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

(1st Semester- SUPPLEMENTARY EXAMINATION)

WATER WORKS ENGINEERING

Paper Code: PG/WRE/T/115A

Paper V

Time: Three Hours Full Marks :100

Answer any ***four*** questions.

1. (a) The water with the following chemical constituents is to be softened using quantities of the following Lime Soda Ash Process. Compute the quantities of Chemicals required (lime as CaO and soda ash as Na_2CO_3) to treat 250 m^3/hr. water flow assuming practical units of removal for $CaCO_3$ to be 30 mg/L and for Mg $(OH)_2$ as 10 mg/L. Also, prepare a meq/L bar graph of raw and finished water with hypothetical consideration.

CO_2 = 9.9 mg/L; Ca^{+2} = 100 mg/L; Mg^{2+}= 8.9 mg/L; Na^+ = 11.5 mg/L; Alkalinity = 175 mg/L; SO_4^{-2} = 107 mg/L, Cl^- = 17.8 mg/L

(b) Design a secondary Circular sedimentation tank to remove alum with the following data,

Average flow= 250 m^3/hr., water lost in desludging = 2%.

Minimum size of alum floc to be removed= 0.8 mm; specific gravity of alum=1.002; Expected removal efficiency of alum = 80%, Assumed Performance of settling = very good (n=1/8); Kinematic viscosity of water at 20^0C= 1.01×10^{-6} m^2/s

15+10

2. (a) Design a clariflocculator for a conventional water treatment plant using the following data & design criteria:

Desired average overflow from the clariflocculator: 300 m^3/hr
Water loss in de-sludging: 2.5%
Detention period in flocculator zone: 25 min.
Average velocity gradient: 50/s
Dynamic viscosity: 0.98×10^{-3} N-s/m^2
[Assume any other data, if required.]

Calculate the following: i) Size of influent pipe ii) Diameter of the flocculation iii) Dimension of the paddles iv) Design of clarifier

(b) Discus briefly the concept of colloidal stability, electric double layer, and zeta potential in connection with the coagulation process in water treatment.

19 +6=25

3.**(a)** Briefly discuss design criteria and guidelines for rapid mixing unit.

(b) A rapid mixing unit is to be designed for dosing alum for water treatment. The following data may be used for calculation.

Design flow to be treated = 6.5 MLD, Detention time = 40 sec, Ratio of tank height to diameter = 2: 1, Ratio of impeller diameter to tank diameter = 0.3: 1, Rotational speed of impeller = 130 rpm, velocity gradient = 500/sec, viscosity of water = 1.0087×10^{-3} N-s/m^2

Calculate the following:

(i) Dimension of rapid mixing tank

(ii) Power requirement

(iii) Dimension of mixing system

7+18=25

4. (a) Find the settling velocity of a sphere having a diameter 'd' and specific gravity = 2.65. Also, find the rising velocity of particles of the same 5×10^{-3}cm diameter but specific gravity is 0.80. Assume $\nu = 1.012 \times 10^{-2}$ cm^2/sec. Assume other data suitably.

(b) River water is supplied in a town after treatment in a water works. The suspended solids in river water is 250 mg/L. The cumulative frequency distribution for the settling velocity of those solids particles shows a straight line with the following characteristics.

12% 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 30000 m^3 of water per day. The size of the settling tank is 65 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 the first 45 m length of the sedimentation tank.
c. Maximum allowable interval between two cleanings if the depth of the sludge deposit containing 97% water is limited to 0.88 m (Density of sludge 1050 kg/m^3).
d. The minimum length of the effluent weir is to be applied. How is it to be adjusted in the sedimentation tank?

10+15=25

5. (a) Calculate the Ryznar Index of a water sample whose temperature is 15^{0}C, 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 110 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