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-

<u>Sand</u>

أرخص مادة كوسط للترشيح، يستخدم 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 الرمال 60-70 cm

e.f 0.45-0.55 mm

$1.2 \leq U \leq 1.7$

<u>الفحم</u> يوضع بخمس أو ست طبقات حيث تكون الطبقات
العليا حاوية على الكسر الصغير، صلب، مدور، مقاوم
الوزن النوعي 1600 كغم/م٣ خالي من الشوائب
قطع قطع رقيقة وطويلة، غير حاوي على الاطيان، الرمال
التراب الرطب، مواد او مواد غريبة

3-

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

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

$$P_t = P_0 + k_a t$$

- 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.

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

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

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

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

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

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

$$= 2.358 + 0.198$$

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