Done by : Ten Wei Ze

En2003

Ay-22-23 S2

Q1(a)

Baffled flocculators have large head loss. The implication is that source of water will need to be at a sufficient height to ensure that water has sufficient (elevation) head to flow through the entire water treatment plant to prevent stalling of water flow or reverse in direction of flow due to head loss.

Baffled flocculators have little short circuiting. This ensures that most incoming water will remain in the tank for sufficient time, ensuring sufficient flocculation of particles.

Baffled flocculators are cheap to build and maintain, allowing for treatment of large volumes of water at lower cost, and also allows for operation in poorer or less developed areas.

Baffled flocculators have efficiency that depend on incoming flow rate. This means that we need to maintain a constant incoming flow rate to ensure that water leaving the tank is of consistent quality.

Q1(b)

	Mechanical flocculator	Hydraulic flocculator
Floc type produced	Large and fluffy	Very large and fluffy
Head loss	Nil	0.05-0.15 m (significant)
Operational flexibility	Good	Moderate to poor
Capital cost	Moderate to high	Low to moderate
Maintenance cost	Moderate	Low to moderate

Q1(c)

Drag coefficient determines the magnitude of drag force that opposes the settling of particles caused by gravitational force. It can be determined via the use of a settling column. Measure the time taken for particles of a certain size to settle a certain distance to calculate their settling velocity. Calculate Reynolds number using settling velocity. Reynolds number can then be used for the calculation of drag coefficient.

Formulas used :

$$Re = \frac{dV_s\rho}{\mu}$$

$$C_d = \frac{24}{Re} \; for \; Re \leq 1$$

$$C_d = \frac{24}{Re} + \frac{3}{\sqrt{Re}} + 0.34 \; for \; 1 < Re < 10^4$$

Q2(a)

$K_1 = 749 \quad K_2 = 6476 \quad K_3 = 899$

Pipe	K	Q	H	H/Q	ΔQ
1	749	1.5	1587	1058	
2	6476	-0.5	-1796	3592	0.297
3	899	-2	-3241	1620.5	
			$\Sigma H = -3450$	$\Sigma \frac{H}{Q} = 6270.5$	

Pipe	K	Q	H	H/Q	ΔQ
1	749	1.797	2215	1233	
2	6476	-0.203	-339	1670	0.067
3	899	-1.703	-2407	1413	
			$\Sigma H = -531$	$\Sigma \frac{H}{Q} = 4316$	

$\boldsymbol{Q_1 = 1.864\, m^3/s \quad Q_2 = 0.136\, m^3/s \quad Q_3 = 1.636\, m^3/s}$

$$H = KQ^{1.85}$$

$$\Delta Q = -\frac{\Sigma H}{\alpha \Sigma |\frac{H}{Q}|}$$

Q2(b)(i)

Total daily demand = $1800 + 4200 + 6600 + 7700 + 10700 + 4000 = 35000\ m^3$

Q2(b)(ii)

Pumping rate = $\frac{35000}{12} = 2916.67\ m^3/h\ = 0.81\ m^3/s$

Q2(b)(iii)

Inflow = $11666.67\ m^3/4h$

Time		Inflow (m^3)	Draft (m^3)	Deficiency(m^3)	Cumulative deficiency (m^3)
From	To				
0	4		1800	1800	1800
4	8		4200	4200	6000
8	12	11666.67	6600	-5066.67	933.33
12	16	11666.67	7700	-3966.67	-3033.34
16	20	11666.67	10700	-966.67	-4000
20	24		4000	4000	0

Equalising storage = 6000 m^3

Operational storage = 4000 m^3

Sum = 10000 m^3

Q2(b)(iv)

It will decrease. Equalising storage will slightly increase, but operational storage will decrease greatly, resulting in a net decrease as more water is being pumped during periods of lower demand.

Q3(a)

Dosage of chlorine = $\frac{6.87\times10^{6}\ mg}{16.2\times10^{6}\ L} = 0.424\ mg/L$

Chlorine demand = $0.424 - 0.19 = 0.234\ mg/L$

Q3(b)(i)

$mass\ of\ 111\ L\ of\ water = 1000g\ X\ 111L = 111000\ g$

$mass\ of\ hypochlorite\ needed \approx 2.1\% \times 111000g = 2331\ g$

$mass\ of\ dry\ hypochlorite\ needed = \frac{2331\ g}{72\%} = 3237.5\ g$

Q3(b)(ii)

In 2.1% solution,

In 1 L solution → $1000g\ of\ water \rightarrow 21\ g = 21000\ mg$ of hypochlorite

To dilute to 53mg/L,

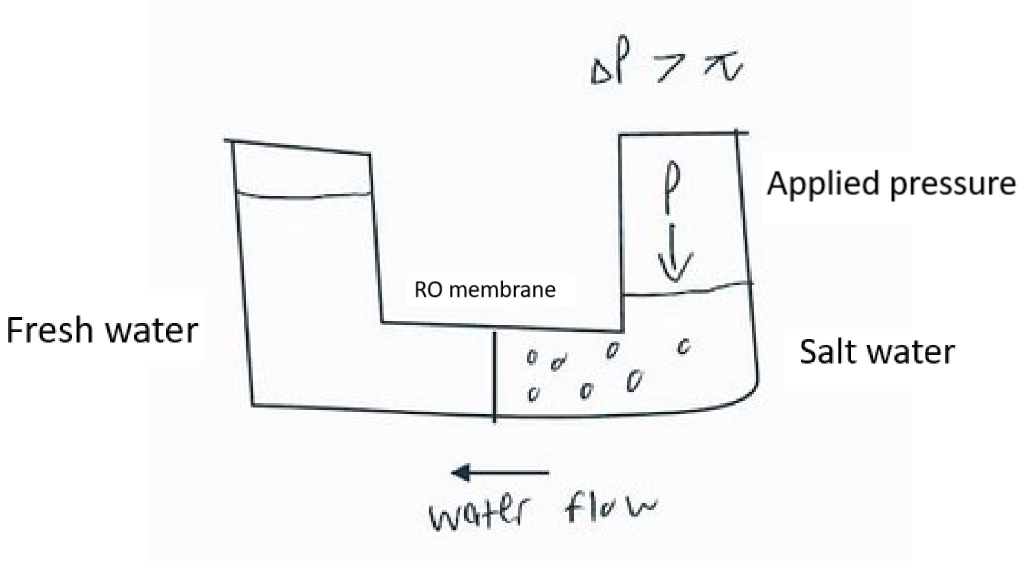
$\frac{21000}{53} = 396\ L\ of\ water$

Hence we use 396 times dilution

Q3(b)(iii)

$Volume\ needed = \frac{36543}{396} = 92.3\ L$

Q4(a)



$$\Delta P = transmembrane\ pressure, \quad \pi = osmotic\ pressure$$

1. Seawater desalination
2. Recovery of 2nd effluent
3. Drinking water production from ground and surface water
4. Water for dilution in food and beverage industry
5. For manufacturing of high purity water (example : semiconductor industry)
6. Water for dilution in chemical process industry
7. Bottled water manufacturing
8. Boiler feed water

Q4(b)

Organic fouling. Consists of carbon-based material, removed using sodium hypochlorite solution

Biofouling. Consist of microbes, fungi and other microorganisms. Removed using sodium hypochlorite solution

Inorganic fouling. Consist of inorganic materials like deposited ions (Calcium, magnesium etc). Removed using citric acid

Q4(c)

1. Plate and frame membrane
2. Spiral wound modules
3. Tubular membrane
4. Hollow fibre membrane