University of Technology
Building and Construction Engineering Department
Final Exam 2013-2014/FIRST ATTEMPT

Subject: Sanitary Engineering
Division: Dams & Water Eng. Bra.
Examiner: Walaa K. Ali

Year: Three
Time: 3 hours
Date: 29 / 05 /2014

Answer ***FOUR*** Questions Only

Q1:

A: Determine the percentage of saving in water used for backwashing rapid sand filter if the uniformity coefficient was reduced from 1.3 to 1.2 (10 marks)

B: Calculate the maximum flow rate that can be handled by three clarifiers (each is 20 m diameter, 3m side water depth and single effluent weir located on the peripheries of the tanks, noting that:

- Peak factor is 3
- Return sludge flow rate is 100% of the average flow rate.
- MLSS is 4000 mg/lit.
- Recommended SOR is 30m/day
- Solids loading rate is 6 kg/m^2-hr at peak flow (15 marks)

Q2:

A:

1. Explain why the chlorine dosage could be less if pH of the treated water is less than 7.5
2. Define mudballs, breakthroughs. (10 marks)

B: A sewage pumping station to serve a residential area of 100 hectare, the population density is 100 capita per hectare and the per capita consumption is 250 liter/day. Number of pumps is four, three of them are on duty and the fort is standby. Determine the flow rate of each pump and the volume of wet well between start and stop levels of each pump assuming maximum number of starts is 6 per hour. (15 marks)

Q3:

A: Check whether *500* mm uPVC sewer is adequate or not to carry the rainwater drainage from *20* hectare area. Noting that:

- Time of concentration is *30* min.
- Rainfall intensity can be estimated from the following formula:

  $I = \frac{1400}{70+t_c}$ Where I in mm/hr, t_c in minutes
- Pipe slope is *0.14%* , n = *0.011*
- Average surface runoff coefficient = *0.3* (15 marks)

B: determine the number of one ton chlorine cylinders in WTP according to the following data:

- Capacity of the plant is 4000 m^3/hr.
- Chlorine dosage is 8 mg/lit.
- One month supply must be kept on hand at all times. (10 marks)

Q4:

A: If a waste with BOD_5 of *160* mg/lit is discharged to a stream at an average temperature of *15*°C, what fraction of the BOD would be exerted in *5* days? $K_1 = 0.25$/day at 20°C (10 marks)

B: Using the NRC formula to calculate the effluent BOD_5 of a two-stage trickling filter with the following flows, BOD_5 and dimensions: (15 marks)

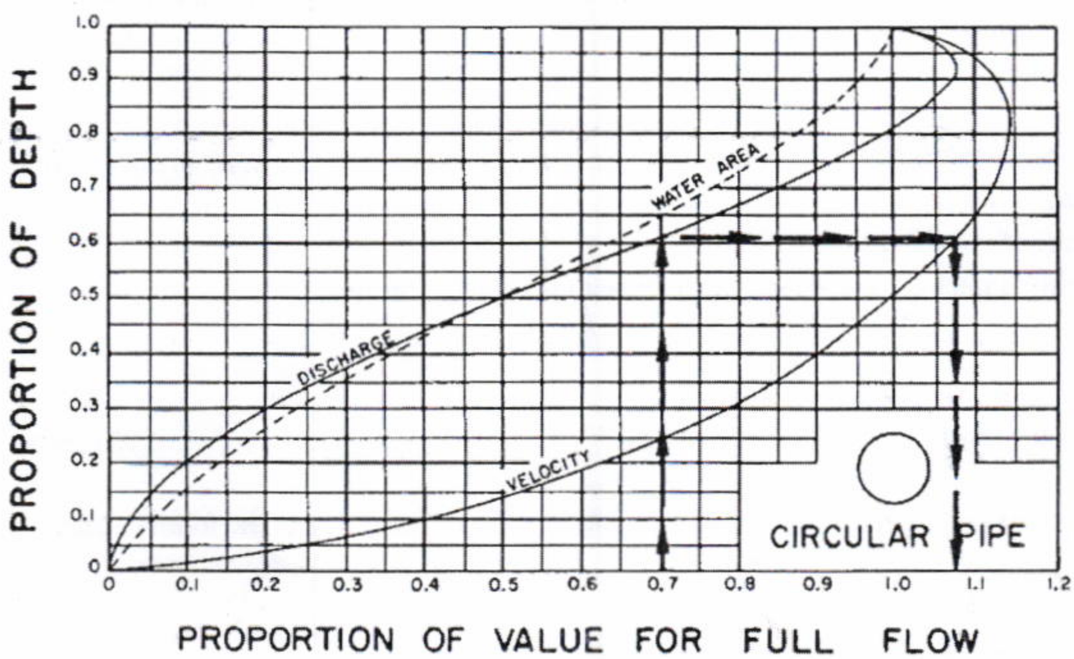
- $Q = 4000$ m^3/day
- $BOD_5 = 300$ mg /lit
- Volume of filter no. 1 = *800* m^3
- Volume of filter no. 2 = *600* m^3
- Filter depth = *2* m
- $r_1 = 1.1$, $r_2 = 1$

Q5: A: State true or false: (only two)

a) Suspended solids can be determined by evaporation.
b) COD is always lower than BOD.
c) Generation of CH_4 in sewers is the main cause for the corrosion of sewers and appurtenances. (5 marks)

B: Determine the fire flow for a 4-story ordinary construction building (three floors and basement) covering *800* m^2. (10 marks)

C: Sewage is applied to an aeration tank at a rate of 5000 m^3//day. The average BOD_5 of the influent is 300 mg/lit and it contains no dissolved oxygen. The effluent has a BOD_5 of 20 mg/lit and contains 2mg/lit of dissolved oxygen. If K_1 is 0.25/day, how many kilograms of oxygen shall be added to the aeration tank? (10marks)



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Sample 1 :

Q, : A :

$$\% \text{ saving} = -\left(\frac{1.2}{1.3} \times 100\right) + 100$$

$$= 7.69\%$$

B : assume Peak flow rate = X m^3/hr

$\therefore$ average flow rate = $\frac{X}{3}$ m^3/hr

Solid loading rate = 6

$$6 = \frac{\left(X + \frac{X}{3}\right) \times 4}{\pi\left(\frac{20^2}{4}\right)(3)}$$

$X = 1062.4$ m^3/hr

check for hydraulic loading :

SOR = 30 m/day = 1.25 m/hr

$$\therefore X = 3 \times \pi \left(\frac{20^2}{4}\right) \times 1.25$$

$$= 1177.5 \ m^3/hr$$

check for weir loading :

weir loading rate = 250 $m^3/d\text{-}m$

= 10.41 $m^3/hr - m$

$$X = 3 \times \pi \times 20 \times 10.41$$

$$= 1961.2 \ m^3/hr - m$$

$\therefore$ max. flow that can be handeled

= 1062.4 m^3/hr

Q_2 : A: 1: HOCl is more effective disinfectant than OCl^-, and as HOCl is favored below pH 7.5 then the chlorine dosage will be less.

2: Mudballs are approximately round conglomerations of filter material. They formed on the surface of filter when adhesive materials cause particles out of the water and the media grains to stick together.

breakthroughs:

Are the cracking of filter media and/or separation the media from the filter wall. They are caused by running filter at an excessive filtration rate or extending filter runs too long between backwashing.

B: Pop. = Area x pop. density

$= 100 \times 100 = 10\,000$ cap.

$$P_f = \frac{5}{Pop^{1/6}} = \frac{5}{10^{1/6}} = 3.41$$

∴ Design flow $Q = 10\,000 \times \frac{250}{1000} \times 3.41$

$= 8525\ m^3/day$

∴ pump flow rate $= \frac{q}{\text{no. of duty pumps}} = \frac{8525}{3}$

$= 2842\ m^3/day = 118.4\ m^3/hr$

$\simeq 120\ m^3/hr$

Vol. of wet well $= \frac{t_c \times Q_p}{4} = \frac{10 \times 120/60}{4}$

$= 5\ m^3$

Q3: A:

$R = CIA$

$$I = \frac{1400}{70+30} = 14 \text{ mm/hr}$$

$\therefore$ R (desig flow) $= 0.3 \times \frac{14/1000 \text{ m}}{\text{hr}} \times \frac{20 \times 10\,000}{3600}$

$$= 0.233 \text{ m}^3/\text{sec}$$

$$Q_{full} = \frac{1}{n} A R^{2/3} S^{0.5}$$

$$= \frac{1}{0.011} \left(\frac{\pi \times 0.5^2}{4}\right)\left(\frac{0.5}{4}\right)^{2/3} \times (0.0014)^{0.5}$$

$$= 0.17 \text{ m}^3/\text{sec} < 0.233$$

$\therefore$ ∅ 500 mm u.P.V.C pipe is not adequate

B:

Daily consumption $= \frac{4000 \times 24 \times 1000 \times 8}{1000\,000}$

$$= 768 \text{ kg/day}$$

$\therefore$ Required storage $= \frac{768 \times 30}{1000} = 23.05$ cylinders

$\simeq$ 24 cylinders

Q_4 : A : $K_1^{15} = K_1^{20}(1.047)^{(15-20)}$

$= 0.25(1.047)^{(15-20)} = 0.199$ /day

$BOD_5^{20} = L(1 - e^{K_1^{20} 5})$

$160 = L(1 - e^{-1.25}) \Rightarrow L = 225.35$ mg/lit

$\therefore BOD_5^{15} = 225.35(1 - e^{-0.199 \times 5})$

$= 142.03$ mg/lit

B : $Q = \frac{4000}{1440} = 2.78\ m^3/min$

$F = \frac{1+r}{(1+0.1r)^2} \Rightarrow F_1 = 1.78,\ F_2 = 1.65$

$E_1 = \frac{1}{1 + 0.532\sqrt{\frac{QC_i}{V_1 F_1}}}$

$= \frac{1}{1 + 0.532\sqrt{\frac{2.78 \times 300}{800 \times 1.7}}}$

$= 0.71$

$= \frac{C_i - C_e}{C_i} = \frac{300 - C_e}{300} \Rightarrow C_e = 87$ mg/lit

$E_2 = \frac{1}{1 + \frac{0.532}{1 - E_1}\sqrt{\frac{QC_e}{V_2 F_2}}}$

$= \frac{1}{1 + \frac{0.532}{0.29}\sqrt{\frac{2.78 \times 300}{600 \times 1.65}}} = 0.52$

$\frac{C_e - C_e'}{C_e} = E_2 = 0.52$

$\Rightarrow C_e' = 41.76$ mg/lit

Q_5: A: ⓐ T ⓑ F ⓒ F

B: $F = 18C\sqrt{A}$

$= 18(1)\sqrt{3 \times 800 \times 10.76}$

$= 2892 \text{ gpm} > 500 \text{ gpm}$

$< 8000 \text{ gpm}$

$\therefore$ Fire flow $= 2892$ gpm

C: $BOD_5 = L(1 - e^{-1.25})$

$\therefore L = 1.4\ BOD_5$

$$O_2 (kg/d) = \frac{5000 \times 1000\,[(300-20) \times 1.4 + 2]}{10^6}$$

$= 1970$ kg/day