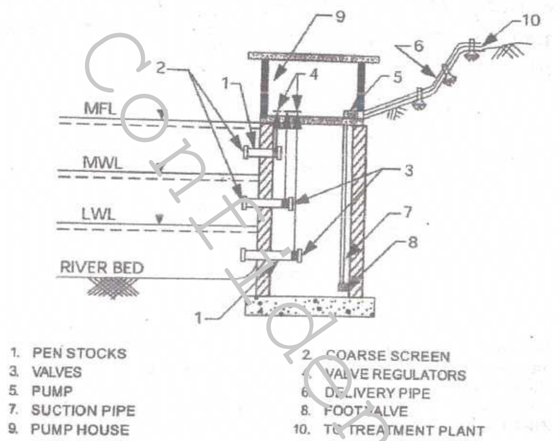
SCHEME OF VALUATION
(Scoring Indicators)

Revision – 2015 **Course Code: TED(15) 6012**
Course title : ENVIRONMENTAL ENGINEERING

Qst No.	Scoring Indicator	Split up score	Sub total	Total
	PART - A			
I.1.	**Drawdown** is the difference of water level in the well before and after pumping.		2	
I.2.	**Air gap** is the unobstructed vertical distance through free atmosphere between the lowest opening from any pipe or fitting supplying water to a tank and the flood level rim of the receptable in a water supply system.		2	
I.3.	**Sewage** is the liquid waste of the community which includes wastes from water closets, urinals,bathrooms,kitchens, waste water from industries and storm water and **Sullage** is the waste water from bathrooms, kitchens, wash basins etc and also storm water.		2	
I.4.	**Dry weather flow** is the average discharge of sanitary sewage that flows in a sewer during the dry weather. It consists of domestic and industrial sewage and also ground water infilttration.		2	
I.5.	**Rural sanitary latrines** – Pit privy, Bore-hole latrine, Aqua- privy, Cess-pools.		2	10
	PART – B			
II.1.	**Ponds and lakes:** Pond is a natural small depression and a lake is a large one on the ground into which water flows from streams and finally stored. In the ponds and lakes, the quality of water changes due to sedimentation and self-purification. Village side ponds are generally polluted due to various activities like bathing, washing clothes, cleaning cattle etc. Larger lakes have better quality than smaller ones.	2		
	Rivers and streams: The quality and quantity of water flowing in the rivers and streams varies with time. During the initial periods of runoff, water contains more impurities. Its quality depends on the nature of the soils traversed by water. Though self purification takes place, some effect of pollution always remains Water from upland regions of high rainfall is soft and water from low land regions of low rainfall and high evaporation is hard. Hence river water from low reaches should be treated before supply.	2		
	Impounding reservoirs: These are artificial lakes formed by the construction of dams across valleys containing water courses. The storage reservoirs impound water during high rate of flow and supply it during periods of high demand rate. The quality of water is same as that of lakes and requires treatment.	2	6	
II.2.	Impurities in water are either organic or inorganic in nature. They are classified as Physical, chemical and bacteriological impurities which may be present in the form of suspended solids, colloidal particles and dissolved solids.			
	Physical impurities give taste, odour, colour and turbidity. Taste and odour is caused due to presence of organic matter in water, dissolved during passage through the ground or due to growth of algae. Colour is due to the presence of mineralogical compounds like iron oxide etc. Turbidity is caused by the suspended and colloidal matter. Physical impurities do not have direct relationship with health but produces many indirect consequences.	2		

Chemical impurities may be either organic or inorganic.These impurities may be present either in suspended or dissolved form.
Suspended particles of silt and clay causes turbidity. Organic impurities like decayed leaves, algae, fungi, dead animals, insects etc causes acidity, taste, change of colour, bacteria, water contamination etc.
Dissolved particles likecarbonates and bicarbonates of calcium and magnesium causes hardness and alkalinity. Chlorides of Sodium causes brackish taste. Large quantities of albuminoid nitrogen with ammonia and 2
chlorides causes disease producing bacteria, pollution due to sewage etc.
Bacteriological impurities are caused by the pathogenic or disease producing type of bacteria present in the water making it dangerous for human consumption and health. The pathogenic bacteria or Coliform group of bacteria called as E coli, present in the intestine of human beings and appear in their daily faecal discharges, are not harmful as such but when 2 6
present in water causes water pollution.

II.3.



3

River intake consists of circular tower 3 to 6 m in dia constructed in masonry or concrete on the bank of river at a suitable point. A pump house is located on top of the tower. The lower chamber acts as a sump well. Two or more penstocks covered with coarse screens are provided at different levels to the sump well. Penstocks are fitted with valves to regulate the flow into the well. The penstock just below the existing water level is only operated at any time and the remaining are closed to avoid high entry velocities. Water collected in the sump is pumped to the treatment plant. 3 6

II.4. Causes of corrosion:

i) Corrosion is caused by the physical movement of water. At low pressure, vapours or gas bubbles are released by water and with sudden increase of pressure the bubbles repeatedly collapse setting impulsive forces on the metallic surfaces of the pipe causing erosion of the surface.

ii) A metal (iron) when immersed in water electrolyses ie., Fe ions on the anodic side is released and reacts with the H ions on the cathodic side replacing it. Continous removal of Fe ions from the anode results in corrosion of the iron pipe.

iii) When two dissimilar metals are in the same electrolyte, an interchange of ions takes place resulting in a bimetallic electrolytic corrosion.

iv) The sulphate reducing bacteria are anerobic and reacts with sulphates in water producing hydrogen sulphide which attacks the iron and steel. The iron consuming bacteria are aerobic and oxidizes iron from water and fron pipes and store it to form deposits which gives bad odour to water. 3x1

Prevention of corrosion:

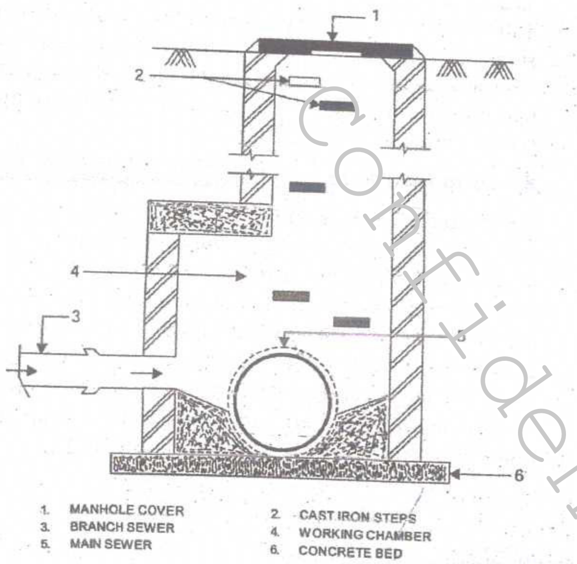
i) By coating the pipes with materials like tar, asphalt,bitumen, cement mortar, enamels, resins, paints etc. The Angus Smith process is coating iron pipes by dipping into hot mixture of coal tar, oil and paranaphthalein.

ii) In cathodic protection, the entire pipe line is made to act as a cathode so that the emerging currents from anodic areas are suppressed and prevents corrosion.

iii) Addition of alkalinity in the form of lime or powdered chalk to raise the pH value of water. Contact beds of limestone, calcite or marble are also used.

iv) Sodium hexa metaphosphate also called as Calgon when added to water in small doses of 0.5 to 2 mg/l, prevents corrosion. 3x1 6

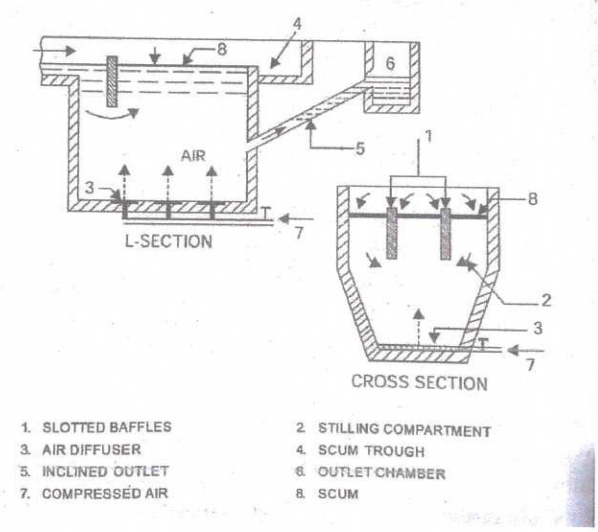
II.5



3

Man-hole consists of a man-hole cover, access shaft and a working chamber. It is a concrete or masonry structure to have a working chamber with sufficient space for a man to stand inside and carry out work. The chamber is either circular minimum dia 1200mm or rectangular 900x1200mm in plan. The access shaft provides access to the working chamber. A series of steps are provided to the side of manhole for descending into the working chamber. The top of the access shaft is covered with R.C.C slab with an opening for man-hole cover made of cast iron. The man-hole is built on a concrete bed of 150 to 300mm thick. The concrete floor of the chamber slopes at 1 in 6 towards the centre so that sewage from inlet sewers flows into the semi circular channel and then into the outlet sewer. 3 6

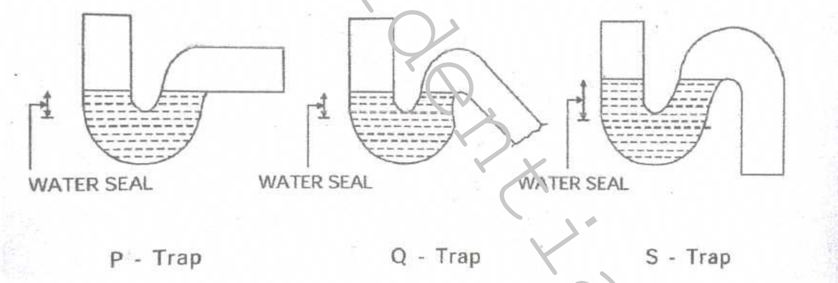
II.6



3

Skimming tank is a chamber in which the floating substances like oil, grease etc is separated and removed. Sewage is allowed in the tank and detained for 3 minutes and skimmed or agitated by sending compressed air through air diffusers provided at the bottom. The oils, fats and grease whose specific gravity is less than one are separated from water and float to the top surface. The floating substances are collected in the outlet channel and then removed. 3 6

II.7 Traps according to shape:



3x1

P – trap: This has the shape of letter 'P'. The legs of this trap are at right angles to each other.

Q – trap: This resembles the letter 'Q'. The legs are at some angle other than 90*.

S – trap: This has the shape of letter 'S'. The legs of the trap are parallel to each other. 3x1 6 42

PART – C :

III.(a)

i) People with higher social and economic status have better standards of living and consume more water.

ii) Consumption of water is more during hot and dry climates due to increased use of bathing, air cooling, drinking, sprinkling lawns etc.

iii) Consumption is more in the towns of increased industrial and commercial activities.

iv) If the quality of water is not good, then people tend to use private wells.

v) If the quality of water is good, consumption will be more.

vi) Consumption is more in continous system, in which water is available through out the day.

vii) Consumption increases with increase in distribution pressure causing high rate of flow and availability of water to the upper floors.

viii) If metering is introduced, consumer will be cautious in using water.

ix) If water rates are high, less water may be consumed by the peaple. 8 x 1 8

x) Per capita demand is more for the towns with water carriage system.

xi) Rate of demand is low for smaller cities.

III.(b) Depending on the type of construction – Dug well, Sunk well, Driven well, Bored well and Drilled well. 1

Dug well: These are constructed by open excavation with hand tools like pick axes and showels or by blasting in rock formation. After excavation is completed, a well steining with masonry or concrete cavity blocks is constructed. Weep holes are provided in the steining to permit water into the well. A parapet is constructed above ground level and a circular platform is provided around the well. Provision for drawing water is made either by rope and bucket or pumping.

Sunk well: When soils are loose, and cannot withstand open excavation. a well curb with cutting edge made up of R.C.C is placed on the ground. Masonry or hollow concreted blocks in mortar is constructed to some height on the curb. Instead of masonry, R.C.C rings can be placed. Then the earth within the curb is scooped out by hand tools and thrown out, thus sinking the masonry or R.C.C rings slowly. The process is repeated till the required depth is reached.

Driven well: These are constructed by driving a casing pipe 25 to 100mm dia into the sandy unconsolidated unconfined aquifers to a depth of 25m. The lower end of the pipe is provided with a closed and pointed well point. The pipe is driven with hammer or by wet jet. The pipe is perforated or attached with strainer at bottom above the well point, through which water enters into the pipe and is then pumped out. any 2x3 7 15

Bored well: These wells are bored with augers by hand or machinery in cohesive soils. As boring proceeds, sections of rods are added to the auger stem. A well casing with strainer is inserted into the hole and is arranged with a pump to bale out water.

Drilled well: These wells are drilled by percussion, core or rotary drilling. A casing pipe is driven into the hole, dia varying from 0.15 to 1m and depth 100 to 300m. Strainers are provided at all places where aquifers are intercepted. A gravel pack is provided around the strainer. These are also called as tube wells.

IV. (a)

Year	Population	Increase in population 'i'	Incremental increase	
1931	350000	---	---	
1941	466000	116000	---	
1951	994000	528000	+ 412000	
1961	1560000	566000	+ 38000	
1971	1623000	63000	- 503000	
1981	1839000	216000	+ 153000	
1991	2430000	591000	+ 375000	
	Total	2080000	475000	2 + 2
	Average	346667	95000	

Population in 2021:

i) By arithmetical increase method = P + ni
= 2430000 + 3 x 346667
= 3470001. 2

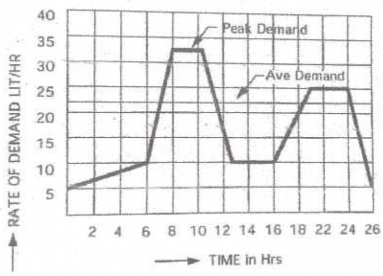
ii) By incremental increase method = 2430000 + 3 (346667 + 95000)
= 3755001. 2 8

IV.(b) Per capita consumption demand is not uniform throughout the year but varies in different seasons, different months of the year, different days of the month and different hours of the day named as Seasonal variation, Monthly variation, Daily variation and hourly variation. Allowance should be made in the design of water supply units to meet the peak demand.

Seasonal variation: The maximum consumption occurs during summer and is about 130% of the average consumption. These fluctuationsmay also be caused due to variation in use of water by industries in different seasons. 2

Daily variation: This reflects household and industrial activities and depends on the habits of the people, climatic conditions of the day and nature of the industrial and commercial activity. The consumption is more on Sundays and holidays. Maximum daily consumption is about 180% of the average daily consumption. 2

Hourly variation: The demand is less during 0 to 6 AM and increases sharply to the peak value between 8 to 10 AM, then decreases upto about 1 PM, remains constant upto 4 PM, again increases in the evening reaching another peak between 6 to 9 PM and finally falling to a low value in the late hours of the night. Maximum hourly variation is taken as 150% of the average demand.



3 7 15

V. (a)

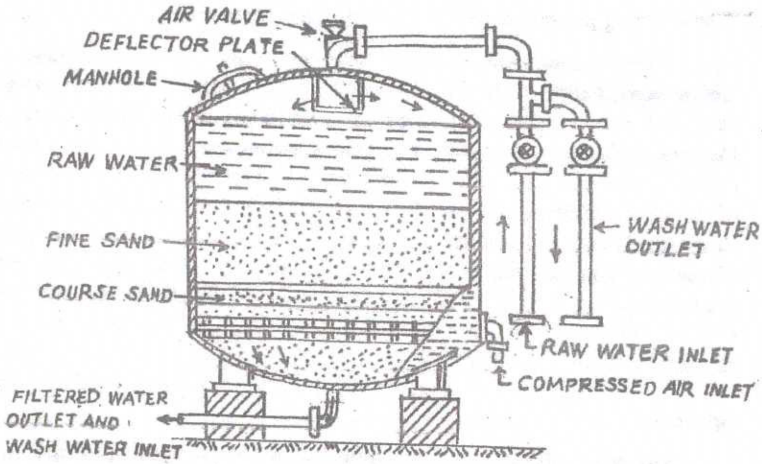


fig 3

Pressure filter is a rapid gravity sand filter enclosed in an airtight cylindrical steel container. The sand bed is 45 to 90 cm thick and lies upon graded layers at the base of which are perforated collecting pipes for collecting the filtered water. The coagulated water allowed into the filter passes through the sand and gravel and finally emerges at a pressure sufficient to allow distribution without pumping. The rate of filtration is high , 100 to 250 litres/ sq.m/mt. Pressure filters are used for small public supplies, industrial plants and for swimming pools. The efficiency of removal of suspended matter and 4 7
bacteria is very low and hence not suitable for treatment of public water supply.

V.(b) Forms of chlorination:

i) **Plain chlorination:** This is chlorination in plain or raw water in the reservoir, which checks growth of weeds, organic matter and algae.

ii) **Pre-chlorination:** This is application of chlorine before filtration. It improves coagulation and reduces loads on filters.

iii) **Post-chlorination:** This is addition of chlorine after all the other treatments. Chlorine is added to the filtered water well to make adequate time of contact.

iv) **Break point chlorination:** When chlorine is passed into water, it removes or kills bacteria and oxidises organic matter. Chlorine is first used up for disinfectioning. During disinfectioning, amount of residual chlorine is less in the beginning and gradually increases as the demand is satisfied. After this, oxidation of organic matter starts and chlorine is again used up and water contains less residual chlorine. When this demand is also satisfied, the amount of residual chlorine again increases. The stage at which both these demands are satisfied and amount of residual chlorine increases is called Break point. At this stage, any further dose of chloring added reappears as free chlorine.

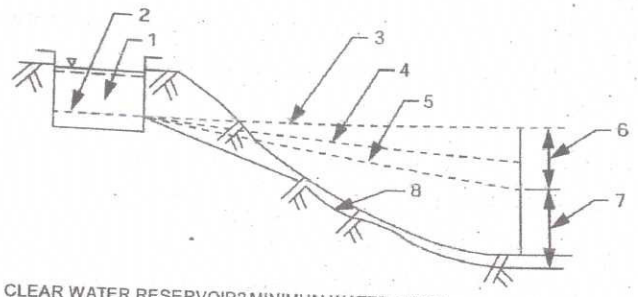
v) **Super chlorination:** In this, excessive of chlorine is added to water when it is heavily polluted and during periods of water borne diseases.

vi) **De-chlorination:** Presence of chlorine gives an unpleasant taste and odour to water. This chlorine can be removed by a dose of Sulphur di oxide for large supplies and sodium thio sulphate for small supplies.

vii) **Chloramines:** Ammonia is added to filtered water half an hour before addition of chlorine and chloramines are formed. Dosage of ammonia, chlorine is 1:4.

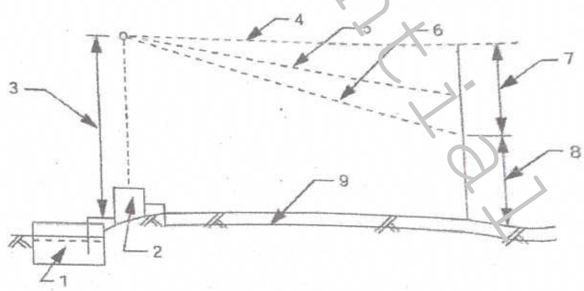
viii) **Hypo chlorination:** This is the hypochlorite of lime. Bleaching powder is dissolved in water and the solution is added to filtered water. A dose of 1.5 to 4 kg/ML is used. This needs 24 hours for its action. 8 15

VI.(a) Gravity system: In this system, water is distributed by gravity only to the consumer points. It is suitable where the source of water is located at a higher level than the town to maintain the required pressure after allowing the frictional and other losses in the pipes. This system is economical since no pumping is involved. It needs a lake or storage reservoir as a source of supply located at a higher level.



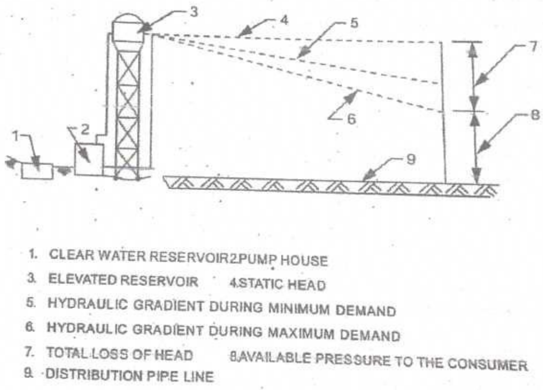
1. CLEAR WATER RESERVOIR2.MINIMUM WATER LEVEL
3. STATIC HEAD
4. HYDRAULIC GRADIENT DURING MINIMUM DEMAND
5. HYDRAULIC GRADIENT DURING MAXIMUM DEMAND
6. TOTAL LOSS OF HEAD 7.HEAD AVAILABLE TO CONSUMERS
8. DISTRIBUTION PIPE LINE

Direct pumping system: In this system, the treated water is directly pumped into the distribution of pipes by means of high lift pumps without storing. The high lift pumps should be capable of being operated at variable speeds to meet the maximum and minimum demands and maintain sufficient residual pressures at various points of consumption.



1. LOW LEVEL CLEAR WATER RESERVOIR 2. PUMP HOUSE
3. PRESSURE DEVELOPED BY PUMP 4. STATIC HEAD
5. HYDRAULIC GRADIENT DURING MINIMUM DEMAND
6. HYDRAULIC GRADIENT DURING MAXIMUM DEMAND
7. TOTAL LOSS OF HEAD 8.HEAD AVAILABLE TO CONSUMERS
9. DISTRIBUTION PIPE LINE

Combined or pumping with storage system: In this system, the treated water is pumped at constant rate into and elevated reservoir as well as directly into distribution system. During the minimum demand, pumping rate is more than the demand. This excess water is pumped to and stored in the elevated reservoir and used during maximum demand by gravity.



8

VI.(b)

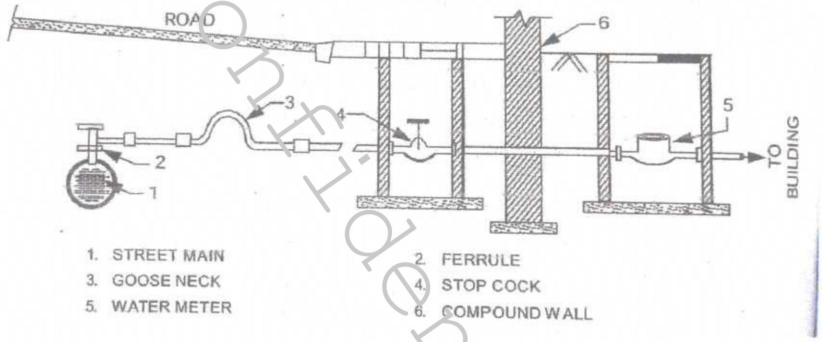


fig 4

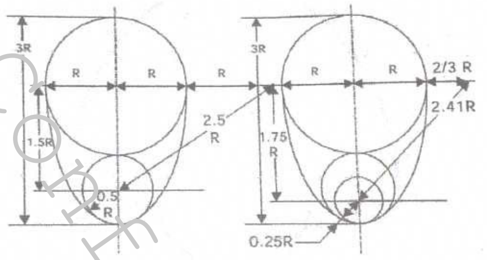
The water supply to a house or building begins with the connection of the service pipe by means of Ferrule fixed to the water main or lateral. A 'goose- neck' or expansion loop is provided to avoid stresses and strains on the joint due to variation of temperature and vibrations. A stop cock is fixed outside the compound. 3 7 15
A water meter, housed in a small chamber is also provided for the measurement of consumption of water.

VII.(a) Combined sewerage system: In this system, only one set of sewers is laid which carry the domestic and industrial sewage and also the storm water. This system is suitable for areas with small and evenly distributed rainfall and where combined sewage has to be pumped and also for heavily built up areas with a little space for laying sewers.

Separate sewerage system: In this system, there are two separate set of sewers. One set carries domestic and industrial sewage and another set carries storm water. This system is suitable for towns with heavy uneven rainfall and also where sewage is to be pumped and also suitable for areas with steep slope and hard soils.

Partially separate or partially combined sewerage system: In this system, there are two separate sets of sewers. One set carries domestic and industrial sewage and also a part of storm water during heavy rains. The other set carries only storm water during normal rains. As it is a compromise between combined system and separate system, it is suitable for situations with average conditions of distribution and intensity of rainfall and occasional heavy rains. 7

VII.(b). Egg shaped sections: This is used both in the combined system where dry - weather flow is small as compared with the total capacity of the sewer, as well as in the separate system for town or a city where the present population is only a small proportion of the ultimate development as then allows for increased future flows. There are two types of egg shaped sections, Standard egg shape and New ovoid shape. These two forms are constructed with R.C.C m masonry at site. New ovoid shape is an improvement over standard egg shaped section.



(a) Standard Form (b) New Ovoid Form

2+2

Merits: i) Self cleansing velocity will be available even during small discharges.

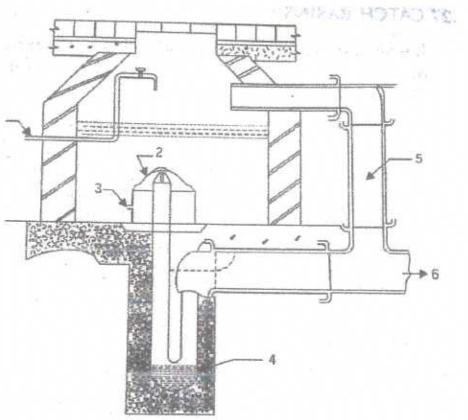
ii) Suitable for combined sewerage system as well as separate system. 2

iii) Better hyraulic properties compared to circular sections.

Demerits: i) Construction is difficult.

ii) Less stable than circular sections. 2 8 15

VIII.(a)



1. WATER SUPPLY AT REGULATED RATE
2. BELL   3. SNIFF HOLE   4. SYPHON PIPE
5. OVER FLOW PIPE   6. TO SEWER

4

A **Flushing tank** is a device which holds and then quickly releases periodically sufficient quantity of water in to the sewer so that the deposited solids in the sewer are flushed and washed away. It consists of a concrete chamber fitted with a U-tube acting as a syphon and inverted bell with a sniff hole. The tank receives water from a tap which is regulated as per design depending on the period between successive flushings. The discharging leg of the syphon is connected to the sewer. An overflow pipe is also fitted.

As the water rises in the tank, some air is entrapped in the bell and further rise in the water level compresses the air inside. When the water reaches the overflow level, syphonic action starts automatically and water is quickly released into the sewer causing flushing. The water level now falls to the level when sniff hole is exposed. Air enters through the sniff hole and stops syphonic action and the flushing stops. 4 8

VIII.(b)

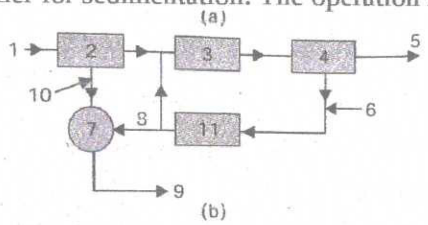
BOD: It is the amount of oxygen required for biological decomposition of biodegradable organic matter under aerobic conditions and expressed in mg/lit. The oxidation process proceeds in two stages. In the first stage, carbonaceous matter is oxidised and in the second stage, the nitrogenous matter is oxidised. Nearly 70 to 80 percent of total B O D is satisfied within 5 days at a temperature of 20* C.

The dissolved oxygen value of the sewage sample diluted with aerated distilled water is first found. Then the sample is added with small amount of nutrient salts and incubated for 5 days at 20*C. The residual dissolved oxygen in the sample after incubation is determined. The difference in D.O before and after incubation gives the depletion of oxygen in ppm. B O D_5 = Depletion of oxygen in ppm X Dilution factor. 4

pH value: It is the logsrithm of the reciprocal of hydrogen ion concentration. It shows whether the sample is acidic or alkaline in nature. The fresh sewage is slightly alkaline and as it becomes stale, it turns acidic. In chemical and biological process of treatment, the pH value is so adjusted that each process is carried out efficiently. 3 7 15

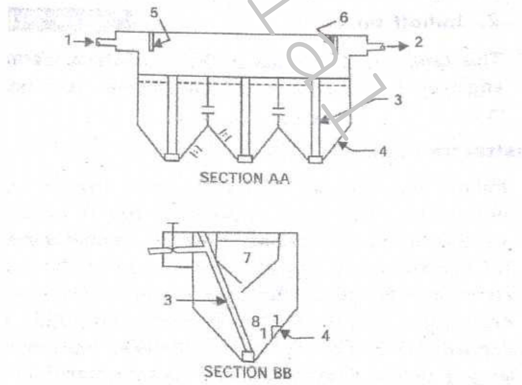
IX.(a) Activated sludge process is the method of secondary treatment of the effluent from primary sedimentation tank.The sludge of the sewage which is previously agitated under aerobic conditions containing full of aerobic bacteria is called as activated sludge. It consists of a rectangular tank 3 to 4.5 m deep, 6 m wide and 10 to 20 m long. The tank has an arrangement of sending diffused air from the bottom or mechanical agitators.

The primary effluent is mixed with a portion of activated sludge and allowed in to the tank. This mixed liquor is then aerated in the presence of air. The aerobic bacteria kept in suspension oxidise the sludge. The oxidised sludge is withdrawn and sent to secondary clarifier for sedimentation. The operation is a continous process. 4



1. RAW SEWAGE
2. PRIMARY SEDIMENTATION TANK
3. AERATION TANK
4. SECONDARY SEDIMENTATION TANK
5. EFFLUENT
6. ACTIVATED SLUDGE RETURN
7. SLUDGE DIGESTION
8. WASTE SLUDGE
9. TO SLUDGE DRYING BEDS
10. RAW SLUDGE
11. REAERATION TANK

IX.(b) Imhoff tank consists of two chambers arranged one below the other. Upper chamber is used for sedimentation of solids and the lower chamber is meant for digestion and storage. The lower chamber has an hopper bottom. The sewage enters the sedimentation chamber and solids are deposited in it. The effluent is withdrawn from the outlet and sent to the soak pit or for biological treatment. The sludge settled in the upper chamber slides down into the digestion chamber. There the sludge undergoes anerobic digestion. The digested sludge settles into the hoppers from which it is withdrawn by sludge pipe under hydrostatic pressure. The top of the tank may be provided with a floating steel dome to collect the gas which can be used as a fuel. The detention period in sedimentation chamber is 2 to 4 hours. Length of the tank 30 m and length to depth ratio is 3 to 5. Depth of sedimentation chamber only is3 to 3.5 m with total depth as 9 to 11 m.



1. INLET
2. OUTLET
3. SLUDGE REMOVAL PIPE
4. HOPPER BOTTOM
5. INLET BAFFLE
6. OUTLET BAFFLE
7. SEDIMENTATION CHAMBER
8. SLUDGE DIGESTION CHAMBER
9. RECIRCULATION

X. (a)

i) The drainage pipes should be designed to carry waste water at atmospheric pressure.

ii) The diameter and slope of pipes should be designed to maintain self-cleansing velocity to avoid deposits.

iii) Sanitary blocks should be located that length of drainage pipes required is minimum.

iv) In multi-storeyed buildings, the sanitary blocks should be arranged one above the other.

v) Traps should be provided at all necessary points.

vi) All the pipes should be strong, durable, water tight and resistant to corrosion.

vii) Alignment of pipes should be straight. 7X1

viii) Rain water pipes should be planned to drain away rain water to street gutters.

X. (b) Total number of students = 200

Rate of water supply = 100 lpcd

<u>Assumptions:</u>

Detention period = 24 hours.

All the water consumed is converted as sewage.

Effective depth of tank = 1.5 m

Quantity of sewage discharged into septic tank = $\frac{200 \times 100}{1000}$ = 20 m^3/ day 2

Capacity of the tank = $\frac{20 \times 24}{24}$ = 20 m^3 2

Plan area of the tank = $\frac{20}{1.5}$ = 13.33 m^2 2

Assume $\frac{L}{B}$ = 2.5 , Breadth B== 2.31 say 2.4 m

Length L = 2.5 x 2.4 = 6 m 1

Allow 0.5 m for free board and scun depth.

Total depth = 1.5 + 0.5 = 2 m

Hence provide 6 m x 2.4 m x 2 m tank. 1 8 15
