BALASORE SCHOOL OF ENGINEERING

Water Supply & Waste Water

Engineering

SEM: 5TH

BRANCH: CIVIL

SUB CODE -(TH- 04)

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Chapter-1

Short Question : 2 (marks)

1. **Explain the term per capita demand. (2015) (s) 3(a), 2015 (BP) 1(a) 2013(w) 1(c)**
Ans : It is the annual average amount of daily water required by one person and includes the domestic use industries and commercial use, public use, wastes, thefts etc.
2. **What is the meaning of LPCD ? 2014 2(a)**
Ans : LPCD Stands for litre per capital day.

Chapter-1(5 Marks)

1. **Describe briefly various types of water demand. 2015 4(b) 2016 3(b)**
Ans. Following are the various types of water demant of a city of town.
(I) Domestic water demand.
(ii) Commercial and Industrial demand.
(iii) Fire demand.
(iv) Demand for public uses.
(v) Compensate losses demand.
Domestic water demand : The total consumption in this demand, generally amounts to 55 to 60% of total water consumption the break up of 135 It/day/person. Commercial and Industrial demand — Commercial building and commercial centres include office building, water house, stores, hotels, shopping centers, health centres, schools, temples, cinema house, railways and bus stations etc. The water requirements of commercial and public places may be upto 45 It/day/ capital.
Fire demand
Demand to public uses-Provision of 5% of the total consumption is made while designing the water works for a city.
2. **Explain one methods of forecasting population :**

2014 1(b), 2013 2(b) 2016 (2b)

The future population may be estimated by the methods described below for the given data.
1. **Arithmetical mean method** Here, we assume that actual increase in-population is constant. This may be taken either as an increase in the last decade or may be taken as an average of the increase in the 2 or 3 decades.
2. **Uniform percentage growth method or geometrical increase method:** In this method, the percentage increase (ratio) from decade to debate is constant.
This method is suitable *en the city is young and rapidly increasing.

3. **Describe briefly the factors affecting the per capita demand of a city. 2014 2(b)**
Ans : Ans. The factors affecting the average per capita
demand of water of a city are as follows
1. **Size of the city –** The per capita demand for big cities is generally large as compared to that for smaller towns. This is because of the fact that in big cities huge quantities of water are required for maintaining clean and healthy environments.
2. **Climatic conditions-** At hofter and dry places, the consumption of water is generally more, because more of bathing, clearing, air coolers, air conditioning, sprinkling in lawsn, gardens, roofs etc are involved. Similarly, in extremely cold countries, more water may be consumed, because the people

may keep their taps open to avoid freezing of pipes and there may be more leakage from pipe joints, since metals contract with cold.

3. **Industrial and Commercial Activities**=The pressure of industrial and commercial activities at a particular place increases the water 3ewerage3on by large amounts.

4. **Quality of Water Supplies** — If the quality nd taste of the supplied water is good, it will be consumed fore because in that case, people will not use other ources such as private wells hand pumps etc.

5. **Pressure in the distribution system** — If the pressure in the distribution pipes is high and sufficient to make the water reach at 3rd or even 4th storey, water consumption shall definitely be more.

6. **Development of 3ewerage facilities** — The water consumption will be more, if the city is provided with flush system and shall be less if the old conservation system of latrines is adopted.

7. **System of supply** — The water may he supplied either continuosly for all the 24 hours of the day, or may be supplied only for peak periods during the morning and evening.

1.   The Population statics pertaining to a town are given below. Estimate the population expected in 2060 by arithmetical and geometrical increase method.
2015   2014 1(c)

Po

Year	Population in thousand
1980	22. 6
1990	27. 8
2000	33. 6
2010	39. 8

Estimate the population of the town by arithmetical and geometric method for 2030.

Ans.

Year	Population (thousand)	Increase in Population (thousand)	%increase in Population
1980	22.6	—	—
1990	27.8	5.2	23%
2000	33.6	5.8	20.86%
2010	39.8	6.2	18.45%

$$\bar{x} = \frac{5.2 + 5.8 + 6.2}{3} = 5.73$$

Population expected in 2030 by arithmetical increae method

$$= P_o + n\bar{x}$$
$$= 39.8 + 2 \times 5.73$$
$$= 51.26 \text{ thousands.}$$

$$r = \sqrt[3]{23 \times 20.86 \times 18.45} = 20.68$$

Population expected in 2030 by geometrical

increased method $= P_o\left(1 + \frac{r}{100}\right)^n$

$$= 39.8\left(1 + \frac{20.68}{100}\right)^2$$

$$= 57.96 \text{ thousands.}$$

CH-2(2 MARKS)

1. **What do you mean by unconfined aquifer ? 2015 6(a)**

Ans. The top most water bearing stratum having no confined impermeable over burden (i.e. aquiclude) lying over it is known as an unconfined aquifer or non- artesian aquifer.

2. **Define specific yield.   2016 1.(e)**
Ans : The volume of ground water extracted by gravity drainage from a saturated water bearing material is known as the yield and when it is expresses as the ratio of the volume of the total material drained, then it is known as specific yield. S.P. Yield =

$$\text{S.P. Yield} = \frac{\text{Volume of water obtained by gravity drainage}}{\text{Total volume of the material drained}} \times 100$$

3. **What is self cleaning velocity ?   (2015 6(a)**
Ans : The silting of sewers can be avoided by generating such high velocities that would not permit the solids to settle down, i.e. the velocity should be such as to cause automatic self-cleansing effect. Such a self cleansing velocity, i.e. the velocity which will even scour the deposited particles of a given size, must be developed in the sewers.

4. **What do you mean by cone of depression ? 2016 3(a)**
Ans : A cone of depression occurs in an aquifer when ground water is pumped from a well. In an unconfined aquifer, this is an actual depression of the water levels.

5. **What is yield at a well   (2016   2(a)**
The flow rate of well is usually defined as the rate in gallons per minute that water can be extracted from or pumped out of a well.

CH-2 (5 MARKS)

1. **Explain about the surface sources of water supply :-   (2015 6(b)**
Explain about the surface sources of water supply.
Ans. Water is available at the ground surface is known as surface sources of water.
 It includes the following:
(I) Lakes and ponds
(ii) Streams or rivers
(iii) Storage reservoir
(iv) Oceans
(i) Lake: Lake water may have plenty of algae, weed and other vegetable growth imparting bad smell, tasks and colour to the water.
(ii) Streams or Rivers In the mountains the river water is fairly pure but as the river approaches plains the quality deteriorates considerably, since it picks up lot of suspended matter, clay, slit etc.
(iii) Storage Resorvoir : The storage resorvoir are the main sources of water supply for big cities.
(iv) Oceans: Highly saline. The process of removing salt from water is known as "desalination".

In a recuperation test, the following results were obtained :

Initial depression head = 10 m
Final depression head = 6 m
Time of recuperation = 6 hrs
Diameter of well = 4 m.

Calculate the specific capacity of well and yield under the head of 3 m.

Ans. yield $= Q = \left(\dfrac{C'}{A}\right) A.S$ .....(1)

Specific capacity $= \dfrac{C'}{A} = \dfrac{2.3}{T} \log \dfrac{S_1}{S_2}$

Specific capacity $= \dfrac{C'}{A} = \dfrac{2.3}{3 \times 60 \times 60} \log \dfrac{10}{6}$

$= 0.47 \times 10^{-4}$

From equation (1) we get,

Yield, $Q = 0.47 \times 10^{-4} \times \dfrac{\pi}{4} \times 16 \times 3$

$= 1.78 \times 10^{-3} \ m^3/s$

$= 1.78 \dfrac{litre}{sec.}$. (Ans)

(5 Marks)

3.Write briefly advantages and disadvantage of R.C.C Pipes.

Ans : Advantages of R.C.C. Pipes.

➢ They can resist external compressive loads and do not collapse under nominal vaccums and traffic loads.
➢ They are not corroded tiom inside by normal potable waters and from outside by ordinary soils.
➢ They are quite strong and their useful life is ofthe order of 75 years or so.
➢ They are easy to construct either at site or at factories and with local ingradients.
➢ The coefficients of expansions being low, expansionjoints maynot be needed when bid above the ground.
➢ if lain under water the empty pipes donot float because of their heavy weights.

Disadvantages of R.C.C. pipes

➢ They are like to corrode by ground waters due to the presence of acids, alkalis or sulphur compounds.
➢ They are difficult to be repared.

- They can't withstand very high pressure.
- They are heavy and bulky and hence difficult to transport.
- Making of connections in them is a little difficult job.

CHAPTER-3(MARKS)

CH-6 (2 MARKS)

1. Define plain sedimentation. 2015 5(a), 2013 1(b)

Ans. Plain sedimentation is the process of removing suspended matters from the water by keeping it quiescent in tanks, so that suspended matter may settle down in the bottom due to force of gravity.

2. Define Flocculation 2015 7(a)

Ans : Flocculation :

- It is a gentle mixing stage, increase size from sub-microscopic microfloc to visible suspended particles.
- The microflocs are brought into contact with each other through the process of slow mixing.
- Collisions of the microfloc particles cause them to bond to produce larger, visible flocs called pinflocs.

3. Define disinfection of water 2015 6(a) 2016 4(a)

Ans : Disinfection of water :

The filtered water which is obtained either from slow send filter or rapid gravity filters may contain.
Some harmful disease causing bacteria in it.

These bacteria must be killed in order to make the water safe for drinking.

The process used for killing these bacteria is known .as disinfecctiOfl of water.

4. Define detention period of a setting tank (2013 (w) 1(d)

Ans : Water should be electained in the setting zone for such a period that all the desired suspended particles may reach the sludge zone & are removed. The time for which a water is detained in the setting time is called detention period.

5. What do you mean by hardness of water ? 2013 (1 (g) 2014 7(a)

Ans. it is the property of water whióh prevents the lathering of the soap. It is caused due to the presence of carbonates & suiphates of calcium in the water. Sometimes the presence of chlorides & nitrates of calcium & magnesium also cause hardness in the water.

6. Define coagulation : 2014 (3)a

The process of addition and mixing of the chemicals (coagulats) to increase the size of very fine suspended mud particles and colloidal matters present in water is called the coagulation.

1. **Differentiate between slow sand and rapid sand filter. 2015 (s) 1(b) 2013 (2(b) 2014 3(b)**

| Item	Slow Sand Filter	Rapid Gravity Filter
1. Area	Requires very large area	Requires small area
2. Quantity of sand	Requires considerable quantity of sand	Requires less quantity of sand
3. Quality of sand	Finer filter media of 0.2 to 0.4 effective size and 2 to 4 uniformity coefficient	Slightly coarser filter media media of 0.36 to 0.6 effective size and 1.2 to 1.8 uniformity coefficient
4. Quality of raw water	It may not be treated with chemicals, but should not have turbidity more than 50 p.p.m.	Treatment with chemicals is essential
5. Flexibility in operation	Not possible	Possible
6. Rate of filtration	100-180 litres/m²/hour	4,000 − 5,000 litres/m²/hour
7. Size of one unit	30 m × 60 m	6 m × 8 to 8 m × 10 m
8. Distribution	Uniform	Smaller at top and coarser in bottom
9. Underdrainage system	Open jointed pipes or drains covered with blocks	Manifold and pipe laterals, vitrified tile blocks, the wheeler filter bottom, the porous plate bottom concrete ridge and valley bottom etc.
10. Period of cleaning	1 to 3 months	24 to 48 hours
11. Method of cleaning	Scrapping 2-3 cm sand from the surface and replacing it with new sand	By back washing with water under pressure, with or without compressed air agitation before washing with water
12. Skilled supervision	Not required	Most essential
13. Loss of head	15 cm to 75 cm	2 m to 4 m
14. Penetration of impurities	Very small, only a dirty layer surface	2 m to 4 m very deep
15. Amount of water washing	0.2 to 0.6% of filtered water	2 to 4% of filtered water
16. Overall cost of unit	More, because large land and much quanity of materials are required	Cheap and economical
17. Cost of maintenance	Small	More
18. Efficiency	Efficient in removal of bacteria bacteria and suspended matter	Cannot remove all bacteria disinfection necessary. Removes colour, odour and taste.

2. Explain break point chlorination : 2015 5(b), 2014 4(b)

Ans. The chlorine when passed into water removes or kills bacteria (i.e. disinfection is effected), and oxidized organic matter. The chlorine is first used up for disinfection. During the disinfection process, the amount of residual chlorine will be less in the beginning and will gradually increase as the demand for disinfection is satisfied. After sometime, the demand starts to be Lisfied, i.e.the oxidation of organic matter starts and e chlorine again starts to be used up and water contains less and less amount of residual chlorine as the process continues. When this demand is also satisfied the amount of residual chlorine again builds up.The stage at which both these demands are satisfied and residual chlorine just tends to increase is called the 'break-point', Le. ay further doese of chlorine re- appears as free chlorine. The Worine is added in such amounts which gives the residual chlorine as 0.1 -0.2 ppm. The break-point chlorination also clear from figure.

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Break-point chlorination
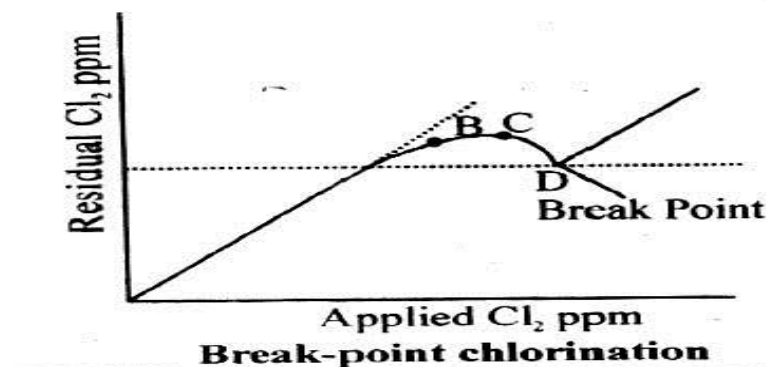
3. What is necessity of water softening ?   213 2(a)) 2014 5(b)
Ans : The reduction of hardness of softening is also concerned withwater supply engineering. The purpose of reducing hardness is:
1. To reduce the soap consumption – For ordinary domestic use hardness has no
effect on human health usless it is excessive (i.e. of the order of 200- 300 ppm);
2. To reduce work in laundries;
3. To increase the efficiency of filtration;
4. To prevent the scale formation in steam boilors;
5. To aid in removal of colour, iron and manganese;
6. To render the water non-corrossive ; and
7. To improve cooking of food etc.

4.What are the physical tests carried out to examiner water ? (2015 3(b) 2016 4(b)

Ans. The physical examination consists in finding out the temperature, turbidity, colour, taste and odour of a sample of water.

i.   **Temperature** - For drinking purpose the temperature of water should not be beyond 27°C.

ii.   **Turbidity** - ft is an indication of apparent colour of water due to presence of suspended inorganic mater like silt, clay etc. This is expressed by the amount of suspended mater in parts per million (ppm) by weight in water as ascertained by optical observation. The standard unit of turbidity is that produced by I part of finely divided silica in million parts of distilled water. Turbidity may be also be measured by immersing a standard platinum wire 1.0mm in 10iameter in the sample of water under standard lighting conditions and nothing the exact depth at which it disappears from view, while seeing through naked eye. It is also measured by Jackwon Turbiditymeter. For less turbidity (5-100 ppm) the Baylis Turbiditymeter is used.

iii.   **Colour** — The colour of water is due to substances in the true solution or in colloidal suspension. This is measured by comparing water with standard solutions of platinum-cobalt or standard coloured glass discs. In case of colour also, the unit of colour is that produced by 1.0mg of platinum in a litre of distilled water. The maximum permissible colour for drinking purpose is 20 units or2O ppm on platinum- cobalt scale. The colour is harmless but it cannot be allowed more than 20 ppm as the consumer feels repellant. According to IS 3025 – 1964, if 1.245 g of potassium chloroplatinate and I .Og of cobalt chloride are dissolved in distilled water and then the solution is diluted to 1.0 litre, the same has a colour of 500 Hazen units.

iv.   **Taste and odour** — The taste and odour in water are due to mineral salts, tarry substances, industrial wastes, domestic sewage etc. The odour is expressed as a number which is called "Threshold Odour Number". The number indicates the maximum dilution to a made of a sample, i.e. if 100 cm3 of fresh water have to be added to 8 cm3 of a sample of water to produce no effect of odour in it, the Threshold OdourNumber is 8. If more than 8cm3 of a sample of water is added to 100 cni3 of fresh water, the odour is produced.

Chapter-6 (7 Marks)

1.Explain the minor methods of disinfection of water.2015 1(c)

Ans. Due to small size of bacteria it is not possible to ensure their complete removal from water by physical and chemical means alone and for potable water suppliers, it is necessary to ensure the death of harmful microorganisms by disinfection.

The methods of disinfection of water is discussed below:

(i) Chlorine: Chlorine and its compound is widely used for the disinfection of water because of the following advantages:

➢   It is readily available as gas, liquid or power.
➢   It is cheap. It is easy to apply to its high solubility.
➢   It is very toxic to micro organisms. It has several secondary uses, e.g., - oxidation of iron, manganese and H,S, destruction taste and odour.

ii. Ozone : Ozone (03) is an allotropic form of oxygen produced by passing dry oxygen on air through art electrical discharge by passing dry oxygen on air through an electrical discharge {(5000 —20,000 V), (50—500 H2)}.

-It is an instable, highly toxic flue gas with pungent odour of new mown hay.

-A powerful oxidizing agent it is an effcient disinfectant and useful in bleaching colour and removing tasks and odours.

-Like oxygen it is only slightly soluble in water and because of its is table form it leaves no residual.

(iii) Heat

-Disinfection by heat is very effective but costly and impairs polatability of water by removing do and dissolved salts.

-There is no residual effect. (iv) Ultraviolet and nuclear radiations:

-Micro-organisms are fairly sensitive to radiation damage due to the toxic effects of energy absorption their limited use is the fact that radiation is readily absorved by water leaving a thin film.

-There is no residual effect.

(v) Silver:

- Colloidal silver was used by the Romans to preserve the quality of water in storage jars, since at the concentration of about 0.05 mg/I, silver is toxic to most micro-organisms.

-The cost become excessive for other than very small suppliers.

(vi) Bromine:

Bromine has similar disinfection properties live chlorine and is sometimes used in swimming pools where residual tends to be less irritating to the eyes than chlorine residuals.

1. **Draw the flow diagram of water treatment plant and describe each unit. (2013(w) 2016 4©**
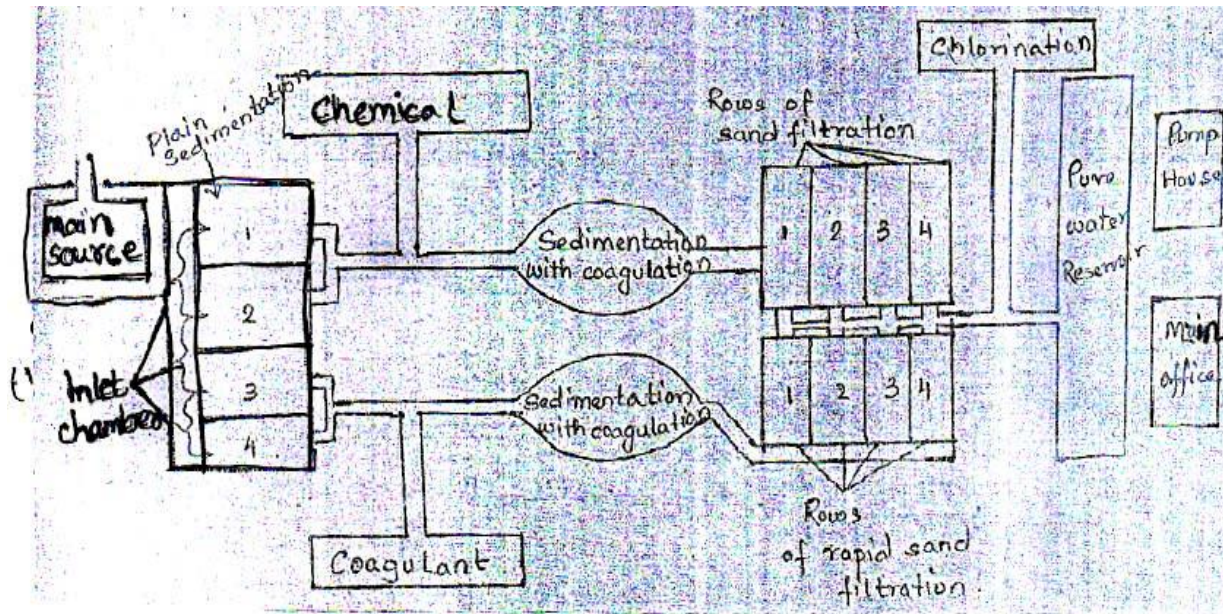
Treatment Process :-

1.Main source : From main source the process goes on scrieening due to the floating impurities.

2.   Plain Sedimentation :-

It is the process of removing suspended particulars from present in by tipping. The suspended particle settle down at the bottom of the tank.

Principle of sedimentation :-

Any particle which contain 115 shape and size while it settles down in the fluid, that is called district particles. All the particle having more specific gravity than the liquid will more vertically downward due to gravitational force.

Chapter 4 (2 Marks)

1.   Define gravity system of distribution of water :

Ans : Gravity system of distribution of water can be defined as the process of supply of water from the source to destination through channels by the help of gravity, it means from higher elevation to lower area.

(5 marks)

1.   Write any one method of distribution system of water.

Ans. Depending upon the methods of distribution, the distribution system is classified as follows.
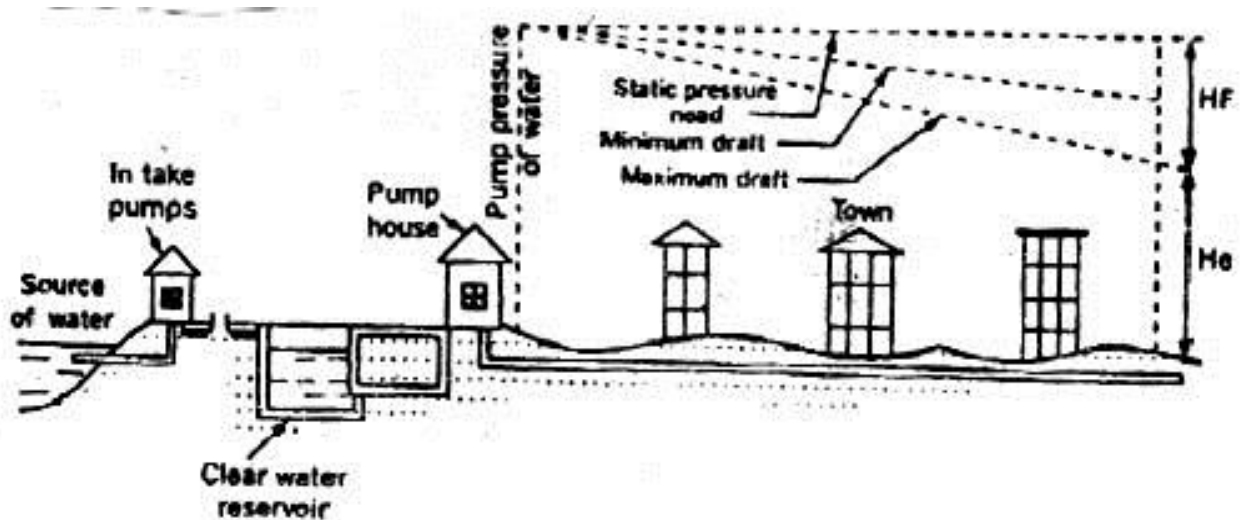
➢   Gravity system.
➢   Pumping system.
➢   Dual system or combined gravity and pumping system.

Gravity system

When some ground, sufficiently high above the city area, is available, this can be best utilized for distribution- system in maintaining pressure in water pipes. This method is also much suitable when source of supply such as lake, river or impounding reservoir is at sufficient height than city. The water flows in the mains due to gravitational force. As no pumping is required, therefore
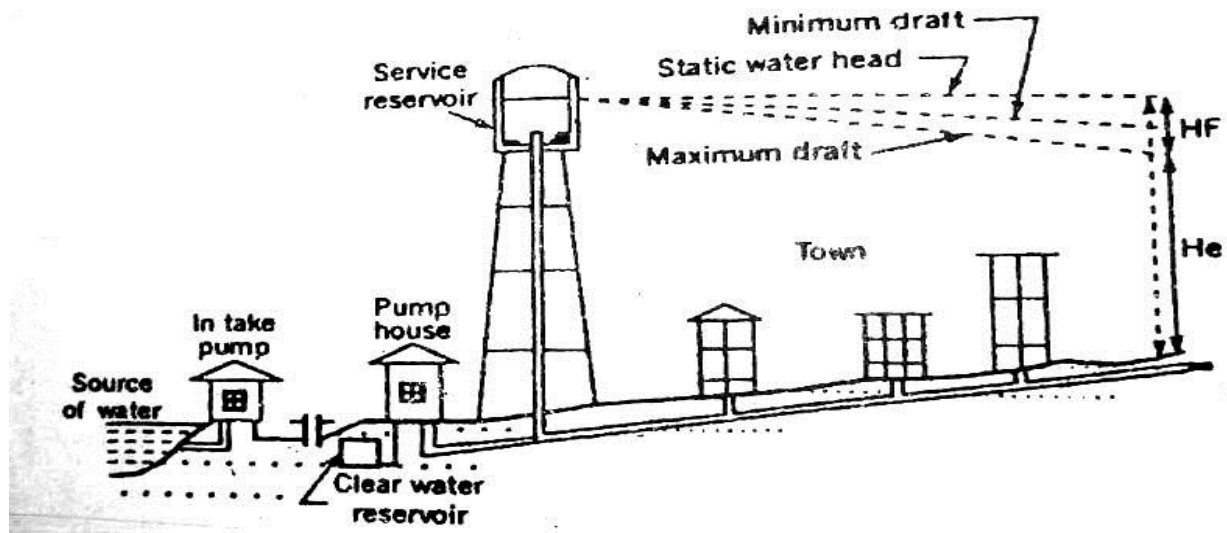
Pumping system -

In this system water is directly pumped in the mains. Since the pumps have to work at different rates in a day, the maintenance cost increases. It is preferred to have number of pumps and only the required numbers may work at various times to meet the varying demand, in place of providing pump of variable speedhigh lift çumps are required and their operations are continuously watched. If the power fails, the whole supply of the town will be stopped. Therefore, it is better to have diesel pumps also in addition to the electric pumps as stand bye.During fires, the water can be pumped in the required quantity by the stand- bye units also.

Dual system.

This is also known as combined gravity and pumping system. The pump is connected to the mains as well as to an elevated reservoir, in the beginning when demand is small the water is stored in the elevated reservoir, but when demand increases. The rate of pumping, the flow in the distribution system comes from both the pumping station as well as elevated reservoir. As in this system water comes from two sources one from reservoir and second from pumping station, it is called dual system.

Advantage of this system :-

a. The balance reserve in the storage reservoir will be utilized during lire. In case the fire demand is more, and if required the water supply of few localities maybe closed.

b. This system is overall best system. It is economical, efficient and reliable.

c. This system has the advantages that during power failure, the balance water stored in the water will be supplied to the town.

d. The pumps have to work at constant speed, without any variation in their speed. This increases the efficiency of the pumps and reduces the wear and tear of the pumps. The supervision, operation and maintenance of these pumps is much less as compared with the pumps working at variable speed.

(7 Marks)

1. Write down the different appurtenance in distribution system. 2013 (6) 2016(1(b)

Ans : After complete treatment of water, it becomes necessary to distribute it to a number of houses, estates, industries and public places by means of a network of distribution system. The distribution system consists of pipes of various sized, valves, meters, pumps, distribution reservoirs, hydrants, stand posts etc .The pipe lines carry the water to cacti and every street, road. Valves control the flow for water through the pipes. Meters are provided to measure the quantity of water consumed by individual as well as by the town. Hydrants are provided to connect the water to the fire fighting equipments during fire. Service connections are done tocontiect the individual building with the water line passing through the streets. Pumps are provided to pump the water to the elevated service reservoirs or directly in the watermains to obtain the required pressure in the pipe lines. The following are the requirements of a good distribution system.

(i) It should convey the treated water upto the consumers with the same degree of purity.

(ii) The water should reach to every consumer with the required pressure head.

(iii) Sufficient quantity of treated water should reach for the domestic and industrial use.

(iv) The distribution system should be economical and easy to maintain and operate.

(v) It should be able to transport sufficient quantity of water during emergency such as fire-fighting.

(vi) It shold be reliable so that even during breakdown or repairs of one line water should reach
that locality from other line.

Distribution System - For efficient distribution it is required that water shoukl reach to every consumer with required rate of flow. Therefore, some pressure in pipe line is necessary, which should force the water to reach at every place. Depending upon the methods of distribution, the distribution system is classified as follows.

(i) Gravity system

(ii) Pumping system

(iii) Dual system or combined gravity and pumping system.

CHAPTER-6(Marks)

1. **What is a vent pipe ?-   2013 1(h), 2014 5(a)**

Ans : It is a pipeline installed to provide circulation of air within adtrainage system of protect trap sales from siphonage and back flow .

2. **What is sewage ?)2016 5(a))**

Ans : Sewage is a water carried waste in solution or suspension, that is intended to be removed from a community. Also known as domestic or municipal waste water.

3. **What is sewerage ? 2016 6(a)**

Ans : Sewerage is the infrastructure that conveys sewage or surface runoff water rain water)

Chapter-7 (5 Marks)

Comparison between conservancy and water carriage system

Conservancy system	Water carriage system
Very chaps in initial cost	High initial cost
Its maintenance cost is expensive	Its maintenance cost is low
It is normally considered as system of rural condition.	It has been normally considered as system of Urban condition.
The labour force required is more	Only few labour are required.
The city remains dirty and foul smelling	The city appears net and clean
Large area required.	Small area required
Three is presence of segregation.	There is absence of segregation
They are Exist purification.	There is no chance of purification.

Chapter-07 (5 Marks)

1. **Determine the velocity ; circular sewer of diameter 160 cm sand on a slope of 1 iii 650 while running full by using Chezy's formula. Take value of C 70.**
2013 2(e), 2014 6(b) 2016 5(b)

Ans. According to Chezy's formula

$$V = C \sqrt{RS}$$

Where

V= Self Where,

V = Self clearing velocity

C = Chezy's constant

H Hydraulic meaii radius = d/4 when running hill

S = Slope of the channel

Given, C = 70, D 160 cm

$S = \dfrac{1}{650}$

$\therefore V = 70\sqrt{(\dfrac{1600}{4})x\dfrac{1}{650}} = 54.91mm/\sec.$

Chapter-8 (2 Marks)

1. **Write down different types of sewage system. 2013 1(f)**

Ans : There are 3 types of sewage system of follow .

i.Combined system.

ii. Separtae system

Partially separate system.

2.Mention the types of distribution system in the pipelines 2013 1(j)

Ans Gravitational system

Pumping system

Combined gravity and pumping system.

(7 Marks)

1. **Describe briefly the various types of sewers with respect to the material in which they are constructed.   2015 6 (c)**

Ans : Axis. The sewers of different possible materials and their comparative utilities are described below:

(i) Asbestos cement sewers Asbestos cement pipes are manufactured from a mixture of asbestos fibre, silica and cement, converted under pressure to a dense homogenous material, possessing considerable strength called asbestos cement.

The asbetos fibre which is thoroughly mixed with cement serves as reinforcement and provides a strongmaterial.

The pipe are normally available in sizes say fro 10 to 90cm in diameter and 4 meter in length.

(ii) Plain cement concrete and reinforced cement concrete Sewers

Plain cement concrete pipes are manufactured in small sizes (i.e., upto say 0.45 in diameter), while they are reinforced with steel reinforcement for large diameter pipes.

RCC pipes are easily available in sizes upto diameter say LX meters and may be got manufactured for larger diameters say upto about 4.5 meters on special orders.

(iii) Vitrified clay or stoneware on salt-gazed sewers

Vitrified clay pipes are widely used for carrying sewage and drainage as house connections as well as lateral sewers.

They are available in size of 5 cm increments from 10 to 30cm and in 7.5cm increments from 30cm to 90 cm. They are however rarely made in sizes bigger than 90 cm diameter.

iv) Brick sewers;

Bricks has been used as sewer material since ancient days. They however have now-a-days been almost replaced by cement concrete sewers.

Brick sewers are generally plastered on their outer surface so as to prevent the entry of tree roots and ground water through the brickjoints.

(v) Cast iron sewers:

Cast iron pipes are structurally stronger and capable of withstanding greater tensile, compressive as well as bending stresses but are costlier compared to cement concrete or stone ware pipes.

2. Describe briefly different types of sewerage system and discuss merits and demerits of each system.   2015 7(c)

Axis. The sewarage system can be of following three types:

(i)   Combined system

(ii) Separate system

(iii) Partially separate system

(1) Combined sewerage System

 Advantages

* Easy cleaning because of large diamenzi.
* Reasonable maintenance cost.
* Strength of sewage is reduced due to dilution of sewage by storm water.
* This system requires only one set or sewer making it economical

Disadvantages:

* In storm season sewer may overflow and the sewer may damage causing serious health risks.
* The combine sewer gets silted and become foul in dry days.
* Load on treatment plant is more because steam water is also carried there.
* The storm water gets polluted unnecessarily.
* The system becomes uneconomical when pumping is needed.

(ii) Separate sewerage system

Advantages

➢ The load on treatment plant is less as only sewage is carried to the plant.

- ➢ The size of sewer is small, thus economical.
- ➢ When pumping is jui.red, the system proves to be economical.
- ➢ Natural/storm water is not unnecessarily polluted by sewage.

Disadvantages

- ➢ Clearing of sewer is difficult due to their small size.
- ➢ The self-cleansing velocity is not easily obtained.
- ➢ The storm sewers come in operation in rainy season only. They may be choked in dry season by garbage.
- ➢ Maintenance cost is high.
- ➢ Sewage sewers are provided below storm sewer which causes greater depth and pumping at waste water treatment plant.

(iii) Partially separate sewerage system

Advantages

- ➢ If combines good features of both systems.
- ➢ The silting is avoided due to entry of storm water.
- ➢ The storm water from houses is easily disposed off
- ➢ The sewers are of reasonable size.

Disadvantages

A very small fraction of bad features of combined system are there in partially separated system.

Ch-9 (5 Marks)

1. **Explain manhole and different types of manhole. 2015 2(b), (2013 2(d) 2016 6(b)**
Ans. Manholes are masonary or R.C.C. chambers constructed at suitable intervals along the sewer lines, for providing access into them.

Which helps in joining sewer lengths and also help in their inspection, cleaning and maintenance. If the manhole covers are perforated, they may also assist in ventilating the sewers.

(Benching)
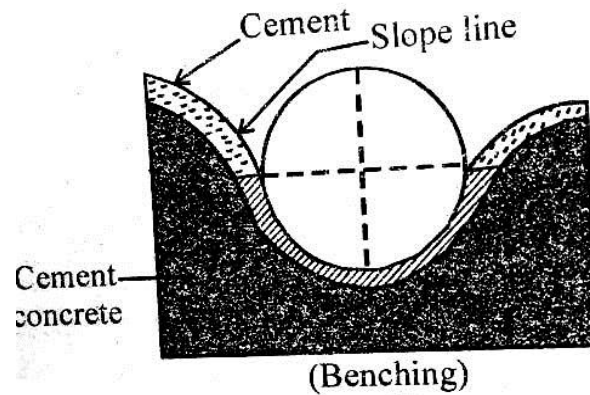
Classification of Manholes: -

Depending upon their depth, the manholes may be classified as:

I. Shallow manholes

2. Normal manholes

3. Deep manholes

A shallow manhole is about 0.7 to 0.9 m in depth, and is constructed at the start of branch sewer or at places, which are not subjected to heavy traffic. Such a manhole is provided with a light cover at its top, and is called an inspection chamber.

A normal or medium manhole is about l.5m in depth and is constructed either square (Im x 1 m) or rectangular (1.2 m x 1 m) in cross-section. Its section is not changed with depth, as is done in deep manhole. Such a manhole is provided with a heavy cover at its top.

A deep manhole is having depth more than I .Sm. The section of such manhole is generally not kept the same. The size of the upper portion is reduce by providing an offset, as shown in figure. Steps etc, are provided in such a manhole for facilitating descending into the manhole, and to enable the workers to go upto its bottom. Such a manhole is provided with a heavy cover at its top.

2. Inverted Syphon : 2013 7 (iii)

Ans : (c) During lying of sewer lins in a ton at some places, the hydraulic gradient line falls above the ground surface. If there is more depression in the ground the area is undeveloped or cultivated, sewer line can be laid above the ground by supporitig on piers. But sewer cannot be laid above the ground at such piaecs where road, canal and railway lines cross the sewer line. To overcome such an obstructions in sewer lines, inverted siphons are provided, inverted siphons axe also known as depressed sewers.

3. Explain Gully traps with neat sketch (2014 6(b)
Ans : Provision of gully traps is essential in the house drainage system. The aim of providing a gully trap (Figure) ãs to cut off the house fron the direct communication with the drain (by providing at least 7.5 cm water seal in it). They are employed for reception of waste water from sinks, baths, lavatory basins, and rain water and surface water from the paved yards. They are provided with good CI or SW grating (10mm, openings) on the top to deliver the waste water rapidly into the gully and to exclude the coarser matter. The gully traps are firmly bedded in conàrete and provided with flat bed. Open

gullies should be outside the house. The self-cleaning gullies should be used for sewage and path pit gullies, which retain deposits, should be used for surface water. Gully traps may have P or S-trap.

Gully trap
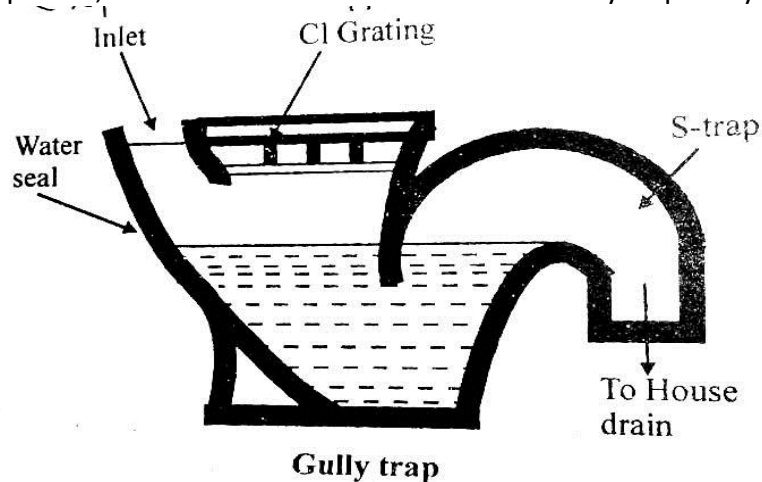
CH-13 (7 Marks)

1. Write down briefly about various types of sewer appurtenances. 2015 5(c)

Ans. The structure which are constructed at suitable intervals along the sewerage system to help its efficient operation and maintenance are called as sewer aprutenances.

These includes the following:

The man-hole :

The man hole is masonry of R.C.C. chamber constructed at suitable intervals along the sewer lines, for providing access into them.

Thus the man-holes helps in inspection, cleaning and maintenance or sewer.

(ii) Drop man-holes:

When the sewer connects with another sewer, where the difference in level between invert level of branch sewer and water line in the main sewer at maximum discharge is greater that 0.6 m, a manhole may be built either with vertical or nearly vertical drop pipe from higher sewer 4 to the lower one.

(iii) Lamp holes:

It is an opening on hole constructed in a sewer for purpose of lowering a lamp inside it.

(iv) Clean outs:

It is a pipe which is connected to the underground sewer. The other end of the clean-out pipe is brought up to ground level and a cover is placed at ground level.

(v) Catch Basins:

These are provided to stop the entry of heavy debris present in the storm water into the sewers. However their use is discourage because of the nuisance due to mosquito breeding apart from posing substantial maintenance problems.

(vi) Inverted siphons

An inverted siphon or depressed sewer is a sewer that runs full under gravity flow at a pressure above atmosphere in the sewer.

(vii) Storm water inlets:

Storm water inlets are provided to admit the surface run-off to the sewers.

These are classified in three major groups, i.e., curb inlets, gutter inlets and combined inlets.

(viii) Regulator or overflow device:

These are used venting overloading of sewers, pumping stations, treatment plants or

disposal arrangement, by diverting the excess flow to relief sewer pumping stations treatment plants or disposal arrangement by diverting the excess flow to relief sewer.

ix. Flap gates and flood gates :- Flap gates or backwater gates are installed at or near sewer outlest to prevent back flow of water during high hine, on at high stages in the receiving stream.

CH-14 (2 (Marks)

1.What do you mean by BOD ?   (2015 1(a) 2013 1(a),2014 1(a)

The extent of organic matter present in water sample can also be easily estimated by supplying oxygen on this sample and finding the oxygen consumed by the organic matter present in water. This oxygen demand is as Biochemical Oxygen Demand.

CH-15 2 MARKS

1. Define sewage sickness : 2015 4(a) 2013 1(k)

Ans. When sewage is applied continuously on a piece of land, the soil pores or voids may get filled up and clogged with sewage matter retained in them. When once these voids are clogged, free circulation ofair will be prevented and anaerobic condition will develop within the pores. This phenomenon of soil getting clogged is known as sewage sickness of land.

CH-15 (5 Marks)

1. Sewage farming 20137(ii) 2014 (7(c) (ii)

In case of sewage farming the stress is laid on the use of sewage effluents for irrigating crops and increasing the fertility of soil.

The pretreatment of sewage in removing the ingredients which may provide harmful and folic to plants is necessary.

Ans : **The cause of sewage sickness :-**

When the sewage is continuously applied on the land the pores of soil continuous goes on describing and stage comes when soil gets logged by the decomposition of solids.

At this stage, air can not reach the soil gets clogged by the decomposition of solids.

At this stage, air can not reach the soil pores and results anaerobic.

Then the cerobie condition starts, hydrogen sulphile gas is produced creating nuisanu in the area.

Thus the aerobic condition starts hydrogen sulphide gas is produced creating nuisance in the area.

Thus treatment capacity of land becomes poor and can not take more and slewge.

Hence, the land becomes sick

The remedies for sewage sickness ;-

By giving primary treatment to the sewage the suspended sulids are removed due to which the pores of the soil will not be clogged easily.

By providing under drainage system to collect the excessive quantity of sewage.

7 Marks

1.What do you mean by sewage sickness ? Write down its causes & remedies)
2014-5 (c)

Mis. When sewage is applied continuously on a piece of land, the soil pores or voids may get filled up and dogged with sewage matter retained in them. When once these voids are clogged, free circulation of air will be prevented and anaerobic conditions will develop within the pores. This phenomenon of soil getting clogged is known as sewage sickness of land.

2. Define sewage farming & the condition of sewage farming. What are the preventive measures to avoid sewage sickness ? 2016 6 (c)

Ans. When sewage is applied continuously on a piece of land, the soil pores or voids may get filled up and clogged with sewage mailer retained n them. The time taken for such a clogging will, of course, depend upon the type of soil and the load present in sewage. But when once these voids are clogged, free circulation of air will be prevented and anaerobic conditions will develop within the pores. Due to this the aerobic decomposition of organic matter will stop, and anaerobic decomposition will start. The organic matter will thus, of course, but with the evolution of foul gases like hydrogen sulphide, carbon dioxide and methane. This phenomenon of soil getting clogged is known as sewage sickness of land in question.

In order to prevent the sewage sickness of a land the following preventive measures may be adopted.

(I) Primary Treatment of Sewage — The sewage should be disposed of only after primary treatment, such as screening, grit removal, and sedimentation. This will help in removing settle able solids and reducing the B.O.D. load by 30% or so and as such, soil pores will not get clogged, quickly.

(ii) Choice of land — The piece of land used for sewage disposal should normally be sandy or loamy. Clayey lands should be avoided.

(iii) Under-drainage of soil— The land on which the sewage is being disposed of can be better drained, if a system of under-drains (i.e. opened joined pipes) is laid below to collect the effluent and this will also minimise the possibilities of sewage sickness.

(iv) Gloving rest to the land — The land being used for disposal should be given rest, periodically keeping some extra land as reserve and stand-by for diverting the sewage during the period the first land is at rest. Moreover, during the rest period, the land should be thoroughly ploughed, so that it gets broken up and aerated.

(v) Applying shallow depths — The sewages should not be filled over the area in larger depths, but it should be applied in thin layers. Greater depth of sewage.

CH-10 (7 Marks)

1. Explain briefly about the primary treatment of sewage. 2015 3(c)

Ans. Primary Treatment- It consists of free oil removal. Oil removal is also affected by in-plant processes like stripping and extraction. Further, removal of oil from the waste water is carried out principally in two stages the first stage fracturing gravity separation and the second stage floatation with or without addition of chemicals/ coagulants. Gravity separation is meant for removal separable free oil.

Oily effluents originating from various sources the refinery are collected in a sump routed to an separator for removal of free oil. Oil separators designed considering hydraulic load, density and

viscosity of the oil and diameter of oil globules. A brief description of a typical API oil separator is given below.

The API separator mainly consists of an inlet a middle or a separator bay and an outlet bay. The inlet bay contains sluice gates for commissioning decommissioning the individual bays of the separator. contains a vertical hanging baffle to retain the oil also arrangement to collect the separated oi. The middle or separator hay is the place where remaining portion of the oil is separated by reducing velocity, so that the water becomes almost quiescent. separated oil is retained in the middle bay by another vertical hanging baffle situated at the end of this bay the collected oil is skimmed by a skimmer provided near this baffle. A flight scrapper provided in the middle brings oil to skimmer for its removal and also at the same time pushes the sludge collected at the bottom of the sludge pit or hopper for periodic removal.

To outlet bay contains a weir over which the free water flows out for further treatment. Oil content the effluent after the API separator is normally less than 100 mg/I in water. Describe the process of primary treatment of sewage with the help of neat sketch.

2.   Describe the process of Primary treatment of sweage with the help of neat sketch. 2013 (3) 2014 4 (c)

Ans. Sewage treatment can be classified follows.

Preliminary treatment.

Secondary treatment

Final treatment

Preliminary treatment

Sl. No.	Treatment unit or operation	Percentage removal of		
		Suspended solids	Bacterial	B.O.D at 5 days 20°C
1.	Screens	5 to 20	10 to 20	5 to 10
2.	Plain sedimental tanks	35 – 65	30 – 70	25 – 40
3.	Sedimentation with chemical	70 – 90	40 – 80	50 – 85
4	Trickling filter followed by plain sedimentation	70 – 90	90 – 95	80 – 95
5.	Trickling filtersproceded & followed by the plain sedimentation	65 – 92	80 – 95	70 – 95
6.	Activated sludge process treatment followed by the plain sedimentation	85 – 90	90 – 98	75 – 96
7.	Sedimentation	85 – 95	95 – 98	90 – 95
8.	Intermittent sandfictration	–	90 – 96	18 – 30
9	Chlorination of settled sewage	--	--	98 – 99.2
10.	Activated sludge process preceded followed by plair	65 – 96	80 – 96	65 – 96

2.Draw the flow diagram of secondary treatment sewage & describe each unit 2016 5 (c)

Ans : Secondary treatment : It consists of free oil removal. Oil removal is also affected by in-plant processes like stripping and extraction. Further, removal of oil from the waste water is carried out principally in two stages the first stage fracturing gravity separation and the second stage floatation with or without addition of chemicals coagulants. Gravity separation is meant for removal of separable free oil.

Oily effluents originating from various sources in the refinery are collected in a sump routed to an oil separator for removal of free oil. Oil separators are designed considering hydraulic load, density and viscosity of the oil and diameter of oil globules. A briefed description of a typical API oil separator is given below.

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1. Described sludge digestion tank : 2015 (7b)

Ans. A typical sludge digestion tank is shown in fig. It consists of a circular R.C.C. tank with hopper bottom and having a fixed or a floating type of roof over its top. The raw sludge is pumped into the tank and when the tank is first put into operation it is seeded with the digested sludge from another tank, as pointed out earlier. A screw pump with an arrangement for circulating the sludge from bottom to top of the tank or vice versa (by reversing the direction of rotation of the screw) is commonly used for stirring the sludge. Sometimes power derived mechanical devices may be used for stirring the sludge, although these are not very popular at present.
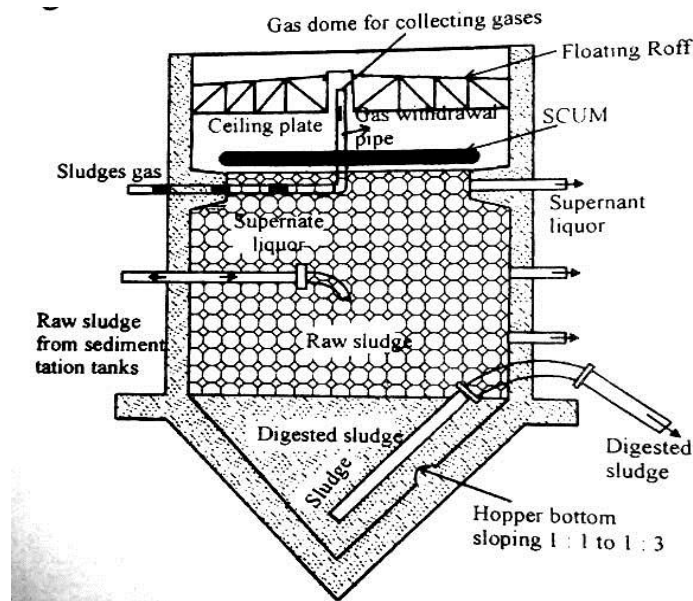
It cold courtiers the tank may have to be provided with heating coils through which hot water is circulated in order that the temperature inside the tank is maintained at optimum digestion temperature level.

2. Explain the Principle and operation of an oxidation pond. (2013 2(f)

Ans. The oxidation pond offers a simple and most economical method for treatment of textiles waste in combination with domestic sewage, especially for warm climates providing in this country. Pretreatment of wastes for colour removal will be more advantageous from the point of view of light penetration. Pond depths in the range of 0.9 to I .2m with retention period in the range of 10 to 30 days are considered suitable.

3. Write short notes on : Sludge digestion : 2013 (7i)
Ans. A typical sludge digestion tank is shown in fig. It consists of a circular R.C.C. tank with hopper bottom and having a fixed or a floating type of roof over its top. The raw sludge is pumped inot the tank and when the tank is first put into operation it is seeded with the digested sludge from another tank, as pointed out earlier. A screw pump with an arrangement for circulating the sludge from bottom to lop of the tank or vice versa (by reversing the direction of rotation of the screw) is commonly used for stirring the sludge. Sometimes power derived mechanical devices may be used tubularr stirring the sludge, although these are not very popular at present.

4. Write a short note oxidation pond : 2014 6 (c) (ii) 2016 1(a)

Ans. Stabilization ponds are open flow-through earthen basin, specifically designed and constructed to treat sewage and biodegradable industrial wastewaters. Such ponds provide comparatively long detention periods extending from a few days to several days, during which time the wastes get stabilized by the action of natural forces. Stabilization ponds may be classified as aerobic, anaerobic and facultative.

The term oxidation pond was originally referred to that stabilization pond which received partially treated sewage; whereas the pond that received raw sewage was used to be called a sewage lagoon, but in recent years, the term oxidation pond has been widely used as a collective term for all types of ponds, and most particularly the facultative stabilization ponds.

Chapter-10

1. Grit chamber: 2016 (7) a.

Grit Chamber :

The sewage contains large number of gritty substance in addition to the other substances.

The main sources of grit are industrial waste, kitchen, ground water supply.

The grits from sewage are generally removed by grit chamber.

It consists of 10-17m long narrow open channel.

The sewage flows in this chamber horizontally with a constant velocity of 2.3m-0.3m/sec.