M.E. (Water Resources & Hydraulic Engineering) Examination, 2025

(1st Semester-SUPPLEMENTARY EXAMINATION)

WATER WORKS ENGINEERING

Paper Code: PG/Int-B/SWRE/07

Paper-VI

Time: Three Hours Full Marks :100

Answer any ***four*** questions.

1. River water is supplied in a town after treatment in a water works. The suspended solids in river water are 200 mg/L. The cumulative frequency distribution for the settling velocity of those solids particles shows a straight line with the following characteristics.

10% of the particles have a settling velocity larger than 1.5 m/hr

15% of the particles have a settling velocity less than 0.6 m/hr.

A rectangular settling tank has been constructed to treat 36000 m^3 of water per day. The size of the settling tank is 70 m (L) ×20 m (B) ×3.2 m (H). Calculate the following for ideal settling condition

a. Suspended solids concentration after the sedimentation tank.
b. Sludge deposition in kg/day over first 50 m length of the sedimentation tank.
c. Maximum allowable interval between two cleanings if the depth of the sludge deposit containing 95% water is limited to 0.90 m (Density of sludge 1050 kg/m^3).

25

2.(a) Design a mechanical rapid mixing unit with following data for the treatment plant – design flow 6.5 MLD, detention time 30 sec, ratio of tank height to tank diameter = 1.5: 1, ratio of impeller diameter to tank diameter = 0.4: 1. Rotational speed of impeller 130 rpm, velocity gradient 500 sec^{-1}. Assume temp 20^0C and any suitable data as per the guideline.

(b) Water with the ionic characteristics presented below:

CO_2 = 22 mg/L; Ca^{+2}= 80 mg/L; Mg^{+2} = 12 mg/L; Na^+ = 46 mg/L; HCO_3^- = 152.5 mg/L; SO_4^{-2} = 216 mg/L

The water is to be softened the minimum Ca hardness by lime soda ash process. Mg removal is not demand necessary. Calculate (i) the chemical requirement and solids produced in meq/L. (ii) Draw a bar diagram for finished water (iii) For a flow of 30000 m^3/day, calculate daily chemical requirement and mass of solids produced. Assume the lime used is 98% pure and soda ash is 85% pure.

10+15=25

3. (a) Explain briefly the physical and chemical forces that govern coagulation and flocculation.

(b) A water treatment plant is being designed to process 70000 m^3/day of water. Jar testing and pilot plant analysis indicate that an alarm dosage of 60 mg/l with flocculation at a G*t value of 5.5 $x10^4$ produces optimal results at the expected water temperature of 18°C. Determine:

(i) The monthly alum requirement

(ii) The flocculation basin dimension if three cross flow horizontal paddles are to be used. The flocculator should be a maximum 12 m wide and 5 m deep in order to connect appropriately with settling basin

(iii) The power requirement

(iv) Size and number of paddles configuration

(v) Draw sketch of flocculator and paddles.

Given: At 18°C, $\mu=1.053 \times 10^{-3}$ NS/m² ; At 18°C density of water = 998.7 kg/m³

$C_D=1.9$ (Assume any other data if required)

5+20=25

4.(a) How does the flow rate differ between SSF and RSF, and what impact does it have on treatment efficiency?

(b) Water from the clariflocculator at 17°c is passed through the Rapid Sand Filter bed. The rate of filtration is 6000 ltr/hr/m². The filler bed is 0.75 m deep and is composed of non-uniform sand (sp. gravity 2.65) stratified so that the smallest particles are on top and the largest on the bottom. The porosity and shape factor are 0.48 and 0.85 throughout the depth of the bed. The size distribution of sand is given in the following table. Determine the head loss through the filter bed during filter operation.

US Sieve (no.)	Particle Size range (mm)	Mass fraction in size range (%)
14-20	1.0	0.87
20-28	0.71	8.63
28-32	0.54	21.30
32-35	0.46	28.10
35-42	0.38	23.64
42-48	0.32	7.09
48-60	0.27	3.19
60-65	0.23	2.16
65-100	0.18	1.02

7+18=25

5. (a) Calculate the Ryznar Index of a water sample whose temperature is 15^0C, pH is 7.9, TDS is 260 mg/l, calcium ion concentration is 56 m/l as Ca^{2+}, total alkalinity (bicarbonate only) is 95 mg/l as $CaCO_3$.

   (b) What kind of pump is preferred in a raw water pump house? Why?

   (c) Why is the peak factor considered for designing a water supply distribution network?

   (d) The hourly time-demand data for a distribution system are given here. The water is pumped into an elevated storage reservoir at a constant rate of 1069.32 m^3/h. Determine the reservoir capacity by using the deficiency method.

Time	Demand (LPM)	Time	Demand (LPM)
1 am	7125	1 pm	24586
2	7220	2	24548
3	6992	3	24472
4	6821	4	24776
5	6978	5	25498
6	7296	6	27037
7	12236	7	34238
8	19000	8	33060
9	21090	9	20216
10	22876	10	8436
11	23636	11	8018
12 noon	24016	12 midnight	7600

7+2+2+14 = 25

6. (a) Define the term non-conventional water treatment technology?

   (b) Write short note on Reverse osmosis (RO)

   (b) Determine the volume of hydrogen cation and strongly basic anion exchanger bed to demineralize 120 m^3/d water that has following chemical quality

Cations	Anions
Ca^{2+}= 145 mg/L	HCO_3-=258 mg/L
Mg^{2+}=18 mg/L	SO_4^{2-}=220 mg/L
Na^{+}=130 mg/L	Cl^{-}=214 mg/L
K^{+}=50 mg/L	NO_3=50 mg/L

The ion exchange capacities of hydrogen cation and anion exchange resins are 80,000 and 50,000 g $CaCO_3/m^3$ cycle respectively. Also calculate the required quantities of regeneration chemicals. The regeneration cycle is once per day.

3+4+18=25