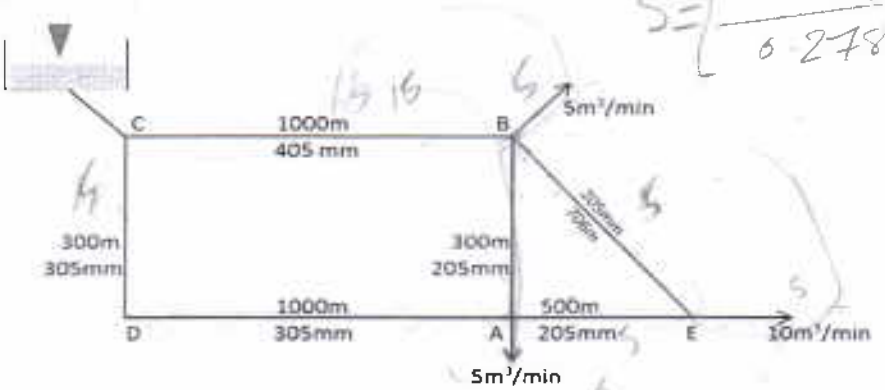
University Of Technology
Building and Construction Eng. Dept.
Final Exam-First Attempt–2016/2017

Branch :All Branches. **Class: Third**
subject : Sanitary Engineering **Time : 3 Hours**
Examiner : sanitary committee **Date : 1 /6/2017**

Answer Four questions only

Q1:- Calculate the flow in each pipe in the system shown in fig. (1) (use two trail only and take c=100).



(25 mark)

Q2:- A/ Explain the purposes of the following processes:

1- Preaeration.
2- Grit chamber.
3- Primary treatment.
4- Secondary treatment. (10 mark)

B/ The BOD_5 of waste water is 190 mg/l and discharged to a stream at an average temperature of 30°C. What fraction of the BOD would be exerted in 5 day? How long would be required for the same degree of stabilization if temperature were 10°C? k_1= 0.25/day at 20°C.

(15 mark)

Q3:- A/ Design rectangular primary sedimentation tank to remove 30% of BOD from total an equivalent load for each of BOD and SS = 700 Kg/ day when the maximum expected flow is 8000 m^3/day in a detention time of 2.5 hr (L:W = 3:1). Then estimate:

1- The sludge quantity that removed in this tank with an efficiency of 90% by using chemical coagulants which also produce 80 mg/l of metallic hydroxide in sludge (moisture content of sludge (m.c) = 90%).
2- The effluent concentration of BOD and SS.

(15Mark)

B/ State and draw the schematic for the types of biological treatment systems and give examples for each one.

(10 mark)

Q4:/ Waste water with flow of 15000 m^3/day and BOD of 180 mg/l is treated in an activated sludge process to yield effluent BOD of 25 mg/l and SS 30 mg/l in a residence time of 10 days with recirculated rate of 0.3 and hydraulic retention time of 8 hr.(y= 0.65, k_d =0.05).

Estimate:-
1- Mass concentration in the reactor (x).
2- Under flow concentration.
3- Total mass be removed per day.
4- Biological treatment efficiency based on BOD_5 .

(25Mark)

Q5:- A/ State the major operational problems in trickling filter.

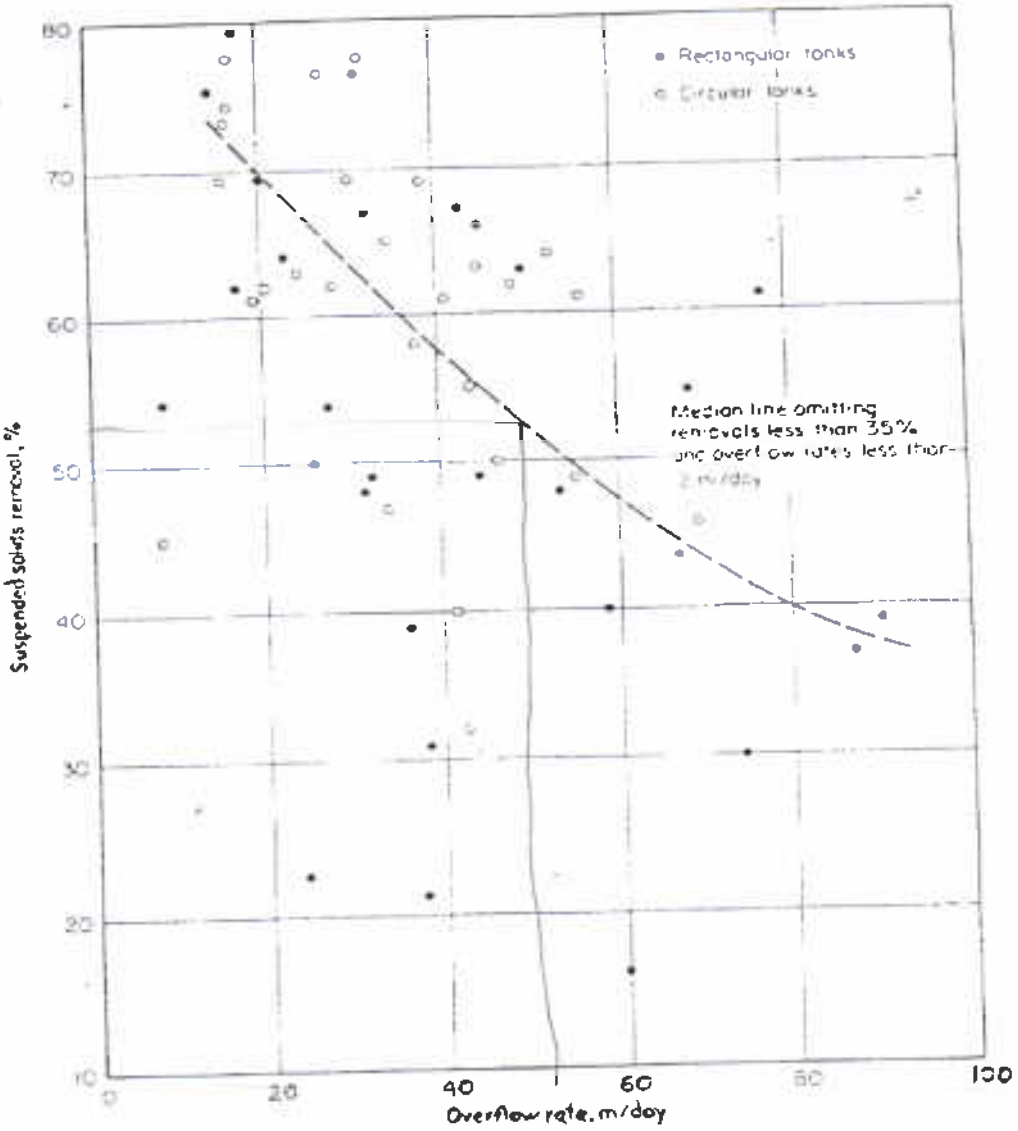
(5 mark)

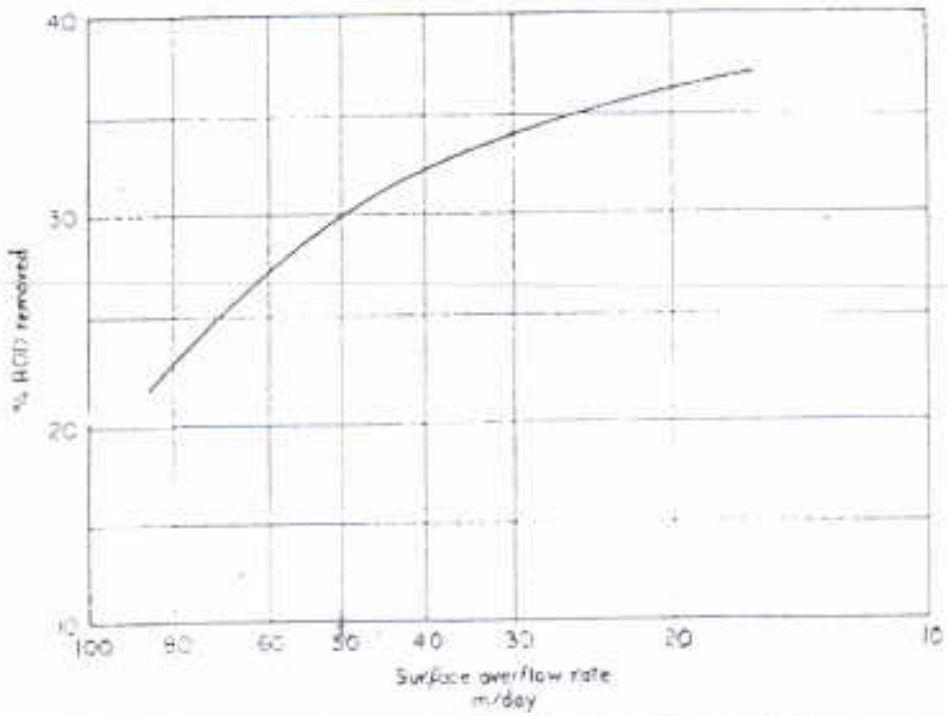
B/ Draw the growth pattern of microorganisms in waste water.

(5 mark)

C/ Estimate the total sludge production from waste water treatment plant to treat 1000 m^3/day with influent BOD of 210 mg/l and SS of 260 mg/l , assume that primary clarifier remove 30% of BOD and 60% of SS.

(15 mark)


Rectangular tanks
Circular tanks
Median line omitting removals less than 35% and overflow rates less than 2 m/day
Suspended solids removal, %
80
70
60
50
40
30
20
10
0
20
40
60
80
100
Overflow rate, m/day


% BOD removed
40
30
20
10
100
80
60
50
40
30
20
10
Surface overflow rate
m/day

Useful informations

$$M=1+\frac{14}{4+P^{0.5}}$$

$$r=\frac{Q_r}{Q}$$

$$y=1.73\sqrt[3]{\frac{Q_h^2}{g\,b^2}} \qquad vh=\left[\frac{8B(S-1)gd}{f}\right]^{1/2}$$

$$XV=\frac{Y\,Q\,(S_o-s)\theta_c}{1+K_d\,\theta_c} \quad \ldots\ldots \quad \text{vol. of air required} = \frac{wt.of\ O_2}{\%\ O_2 \times \rho_{air}}$$

$$\frac{dX}{dt}=\frac{xV}{\theta_c}$$

$O_{2\,demand}= 1.47(S_0-S)Q - 1.15(XV/\Theta C)$ or $O_{2\,demand}= 1.47\,(S_o - S)\,Q - 1.14\,X_r\,Q_w$

$QrXr= (Q+Qr)\,X$

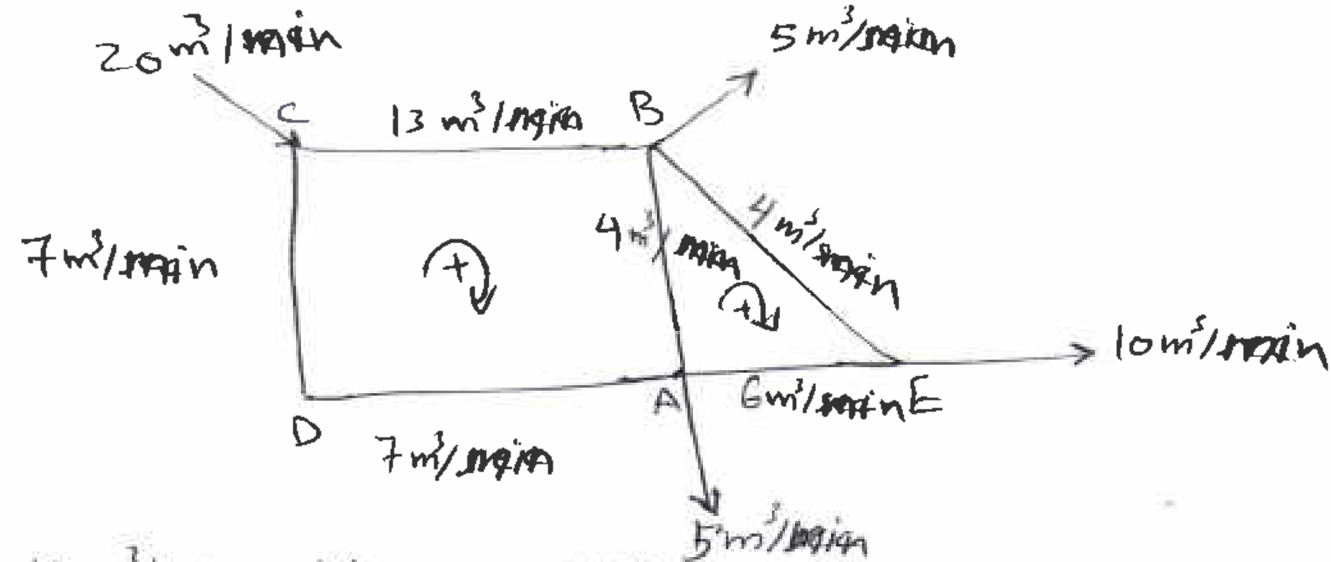
$$S=\frac{ks(1+kd\theta C)}{YK\theta C-Kd\theta C-1} \qquad X=\frac{Y(S_o-S)}{1+Kd\theta C}$$

$$\frac{1}{\theta_c}=\frac{YQ(S_o-S)}{VX}-k_d$$

حلول اسئلة الهندسة الصحية للمرحلة الثالثة 2017-2016

الدور الاول Sanitary engineering جميع الفروع

Q1.



$Q = 13\ m^3/min * 1/60 = 0.2167\ m^3/sec$

ALL Flow divided by 60 to convert to m^3/sec

First Loop.

Pipe	D (m)	L m	Q m³/sec	S	hL	hL/Q
CB	0.405	1000	0.217	0.01	+ 10	46.083
BA	0.205	300	0.067	0.1217	9.6	143.284
DA	0.305	1000	−0.117	0.306	−13	143.284
CD	0.305	300	−0.117	0.306	−3.9	33.333
				sum	−2.7	333.811

$\Delta = \frac{-(2.7)}{1.85(333.811)} = |0.0043| > 0.0033$ Not ok

Loop II

pipe	Dm	Lm	Q m³/s	S	hL(m)	hLQ
EB	0.205	706	+0.067	0.032	22.47	335.373
AE	0.205	500	-0.1	0.067	-33.5	335
AB	0.205	300	-0.567	0.032	-9.6	143.284
				SUM	-20.63	813.657

$$\Delta = \frac{-(-20.63)}{1.85*(813.657)} = |-0.0137| > 0.0033 \quad \text{not ok.}$$

The correct

Loop I $\Delta I = -0.008$	Loop II
Q correct = Q1 + ΔI	Q correct = Q1 + ΔI
$Q_{CB} = 0.217 - (-0.0043) = 0.2127$	$Q_{BE} = +0.067 + (0.0137) = -0.0807$
$Q_{AD} = -0.117 + (-0.0043) = -0.1213$	$Q_{EA} = -0.1 + (0.0137) = -0.0863$
$Q_{DC} = -0.117 + (-0.0043) = -0.1213$	

subscribe pipe

$Q_{AB} = Q_I + \Delta I - \Delta II$ or

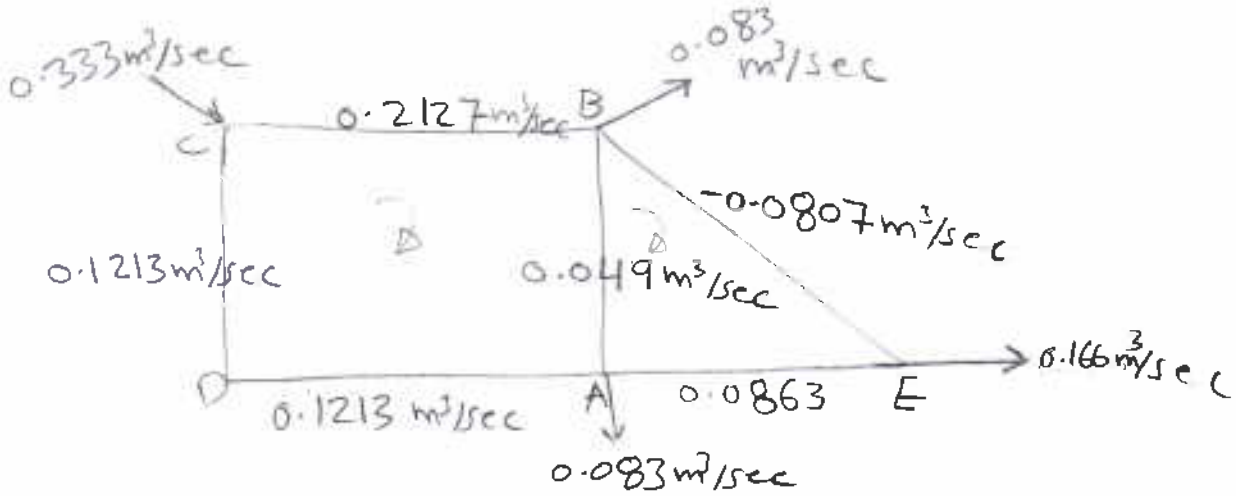
$Q_{AB} = Q_{II} + \Delta II - \Delta I$

$Q_{AB} = +0.057 + (-0.0043) - (0.0137)$

$= +0.049$ or →

$Q_{AB} = -0.067 + (0.0137) - (-0.0043)$

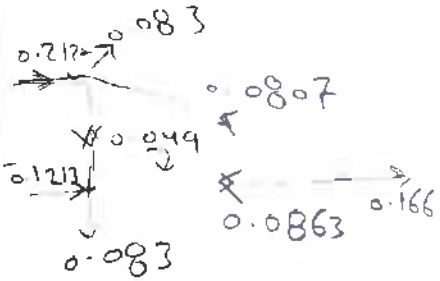
$= -0.049$



after two trails the Q corrected that $\Delta t \leq 0.0033$

Loop I

Pipe	Q	S	hL	hL/Q
CB	+0.2127	0.0098	+9.8	46.074
BA	0.049	0.0178	+5.34	108.979
DA	-0.1213	0.013	-13	107.172
CD	-0.1213	0.013	-3.9	32.151
Sum			-1.76	294.376



$$\Delta I = \frac{-1.76}{1.85(294.376)} = |0.0032| < 0.0033 \quad \text{ok}$$

Loop II

Pipe	Q	S	hL	hL/Q
EB	-0.0807	0.0446	+31.488	390.185
AE	-0.0863	0.05085	+25.425	294.618
AB	-0.049	0.0178	+5.3488	109.159
		sum	-0.714614	793.962

$$\Delta II = \frac{-0.7142}{1.85(793.8242)} = |-0.0048| > 0.0033 \quad \text{not ok.}$$

Q2. A. the purposes of the following process

① preaeration :

① reduce or decrease odor production تقليل الروائح

② increase dissolved oxygen content of flow

③ mixing provide and improve grease removal slightly

④ offer or provide opportunity for flocculation of suspended solids.

⑤ help to make flow uniform

aeration can also help in grit removal. ويمكن ايضاً

② Grit chamber.

تستخدم في ازالة grit ك الزجاج، العظم، eggshells metal fragment

وترسيبها دون السماح للمواد العضوية بالترسيب عن طريق الفرق بين الوزن النوعي وسرع الترسيب the difference between specific gravity of organic and inorganic according to Newton's Law

$$V_s = \left[\frac{4g(\rho_s - \rho)d}{3CD\rho}\right]^{1/2}$$

$$V_h = \left[\frac{8B(S-1)gd}{f}\right]^{1/2}$$

وسرعة

وهذا يضمن ترسيب المواد الغير عضوية وترسيبها وعدم ترسيب المواد العضوية لتتمكن من الانتقال للمرحلة اللاحقة في المعالجة البايولوجية

③ primary treatment
is designed to remove the suspended solid in wastewater

④ secondary treatment:
is intended or designed to remove the soluble and colloidal organic matter which remains after primary treatment

من خلال المعالجة البايولوجية يتم ازالة المواد العضوية الموجودة في مياه الصرف.

B

$$L_u = \frac{BOD_5}{1-e^{-kt}} = \frac{190}{1-e^{-.25(5)}} = 266.29 \text{ mg/l}$$

$$K \text{ at } 30^\circ C = k_1 (1.047^{T-20}) = 0.25(1.047^{30-20}) = 0.395 \text{ /day}$$

$$K \text{ at } 10^\circ C = k_1 (1.047^{10-20}) = 0.1579 \text{/day}$$

$$BOD_5 \text{ at } 30^\circ C = 266(1-e^{-k_{30} t}) = 229 \text{ mg/l}$$

$$BOD \text{ at } 10^\circ C$$

$$229 = 266(1-e^{-0.157(t)})$$

$$t = 12.5 \text{ day}$$

Q3. B/ SoR from Fig of 80% BOD Removal

$= 50 \text{ m/day}$

$Q = 8000 \text{ m}^3/\text{day} \Rightarrow A = \frac{8000}{50} = 160 \text{ m}^2$

$A = L * W \Rightarrow L = 3W \Rightarrow A = 3W^2$

$W = 7.3 \text{ m} \Rightarrow L = 21.9 \text{ m}$

$$\text{depth} = \frac{Q \cdot t}{A} = \frac{8000 \times \frac{2.5}{24}}{160} = \frac{Q * t}{A}$$

depth = 5.2 m ≈ 2.5 with Free board

Concentration of BOD & SS $= \frac{700}{8000} = 87.5$ mg/l

or 0.0875 kg/l

Sludge quantity = Q(C) * Removal eff.

$= 8000 (87.5 * 0.9 + 80) =$

$= \frac{1270}{0.1} \text{ kg/day} = 12700 \text{ kg/day}$

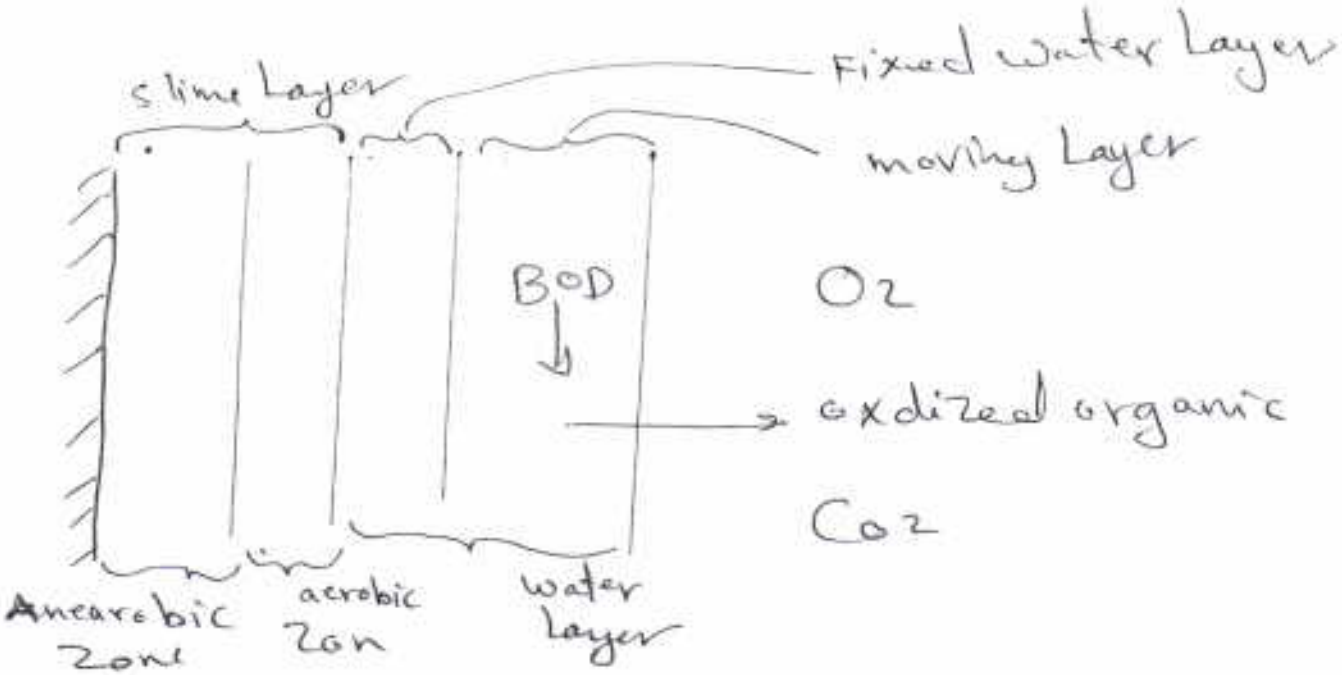
effluent conc

① BOD $= 87.5(1 - 0.3) = 61.25$ mg/l

② SS $= 87.5(1 - 0.9) = 8.75$ mg/l.

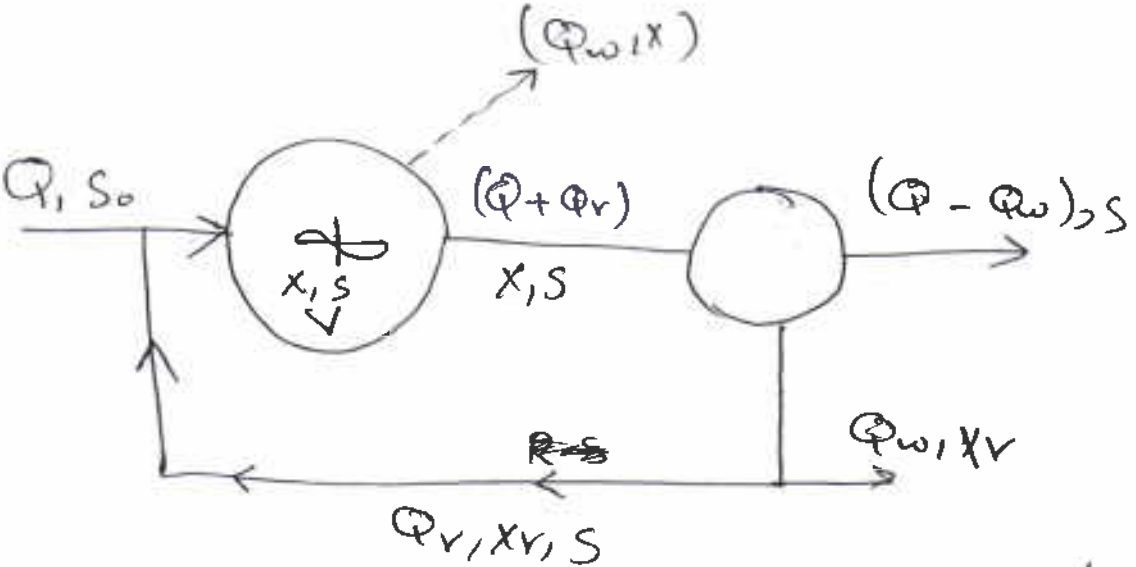
Q3 B/

① attached growth system



ex. trickling filter

② suspended growth system



ex: Activated sludge or conventional activated sludge.

Q4. 1. $S_{BOD} = 25 - 30 * 0.63 = 6.1$ mg/lt.

or $S = 25 - 30 * 0.77 * 0.8 = 6.52$ mg/lt.

$V = Q * t = 8/24 * 15000 = 5000\ m^3$

$$XV = \frac{Y Q \Theta c (S_o - S)}{1 + kd\,\Theta c} = 1.12775 * 10^{10}\ mg \text{ or } = 1.1303 * 10^{16}\ mg$$

(1) $X = 2260.7$ mg/lt or 2215.5 mg/lt.

$$r = \frac{Q_r}{Q} = 0.3 \Rightarrow Q_r = 4500\ m^3/day$$

$$Q_r X_r = (Q + Q_r) X$$

$$4500\, X_r = (15000 + 4500)(2260.7)$$

(2) $X = 9796$ mg/lt as MLVSS

as MLSS $= 12245$ mg/lt

(3) $$\frac{XV}{\Theta c} = \frac{10^3 * 2260.7 * 5000}{10} = 1130350 * 1000$$

$= 1130.35$ kg/day

mass be removed per day $= \frac{1130.35}{0.8} = 1412.93$ kg/day

(4) efficiency Based on BOD soluble $= \frac{180 - 6.1}{180} * 100$

$= 96.8\%$ or 96.38%

Q 5. A. أثناء فقط لطلاب

major operational problems of trickling filter

① Cold weather operation, so efficiency in high rate filter is reduced by approximately 30% per 10°C. and freezing caused plugging of filter

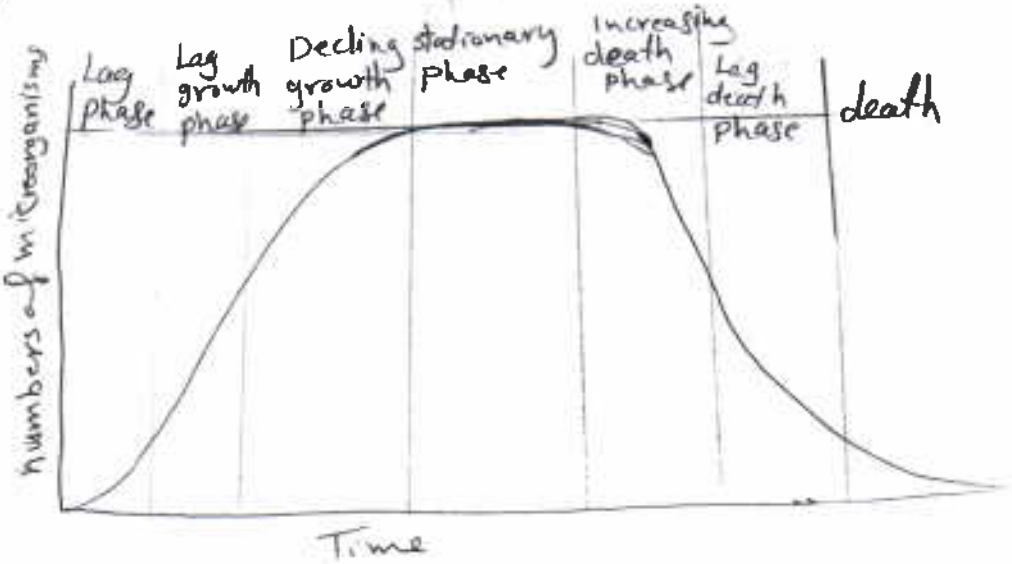
الجو البارد والتجمد الزيادة الانسداد

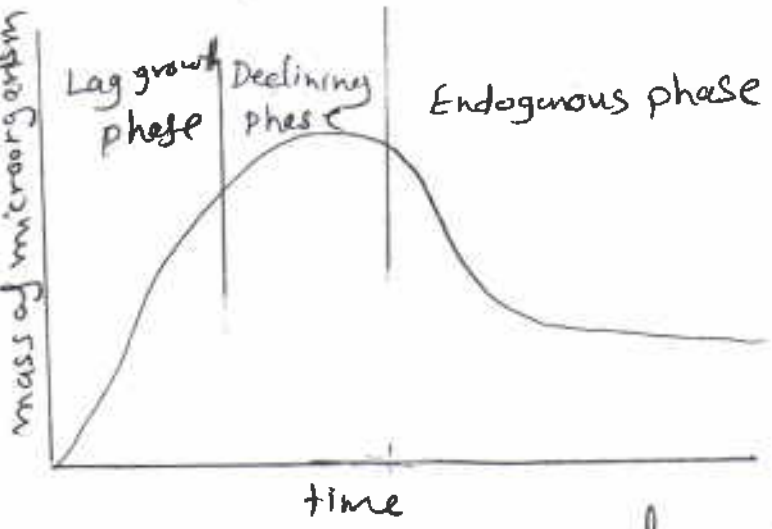
② odors الروائح الكريهة

③ psyshcoda alternata or filter flies

الحشرات، الذباب

P5. B/





growth pattern of microorganisms in Wastewater

Q5. C

The removal in the primary is

$0.6(260) = 156 \text{ mg/l}$

production in the secondary is

$0.7(210)0.5 = 74 \text{ mg/l}$

total solids production

$$\frac{(156+74)*10^6}{10^6} = 230 \text{ kg/day}$$