M.E. (Water Resources & Hydraulic Engineering) (Evening) Examination, 2024

(1st Semester)

WATER WORKS ENGINEERING

(Paper - V)

Time: Three Hours Full Marks: 100

Answer any ***four*** questions.

1. (a) Briefly discuss the theory of flocculation. On What factors flocculation depends?

(b) A water treatment plant is being designed to process 60000 m³/day of water. Jar testing and pilot plant analysis indicate that an alarm dosage of 50 mg/l with flocculation at a G*t value of 6.0 $x10^4$ 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) The paddle configuration

Given: At 18°C, $\mu=1.053\ x10^{-3}$ NS/m²

At 18°C density of water = 998.7 kg/m³

$C_D=1.9$

(Assume any other data if required) 10+15=25

2. (a) Design a mechanical rapid mixing unit with following data for the treatment plant – design flow 8.0 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 140 rpm, velocity gradient 600 sec^{-1}. Assume temp 20^0C and any suitable data as per the guideline.

(b) An Ion Exchange softener has been installed to treat water 26000 m³ per day having following characteristics:

Ca^{+2}= 100 mg/l; Mg^{+2} = 24 mg/l; Na^+ = 23 mg/l; HCO_3^- = 244 mg/l; SO_4^{-2}= 192 mg/1

Determine the volume of medium required and the physical arrangement for continuous operation in fixed beds. Also determine the chemical requirement and regeneration cycle time.

The medium selected has an adsorption capacity of 90 kg/m³ at a flow rate of 0.45 m³/min.m². Regeneration is accomplished by using 160 kg of Sodium Chloride per cubic meter of resin in 12% solution.

10+15

3. (a) Highlight natural and anthropological water quality problem affecting public water supply in India.

(b) An ideal sedimentation tank will be built to treat 1700 m^3/hr. The suspended solid in raw water has been analyzed as 200 gm/m^3. The settling column analysis result shows the following.

12% of the particle having settling velocity greater than 1.5 m/h

10% of particles have settling velocity less than 0.6 m/h

The dimension of settling tank is as follows:

Length = 80 m, Width = 20 m, Depth = 3 m.

Calculate for ideal settling condition the following:

i) Removal of suspended solids in the settling tank and SS concentration in clarified water.

ii) Sludge deposition in kg/day over the first 60 m length of the basin.

iii) Maximum allowable interval between two cleaning if the depth of sludge deposit containing 98% water is limited to 0.9 m.

iv) Length of effluent weir to be applied.

v) Placement of effluent weir in the tank. 10+15

4. (a) Explain briefly objectives of pre-treatment in conventional water treatment plant.

(b) Discuss salient features and functioning of HRF. How headloss is developed during operation of HRF?

(c) A village water scheme for 6000 population is prepared. It is proposed to treat surface water by installing HRF and SSF with disinfection arrangement. Find out the number and sizes of HRF and SSF and their placement. The surface water quality analysis report shows the following:

pH:7.7

Suspended solids: 120 mg/1

Total Hardness (as $CaCO_3$): 130 mg/l

Chloride as Cl: 40 mg/l

Total Dissolved solids: 280 mg/l

Total coliform: 360/100 ml

Faecal coliform: 180/100 ml

5+6+14=25

5. a) Calculate the Ryznar Index of a water sample whose temperature is 15^0C, pH is 7.8, TDS is 265 mg/l, calcium ion concentration is 65 m/l as Ca^{2+}, total alkalinity (bicarbonate only) is 90 mg/l as $CaCO_3$.

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

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

d) What are the minimum pipe sizes, and the elevation of the reservoir, as per CPHEEO guidelines, to design a water supply distribution system?

e) Explain briefly the purpose of the air valves used in the distribution system.

f) 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 1070 m^3/h. Determine the clearwell capacity by using the deficiency method. Assume any other data, if required.

Time	Demand (LPM)	Time	Demand (LPM)
1 am	3610	1 pm	12293
2	3562	2	12274
3	3496	3	12236
4	3410	4	12388
5	3439	5	12750
6	3648	6	13517
7	6118	7	17120
8	9500	8	16530
9	10545	9	10105
10	11438	10	4220
11	11820	11	4010
12 noon	12008	12 midnight	3800

5+2+2+2+2+12 = 25

Table Values of $pK_2 - pK_s$ with Respect to Temperature and Total Dissolved Solids (TDS)

TDS, mg/L	$pK_2 - pK_s$						
	0°C	10°C	20°C	30°C	40°C	50°C	80°C
	2.45	2.23	2.02	1.86	1.68	1.52	1.08
40	2.58	2.36	2.15	1.99	1.81	1.65	1.21
80	2.62	2.40	2.19	2.03	1.85	1.69	1.25
120	2.66	2.44	2.23	2.07	1.89	1.73	1.29
160	2.68	2.46	2.25	2.09	1.91	1.75	1.31
200	2.71	2.49	2.28	2.12	1.94	1.78	1.34
240	2.74	2.52	2.31	2.15	1.97	1.81	1.37
280	2.76	2.54	2.33	2.17	1.99	1.83	1.39
320	2.78	2.56	2.35	2.19	2.01	1.85	1.41

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

(b) Determine the volume of hydrogen cation and strongly basic anion exchanger bed to demineralize 100 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.

(c) Briefly describe the Reverse Osmosis process

2+20+3=25