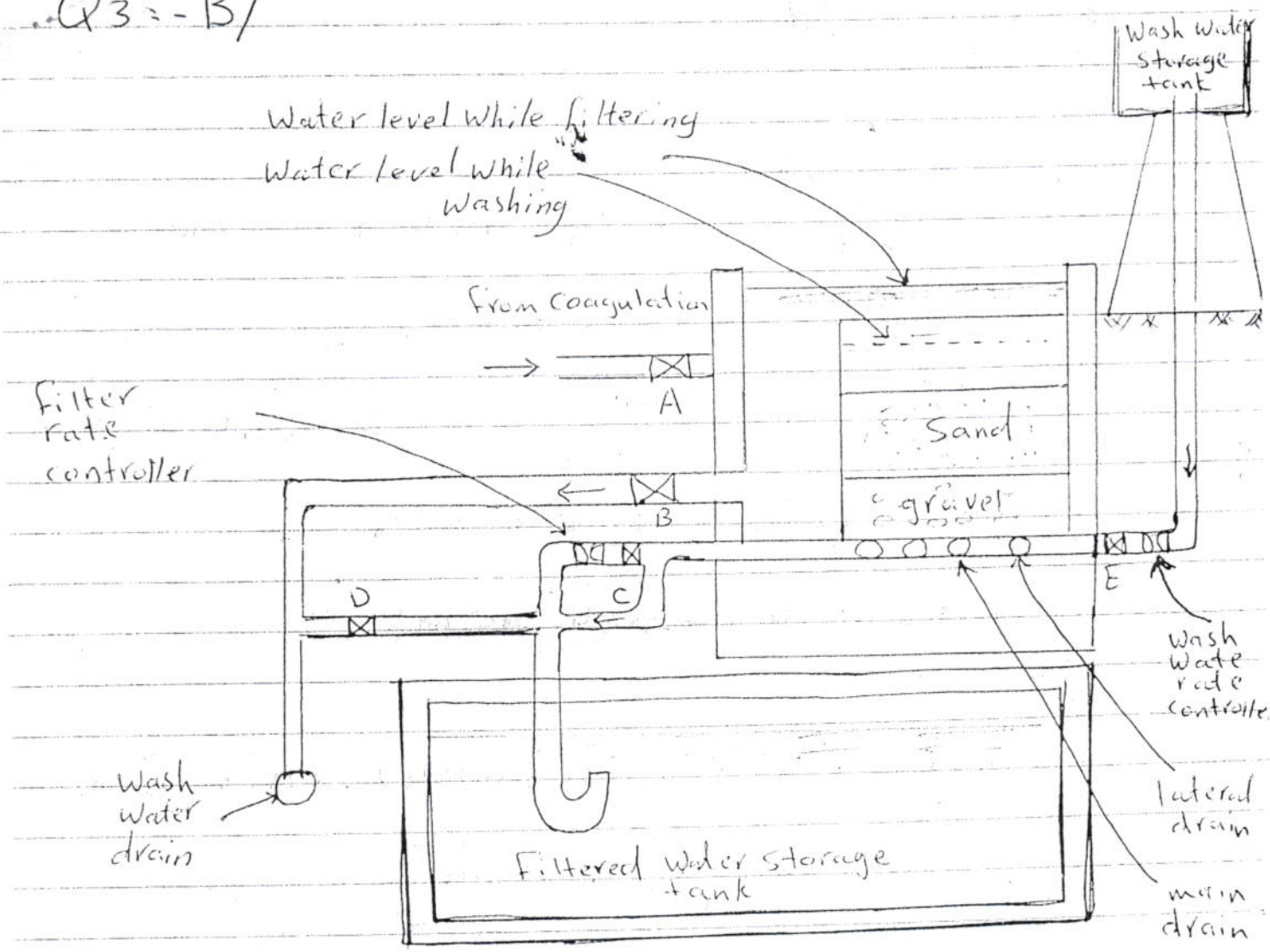
$L = W = H = 1.4\ m$

3- $G = \left(\frac{P}{\mu V}\right)^{0.5}$

$P = \mu V G^2 = 1.307 * 10^{-3} \times 2.64 \times (900)^2$

$= 2795\ \frac{kg.m^2}{s^3} = 2.8\ kW$

Q3 :- B/


Wash Water storage tank
Water level while filtering
Water level while washing
From Coagulation
A
Filter rate controller
Sand
gravel
B
C
D
E
Wash Water rate controller
Wash water drain
lateral drain
main drain
Filtered Water storage tank

Q4: A/ sol.

1- $A_s = L \times W$

$= 9 \times 4.5$

$= 40.5\ m^2$

$V_f = \frac{Q}{A_s} = \frac{20\,000}{40.5}$

$= 493.827\ m/d$

2- Quanity of water for one trough $= A_s \times V_b \times t \times$ no. of filte

$= 40.5 \times 0.6 \times 15 \times 1$

~~$= 3651$~~

$= 364.5\ m^3$

3- $Q_b = \frac{0.6 \times 40.5}{4} = 6.075\ m^3/min$

$= 0.101\ m^3/sec$

$y = 1.73 \sqrt[3]{\frac{Q_b^2}{g b^2}}$

$y^5 = (1.73)^3 \times \frac{(0.101)^2}{9.81}$

$y = b = 0.352\ m$

$= 35.2\ cm$

Q4 = B/

1- . The intake should be located in a place where there is no fast current.
. The ground near the intake should be stable
. The approach to the intake should be free from obstacles
. Should be located at some distance from the bank.
. Intake located on the upstream of the town
. the low water level and max water level should be considered.

2-

الطرق الفيزيائية

أ- الغلي بالحرارة ورفع درجة الحرارة الى 100°م لمدة 15 - 20 دقيقة

ب- استخدام الاشعة فوق البنفسجية

ج- استخدام ايونات الفضة مثل الفضة والنحاس

د- استخدام الشمس

الطرق الكيماوية: استخدام المواد الكيماوية المؤكسدة لتنقية المياه مثل غاز الكلور، الأوزون، البيروكسيدات، البوتاسيوم

Q5: A/ sol.

$$V_s = SOR = \frac{h}{t} = \frac{5}{3.5} \times 24\,hr = 34.285\ m/d$$

$$= 3.97 \times 10^{-4}\ m/s$$

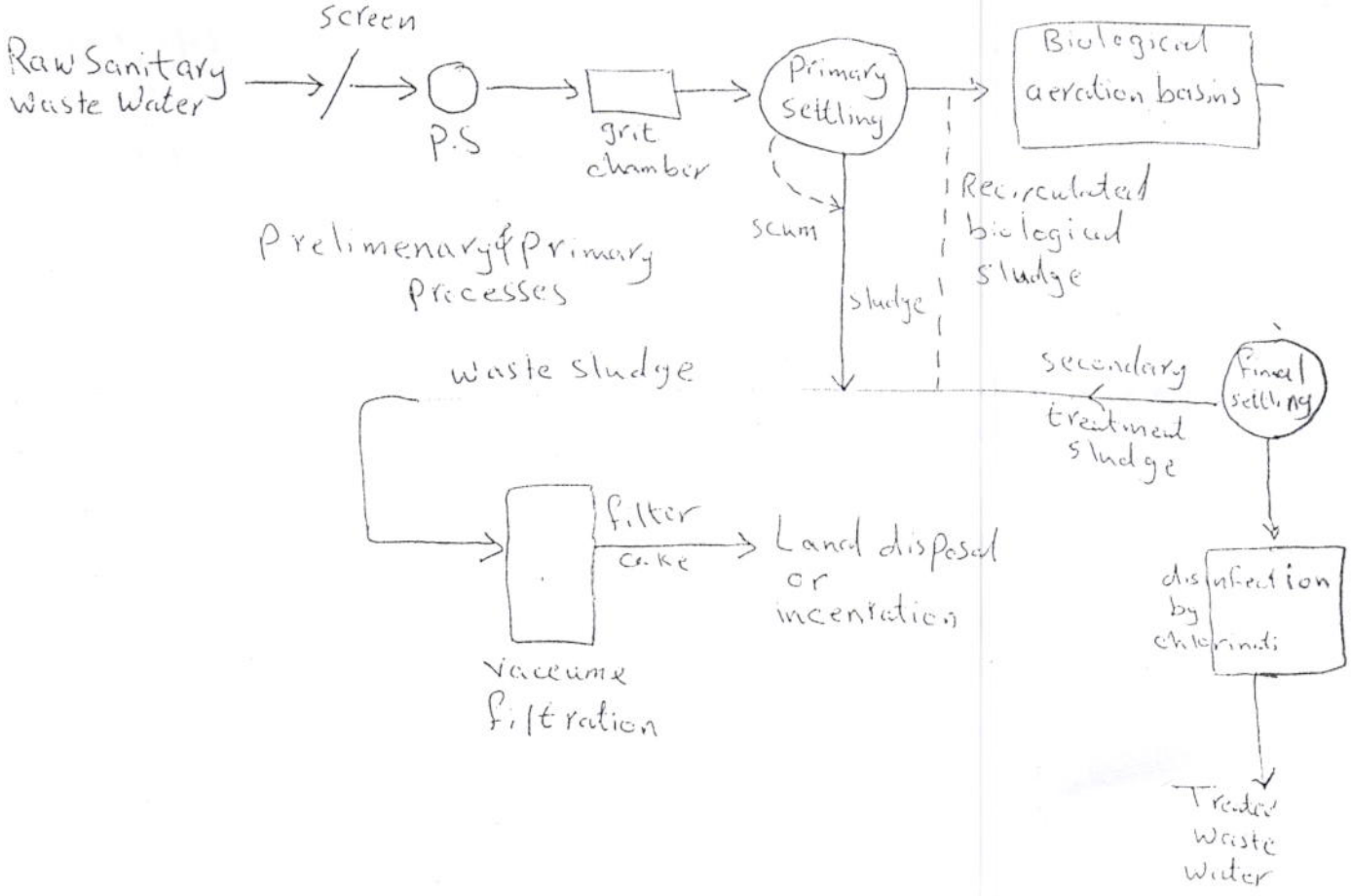
$$V_s = \frac{g}{18\mu}(\rho_s - \rho_w)\, d^2$$

$$34.285 = \frac{9.81 \times 10^3}{18 \times 1.027}(1200 - 1000)\, d^2$$

$$d^2 = 0.00032303$$

$$d = 0.061$$

Q5 B/


Raw Sanitary waste Water
screen
P.S
grit chamber
Primary settling
Biological aeration basins
Recirculated biological sludge
scum
sludge
Prelimenary & Primary Processes
waste sludge
secondary treatment sludge
Final settling
filter cake
Land disposal or incineration
vaccume filtration
disinfection by chlorinati
Treated waste water