PNS SCHOOL OF ENGINEERING & TECHNOLOGY

Nishamani Vihar, Marshaghai, Kendrapara-754213

Lecture Note on WATER SUPPLY & WASTE WATER ENGINEERING
(5th Semester)

Prepared By **Er.Sudeepta Mishra**

DEPARTMENT OF CIVIL ENGINEERING

WATER SUPPLY& WASTE WATER ENGINEERING

IMPORTANCE AND NECESSITY OF WATER SUPPLY SCHEMES:-

- For any living being water, air, food, shelter, etc. are the primary needs, for which water has the greatest importance.
- Everywhere water is required for the various purposes,
  (1) for drinking and cooking
  (2)for bathing and washing
  (3) for watering of lawns and gardens
  (4) for heating and air-conditioning system
  (5) for growing of crops
  (6) for street washing
  (7) for fire fighting
  (8) for recreation in swimming pools, fountains and cascades,
  (9) for steam power and various industrial processes etc.

=>Withoutfood human can survive for a number of days, but water is such an essentialelement thatwithout it he cannot.

=>In the ancient times human required water for drinking. bathing, cooking etc.

=> But with the advancement of civilization the utility of water uses increased, and now such a stage hascome that without well-organized public water supply scheme,

Water Treatment:-

- In ancient times some cities were able to collect water, which was safe for drinking purpose. But most of the cities were unable to collect safe water, which lead to the water born diseases.
- This caused necessity of water treatment.
- The first type of treatment which was started was filtration of water.
- Engineers recognized the used and efficiency of the water filtration.
- But due to financial difficulties most of the city councils did not start its use and save the human lives.
- From 1980 the cities authorities started use of filters. Due to reductionin the diseases in the cities having filters, other cities also started treatment of water.

ESSENTIALS OF WATER SUPPLY ENGINEERING:-

- The most important things under the water supply schemes is the selection of source of water, which should be reliable and have minimum number of impurities.
- After the selection of source of water, the next step is to construct intake works to collect it and carry upto treatment plants.
- At the treatment plants this water will be treated. Types of treatment processes directly depend on the impurities in water at the source and the quality of water required by the consumers.
- In low level areas water will directly flow under gravitation force, but for high level areas elevated tanks, or pumping will be required.

DUTIES OF WATER WORKS ENGINEERS:-

- He must be well conversant with the planning, designing, construction, maintenance and operation of water works.
- He must be capable to design the water works scheme in the best possible waywith maximum economy and efficiency to remove the impurities and bacteria.
- He must be capable to operate the water works without fail and should supply the safe water to the public in the required pressure at various points.
- He should protect as well as treated water from contamination.
- He should be able to do the laboratory tests of the samples of water, to check its quality and presence of any diseased bacteria, though the testing of works is done by the chemist or biologist.

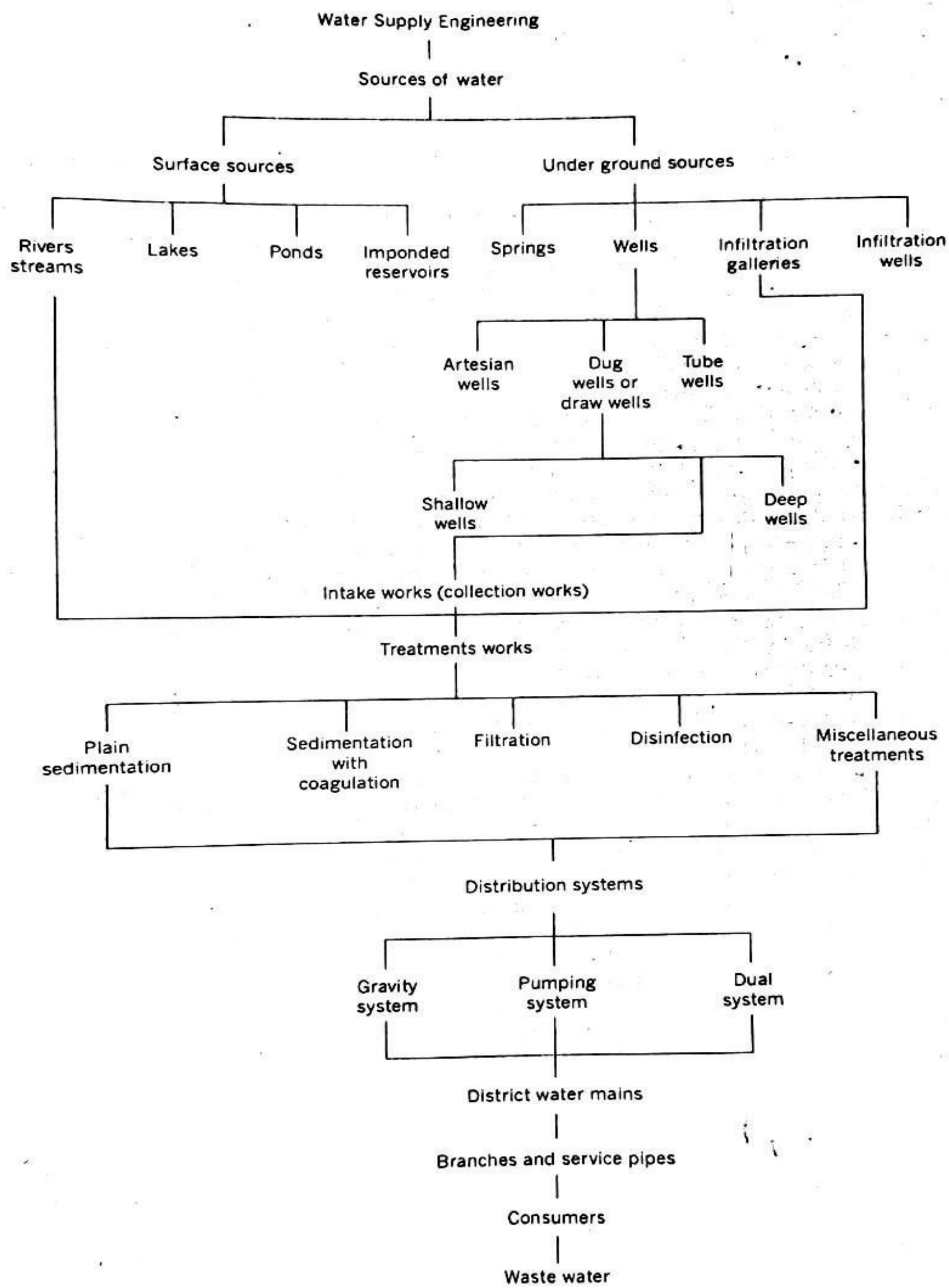


Fig. 1.1. Flow diagrams of water supply scheme.

Impurities in water:-

Suspended impurities:-

- These impurities one dispersion of solid particles that are large enough to be removed by Filtration on surface and heavier ones settle down.
- The suspended Particles which have the same specific gravity as that of water, are mixed in the Water, suspended Impurities include clay, algae, fungi, organic and inorganic matters and mineral matters. These all impurities are macroscopic and cause terbidity in the Water.

Colloidal Impurities:-

- It is very finely divided dispersion of particles in Water. These particles are so small that these cannot be removed by ordinary filters are not visible to the naked eyed.
- As a matter of fact all the colloidal impurities are electrically charge and Remain in continuous motion.

Dissolved impurities:-

- Some impurities are dissolved in water when it moves over the rocks, soil etc.
- Sowd, liquid and gases are dissolved in natural water.
- These dissolved impurities may contain organic compound and inorganic salts and gases etc.
- Dissolved impurities – calcium and magnesium, sodium, metal, gases.

Demand (quantity of watered):-

- While designing the water supply scheme for a town or city, it is necessary to determine the total quantity of water required for various purposed by the cities.
- First duty of the engineer is to determine the water demand of the town and then to find out the suitable water sources from where the demand can be needed.
- Big cities may draw there water works distributed in their various localities for treatment of water supply.

Type of demands:-

- While designing the water supply schemes of the town, It is also necessary to determine the total years as well as monthly demand variations in the demand rates.
- But as there are so many factors involved in demand of water, it is not possible to accurately determine the actual demand.
- So certain empirical or thumbs rules formula to determining the water demand, which is very

nearby to the actual demand.

Types of demand:-

- ⇨ Domestic water demand.

- ⇨ Commercial and Industrial demand.
- ⇨ Fire-demand.
- ⇨ Demand for public uses.
- ⇨ Compensate losses demand.

Domestic water demand of:-

- ⇨ It includes the quantity of water required in the houses for drinking, bathing, cooking, washing etc. The quantity of water required for domestic use mainly depends on the habits, social status, climatic conditions and customs of the people.
- ⇨ In India on an average, the domestic consumption of water under normal condition is about 135 liters/day/ capita as per IS: 1172-1171.
- ⇨ In developed countries this figure may be as high as 350 liters/day/capita.

Domestic water Demand:-

- ⇨ The total consumption in this demand, generally amounts to 55% to 60% of the total water consumption the break up of 135 liters/day/person may be taken as shown in table 5.1

Table 5.1 Average domestic water consumption in anIndian city.

Use	Consumption in litres /day/ person
(a) Drinking	5
(b) Cooking	5
(c) Bathing	55
(d) Washing of clothes	20
(e) Washing of utensils	10
(f) Washing and cleaning of houses and residences	10
(g) Flushing of Latrines etc.	30
Total	135

Commercial and Industrial Demand:-

- ⇨ Commercial building and commercial centers including office building, warehouse, stores, hotels, shopping, centers, schools, temples, cinema houses, railway and bus station etc.
- ⇨ The water, requirements of commercial and public places may be up to 45 liters/day/ capita.

fire Demand:-

- fires generally break in thickly populated localities and the industrial area and cause serious damages. properties and sometimes lives of the people are lost.
- fire may take place due to faulty electric wires by short circuiting, fire catching materials, explosions ,bad intention or criminal people or any other un foreseen mishappening.

- ⇨ If fires are not properly controlled extinguished in minimum possible time, they lead to serious damageand may burn the cities.
- ⇨ All the big cities full fire-fighting squads. As during fire break downs large quantity of water is required for throwing it over the fire to extinguished it, there force provision is made in the water works to supply sufficient quantity of water or keep as reserve in the water mains for his purpose.
- ⇨ In the cities fire-hydrants are provided on the water mains at 100 to 150 m apart. fire brigade men immediately connect this fire-hydrants with their engines and start throwing water at very high rate on the fire.

Fire Demand:-

Generally, in a moderate fire break out, three jet streams are simultaneously thrown from each hydrant;one on the burning property and one each adjacent property, on either side of the burning property.Thisdischarge of each stream should be about 1100 liters/min. Hence in a big city having a population of say 45 lakhs, if six fires break out in a day and each fire stands for 3 hours, the total amount of water required is given by,

Q = 6 x 1100 x 3 x 60 x 3 (i.e. no of fires x discharge x time of each fire)

= 3564×10^3 liters/day.

Then, the amount of water required per person will be = $3564 \times 10^3 / 45 \times 10^5 < 1$ lit/person

from the above example, It is clear that the total amount of water requires hardly to 1 lit/person/ dayfor this purpose.

Demand for public use:-

- ⇨ Quantity of water required for public utility purpose such as for washing and sprinkling of roads cleaning off sewers, watering of public parks, gardens public fountains etc, comes under public demand to meet the water demand for public use, provision of 5% of the total consumption is made while designing the water works for a city.

Compensate Losses Demand:-

- ⇨ All the water which goes in the distribution pipe does not reach the consumers. Some portion of this is wasted in the pipe lines due to defective-pipe-joints, cracked and broken pipes, faulty valves and fittings sometimes consumers keep open their taps or public taps even when they are not using the water and allow continuous wastage of water.
- ⇨ In some way, some quantity of water is lost due to unauthorized and illegal connections.
- ⇨ Generally allowance of 15% of the total quantity of water is made to compensate for losses,

thefts and wastage of water.

Per Capita Demand:-

- In community water is used for various purpose as described above. for the purpose of estimation of total requirements of water, the demand is calculated on an average basic, which is expressed as so many liters/capita/day.
- If Q is the total quantity of water required by a town per year in liters, and the population of the township, the per capita demand will be,

Per Capita demand = $\frac{Q}{P*365}$ liters per day

- The per capita demand of the town depends on various factors and will be according to the living standard of the public and the number and type of the commercial places in the town etc. for an average Indian town, the requirement of water in various uses is as under.

  I. Domestic use - 135 lit/capita/day
  II. Industrial - 40 lit/capita/day
  III. Public use - 25 lit/capita/day
  IV. Business or trade – 15 lit/capita/day
  V. Losses,wastage and thefts – 55 lit/capiota/day

Total - 270 lit/capita/day

- Total quantity of water required by the town per day shall be 270 multiplied with the total population 0f litres/day.

forecasting population:-

- When the design period is fixed, the neat step is to determine the population in various periods, because the population of towns generally goes on increasing.
- The population are increased by births, decreased by deaths, increased by migration and increased by annexation. These all four factors effect the change in population.
- The future development of the town mostly depends on trade expansion, development of industries and surrounding country, discoveries of mines, construction of railway stations etc.
- The following are the standard methods by which the force casting of population is done.

  I. Geometrical increase method.
  II. Incremental increase method.
  III. Arithmatical increase method.
  IV. Decreasing rate method.

Arithmatical Increase Method:-

This method is based on the assumption that the population is increasing at a constant rate. Therate of change of population with time is constant.

i.e. $\frac{dp}{dt}$

= c (a co nstant)

integrating P_2 -P_1 = c(t_2 -t_1)

where P_1 = Population at the time t_1 first census

P_2 = Population at the time t_2 last available

census.The value of constant c is determined.

Now the population after n decade can bedetermined by the

formula,Pn = P + n.c

Example 5.1. The following data have been noted from the census department.

Example 5.1. The following data have been noted from the census depart

Year	Population
1940	8,000
1950	12,000
1960	17,000
1970	22,500

Calculate the probable population in the year 1980, 1990 and *2000.*

Year	Population	Increase in Population
1940	8,000	
1950	12,000	4000
1960	17,000	5000
1970	22,500	5500
	Total	14,500
	Average Inverse	4,833

Solution.

Year	Population
1980	$22,500 + 1 \times 4833 = 27,333$
1990	$27333 + 1 \times 4833 = 32,166$
2000	$32166 + 1 \times 4833 = 36,999$

Geometrical Increased Method:-

- This method is based on the assumption that the percentage increase in population from decade to decade remains constant. In this method the average percentage of growth of last few decade is determined, the population forecasting is done on the basis that percentage increased per decade will be the same.
- If the present population is P and the average percentage growth is Ig the population at the end of A decade will be:

$$Pn = P\left(1+\frac{Ig}{100}\right)^n$$

Example 5.2 forecast the population of example 5.1 by means of geometrical increase method.Solution:

$$P_n = P\left(1+\frac{I_G}{100}\right)^n \quad ...(5.7)$$

Example 5.2. *Forecast the population of example 5.1 by means of geometrical increase method.*

Solution.

Year	*Population*	*Increase in Population*	*Percentage increase in Population*
1940	8,000	—	
1950	12,000	4,000	$\frac{4000}{8000}\times 100 = 50.0\ \%$
1960	17,000	5,000	$\frac{5000}{12000}\times 100 = 41.7\ \%$
1970	22,500	5,500	$\frac{5500}{17000}\times 100 = 32.4\ \%$
	Total	14,500	124.1
	Average per decade	4,833	41.37

The population at the end of various decades shall be as follows :

Year	*Expected Population*
1980	$22{,}500+\frac{41.37}{100}\times 22{,}500 \doteq 31{,}808$
1990	$31{,}808+\frac{41.37}{100}\times 31{,}808 = 44{,}967$
2000	$44{,}967+\frac{41.37}{100}\times 44{,}967 = 63{,}570$

Incremental Increase Method:-

- This method is improvement over the above two methods. The average increase in the population is determined by the arithmatical method and to this is added the average of the net incremental increase once for each future decade. P is the present population, ta = Average Arithmatical increase, and Ic is the average incremental increase, then population after 'n' decade will be,
  $Pn = P + n(Ia + Ic)$

Solved example 5.3 will explain this method clearly

Example 5.3 forecast the population of example 5.1. by means of incremental increase

method.Solution:

Year	*Population*	*Increase in Population*	*Incremental increase i.e. increment on the increase*
1940	8,000	—	—
1950	12,000	4,000	—
1960	17,000	5,000	+1000
1970	22,500	5,500	+0500
	Total	14,500	+1500
	Average	4,833	(+) 750

Decrease Rate of Growth Method or Decreasing Rate Method:-

- It has been seen that all life grow within limited space. If the complete growth of a very old city is plotted, it will be seen that the curve has s-shape, which indicates that early growth takes place at an increasing rate, latter growth is at a decreasing rate which indicates that saturation limit is reached. In this method, the average, decrease in the percentage, increase is worked out and is then subtracted from the latest percentage increase for each successive decade.

This method will be clearly understood from the solved example 5.4

belowExample 5.4. Solve example 5.1, by using decrease rate of growth

method.

Solution:

Year	Population	Increase	Percentage increase in Population	Decrease in the percentage increase
1940	8000	—	—	—
1950	12000	4000	$\frac{4000}{8000}\times 100 = 50.0$	—
1960	17000	5000	$\frac{5000}{12000}\times 100 = 41.7$	+8.3
1970	22500	5500	$\frac{5500}{17000}\times 100 = 32.4$	+9.3
Total		14500		17.6
Average		4833		8.8

Now the population at the end of various decades shall be as follows :

Year	Net percentage increase in Population	Population
1980	$32.4 - 8.8 = 23.6$	$22{,}500 + \frac{23.6}{100}\times 22{,}500 = 27{,}810$
1990	$23.6 - 8.8 = 14.8$	$27{,}810 + \frac{14.8}{100}\times 27{,}810 = 31{,}926$
2000	$14.8 - 8.8 = 6.0$	$31{,}926 + \frac{6}{100} + 31{,}926 = 33{,}842$

Impurities of water:-

All the impurities of water can be listed broadly as follows

(a) Suspended impurities :

- These impurities are dispersion of solid particles that are large enough to be removed by filtration of surface and heavier ones settle down.
- The Suspended particles which have the same specific gravity as that of water, are mixed in the water.
- Suspended impurities include clay, algae, fungi organic matters and mineral matter etc.
- These all impurities are microscopic and cause turbidity in the water.
- The concentration of suspended water is measured by its turbidity.

(b) Colloidal impurities :

- Very finely divided dispersion of particles in water. These particles are so small that there Can not be removed by ordinary filters and are not visible to the naked eye.

- As a matter of fact all the colloidal impurities areelectrically charged and remain in continuous motion.The electric change is due to the presence ofabsorbed ions on the surface of the solid.
- Acid or neutral water, whereas basic materials such as metalicoxidesAl_2O_3 and fe_20_3 are positively charged.
- These electric charge on the surfaces of particles are large enough in comparison with their mass to cause the particles to repel one another when they move within the sphere of action of each others charge.
- Most of the colour of water is due to colloidal impurities. Their quantity is determined by colour tests. The size of colloidal particles is between (1-1 micron- 0.001 mm) to (1-1 millimicron 000001mm)or (10^{-3} mm to 10^{-6} mm).

(c) Dissolved impurities:

- Some impurities are dissolved in water when it moves over the rocks, soil etc. solid, liquids, and gases are dissolved in natural waters.
- These dissolved impurities may contain organic compounds, inorganic salts and gasses etc. The concentration of total dissolved solids is usually expressed in p.p.m. and is obtained by weighing the residue after evaporation of the water sample from a filtered sample.
- The given table shows most of the impurities and substances which occur in natural waters. All these impurities may not occur in a single water and their concentration also varies considerably fromsource to resource.

Water Analysis :

- The analysis of water the source is done to determine the various impurities present in it on the basis of these impurities, the treatment plant will be designed. Therefore, the analysis of water is very necessary before designing any water supply scheme.
- Similarly after the treatment of water, its analysis is again done to ascertain that water has been purified or not treated water before supply to the public it's checked fore it's quality whether it fulfills the requirements of the standards laid down by the public health department.
- As the quality of source water varies daily and in every season. It is necessary that the water samples for analysis should be collected frequently and over a long period of time. According to the quality of water it should be treated. The following are the tests which are done during water analysis :

(a) Physical tests
(b) Chemical tests
(c) Biological tests

Units:<u>Physical test Turbidity test:-</u>

- Turbidity was previously determined by Jackson, Candle Turbidity units (JTU). This unit is now replaced by more appropriate unit called 'Nepholo metric Turbidity' unit or (NTU) because of the the of Nepholometric method of measurement of 1000tutbidities.

- Turbidity is a measure of the resistance of water to the passage of light through it.
- Turbidity is expressed in parts per million (PPM or milligrams per liter mg/1).
- The turbidity produced by one milligram of silica in one liter of distilled water is the unit of turbidity.
- In other words, turbidity produced by one part of finely divided silica in million parts of distilled water is the standard unit. The turbidity of a water Sample is commonly determined by following methods.

(a) By turbidity rod or tap:-

- Turbidity rod is a graduated aluminium or steel rod. One platinum needle is fixed at the Shown in figure. 9.1. The eye is placed at the upper end by the rod and a line indicates the position when eye.
- Keeping the eye constantly at position marked and watching needle the rod is immersed in the water.
- We will go on immersing the rod in water and looking constantly on the platinum needle, till the needle just disappears from the eye-view due to the turbidity of the water.

(b) Jackson's turbidimeter:-

- It is used store measuring turbidity above 50 ppm.
- It essentially consists of a metal stand and metal container for graduated tube.
- The standard candle or bulb is used as a light source. This light source is placed at timed distance from the bottom of the metal container.
- For measuring the turbidity of waters, It is slowly poured in the graduated tube and the light of bulb or candles is constantly seen from the top through the water.
- A stage will come when Light Source will just disappear from the sight.
- At this position we will stop the pouring of water and take out the glass tube. As the tube is graduated to direct readings, the reading at the water level in the glass tube will be the turbidity of water.

Temperature:

The temperature of water is measured by means of ordinary thermometers from the temp the density viscosity vapor pressure &surface tension of water can be determined. The saturation values of solids &gases that can be dissolved in water & the rates of chemical biological bio-chemical activity are also determined on the basic of temperature. The temperature of surface water is generally same to the atmospheric temp. while that of ground water my be more of atmospheric temp. the most desirable temp. for public supply is between 4.4◦C to 10◦C are unfit for public supply because it is not palatable.

(c) By Baylis turbidimeter:-

* fig. 9.3 illustrates a Baylis turbidimeter, It essentially consist of a closed steel box

* Two glass tubes are kept in vertical position side by side on one side of this box.

***** These tubes can also be directly taken out and againheld in the holes provide for the purpose.

*Opposite to the side of tubes and electric bulb of 250w is fined with a reflector to throw light onthetubes.

* The tubes at the bottom are supported on white opal glass plate, and are surrounded by blue cobalt plates Shown in the figures.

* One tube is filled with sample water, whose turbidity is to be determined, and second tube is filled with standard water of known turbidity. In the light of the lamp, both the tubes areobserved by the eyes. If there is any colourdifference between the tubes, till both the tubes look like same ore match will each.

* Now the turbidity of the Standard tube is noted which is equal to that of the sample water under test.

Colour :-

The colour of water of usually que to presence of organic matter in colloidal condition but sometimes itup also due to mineral & dissolved organic and inorganic impurities before testing the colour of water, first of all total suspended matter should be removed from the water by centrifugal force in a special apparatus after, the colour of the water is compared with standard colour solution or colour discs Thecolour produced by one milligram of platinum in a liter of distilled water has been fixed as the unit of colour

Chemical tests:-

In the chemical analysis of water those tests are done that will reveal the sanitary quality, of the water.The chemical tests involve the determination of total solids, hardness, PH value, chlorides residual chlorine, iron and manganese, organic matter etc. The following are the methods of doing various chemical tests:

I. **Hardness:-**

It is the property of watch which prevents the lathering of the soap. It is caused due to the presence of carbonates and sulphates of calcium and magnesium in the water. Sometimes thepresence of chloride and nitrates of calcium and magnesium also cause hardness in the water.The measurement of the hardness can be done by the following formula:

Hardness in ppm ore mg/liter (Hw) = Ca^{++} ions in ppm or mg/1 * $\frac{combinati\ .of\ CaCO_3}{Combination\ wt.of\ Ca^{++}}$

+mg^{++} ions in ppm or mg/1 * $\frac{combinati\quad n\ wt.of\ CaCO_3}{Combination\ wt.of\ Mg^{++}}$

Putting the values of Ca^{++} , Mg^{++} ,$CaCO_3$ as 20,12 and 50 respectively, the above equation will become

$$Hw = \frac{20*50}{Wc} + \frac{12*50}{Wm}$$

Where, Hw= Hardness of water in ppm or mg/liter

Wc = Combination weight of

Ca^{++} Wm=Combination

weight of mg^{++} **Chlorides:-**

- Sodium chloride is the main substancein chloride water. The natural water near the means and sea have dissolve, sodium chloride. Similarly the presenceof chlorides may be due to the mixing of saline water and sewage in the water, excess of chlorides above 250 ppm are not permissiblein water.

Chlorine:-

- Dissolved free chlorine is never found in natural waters. It is present in the treeatedwatere store the cave not resulting from disinfection with chlorine
- The chlorine remains as residual in treated water for the sake of safety against pathogenic bacterias.Residual chlorine is determined by the starch iodide test or ortholodin test.
- In starch-iodide test, potassium iodide and starch solutions are added to the sample of water due to which blue colour is formed.

Iron and Manganese:-

- These are generally found in ground water. If these are present less than 0.3 p.p.m., it is not objectionablebut if exceeds 0.3 p.p.m. the water is not suitable for domestic, bleaching dyeing andlaundering purposes. The presence of iron and manganese in water makes brownish red Colour in it, leads to the growth of micro organism and corrodes the water pipes. Iron and manganese also cause taste and odour in the water.

PH-Value:-

- Depending upon the nature of dissolved salts and minerals the water found in natural Sources may be acidic ore alkaline. The acidity or alkalinity, its usually measured in p.p.m. of the dissolved salts and is expressed in terms of equivalent weight of calcium carbonate.
- When acids or alkalies are dissolved in water they dissociate into electrically charged ions of hydrogen and Hydroxy 1respectively. Hydrogen ions are charged with positive charge whereas Hydroxyl ions are charged, with negetivecharge.Thefollowing equations show the dissociation of some of the acids and alkalies in the water.

QUESTIONS

(1) what is water Supply & Simple words? [2]

⇨ Water Supply is the provision of water Pubile utilities, commericalorganisations, community endeavory or by individual, usually via a systemof pumps and pipes

⇨ It is the process of supplying water publieuses usually including reservoirs tunnels and pipelines, its available water provided to fulfill a particular need like domestic, industrial, or agricultural etc.

(2) Why water treatment is necessary ? [2]

⇨ Water treatment is increasingly necessary due to drinking water shortages and the growing needs of the global Population.

⇨ Water treatment removes contaminate and undesirable components or reduces their concentration so thatthe water becomes fit for its desired end use.

(3) How many types of water Impurities ? [2]

⇨ There are three types of water impurities.

(i) suspended Impurities.

(ii) Colloidal impurities

(iii) Dissolved impurities.

(4) what is demand ? [2]

⇨ It is the annual average amount of daily water required by one person and includes the domestic use, industrial and commercial use, Public use, Wastes, thefts etc.

(5) What is Percapita Demand? [2]

⇨ In community water is used for various purpose as described above for the Purpose of estimation of total requirements of wader the demand is calculated on an average basic, which is expressed asso many liters/ capita / day

⇨ It is the total quantity of water required by a town per year inliters and the population of the town is P,

$$\text{percapita demand} = \frac{Q}{P*365} \text{ liters/day}$$

LONG QUESTION:

(1) Express importance and necessity of water supply? [6]
(2) Explain, Duties of water works engineers ? [6]
(3) What are Impurities in water ? [6]
(4) What is Demand ?Explain per capita demand ? [6]
(5) Explain demand and types of demand? [10]
(6) Explain about water analysis ? [10]
(7) The population of five decades from 1940 to 1980 are given bellow. Find out the populationin decades 1990,2000 and 2010 by using decrease rate of growth method. [10]

YEAR	1940	1950	1960	1970	1980
POPULATION	25000	28000	32500	40000	45000

Chapter -2

SOURCES AND CONVEYANCES OF WATER.

Classification of Sources of Water

Sources of water may be classified as Surface Sources and Ground Sources which are further described below.

Surface Sources:

- Sources of water that are available at the ground surface is called surface source. It includes river, streams, lakes, ponds, impounded reservoir.
- Surface water contains organic debris, suspended materials, herbicides and pesticides, domestic and industrial wastes
- . On reaching to the impounded reservoir the suspended material settles and the water improve in turbidity. Organisms can oxidize material and give rise to colour, taste, and odour.

River;-

- A river is a natural channel which carries surface runoff received by it from its catchment or drainage basin.
- The quantity of water increases as river travels from mountain to downwards. It is due to the small catchment in the mountain. As river move forward more and more springs combine resulting in increased discharge.
- The river may be perennial as well as non-perennial. Perennial rivers are those rivers in which water are available throughout the year.
- The water in such rivers is due to rains in the rainy season and by melting of snow during the summer season. Non-perennial rivers are those rivers in which water are not available throughout the year.

-
- The quality of water is better at the place of origin i.e. mountainous region and goes on degrading as it moves forward as it gets contaminated with organisms, suspended materials, clay, silt, etc.
- As the quantity of supply from the river is large, it is used as a water supply source for towns and cities. The water from river must be analyzed and treated before use.

: 

Streams:

- Streams are defined as the natural drainage channel.
- They are found in the mountainous region.
- The quantity of water from the stream is less as compared to the river due to its small catchment.
- Perennial streams are snow fed and non-perennial streams are fed from surface runoff. It acts as a water source in villages of hilly areas. Generally, water from streams are used without any treatment but it is recommended

that the water should be analyzed and treated before use.

Lakes:

- A large natural depression formed in the earth's surface where water gets deposited is called the lake.
- It is also generally found in the mountainous region. The quantity of water available from lake depends upon the following factors:

1. Size of the lake
2. Catchment area of the lake
3. Annual rainfal
4. Porosity of the ground surface
5. Geological formations

- The quality of water from lake depends upon the characteristics of its catchment.

- The water in a lake would be pure if it draws water from uninhabited upland hilly areas.
- Water would be contaminated if it draws from low land areas.
- Water from Rara Lake can be used without treatment whereas water from smaller lakes must be analyzed and treated before distribution.

Ponds:

Ponds are artificially made the body of standing water. These are smaller than lakes in size. The water from pond cannot be used for water supply purposes. They are used for bathing, washing of clothes.

Impounded Reservoir

- For large cities, a single source cannot fulfil the demand of the growing population.
- The water may not be available throughout the year in adequate amount.
- So a dam is constructed across the river to form a reservoir where water is stored and can be used when there is a limited supply of water from the source.
- Such constructed reservoir are said to be impounded reservoirs.
- These are used for water supply scheme in large cities and towns. The water from impounded reservoir is improved in turbidity.

Ground Sources: Those sources of water that exist below the ground surface is called ground water sources.

The ground water may be contaminated with polluted water from agricultural fields, high mineral content, iron, and sulphur, calcium and magnesium.

Iron and manganese affect taste and odor. Iron and sulphur give rotten egg odor. Calcium and Magnesium cause hardness of water. The various groundwater sources are:

1. Springs
2. Wells
3. Infiltration galleries
4. Infiltration wells

Springs:

A place where ground water naturally comes to the surface at the intersection of the ground surface and the water table is called spring.

Following are the three types of springs

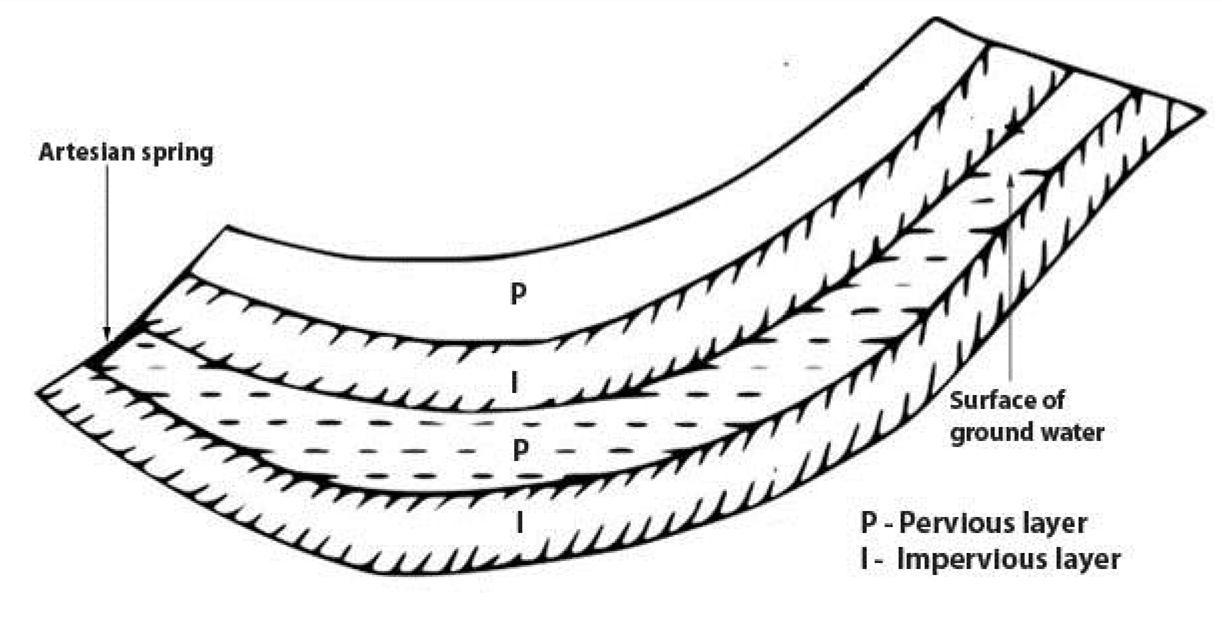
Artesian springs

Gravity springs

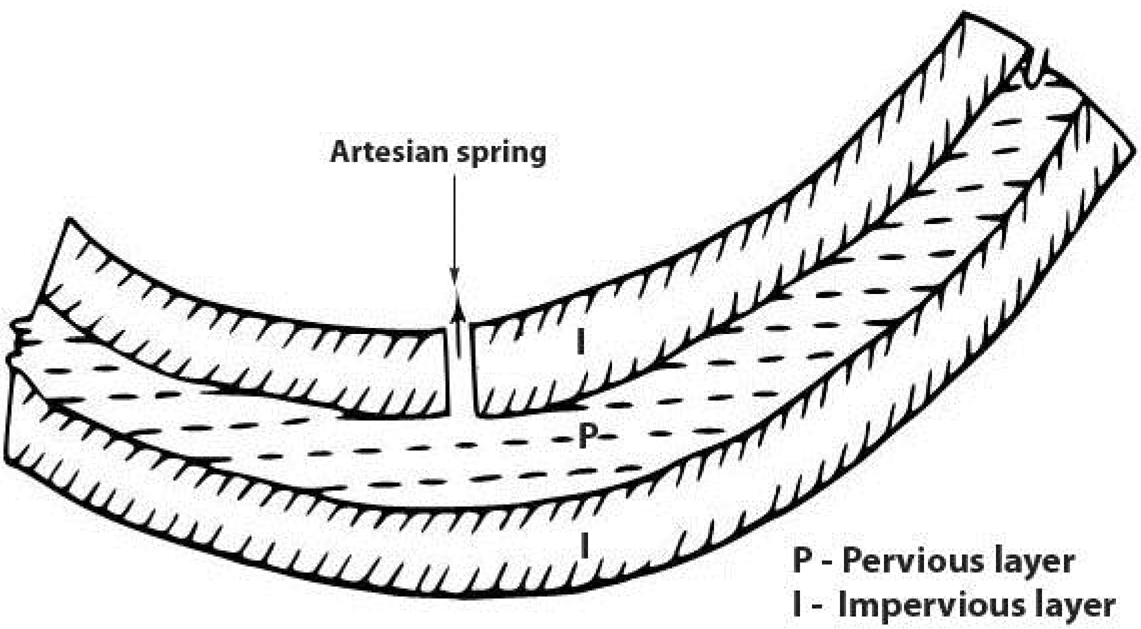
Surface springs

Artesian springs

In this type of spring, the ground water comes to the surface under pressure as shown in the figure



The artesian spring may also be formed due to presence of fissure or crack in impervious layer as shown in the figure. The fissure or crack should be continued upto the ground surface. The artesian springs give practically uniform quantity of water throughout the year.

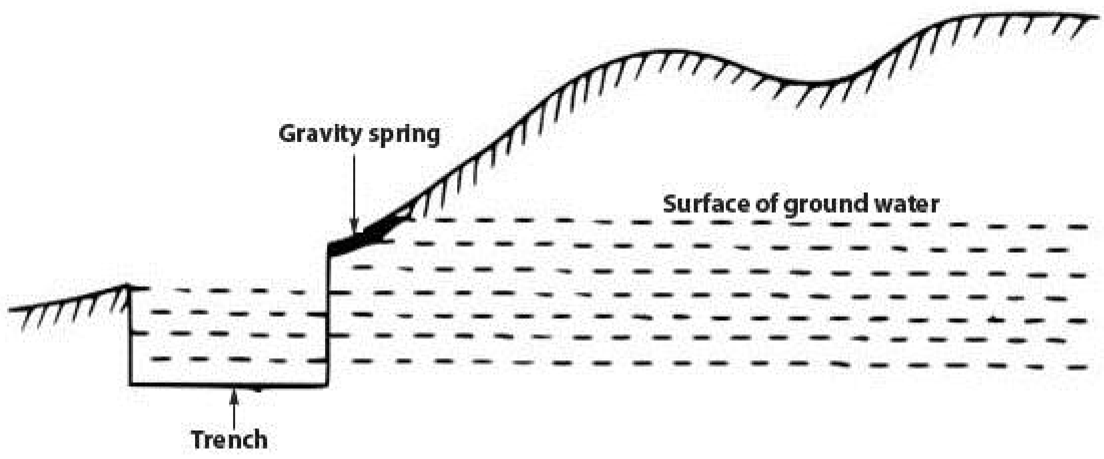


Gravity springs

This type of spring develops due to overflowing of the water table as shown in the figure. The flow from a gravity spring is variable with the rise or fall of water table.

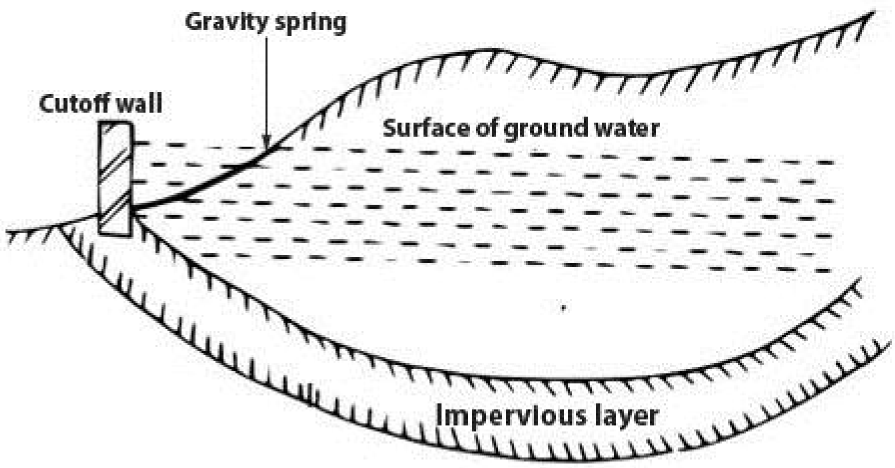
In order to meet with such fluctuations, a trench may be constructed near such a spring as shown in the figure.

The trench acts as a storage reservoir.



Surface springs

This type of spring is formed when subsoil water is exposed to the ground surface by the obstruction of an impervious layer as shown in the figure.



The quantity of water available from surface springs is quite uncertain and cut-off walls, as shown in the figure, may be constructed to develop such springs.

It is found that the quality of spring water depends on geological and topographical conditions and it may be hard or soft, pure or polluted or sometimes saline, etc. Similarly, the yield from springs is mostly inadequate, except for small supplies. The spring water which is not disturbed by rainfall is usually attractive in appearance and of good palatability.

Wells

A well is defined as an artificial hole or pit made in the ground for the purpose of tapping water.

The holes made for tapping oil are also known as wells. But in the general sense, a well indicates a source of water.

In India, the chief source of water supply for most of its population is wells and it is estimated that 75 to 85% of Indian population has to depend on wells for its water supply.

The three factors which form the basis of theory of wells are as follows:

- Geological conditions of earth's surface,
- Porosity of various layers and
- Quantity of water which is absorbed and stored in different layers.

The geological conditions of earth's surface indicate the slope of water bearing strata.

If the slope of water bearing layers is towards the well, there will be some quantity of water in the well even during the severe hot season.

On the other hand, if the slope of water bearing layers is away from the well, such well will soon get dry and it will only give some quantity of water only in monsoon.

The porosity of aquifers will also play a great role in determining the quantity of water in the well.

If the porosity of aquifers is more, the well will easily collect more quantity of water in less time.

The capacity of aquifers to absorb and store water will determine the supply rate of water to the well.

If the aquifers are capable of storing more water, the well will get more quantity of water and practically at a constant rate.

INTAKES

Intakes are the structures used for admitting water from the surface sources (i.e., river, reservoir or lake) and conveying it further to the treatment plant.

Generally, an intake is a masonry or concrete structure with an aim of providing relatively clean water, free from pollution, sand and objectionable floating material.

Its main purpose is to provide calm and still water conditions, so that comparatively purer water may be collected from the source.

If intake well has to withstand the effects of severe forces which may be due to striking of high water currents, it may be made from reinforced cement concrete.

Site for location of intake

While selecting a site for location of intakes, the following points should be taken into account:

- Intake work should provide purer water so that its treatment may be less exhaustive
- Heavy water currents should not strike the intake directly
- Intake should be located at such a situation where sufficient quantity of water remains available under all the circumstances
- Site should be well connected by good type or roads.
- During floods, the intake should not be submerged by the flooding waters.
- As far as possible, the site should be located on the upstream side of the town / city.
- The intake should be so located that good foundation conditions are prevalent and the possibility of scouring is minimal.
- The site should be selected in such a manner that there is ample scope for further expansion.

- Site should be such that intake should be in a position to provide more water, if requied to do so.

Design of intake

An intake should be designed keeping in mind the following considerations:

- Intake should be sufficiently heavy so that it may not start floating due to upthrust of water.
- All the forces which are expected to work on intake should be carefully analysed and intake should be designed to withstand all these forces.
- The foundation of the intake should be taken sufficiently deep to avoid overturning.
- Strainers in the form of wire mesh should be provided on all the intake inlets to avoid entry of large floating objects.
- Intake should be of such size and so located that sufficient quantity of water can be obtained from the intake in all circumstances.

Types of intakes

Submerged intake

Submerged intake is the one which is constructed entirely under water. Such an intake is commonly used to obtain supply from a lake.

An exposed intake is in the form of a well or tower constructed near the bank of a river, or in some cases even away from the river banks.

Exposed intakes are more common due to ease in its operation. A wet intake is that type of intake tower in which the water level is practically the same as the water level of the sources of supply.

Such an intake is sometimes known as jack well and is most commonly used. In the case of dry intake, however, there is no water in the water tower. Water enters through entry point directly into the conveying pipes.

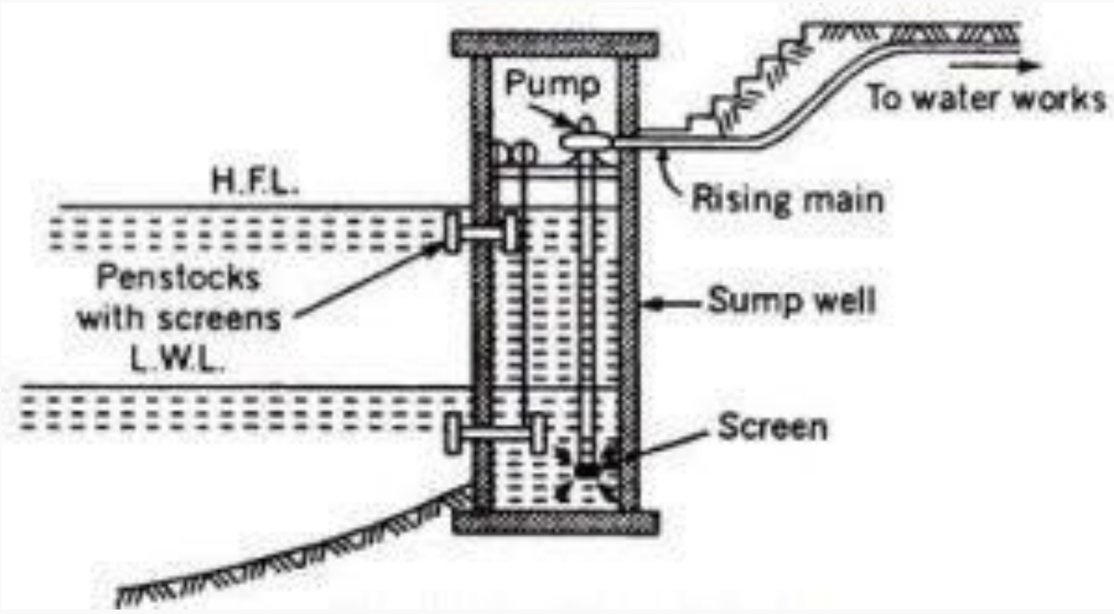
The dry tower is simply used for the operation of valves etc.

River intake

A river intake is located to the upstream of the city so that pollution is minimized.

They are either located sufficiently inside the river so that demands of water are met with in all the seasons of the year, or they may be located near the river bank where a sufficient depth of water is available.

Sometimes, an approach channel is constructed and water is led to the intake tower. If the water level in the river is low, a weir may be constructed across it to raise the water level and divert it to the intake tower.



River intake diegram

Reservoir intake

When the flow in the river is not guaranteed throughout the year a dam is constructed across it to store water in the reservoir so formed.

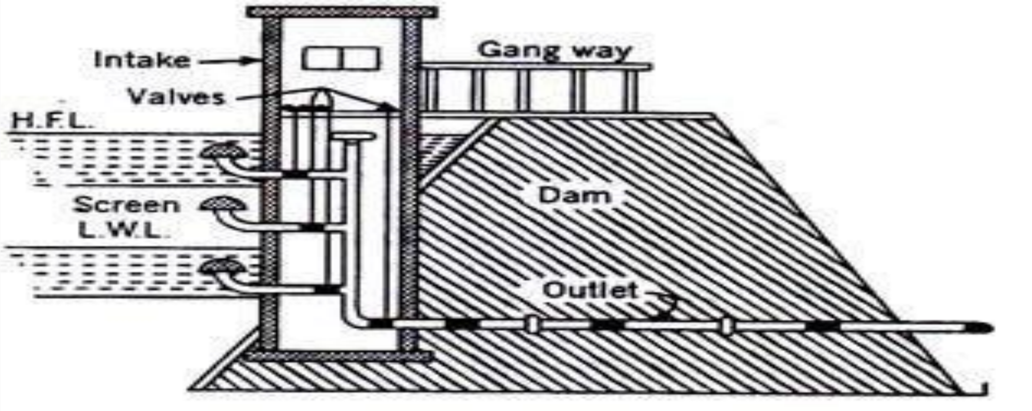


Fig. 7.7. Reservoir intake.

The reservoir intakes are practically similar to the river intake, except that these are located near the upstream face of the dam where maximum depth of water is available.

Lake Intake

Lake intakes are similar to reservoir intakes if the depth of the water near the banks is reasonable.

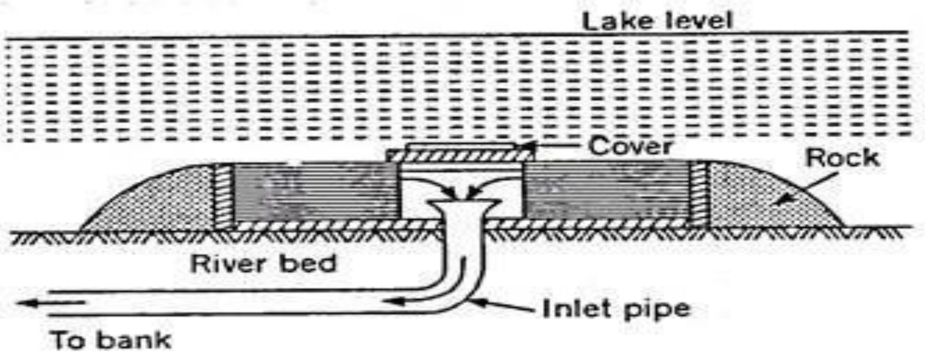


Fig. 7.1. Lake Intake.

If however, the depth of the water near the banks is shallow, and greater depth is available only at its centre, a submerged intake is provided.

Canal intake

Sometimes, the source of water supply to a small town may be an irrigation canal passing near the town.

The canal intake essentially consists of concrete or masonry intake chamber of rectangular shape, admitting water through a coarse screen.

A fine screen is provided over the bell mouth entry of the outlet pipe.

The bell mouth entry is located below the expected low water level in the canal.

Water may flow from outlet pipe under gravity if the filter house is situated at a lower elevation.

Otherwise, the outlet pipe may serve as suction pipe, and the pump house may be located on or near the canal bank.

The intake chamber is so constructed that is does not offer any appreciable resistance to normal flow in the canal.

Otherwise, the intake chamber is located inside the canal bank. Near the location of the intake work, canal is lined.

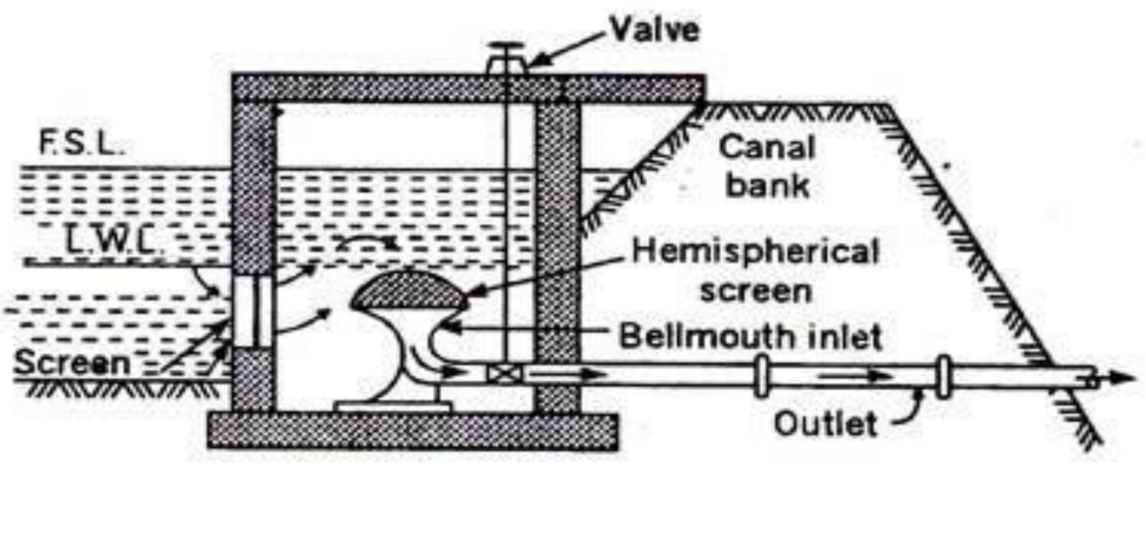


Fig. 7.9. Canal intake.

PUMP

A pump is a mechanical device that lifts liquids from a lower level or low-pressure area to a higher level or high-pressure area. It is a heavy-duty equipment with low suction and high discharge pressure. This makes it easier to pump a fluid from a certain depth and push the fluid to the desired height.

Pumps can also be used as a booster in a pipeline network system. Pumps have evolved into an endless variety having different sizes, types, and applications.

This article covers the requirements, factors of selection, and types of pumps in the water supply system. Many kinds of pumps are used in distribution systems.

Pumps that lift surface water and move it to a nearby treatment plant are called low-lift pumps.

These move large volumes of water at relatively low discharge pressures. Pumps that discharge treated water into arterial mains are called high-lift pumps. These operate under higher pressures.

Pumps that increase the pressure within the distribution system or raise water into an elevated storage tank are called booster pumps. Well pumps lift water from underground and discharge it directly into a distribution system.

Types of Pumps

Displacement or Positive-Displacement Pumps

This pump works on the principle of mechanically inducing a vacuum in a chamber. Based on this principle, the pump draws in water which is displaced mechanically and is then forced out of the chamber. Reciprocating pumps and rotary pumps are the two types of positive-displacement pumps.

RECIPROCATING PUMPS

The reciprocating pumps help transfer a certain quantity of liquid by application of pressure. The hand pump is one of the most commonly used reciprocating pumps but is considered to be an outdated system.

A reciprocating pump is also known a called a positive displacement pump. Because it discharges a definite quantity of liquid. It is often used where a small quantity of liquid is to be handled and where delivery pressure is quite significant. The following are the main **parts of the reciprocating pump.**

1. Cylinder

2. Suction Pipe
3. Delivery Pipe
4. Suction valve
5. Delivery valve
6. Piston and piston rod
7. Crank and connecting rod
8. Strainer
9. Air vessels

Cylinder

In the cylinder, the piston is moving to and fro. The moment of the piston obtains by a connecting rod, which connects the piston and crank.

Suction Pipe

It is the source of water that connects the cylinder together. The suction pipe allows the water to flow in the cylinder.

Delivery Pipe

After the process, the source of water leaves the cylinder and discharges through the delivery pipe. The delivery pipe joins the pump cylinder to the discharge outlet.

Suction Valve

In this valve, the flow of water enters from the suction pipe into the cylinder. It allows only one-directional flow. Hence it is also known as a non-return valve. This valve is found on the suction pipe inlet.

Delivery Valve

With this valve, the flow of water is discharged from the cylinder into the delivery pipe. It is also a non-return valve located between the delivery pipe outlets. The valve is in the closed position during suction.

Piston and Piston Rod

It is a solid part that acts back and forth inside the cylinder for the suction and delivery of the liquid. Whereas the piston rod helps the piston to move in a linear direction.

Crank and Connecting Rod

A crank is a circular disc that is connected to a motor. While the connecting rod connects the crank to the piston. As a result, the rotational motion of the crank is converted into linear movement of the piston.

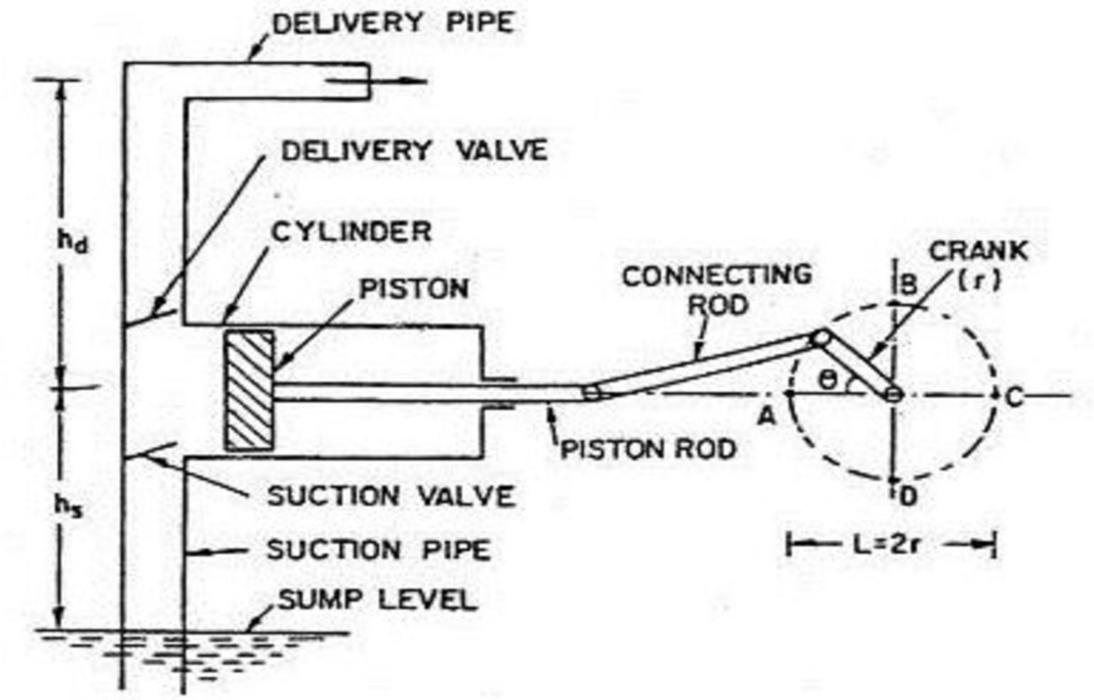
Strainer

A strainer is an essential part of the pump that is located at the end of the suction pipe. This helps in preventing the entry of solids from the water source into the cylinders.

9 Air Vessels

It is a closed chamber made up of cast iron. It has two ends. One ends is open at its base through which the water flows into the vessel cylinder. The air vessels are fitted to the suction pipe and delivery pipe of this pump to get a uniform discharge.

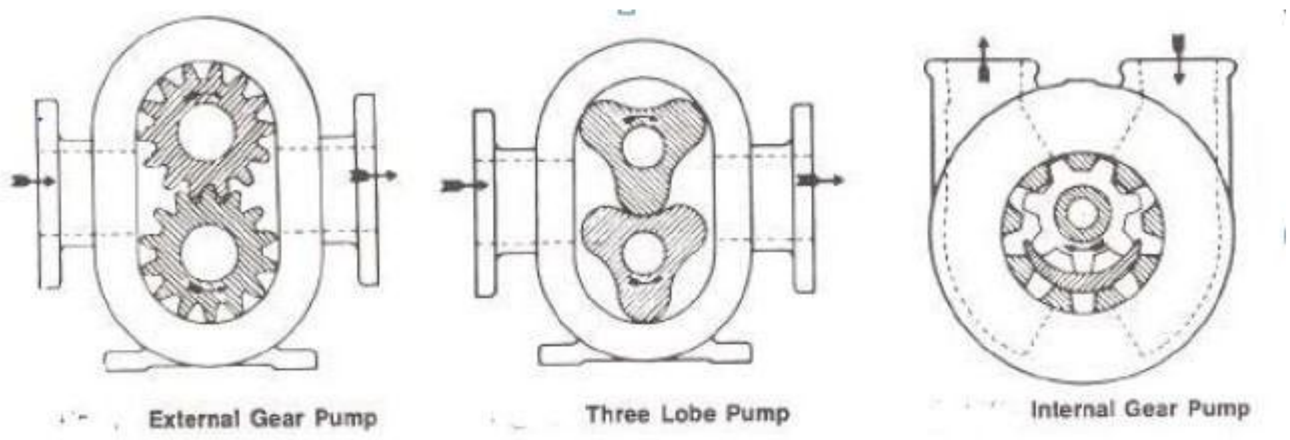
Reciprocating Pump :



SINGLE ACTING RECIPROCATING PUMP

Rotary Pump

In this pump, the rotary motion is achieved by using a pair of cams or gears that mesh together and rotate in opposite directions.



Centrifugal Pump

Mixed flow and radial flow machines are typically called as centrifugal pumps.

It could be either open or closed based on the amount of suspended solids present in the water.

.The closed impeller has plates on each side of the vanes and the open impeller has a hub with vanes attached to it. The efficiency of the closed impeller centrifugal pump is more than that of an open impeller centrifugal pump.

Main Parts of Centrifugal Pump

The Main parts of Centrifugal Pump are:

1. Impeller

It is a wheel or rotor which is provided with a series of backward curved blades or vanes. It is mounded on the shaft which is coupled to an external source of energy which imparts the liquid energy to the impeller there by making it to rotate.

Casing

It is a pipe which is connected at the upper end to the inlet of the pump to the centre of impeller which is commonly known as eye. The double end reaction pump consists of two suction pipe connected to the eye from both sides. The lower end dips into liquid in to lift. The lower end is fitted in to foot valve and strainer.

Delivery Pipe

It is a pipe which is connected at its lower end to the out let of the pump and it delivers the liquid to the required height. Near the outlet of the pump on the delivery pipe, a valve is provided which controls the flow from the pump into delivery pipe.

4. Suction Pipe with Foot Valve and Strainer

suction pipe is connected with the inlet of the impeller and the other end is dipped into the sump of water. At the water end, it consists of foot value and strainer. The foot valve is a one way valve that opens in the upward direction. The strainer is used to filter the unwanted particle present in the water to prevent the centrifugal pump from blockage.

Working of Centrifugal Pump

The first step in the operation of a centrifugal pump is priming. Priming is the operation in which suction pipe casing of the pump and the position of fluid with the liquid which is to be pumped so that all the air from the position of pump is driven out and no air is left. The necessity of priming of a centrifugal pump is due to the fact that the pressure generated at the centrifugal pump impeller is directly proportional to density of fluid that is in contact with it.

After the pump is primed the delivery valve is still kept closed and electric motor is started to rotate the impeller. The delivery valve is kept closed in order to reduce valve is opened the liquid is made to flow in an outward radial direction there by vanes of impeller at the outer circumference with high velocity at outer circumference due to centrifugal action vacuum is created. This cause liquid from sump to rush through suction pipe to eye of impeller thereby replacing long discharge from center circumference of the impeller is utilized in lifting liquid to required height through delivery pipe.

Types of Centrifugal Pumps

Centrifugal Pumps are classified into many types based on many categories, they are

Based on number of impellers in the pump,

1. Single stage pump
2. Two-stage pump
3. Multi-stage pump

Based on orientation of case-split,

1. Axial split Pump
2. Radial split Pump

Based on type of impeller design,

1. Single suction Pump
2. Double suction Pump

Based on the basis compliance with industry standards,

1. ANSI pump – (American National Standards Institute)
2. API pump – (American Petroleum Institute)
3. DIN pump – DIN 24256 specifications
4. ISO pump – ISO 2858, 5199 specifications
5. Nuclear pump – ASME (American Society of Mechanical Engineers) specifications

Based on type of volute

1. Single volute Pump
2. Double volute Pump

Based on where the bearing support is,

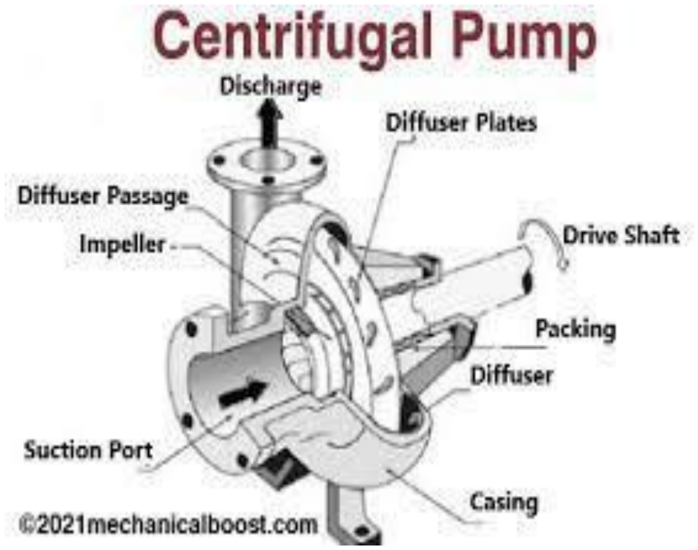
1. Overhung
2. Between-bearing

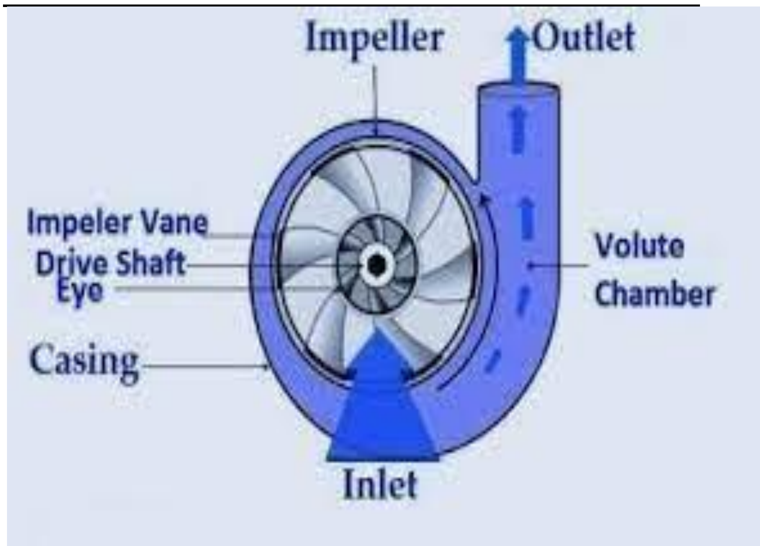
Based on on shaft orientation

1. Horizontal Pump
2. Vertical Pump

Application of Centrifugal Pumps

1. Oil & Energy - pumping crude oil, slurry, mud; used by refineries, power generation plants
2. Industrial & Fire Protection Industry - Heating and ventilation, boiler feed applications, air conditioning, pressure boosting, fire protection sprinkler systems.
3. Waste Management, Agriculture & Manufacturing - Wastewater processing plants, municipal industry, drainage, gas processing, irrigation, and flood protection
4. Pharmaceutical, Chemical & Food Industries - paints, hydrocarbons, petro-chemical, cellulose, sugar refining, food and beverage production
5. Various industries (Manufacturing, Industrial, Chemicals, Pharmaceutical, Food Production, Aerospace etc.) - for the purposes of cryogenics and refrigerants.

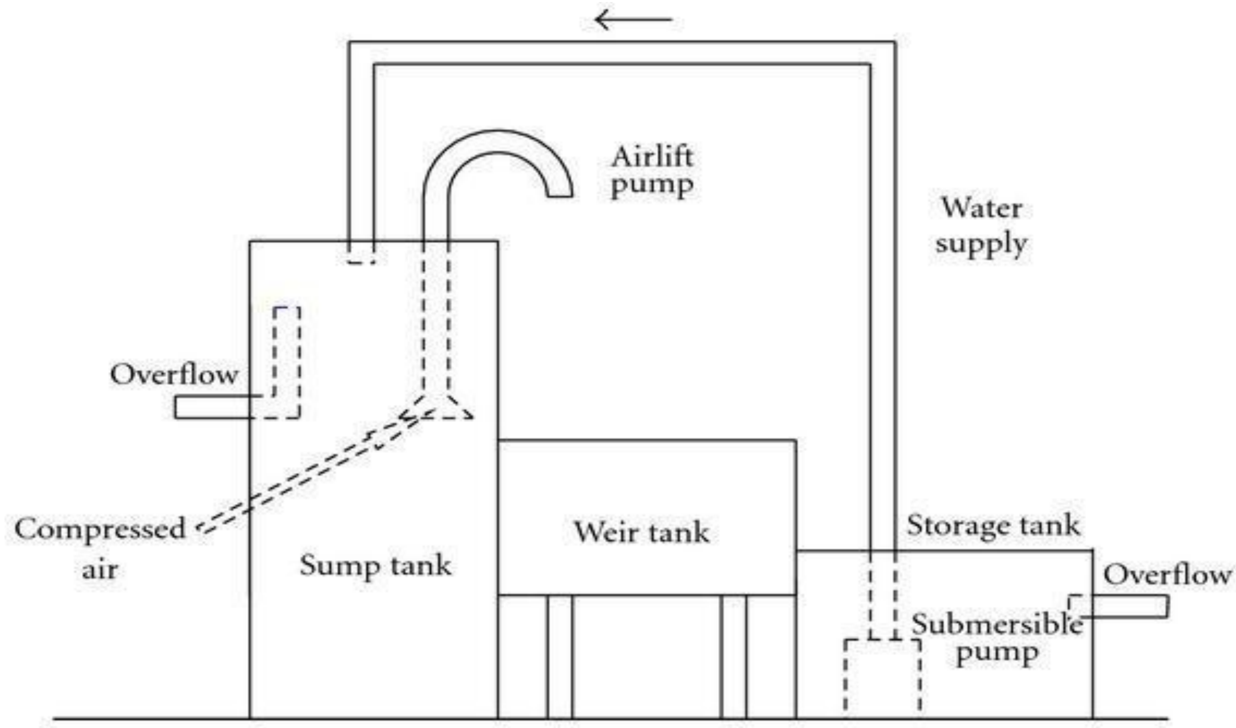




Air lift pump

When the water contains suspended matter and acids or alkalies which may damage other types of pumps ,the air lift pumps can be used very successfully.

These types of pumps are suitable for lifting water from small well or deep wells.



IMPULSE PUMP

This is also called hydraulic ram and works on the principle of impulse.

The advantages of a small fall is taken in lifting the water to great heights by means of the hydraulic ram.

It essentially consists of an inlet pipes,waste valve,delivery valve,ram,air chamber and delivery pipe.

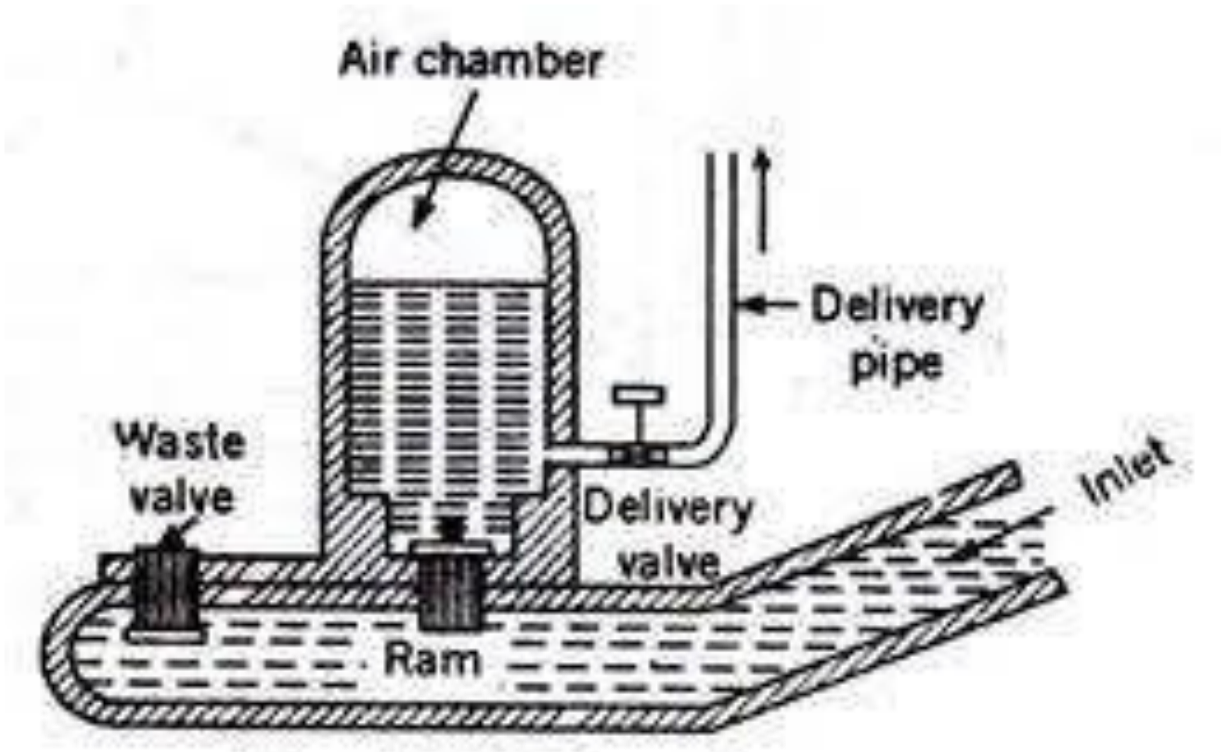


Fig. 6.10. Impulse pump.

PIPES

These are circular conduits in which water flow under pressure.

Now a days pressure pipes are mostly used at every place and they have eliminated the use of channels, aqueducts and tunnels to a large extent.

These are made of various materials as cast iron,wrough iron,steel,cement,asbestos,timber etc..

In the pipes the town pipes are also used for distribution system.

In distribution system pipes of various diameters,having many connections and branches,are used.

TYPES OF PIPES

1.cast iron pipes

2.wrought iron pipes

3. steel pipes.

4.concrete pipes

5.cement lined cast iron pipes

6.Asbestos cement pipes

7.copper and lead pipes

8.wooden pipes

9.vitrified pipes

CAST IRON PIPES

Cast iron pipes are mostely usede in water suplly schemes.

These are highly resistance to corrosion ,therefore have long life about 100 years.

Cast iron pipes are manufactured from best grey pig iron by two methods.

First method is ordinary sand moulding in which pipes are moulded in horizontal position.

Cast iron pipes are manufactured in lengths of 2.50mto 5.50m.

The fitting of these pipes are manufactured in sand mould having core boxes.

These fitting are also weighed,coated with tarcoal and finally tested.

Cast iron pipes are jointd together by mean of bell and spigot threaded or flanged

joints.

WROUGHT IRON PIPES

Wrought iron pipes are manufacture by rolling the flat plates of the metal to the proper diameter and welding the edge.

If compared with cast-iron ,these are more lighter, can be easily cut, headed and worked

These pipes should be used only inside the building, where they can be protected from corrosion.

STEEL PIPES

Steel pipes are cylindrical tubes made from steel that are used many ways in manufacturing and infrastructure.

They're the most utilized product made by the the steel industry. The primary use of pipe is in the transport of liquid or gas underground—including oil, gas, and water. .

Construction uses pipes for heating and plumbing. Structures can be built using steel pipe of varying sizes, such as handrails, bike racks, or pipe bollards.

They are also cheap, easy to constructed and can be easily transported than cast iron pipes

These pipes are much affected by corrosion and are costly to maintain.

The life of these pipes is 25 to 50 years which is much short as compared with cast iron pipes

CONCRETE PIPES

Concrete pipe is a rigid pipe that provides both structure and conduit when it arrives on site. Unlike flexible alternatives, concrete pipe has little dependence on the surrounding soil for its structural performance.

Precast pipes are manufactured in factories and then transported to the site.

The reinforcement of R.C.C pipes consists of a welded steel cylinder with high tension wire would over it.

CEMENT LINED CAST IRON PIPES

When the water contain corrosive elements the cast iron pipes are lined with cement to protects them against corrosion.

The thickness of lining varies from 3mm to6mm.

Afterlining,it properlu cured.

ASBESTOS CEMENT PIPES

These are manufacture by mixture of cement and absorbed fired.

These pipes are manufactured from 5cm to 130cm.

Internal pressure 3.5kg/cm2 .

These are not affected by salt,acids,and other corrosive materials and remain smooth.

COPPER AND LEAD PIPES

Copper pipes are not liable to corrosion even if water contains some traces of acids.

These pipes can be easily bent and also do not sag if used for hot water supply.

These pipes are only used in making gooseneck in the house connections and carrying hot water inside the buildings.

Lead pipes are not used in India,because they cause lead poisoning. But they can be given bends easily and also can withstand high pressure.

These pipes are mostly used in sanitary fittings.

WOODEN PIPES

Wood is being used since long for the construction of pipes .

Modern wood pipes are manufactured from staves are of two types.

Fiest is machine banded piped which is manufactured in small length at the factory.

And second type is continuous pipes which is and assembled on the job itself.

PLASTIC PIPES

Plastic pipe is a tubular section, or hollow cylinder, made of plastic. It is usually, but not necessarily, of circular cross-section, used mainly to convey substances which can flow—liquids and gases (fluids), slurries, powders and masses of small solids. It can also be used for structural applications; hollow pipes are far stiffer per unit weight than solid members.

Plastic pipework is used for the conveyance of drinking water, waste water, chemicals, heating fluid and cooling fluids, foodstuffs, ultra-pure liquids, slurries, gases, compressed air, irrigation, plastic pressure pipe systems, and vacuum system applications.

Types of Pipe Joint

In a **water supply** system network of long pipelines is required for the conveyance and distribution of water. Pipes are not manufactured in a single length as they may be long as 200 in coils of HDPE and other pipes are commonly 2 to 6 m.

Hence these pipes are required to join together of smaller length. Pipe joints are of various types which depend on pipe materials, the resistivity of pressure, durability, water tightness, site conditions, etc.

Pipe joints commonly used in pipelines are as follows,

1. Socket and spigot (bell and spigot joint)
2. Flanged
3. Expansion

4. Collar

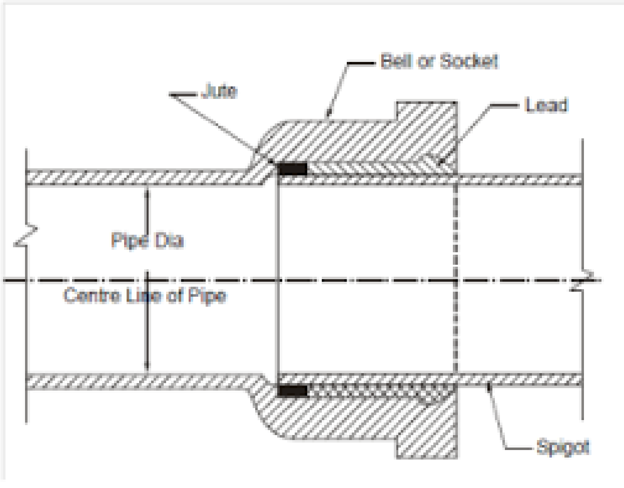
5. Screwed and socket

SOCKET JOINTS

This joint as shown in figure 8-1 is commonly used for CI pipes as well as DI pipes. In this joint spigot of one end of the pipe is slipped in socket or bell end of other pipe and jute or hemp yam is wrapped around spigot tightly up to 50 mm depth and a gasket or joint runner is clamped in place of the round joint to fit tightly.

With the help of a chalking tool, molten lead poured into the V shape opening left on the top by clamped joint runner. Space between hemp yam and the clamped runner is filled with molten lead.

Now runner is removed after hardening of lead then tightened by chalking tool and hammer. Lead about 3.5 to 4 kg may be required for up to the diameter 150 mm and for diameter 120 cm pipe 40 to 45 kg per joint. It takes high cost but

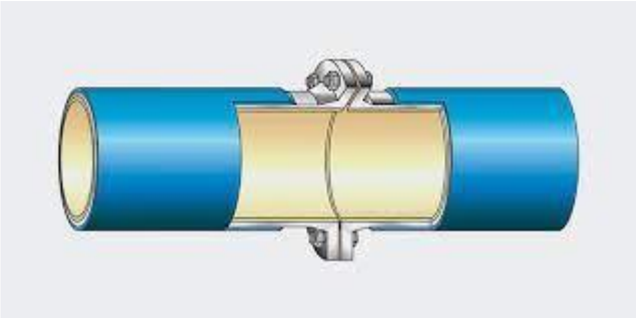


makes joint perfect.

FLANGED JOINTS

This joint is commonly used for CI pipes, steel pipes, and GI pipes This joint as shown in figure 8-2 may be used for temporary works. so that it can easily assemble and dissemble.

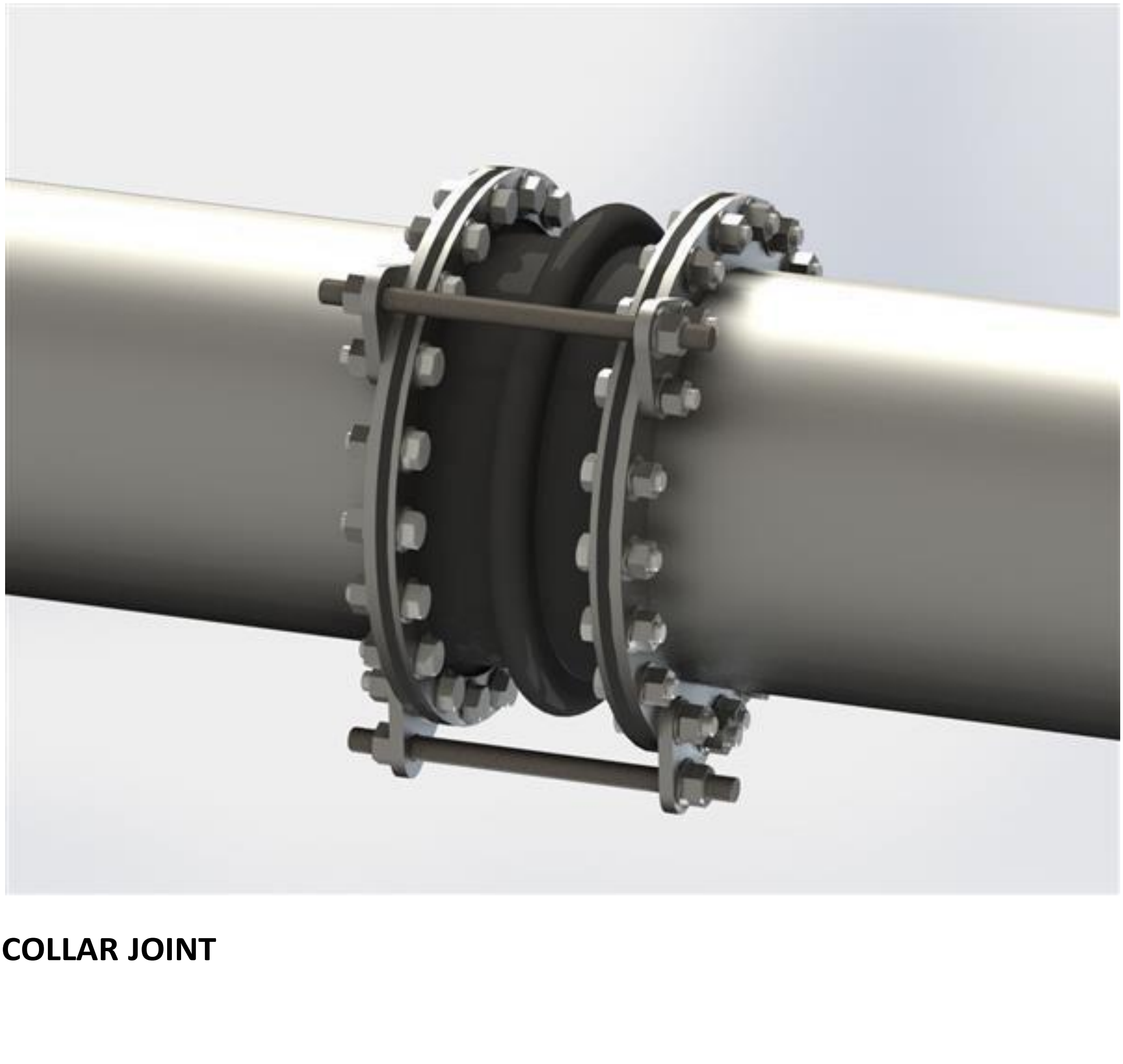
The flanges of both pipes are brought together and placed gasket in-between it is water tightened by screw or welding. This joint is suitable for pumping station filter plants, laboratories, and boiler houses but not used in places having vibration and deflection.



EXPANSION JOINT

This joint can bear temperature stress which results in expansion and contraction. The function of this joint is to maintain the water-tightness of the joint due to stress produced by temperature variations.

The socket end is flanged with a cast iron follower ring which can be freely slid on the spigot end and a rubber gasket is tightly pressed between the annular space of the spigot and socket by means of the **bolt**.



COLLAR JOINT

This joint is commonly used for cement concrete pipes; both reinforced and pre-stressed concrete pipes with plain ends. Tow ends of pipes are brought in the same level with a rubber gasket in-between, the collar is placed with a lap on both pipes. Cement mortar (1:1) is filled between the space of collar and pipe.

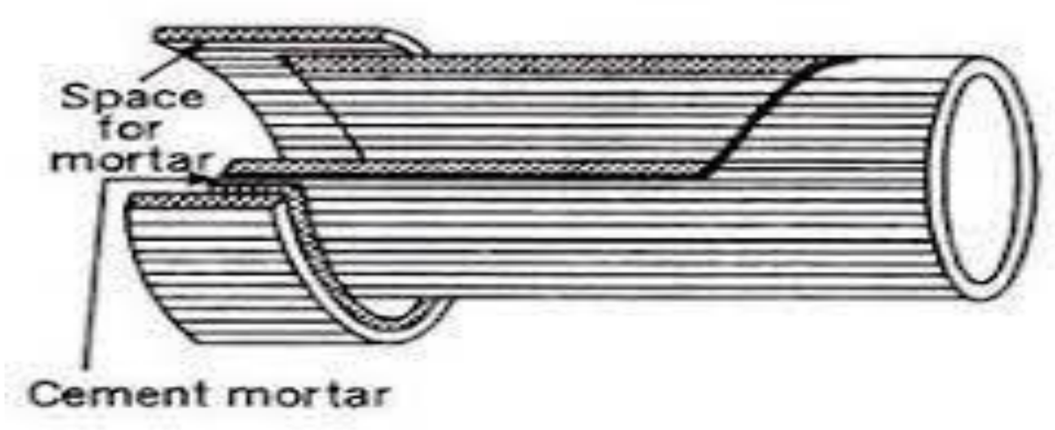


Fig. 6.14. Collar-joint (rigid type)

Screwed and Socket

Screwed and socket joint is commonly used for GI pipes and also for small diameter steel pipes. The ends of both pipes have screw threads on the outer surface in which sockets are screwed to make the joint.

Pipe joints in water supply are major components of plumbing system provided to connect multiple pipes. There are several types of pipe joints, but their selection depends on pipe sizes, material and flow pressure etc.. Pipe joint provided should withstand pressure of each pipe.

SUITABILITY OF PIPES JOINTS

Such joints are suitable for **low temperature and low flow conditions**. Brazing and solder pipe jointing are done on copper or copper alloy pipes by using molten filler material. For the same diameter pipes, butt welding is used to join the pipes as this gives high strength to resist high pressure.

QUESTIONS

1. What is surface sources ?

Sources of water that are available at the ground surface is called surface source.

Surface water source: Surface water is water located on top of the Earth's surface such as rivers, lakes, ponds, creeks, wetlands etc. Sub-surface source: Water beneath the land surface occurs in two principal zones, the unsaturated zone and the saturated zone.

2. What is ground sources ?

Those sources of water that exist below the ground surface is called ground water sources. The ground water may be contaminated with polluted water from agricultural fields, high mineral content, iron, and sulphur, calcium and magnesium.

Iron and manganese affect taste and odor. Iron and sulphur give rotten egg odor. Calcium and Magnesium cause hardness of water. The various groundwater sources are:

1. Springs
2. Wells
3. Infiltration galleries
4. Infiltration wells

3. what is intake ?

Intakes are the structures used for admitting water from the surface sources (i.e., river, reservoir or lake) and conveying it further to the treatment plant.

Generally, an intake is a masonry or concrete structure with an aim of providing relatively clean water, free from pollution, sand and objectionable floating material.

4. write 2 point for designing of intake ?

- All the forces which are expected to work on intake should be carefully analysed and intake should be designed to withstand all these forces.
- The foundation of the intake should be taken sufficiently deep to avoid overturning.

5. **What is pump ?**

   A pump is a mechanical device that lifts liquids from a lower level or low-pressure area to a higher level or high-pressure area.

   It is a heavy-duty equipment with low suction and high discharge pressure. This makes it easier to pump a fluid from a certain depth and push the fluid to the desired height.

6. **What is pipe ?**

These are circular conduits in which water flow under pressure.

Now a days pressure pipes are mostly used at every place and they have eliminated the use of channels, aqueducts and tunnels to a large extent.

LONG QUESTIONS

1.Describe surface sources &ground sources ?

2.Define intake & types of intakes ?

3.what are various necessicity of intakes ?

4.Define pump & eplain about it ?

5. Described reciprocating pump & uses ?

6. Describe centrifugal pump with figure ?

7. what is pipe ? & what are the types ?

8. How many types of joints of pipe are there ?(explain it)

CHAPTER -3

TREATMENT OF WATER

The main objects of treatment processes is to removed the impurities of raw water and bring the quality of water to the require standards.

The objects may be summarized as follows;

1. To removed the dissolved gasses, murkiness and colour of water.

2. To remove the unpleasant and objectionable tastes and odours from the water.

3.To kill all the pathogenic germs ,which are harmful to the human health .

4. To makes water fit for domestics use as cooking and washing and various industrial purposes as dyeing ,brewing ,steam generation etc.

5. To eliminate the tuberculating and corrosive properties of water which affected the conduits and pipes.

LAY OUT OF TREATMENT PLANT

1.intake work including pumping plant

2.plain sedimentation.

3.sedimination with coagulation.

4.filtration.

5. miscellaneous treatment plants.

6. disinfection.

7. clear water reservoir.

PRIMARY TREATMENT

AERATION

Aeration is usually effective against several pollutants are discussed the dissolved gases like random carbon dioxide , some taste and odour producing compounds like methane hydrogen sulphide, the volatile organic compounds like MTB or industrial solvents, it can also raise the pH of water and it can be used for precipitation and removal of iron and manganese aeration.

Aeration is usually not effective against other heavy metals it does not affect them much it is not effective against pathogens okay. So, the disease-causing organisms like bacteria and virus rather they may get more oxygen and they may get like they may proliferate more or so, rapid growth with Aeration, and it is not effective against the turbidity and other suspended materials.

SEDIMENTATION

In sedimentation there are Sedimentation aided with coagulation.

PLAIN SEDIMENTATION

If the water contains suspended impurities of large size, it is very economical to remove them by preliminary sedimentation. The suspended impurities make the water-turbid; therefore, when they will be removed more uniform water will be available for the further treatment processes.

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.

Plain sedimentation has the following advantages:

(i) It lightens the load on the subsequent process.

(ii) The operation of subsequent purification process can be controlled in a better way, because plain sedimentation delivers less variable quality of water.

(iii) The cost of cleaning the chemical coagulation basins is reduced.

SHAPES OF TANKS

Rectangular tanks with horizontal flow

Circular tanks with radial or spiral flow

Hopper bottom tanks with vertical flow

Circular Tank

Circular sedimentation tanks are preferred for continuous vertical flow type sedimentation tanks. In this case influent is sent through central pipe of the tank and radial flow takes place. Mechanical sludge scrappers are provided to collect the sludge and collected sludge is carried through sludge pipe provided at the bottom. But circular tanks are uneconomical as compared to rectangular tanks but they have high clarification efficiency.

Rectangular Tank

Rectangular sedimentation tanks are mostly preferred sedimentation tanks and are used widely. The flow takes place in horizontal direction that is length wise in rectangular tanks. Sometimes baffle walls are provided for rectangular tank to prevent short circuiting. Maintenance costs are low in case of rectangular sedimentation tanks. They are also suitable for large capacity plants

Hopper Bottom Tank

In case of hopper bottom tank, a deflector box is located at the top which deflects the influent coming from central pipe to downwards. Sludge is collected at the bottom and it is disposed through sludge pump.

SEDIMENTATION AIDED WITH COAGULATION

Very fine suspended clay particles are not removed by plain sedimentation.

Silt particles of 0.06mm size required 10 hours to settle in 3m deep plain sedimentation tank and 0.02mmparticles will required about 4 days settling.

This settling time is impracticable, because water cannot detained for such a long time.

In addition to fine suspended matter ,water also contained electrically charged colloidal ,matter which are continuously in motion and never settle down due to gravitational force.

When water contains such fine clay particles and colloidal impurities it becomes necessary to apply such process which can easily removed them from water. After long experiment it has been found that such impurities can be removed by

When water contains fine clay and colloidal impurities it becomes necessary to apply such process which can easily removed from the water. After long experience it has been found that such impurities can be removed by sedimentations with coagulation.

PROCESS

It has been found that when certain chemicals are added to water an in soluble, gelatinous, flocculent precipitation is formed. This gelatinous precipitation during its formation and descent through the water absorb and entangle very fine suspended matter and colloidal impurities.

First the coagulants are mixed in the water to produce the required precipitator

then the water is sent in sedimentation basins where sedimentation of fine and colloidal particles takes place through the precipitate.

CEMICAL COAGULANTS

Aluminums sulphate its also called simply as alum .

Alum which is available in market is directly grey solid in the form of lumps containing about 17% aluminium sulphate. This is the chemical coagulant which is widely used in water treatments plants.

DETERMINATION OF OPTIMUM COAGULANTS

The optimum dose of coagulants is determined by jar-test apparatus.

It essentially consists of four or more large size beakers of 1-2 liters capacity. stirring paddles of non corrosive metal are placed in each jar. which can be rotated at any desired speed by gear and spindle system.

For starting the experiment first of all the sample of water in real amount is taken in every jar. then coagulant is added in the jar in varying amounts. The quantity of coagulants added in each jar is noted. Then with the help of electric motor all the paddles are rotates at a speed of 30-40 R.P.M

For about 10minutes.

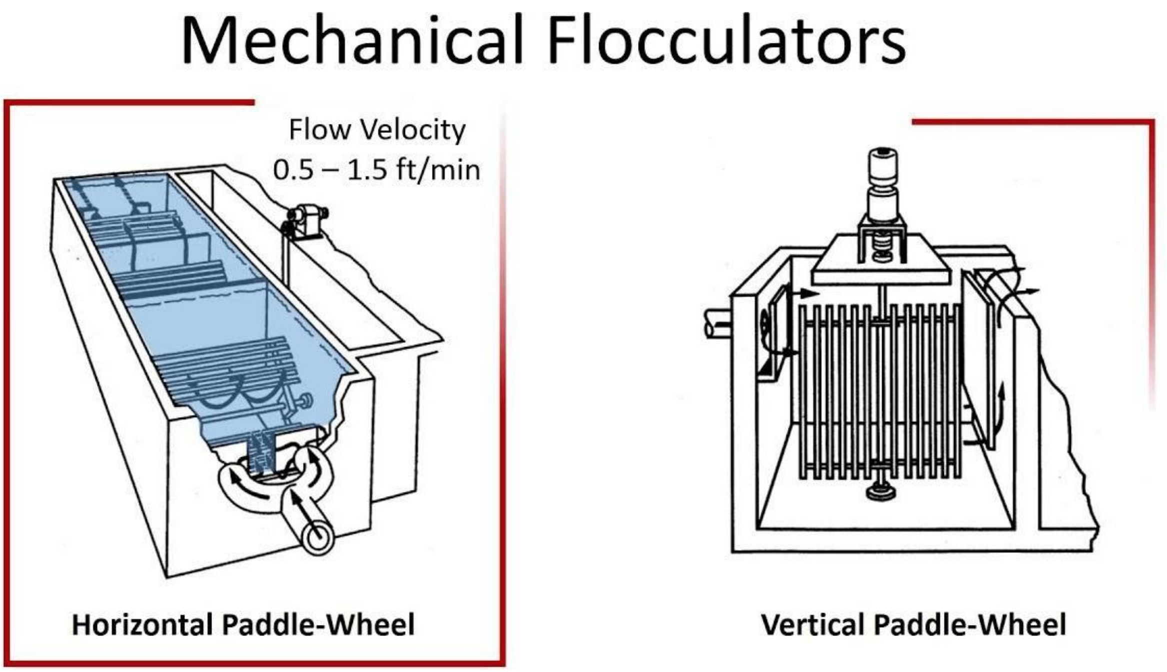
After this speed is reduced and paddles are rotated for about 20-30 minutes.

The rotation of paddles is stopped and the floc formed in each jar is noted and is allowed to settle. The dose of coagulant which gives the best floc is the optimum dose of coagulants.

FLOCCULATION

After thoroughly mixing of coagulants in the water the next operation is flocculation.

Flocculates are slow stirring mechanisms, which forms floc. Flocculates mostly consists of paddles which are revolving at very slow speed about 2-3 r.p.m. the paddles may revolve on a vertical or horizontal shaft.



<u>FILTERATION</u>

The process of passing the water through beds of sand or other granular materials is known as filtration. Filters are used for removing bacteria, colour, taste, odours and producing clear and sparkling water. By sand filtration 95 to 98% suspended impurities are removed.

Filtration is carries out in three types of filters

Slow sand filter

Rapid sand filter

Trickling Filter

Pressure filter

SLOW SAND FILTER

Slow sand filters are best suited for the filtration of water for small towns. The sand used for the filtration is specified by the effective size and uniformity coefficient . Slow sand filter is made up of a top layer of fine sand of effective size 0.2. to 0.3mm and uniformity coefficient 2 to 3 .

The thickness of the layer may be 75 to 90 cm. Below the fine sand layer, a layer of coarse sand of such size whose voids do not permit the fine sand to pass through it.

The thickness of this layer may be 30cm. The lowermost layer is a graded gravel of size 2 to 45mm and thickness is about 20 to 30cm.

The gravel is laid in layers such that the smallest sizes are at the top. The gravel layer retains the coarse sand layer and is laid over the network of open jointed clay pipe or concrete pipes called under drainage. Water collected by the under drainage is passed into the out chamber.

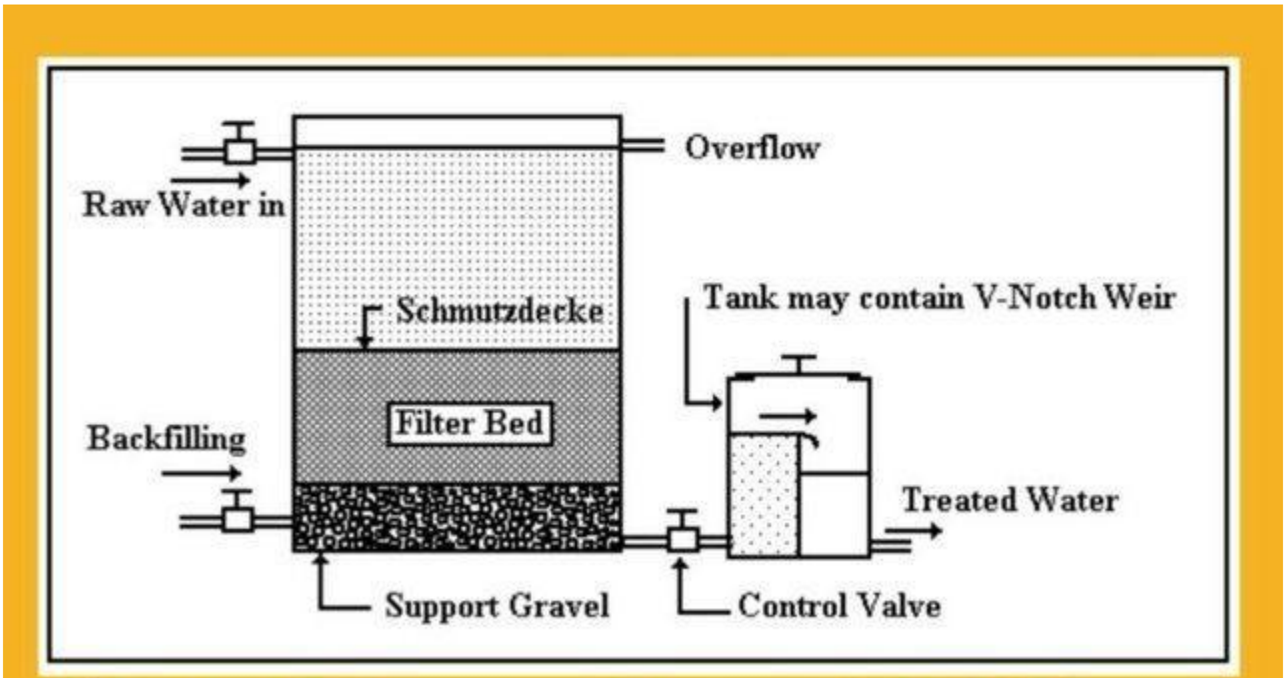
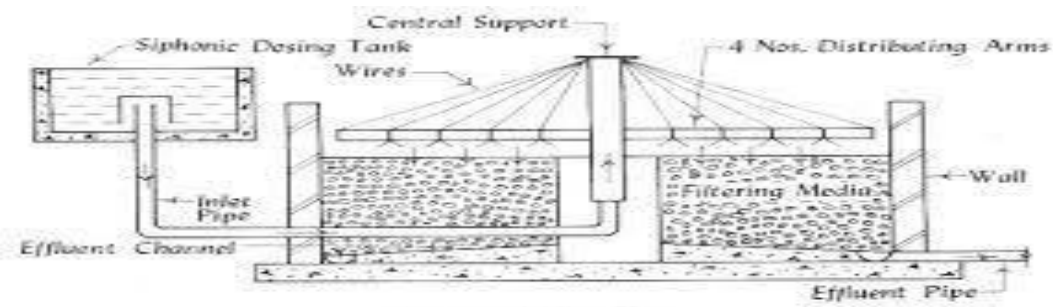


fig:-Slow Sand Filter

TRICKLING FILTER

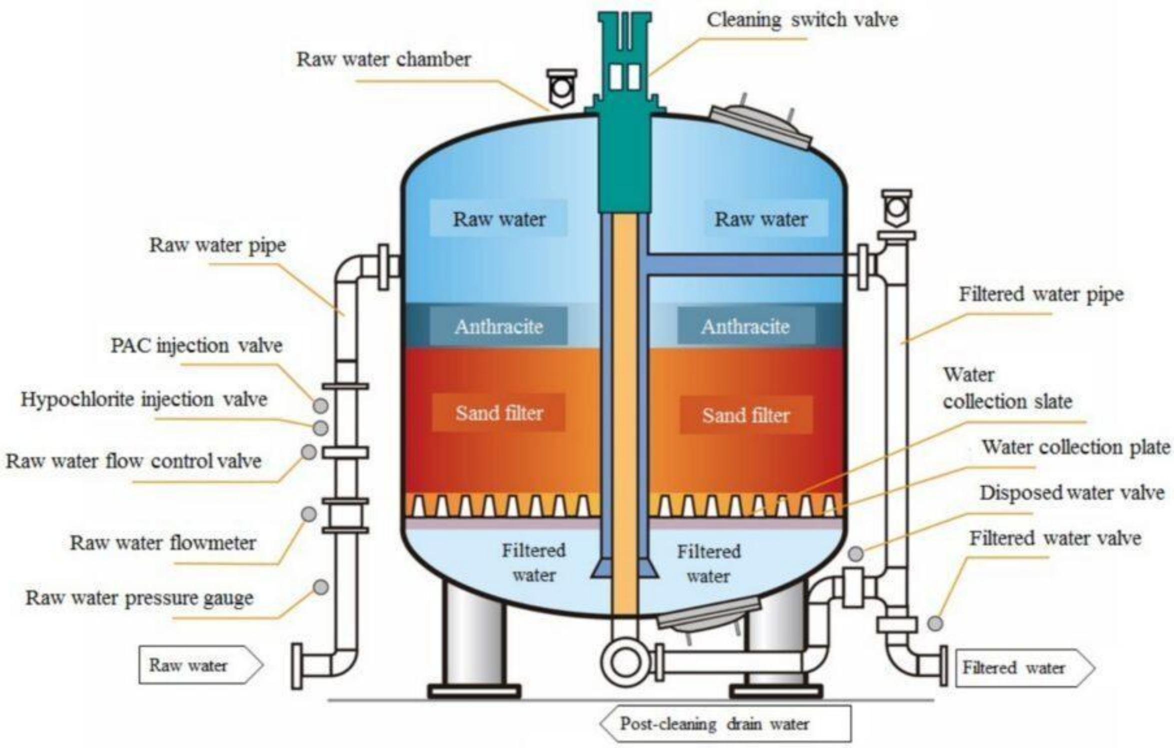
Filter is open to atmosphere, air flows naturally through media .Treated water leaves bottom of tank, flows into secondary clarifier .Bacterial cells settle, removed from clarifier as sludge .Some water is recycled to the filter, to maintain moist conditions.



Circular trickling filter

PRESSURE FILTER

Pressure filter is type of rapid sand filter in a closed water tight cylinder through which the water passes through the sand bed under pressure. All the operations of the filter is similar to rapid gravity filter, expect that the coagulated water is directly applied to the filter without mixing and flocculation. These filters are used for industrial plants but these are not economical on large scale. Pressure filters may be vertical pressure filter and horizontal pressure filter



DISINFECTION OF WATER

The process of killing the infective bacteria from the water and making it safe to the user is called disinfection it dose not mean total destruction of all living things in the medium treated because sterilization means total destruction.

The filters are unable to remove all the diseases bacteria. They can removed only few types of bacteria. therefore the water which comes out from the filter may contain some disease causing bacteria in addition to the useful bacteria. Before the water is supplied to the public it is at most necessary to kill all the diseases causing bacteria. The chemical or substances which are used for killing the bacteria are known as disinfectants, and the process of killing the bacteria is known as disinfection of water.

REQUIREMENTS OF GOOD DISINFECTANS.

1. thet should destroy all the harmful pathogenic organisms from the water and makes it perfectly safe for use.

2. They should not take more time in killing pathogens, but do their task within the required time at normal temperature.

3. They should be economical and easily available.

4. They should not required high skill And costly requirement for their application.

5. After their treatment the water should not become toxic and objectionable to the user.

METHOD OF DISINFECTIONS

BY BOILING OF WATER

The water can be disinfected by boiling for 15 to 20 minutes. By boiling water all the disease causing bacteria are killed and the water becomes safe for use.

This process can only kill the existing germs but dose not provide any protection against future possible contamination. This method is costly and can be used only individually in emergency cases during the break up of epidemics in the town or city.

BY ULTRA -VIOLET RAY

Ultraviolet rays are invisible light rays having waves lengths 1000 to 4000m.

Sun rays also have ultra violet rays which can also be utilized in the disinfection of water.

In this laboratory they can obtained by the ultra violet ray equipment which essentially consists of mercury vapours encosed in quartz bulb and passing current in it.

Ultra violet rays arte highly disinfectants and kill the disease bacteria.

BY THE USE OF IODIN AND BROMIN

It has been seen that addition of iodine and bromine in the water, kills all the pathogenic bacteria. The quantity of iodine and bromine should not exceed 8ppm and they can kill bacteria in minimum contact period of 5 minutes.

These disinfectants are easily available in the form of pills and very handy. beings costly these are also used in treating water works at individual estate or industry.

BY THE USE OF OZONE

Ozone is an excellent disinfectant. it used in gaseous form which is faintly blue in colour of pungent odors.

Ozone is an unstable allotropic form of oxygen with its every molecule containing three oxygen atoms.

Ozone is produced by passing a high tension electric through a stream of air in a closed chamber

BY THE OF EXCESS LIME

.lime is usually used at the water works for reducing the hardness of water.

It has been noted practically that if some additional quantity of lime is added than what it actually required for removal of hardness, it will also disinfect the water while removing the hardness.

The addition of excess lime in the water increases the ph value of the water.

It has been noted that at pH value more than 9.5 all the bacteria are killed.

CHLORINE COMPOUNDS

Various chlorine compounds which are used as disinfectants are hypochlorite's of calcium and sodium,the chloromines, chlorine dioxide and complex chlorine compounds such as(CH_2 CO_2)NCL.

CHLORINE DEMAND

Chlorine demand is defined as the difference between the amount of chlorine added to water and the amount of chlorine remaining at the end of a specified contact period.

The chloride demand for a sample of water depends on

Nature and concentration of chlorine consuming substances present in water.

Time of contact

Ph value of water

Temperature of water

BREAK POINT CHLORINATION

When chlorine is added to water it reacts with organic and inorganic matter and forms common compound some portion of chlorine remains as residual chlorine, which is not the true but combined residual and is much weak in disinfecting action.

If the chlorine dose is increased the combined available residual chlorine also increase. when the chlorine dose is so increased the compounds get oxidized and the substances which are newly formed do not react with orthotolodine to show any residual**.**

SUPER CHLORINATION

Super chlorination is defined as the administration of a dose considerably in excess of that necessary for the adequate bacterial purification of water.

Under certain circumstances such as during epidemics of water borne diseases, high dose of chlorine is given to the water generally 2 to 3 p.p.m beyond the break point, for the safety of public. The adding of chlorine in excess is called super chlorination.

PRE CHLORINATION

When chlorine is added to raw water at more than one point, it is known as double chlorination.

When raw water is highly contaminated and contains large amount of bacterial life it becomes necessary to adopt pre-chlorination and post chlorination for such water.

SOFETENING OF WATER

The removal or reduction of hardness from the water is known as water softening .form the health point of view,it is necessary at all times to removes the hardness from the water .

Water softening is a process in which the ions of calcium, magnesium and sometimes iron are removed. It is these ions in hard water that make it difficult for products with other positively charged ions to dissolve in the water. By doing this, the water softening removes the offending minerals from the water.

METHOD OF WATER SOFTENING

LIME SODA PROCESS

The hardness of a water is defined as soap settling property of that water. The soap is sedimentedby the presence of Ca^{+2} and Mg^{+2} ions in the water. Ions such as Fe^{+2}, Zn^{+2}, and Al^{+3} also help settling. However, the presence of high amounts of Ca^{+2} and Mg^{+2} ions in water usually leads to water hardness. This is the most common type of hardness in natural waters. The hardness caused by these materials is known as total hardness. The part of the total hardness corresponding to carbonate and bicarbonate ions in the water is defined as carbonate hardness. These ions also determine water alkalinity.

Waters are classified according to hardness grades as follows.

(mg/L) $CaCO_3$	**Degree of Hardness**
0-75	Soft
75-150	Middle
150-300	Hard
300 and over	Very hard

The Aim of Softening:

Hard water can cause various problems. The problems created by hard waters are as follows;

– They cause excessive soap consumption.

– They cause to skin irritation.

– They cause lime accumulation in boilers, hot water pipes and heaters.

– They cause discoloration in porcelain. Especially in homes, the white color of the sinks and bathtubs are discolored.

– They reduce the life of fabrics and cause them to wear out.

– They cause problems in canned food industry.

Hardness removal (chemical softening) is a process that removes all or part of the hardness by adding various chemical substances into the water. The processes used for water softening are chemical sedimentation and ion exchange methods. Chemical sedimentation can be carried out in 3 ways.

1- Lime-soda process

2- Caustic-soda process

3- Sodium phosphate process

Lime soda process: In lime-soda process, hard water is treated with lime (CaO or $Ca(OH)_2$) firstly, after that with soda. In this process, the hardness is removed by sedimentation as calcium carbonate or magnesium hydroxide.

Lime is added either as calcium hydroxide or calcium oxide, and soda is added as sodium carbonate. The substances form hardness in water and the reactions

$\longrightarrow$

$\longrightarrow$

of lime and soda can be written as follows.

$Ca(OH)_2 + CO_2$ $CaCO_3 + H_20$

$Ca(OH)_2 + Ca(HCO_3)_2$ $2CaCO_3 + 2\ H_20$

$Mg(HCO_3)_2 + Ca(OH)_2$ $MgCO_3 + CaCO_3 + 2\ H_20$

$MgCO_3 + Ca(OH)_2$ $Mg(OH)_2 + CaCO_3$

$MgCl_2 + Ca(OH)_2 \longrightarrow CaCl_2 + Mg(OH)_2$

$MgSO_4 + Ca(OH)_2$ $Mg(OH)_2 + CaSO_4$

$2NaHCO_3 + Ca(OH)_2 \longrightarrow CaCO_3 + Na_2CO_3 + 2H_20$

$CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3 + NaCl$

$CaSO_4 + Na_2CO_3 \longrightarrow CaCO_3 + Na_2CO_3$

The usual method for lime soda processing is treatment by excessive lime amount. The pH should be greater than 9 for sedimentation of the magnesium hydroxide. Usually pH is between 10-10.5. The process contains lime dosing. A small amount of alum or sodium aluminates is added to ensure good sedimentation. The recycling of some sediment sludge can also help to sediment.

If the water contains excessive alkalinity after the softening process has been

completed, there is a possibility that the calcium carbonate will settle in the pipes. The softened water is treated with H_2SO_4 or CO_2 to remove this from the softened water. This reaction is called recarbonization.

In addition to the recarbonization process, addition small amount of polyphosphate (0.5-5 mg / L) may prevent this sedimentation after purification. If it is requested to retain permanent hardness in water, soda should not be used after softening. This application is defined as partial softening operation.

MATERIALS USED

- $Ca(OH)_2$ and Na_2CO_3
- NH_4Cl
- Eriochrome Black T and EDTA
- Phenolphthalein and Methyl Orange
- H_2SO_4
- Beaker
- Jar test setup
-

PROCEDURE

– Synthetic hard water is prepared using $CaCl_2.2H_2O$, $MgSO_4.7H_2O$ and Na_2CO_3.

– The pH, alkalinity and total hardness of the water described above are determined according to standard methods.

– 2 bottles of sample are taken into the jar apparatus by taking 400 ml.

– The stirrers in the jar test setup are soaked in the beaker sat 150 rpm.

– During rapid mixing, the pH probe is soaked in order to control the water in the beaker, and 18 ml of lime is added to the water in both beakers until pH 10 reaches to 10. After pH is 10, it is slowly mixed at 40 rpm for 25 minutes.

– Wait for 20 minutes. The total hardness and alkalinity of the filtrate water is determined and the measurement results are recorded.

– To control the pH of second beaker if it is 11, pH probe is soaked in water running at 150 rpm, it is added enough amount of lime until pH is 11.

– When pH is 11, it is slowly stirred at 40 rpm for 25 minutes.

– Wait for 20 minutes. The total hardness and alkalinity of the filtrate water is determined and the measurement results are recorded.

QUESTIONS

1. What is the main object of water treatment ?

The main objects of treatment processes is to removed the impurities of raw water and bring the quality of water to the require standards.

1. To removed the dissolved gasses, murkiness and colour of water.

2. To remove the unpleasant and objectionable tastes and odours from the water

2.what is aeration ?

Aeration is usually effective against several pollutants are discussed the dissolved gases like random carbon dioxide , some taste and odour producing compounds like methane hydrogen sulphide, the volatile organic compounds like MTB or industrial solvents, it can also raise the pH of water and it can be used for precipitation and removal of iron and manganese aeration.

3. what is sedimentation?

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.

4. what is filtration ?

The process of passing the water through beds of sand or other granular materials is known as filtration. Filters are used for removing bacteria, colour, taste, odours and producing clear and sparkling water. By sand filtration 95 to 98% suspended impurities are removed.

5. what is disinfection ?

The process of killing the infective bacteria from the water and making it safe to the user is called disinfection it dose not mean total destruction of all living things in the medium treated because sterilization means total destruction.

6. What is flocculation ?

After thoroughly mixing of coagulants in the water the next operation is flocculation.

Flocculates are slow stirring mechanisms, which forms floc. Flocculates mostly consists of paddles which are revolving at very slow speed about 2-3 r.p.m. the paddles may revolve on a vertical or horizontal shaft.

7. what is chlorination ?

Various chlorine compounds which are used as disinfectants are hypochlorites of calcium and sodium,the chloromines, chlorine dioxide and complex chlorine compounds such as(CH2 CO2)NCL.

8. what is softening of water ?

The removal or reduction of hardness from the water is known as water softening .form the health point of view,it is necessary at all times to removes the hardness from the water .

LONG QUESTIONS

1.Define sedimentation & types of tank ?

2.Define necessity and principle of coagulation.

3.Define filtration &type of filter.

4.Define disinfection and requirement of good disinfection .

5.What are the method of disinfection ?

6.Write about pre chlorination, break pointchlorination,superchlorination.

7.Explain lime soda process in softening of water .

CHAPTER -3

DISTRIBUTION SYSTEM AND APPURTENANCE IN DISTRIBUTION SYSTEM

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 sizes,valves,meters,pumps ,distribution reservoirs,hydrants,stand posts etc.

The following are the requirements of a good distribution system.

1. it should convey the treated water up to the consumers with the same degree of purity.

2. The water should reach to every consumer with the required pressure head.

3.sufficient quantity of treated water should reach for the domestics and industrial use.

4.The distribution system should be economical and easy to maintained and operate.

5. It should be able to transport sufficient quantity of water during emergency such as fire fighting.

6. The quantity of the pipes laid should be good and it should not burst.

7. It should be water tight and the water losses due to leakage should be minimum as far possible.

DISTRIBUTION SYSTEM

1. Gravity system

2. .pumping system
3. 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 the distribution-system in maintaining pressure in water pipes.

This method is also much suitable when source of water 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.

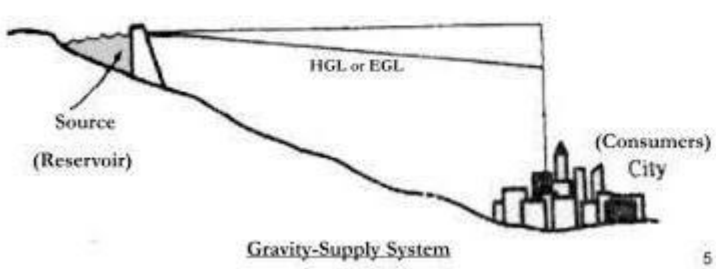
In this system usually pumping is not required at any stage.

In case the source of water supply is lake situated at the hill, low lift pumping may be required to lift the water up to the water treatment units.

The water will flow under gravitational force in the treatment units, and will be finally collected to the again under gravitational force.

This designs of the distribution system p[pies are done in such a way that water head available at the consumer's door is just minimum required,and the remaining head is fully consumed in frictional and other losses.

This will reduce the leakage and wastes to the minimum .but in this case the water will have to be pumped during fires.



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.

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 first the water can be pumped in the required quantity by the stand bye units also.but this system is not preferred than other systems.

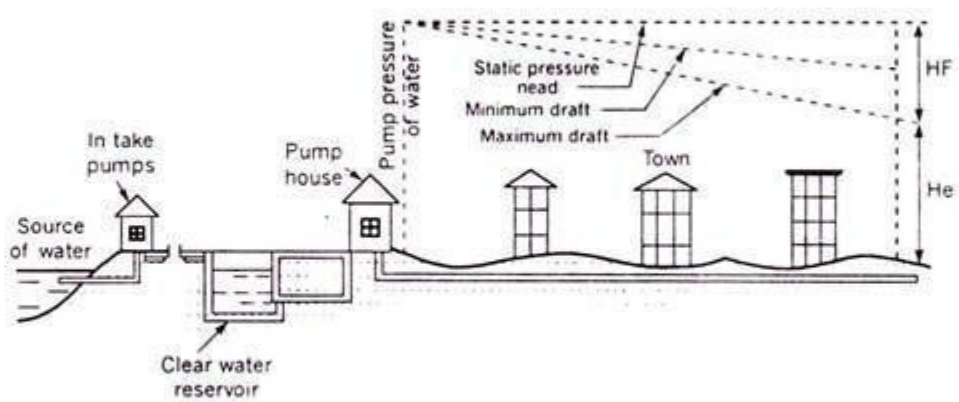


Fig. 18.2. Pumping System of Distribution.

DUAL SYSTEM

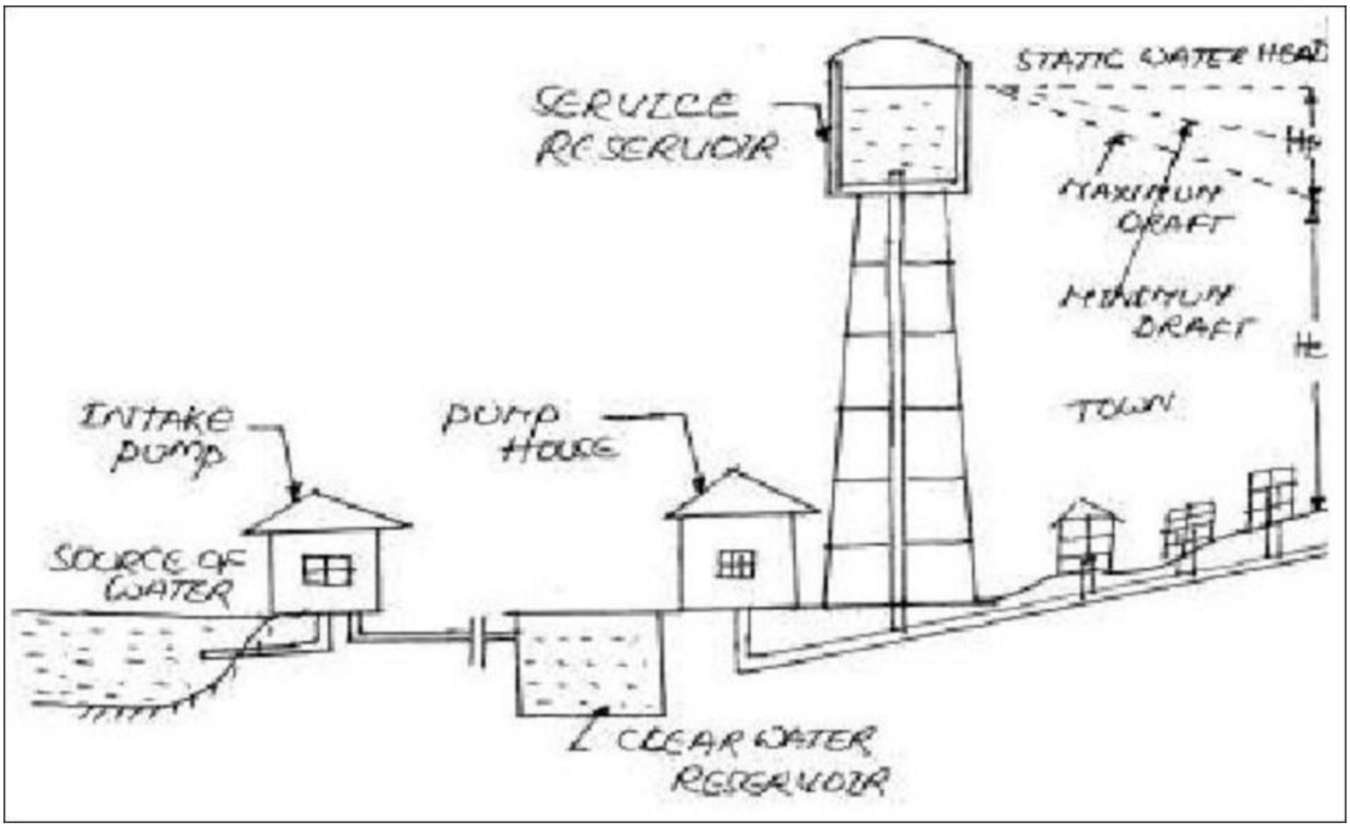
This is also known as well as to elevated reservoir. as in this system water comes from two sources one form reservoir and second from pumping station, it is called dual system. this is system is more reliable and economical, because it requires uniform rate of pumping but meets low as well as maximum demand. The water stored in elevated reservoir meets the requirements of demand during breakdown of pumps and for fighting.

The balance reserve in the storage reservoir will be utilized during fire.

In case the fire is more and if required the water supply of few localities may be closed.

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

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



LAYOUT OF DISTRIBUTION SYSTEM

1.Dead end or tree-system

2.Grid iron system

3.circular or ring system

4.Radial system

1.Dead end or tree-system

It is suitable for irregular developed towns or cities.

1.Dead end or tree-system

In this system one main starts from service reservoir along the main road. Sub mains are connected to the main in both the directions along other roads which meet the main road.

In streers,lanes and other small roads which meet the roads carrying sub mains branches and minor distributiors are laid and are connected to submains.form these branches service connections are made to individual houses.

3.circular or ring system

as reticulated system and is most convenient for towns having rectangular layout of roads.

Actually this system is an improvement over dead end system.

All the dead ends are interconnected with each other and water circulates freely throughout the system.

Main line is laid along the main road.

Sub mains are taken in both the directions along other minor roads and streets from these sub mains branches are taken out and are inter connected.

This system removes all the disadvantages of dead end system.

4.Radial system

This systems is not adopted in india,because for this system the roads should be laid out radically from a centre.

Actually this is reverse of ring system and flow towards outer periphery from one point .this entied district is divided into various zones and reservoiur is provided fort each zone, which is placed in the center of the zone. The water lines are laid radially from it.

This system gives very quick and satisfactory water supply and also the calculation of pipes sizes is very easy.

METHODS OF SUPPLYING WATER

The water can be sup[plied to the consumers by the following two system

1.continuous system

This is the best when there is adequate quality of water for supply.

In this system sample water is water is always available for fighting and due to continuous circulation water always remains fresh.

2. intermittent system

If plenty of water is not available, the supply of water is divided into zones and each zone is supplied with water for the fixed hours in a day. As the water is supplied after intervals, it is called intermittent system. This system should be continued on long term policy due to the following disadvantages

The consumers have to store water for non supply hours which is likely to get contaminated. Some consumers may not have sufficient storage tanks, which may lead to insanitary conditions.

If it gets fire in non supply hours no water is available and it may cause huge damage before the supply could be turned on.

VALVES

In water works practice, to control the flow of water, to regulate pressure to release or to admit air, to prevent flow of water in opposite direction and for so many other purposes valves are require. similarly in every house various types of fittings such as taps, bends, tees, sockets etc. are required for the distribution and forming network of pipes inside the houses.

Check Valves

It also called non-return or one-way valves, are designed to allow flow in only one direction and to automatically prevent or "check" back flow if the fluid in the line reverses direction. These water supply valve types are small, simple and inexpensive, and are often used for backflow prevention in pumps, safety applications and such systems as lawn sprinklers. In addition, backflow preventers work in the same way but tend to be used for larger buildings such as apartment complexes or commercial properties.

Air valves

When water enters in pipes it also carries some air with it which tends to accumulate at high points of the pipes. when the quantity of air increases, it cause serious blockage to the flow of water.

Therefore it is most essential to removed the accumulated air from the pipe line.

Air relief valves are used for this purpose.

These valves consist a cast iron chamber bolted on the pipe over the opening in the crown. weighted float and a lever in it are so adjusted that when the chamber is filled with water under pressure from the pipe line below,the float and the lever remains released up preventing the flow of water through the valve.

But where air goes on accumulating at the top and builds up some pressure the water level gets depressed and the float sinks down with the lever and open the valve.

The water level in the chamber again rises, raising the float with it and the valve gets closed.

Sluice valves

These are also known as gate valves and are most commonly used in water works practice. these valves are cheaper, offer less resistance to the flow of water than other valves used for same purpose.

Gate valves control the flow of water through pipes, and fixed in main lines bringing water from the source to a town at 3 to 5 kilometers intervals, thus dividing the pipes line into different sections.

During repairs only one section can be cut off by closing the sluice valves at both ends.

This valves is made of cast iron with brass, bronze or stainless steel mountings and its ends are screwed flanged or spigot and socketed on the pipe.

HYDRANTS

These devices are used for tapping water from mains for fire extinguishing, street, washing, watering gardens, flushing sewer lines and for so many other purp[oses.

These are generally provided at all junctions of roads and at 100-130 meters apart along the roads.

They are also sometimes used for filling the municipal water carts, to the water requirement during construction of roads, washing of roads, drains, sewers, sprinkling of public lawns etc.

FLUSH HYDRANT

It is illustrates this type of hydrant. It is installed in an underground brick chamber flush with the foot path. It is cover to locate the position of this hydrant even in darkness, some distinct sign is provided near it at the side of road with letters F.H written on it.

POST HYDRANT

The barrel of the hydrant remains projected about 60-90 cm above the ground surface. These hydrants have a long stem with screw and nut at the top to regulate the flow of water.

The post hydrant is connected to the main pipe, through a branch pipes and it can be operated by means of a gate valve.

METERS

To determine the quantity of water flowing through pipes some devices called meters. These are required to measure the quantities of water supplied to private houses,industrial,puplic building etc

The two types of meter are there.

1. Positive displacement types
2. The velocity displacement types

Displacement type

These are used for measuring small flows of water. These are designed on displacement principle and record the number of times a vessel of known volume is fitted and emptied.

From this the rate of flow is calculated automatically. these types of meters include rotaruy, reciprocating , oscillating and nutating disc meters.

Velocity or inferential type

These are generally venture or turbine. They consist of a device by which a vane or propeller turns in direct ratio to the rate of flow of water around the propeller. the venture type meters consist of two tapering cast iron conical pipes, one long and other short joined together at their small ends.

QUESTIONS

1. What are the type of distribution system ?

a. Gravity system
b. .pumping system
c. Dual system or combined gravity and pumping system.

2. what is gravity system?

When some ground sufficiently high above the city area is available, this can be best utilized for the distribution-system in maintaining pressure in water pipes.

This method is also much suitable when source of water 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.

3. What is 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. 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.

4. what is intermittent method ?

If plenty of water is not available, the supply of water is divided into zones and each zone is supplied with water for the fixed hours in a day. As the water is supplied after intervals, it is called intermittent system.

5. what is sluice valve ?

These are also known as gate valves and are most commonly used in water works practice. these valves are cheaper, offer less resistance to the flow of water than other valves used for same purpose. Gate valves control the flow of water through pipes, and fixed in main lines bringing water from the source to a town at 3 to 5 kilometers intervals, thus dividing the pipes line into different sections.

6. what is check valves ?

It also called non-return or one-way valves, are designed to allow flow in only one direction and to automatically prevent or “check” back flow if the fluid in the line reverses direction. These water supply valve types are small, simple and inexpensive, and are often used for backflow prevention in pumps, safety applications and such systems as lawn sprinklers.

7. what is hydrant ?

These devices are used for tapping water from mains for fire extinguishing, street, washing, watering gardens, flushing sewer lines and for so many other purposes.

These are generally provided at all junctions of roads and at 100-130 meters apart along the roads

8. What is water meters ?

To determine the quantity of water flowing through pipes some devices called meters. These are required to measure the quantities of water supplied to private houses,industrial,puplic building etc.

LONG QUESTIONS

1. **What are type of distribution system ?**
2. **what are the method of supply ?**
3. **what is distribution system ?& what are the system ?**
4. **what is valve & what are the valves ?**
5. **what is water meter and explain its types ?**

CHAPTER -5

W/S PLUMBING IN BUILDING

System layout and pipework

The water supply system must be designed to achieve appropriate water pressure and flow, and to avoid contamination to potable water.

On this page:

- Water pressure
- Water flow rate
- Flow rate and pipe size Acceptable Solutions
- System layout
- Connection to the mains supply
- Backflow
- Mains connection
- Pipe materials and specifications

Also see installation, noise and air locks, pipe jointing systems, and valves and controls.

As well as avoiding contamination and achieving the right pressure and flow, the system must be suitable for the temperature of water carried. A well-designed and installed system will also be durable, minimise noise from water flow and from problems such as water hammer, and support efficient use of water.

All water supply systems use a combination of pipes (of different dimensions and materials), valves and outlets to deliver water to building users. Some water supply systems also use storage tanks and pumps. Designing a water supply system involves getting all of these elements right so that clean water is delivered to the user at the appropriate rate and temperature.

Water pressure

If the aim is to provide for building users' needs while also using water efficiently, the right water pressure is crucial. If water pressure is too low, this will be inconvenient for building users – for example, because showers have poor water flow, and baths take a long time to fill. If pressure is too high, this will lead to wastage of water, as well as high wear and tear on the system.

Typically, new buildings in areas with mains water supply will have mains pressure systems. Existing buildings, and buildings that are not connected to mains water, may have low pressure systems or unequal pressure systems (with different pressures for hot and cold water supply).

As an example of the difference in water usage, a low pressure hot water system shower flow may average about 7 litres per minute, while a mains pressure shower may average around 12–20 litres per minute.

Mains pressure systems require pressure limiting and pressure reducing valves to control water pressure and temperature. Typically, pressure limiting or pressure reducing valves will be used to control pressure in mains-supplied hot water systems or where high pressure may lead to problems such as burst pipes.

Low pressure systems require few valves or controls. In low or unequal pressure systems, pressure can be increased to adequate levels by storing water in a header tank (typically in the ceiling space) so that gravity can be used to create water pressure. If a tank is being used, see the BRANZ publications Water and Plumbing for details of installation requirements.

Pressure can also be raised to adequate levels using a pressurising pump, in which case it may be necessary to use pressure limiting and pressure reducing valves.

Water flow rate

The Building Code requires that sanitary fixtures and appliances have adequate water supply at an adequate flow rate.

As with water pressure, flow rates are crucial. A flow rate that is too high will result in water being wasted, whereas a flow rate that is too low will mean that sanitary fixtures and appliances don't work properly.

Flow rate is affected by:

- Water pressure
- Pipe diameters – The smaller the internal diameter of the pipe, the lower the pressure and flow rate. (Note that pipes are generally referred to by their inside nominal diameter (DN), but it is actually the internal diameter that counts; a pipe rated as DN 15 may have an actual inside diameter ranging between 10–18 mm.)
- Water temperature – higher temperatures will tend to raise pressure and flow rates (note: also see materials below).

A flow regulator can be used to maintain a constant flow, independent of water pressure. As an example, if someone is in the shower and the kitchen tap is turned on full, the temperature and flow are likely to remain more stable if a flow regulator is used.

Limiting the flow for a tap or appliance to a reasonable rate helps balance the available pressure throughout the system. Regulating flow allows a simpler design and minimum pipe sizes as peak flow rates can be specified accurately and can also reduce noise, splashing taps, and water hammer.

Manufacturers' recommendations must be referred to for pressure and flow information when selecting tempering valves and outlets (taps, mixers and shower heads).

Flow rate can also be controlled by specifying low-flow outlets.

Flow rate and pipe size Acceptable Solutions

Building Code Acceptable Solution G12/AS1 sets out flow rates and pipe sizes. Pipes must be sized to achieve flow rates set out in accordance with Table 3 (see table below), or the pipes must be sized in accordance with Table 4.

When calculating pipe size, the speed of the water (velocity) moving through the pipes must not exceed 3.0 m/s.

System layout

In the design process, the layout of the plumbing system will largely follow room layout. Nonetheless, there are many things to consider which relate to Code compliance, building users' comfort, and sustainability.

When planning a water supply layout, the following must be considered:

- Pipe runs and lengths – Keep pipe runs as short as possible. Pass pipes close to fixtures to minimise the number of branches and unnecessary elbows, tees and joints. Having longer pipe runs and more fixtures will reduce flow rate, increase heat losses, and increase use of materials
- Point of entry into the building – This should be into a utility space such as garage/laundry and include an accessible isolating valve, line strainer and pressure limiting valve (if required)
- Water heating system – Locate centrally to reduce the length of pipe runs to fixtures because longer pipe runs require more water to be drawn off before hot water is discharged. Install a separate point-of-use water heater for fixtures that are more than 10 m from the main water heater
- Noise prevention – Avoid running pipes over or near bedrooms and living areas.

Backflow

Backflow is the unplanned reversal of flow of water (or water and contaminants) into the water supply system. The system must be designed and used to prevent contamination from backflow. See backflow prevention for more.

Mains connection

Where the water source is a mains supply, the network utility operator is responsible for the water supplied to the property boundary. The property owner is then responsible for providing the pipework to bring the water into the building.

An isolating valve must be fitted at the point of connection to allow for maintenance and repair of the building's water supply system if required.

Pipe materials and specifications

The pipes used in a building must not contaminate potable water supply, and must be suitable for the water pressure, flow rate and temperature of water they will be carrying. This will be influenced by the materials used and also by other factors such as the wall thickness.

Other considerations are durability, ease of installation, cost, and sustainability. Common materials for domestic water supply include copper, polybutylene (PB), polyethylene (PE), polypropylene (PP-3 or PP Type 3), and cross-linked polyethylene (PEX).

Questions

1.What are methods of conections from water mains to building supply?

2.what are the layout of plumbing arrangement ?

WASTE WATER ENGINEERING

INTRODUCTION

Sanitary engineering, also known as public health engineering or wastewater engineering, is the application of engineering methods to **improve sanitation of human communities, primarily by providing the removal and disposal of human waste, and in addition to the supply of safe potable water**.

A branch of civil engineering concerned primarily with the maintenance of environmental conditions (as pure water supply, waste disposal, insect control, nuisance abatement) conducive to public health.

purpose

The overall purposes of sanitation are to provide a healthy living environment for everyone, to protect the natural resources (such as surface water, groundwater, soil), and to provide safety, security and dignity for people when they defecate or urinate.

In every town or cities wastes of different types such as spent water from bath room, kitchens, lavatory basins ,house and street washings, from various industrial processes, semi liquid wastes of human and animal excreta, dry refuse of house and street sweepings, broken furniture , crockery ,wastes from industries etc. are produced daily.

If proper arrangements for the collection, treatments and disposal of all the wastes produced from the town or city are not made ,they will go on accumulating and create such a foul condition that the safety of the structures such as building, roads will be in Danger due to accumulation of spent water in their foundations.

In addition the disease bacteria will bread up in the stagnate water and the health of the public will be in danger.

All the drinkable water will be polluted .total insanitary conditions will be developed in the town and it will become impossible for the public to live in the towns or cities.

Therefore in the interest of community of the town or city it is most essential to collect, treat and disposal of all the waste products of the city in such a way that it may not cause any have to the people residing in the town.

i. Conservancy Sanitation System

In the conservancy sanitation system, **different types of garbages or refuse are collected, conveyed, and disposed of separately by methods like burning, filling, burying, etc.**

Refuse, or garbage is collected in dustbins and is conveyed by trucks to the disposal point. Then, combustible & non-combustible portions are separated.

Combustible portions like dry leaves, waste papers, furniture, plastics, etc., are burnt and remained residue is buried.

Non-combustible materials like sand, silt, clay, etc., are used for filling the low-level areas.

Human excreta is collected separately in conservancy latrines or privies and is carried by human agencies.

The conservancy sanitation system is also called the **dry system of sanitation.**

. Advantages of Conservancy Sanitation System

Some of the advantages of the conservancy system are:

a. Its initial cost is very low.

b. No need for water for flushing purposes.

c. No need for sewer pipes as in the water carriage system.

d. Sewage quantity reaching the treatment plant before disposal is low.

b. Disadvantages of Conservancy Sanitation System

Some of the disadvantages of the conservancy system are:

a. This system entirely depends upon human agencies. So, a lack of workforce or strike by agencies can cause the unhygienic condition in the city.

b. A large area is required to bury the residue (remained part after burning combustible portions) or excremental matter.

c. Labours are needed daily for the collection of waste.

d. Decomposition of excreta takes place before its removal. This causes a nuisance of smell.

e. It is not suitable for most of the buildings.

f. It is unhygienic and causes unsanitary conditions.

g. This method also increases the risk of an epidemic. (E.g., There is a risk of new waves of viruses like coronavirus if labourers do not adopt proper safety.)

h. Liquid wastes from laboratories may percolate into the ground, causing groundwater table pollution.

ii. Water Carriage Sanitation System

A water Carriage System is a method for the disposal of wastes, where water carries the wastes from its point of production to the point of treatment for final disposal.

The wastes become liquid due to the high quantity of water (99.9%) carried by the sewers.

A sewer is a pipe or conduit that carries wastewater.

Solid waste materials like garbage are collected separately in the conservancy system because they may clog the sewers.

Every person uses 5 to 10 litres of water for their hygiene, and wasted water is used to maintain the sewers' flushing system.

Also, the wastewater from kitchens, baths, washbasins, industries, commercial buildings, etc., is led to the sewers and used for flushing.

Finally, those collected sewerage led by the sewers is treated suitably and disposed of by different methods.

Questions

1. **What is sanitary engineering ?**
2. **What are the main objects of sanitary engineering ?**
3. **What are the system of collection of wastes ?**
4. **What is conservancy and waste carriage system ?**

QUANTITY AND QUALITY OF SEWAGE

SEWAGE

The dirty drain water containing urine and faces that is carried from our homes by underground pipes (called sewers) is called sewage.

-
Sanitary sewage includes waste water from residences and industries. bit when this sewage is carried through sewers, ground water also infiltrates in it due to so many factors.
Sanitary sewage is also called as dry weather flow and it flows only in

one system of sewers in separate system throughout the year and in dry season in combined system.

Combined system carries both the sanitary and storm sewage during monsoon.

Sewerage system requires large quantity of water for its proper function ,therefore this system can only be provided in the town or cities having good water supply scheme.

SOURCES OF SANITARY SEWAGE

1. Water supplied to the public for domestic purposes by the local authority.
2. Water supplied to the various industries for industrial processes by the local authority.
3. Water drawn from wells by individual houses for their domestics purposes.
4. Water supplied by the local authority to various public places such as schools. Cinemas ,hotels, railway stations etc.
5. Water drawn from wells,lakes,canal,etc.by industries for their purposes.

Domestic sewage

Domestic sewage is wastewater that is removed from the daily life of households, hotels, restaurants, schools, and shopping malls.

It has a wide range of sources and a huge amount. With the rapid development of economy and the increase in residents' living standards, there is more and more sewage discharge to be treated.

This kind of sewage is characterized by a large amount of organic matter (such as protein, starch, fat, and urea), pathogenic microorganisms, and suspended matter.

The main purpose of wastewater treatment is to remove organic matter and nutrients, not to recycle them.

The selection of the best treatment process mainly depends on the concentration of pollutants and the nature of the wastewater.

This is called the intensity of the wastewater. Wastewater with a chemical oxygen demand (COD) greater than 2000 mg/L is defined as medium to high intensity, and COD less than 2000 mg/L is defined as low-intensity wastewater.

Biomass is one of the largest potential sources of energy. It is extracted from organic materials and natural resources and can be converted into high-energy gases such as methane and hydrogen by anaerobic digestion (Mehrpooya et al., 2018). Generally, high-intensity wastewater is used, but low-intensity wastewater is not widely used because of its poor performance.

Nevertheless, anaerobic systems have been developed and successfully applied to the treatment of low-intensity wastewater such as domestic sewage. Research will increasingly focus on the fermentation of domestic sewage to produce hydrogen, because hydrogen has the characteristics of high energy density, recyclability, and freedom from pollution, and it is considered the most ideal alternative to fossil fuels (Batista et al., 2015).

Domestic wastewater is a relatively diluted resource stream, so the low metabolic capacity of anaerobic bacteria leads to the low efficiency of anaerobic process.

The most widely used domestic anaerobic wastewater treatment fields are high-efficiency systems and membrane biological reactions such as an anaerobic baffled reactor, anaerobic filter, and upflow anaerobic sludge, upflow anaerobic sludge blanket, and expanded granular sludge bed. McCarty et al. (2011) evaluated the potential benefits of anaerobic wastewater treatment

. Compared with traditional anaerobic sludge digestion systems, energy production greatly exceeds the energy required for plant operation. Shoener et al. (2014) explored the potential of the anaerobic treatment of domestic sewage and the economy of energy consumption. Anaerobic fermentation has huge application prospects.

However, because domestic sewage often contains high concentrations of ammonia, in an alkaline environment (pH 9.5), the initial ammonia level will cause a decrease in maximum specific hydrogen yield. The total amount of ammonia is an important parameter in the fermentation process

. When the ammonia ion concentration is changed from When 0–50 mmol/L (0–900 mg/L) is increased, hydrogen production is promoted, but as the ammonia ion concentration is further increased to 500 mmol/L (9000 mg/L), hydrogen production is suppressed (Wang et al., 2018). Therefore, pretreatment of domestic wastewater with a high ammonia nitrogen concentration and controlling its concentration level before hydrogen fermentation are main directions in research.

Industrial Sewage

It means a combination of liquid and water carried wastes, discharged from any industrial establishment, and resulting from any trade or process carried on in that establishment. This shall include the wastes from pretreatment facilities and polluted cooling water.

Industrial Sewage means **a combination of liquid and water carried wastes, discharged from any industrial establishment, and resulting from any trade or process carried on in that establishment**. This shall include the wastes from pretreatment facilities and polluted cooling water.

It can include organic matter such as wood, cardboard, or paper and inorganic materials such as scrap metal, plastic, and construction debris. Common examples of solid industrial waste include: **Coal ash from thermal power plants**. Blast furnace and steel melting slag from iron and steel mills

Burning fossil fuels like oil, natural gas and petroleum; chemical solvents used in dyeing and tanning industries, untreated gas and the liquid waste being released into the environment, improper disposal of radioactive material are some of the main causes of industrial pollution.

Fossil-fuel power stations, particularly coal-fired plants, are a major source of industrial wastewater. Many of these plants discharge wastewater with significant levels of metals such as lead, mercury, cadmium and chromium, as well as arsenic, selenium, and nitrogen compounds .

Characteristics of sewage

I. Physical characteristics of sewage:

1. Temperature:

- Temperature of sewage depends upon season. However temperature is slightly higher than that of ground water.
- High temperature of sewage is due to evolution of heat during decomposition of organic matter in sewage.

2. Color:

- Color of sewage indicates its strength and age.
- Fresh domestic sewage is grey in color but septic sewage is dark in color
- When industrial effluent is mixed it give characteristic color to sewage

3. Odor:

- Fresh domestic sewage is almost odorless.
- Septic or stale sewage is putrid in odor which is due to generation of H2S during anaerobic decomposition of organic matters.
- When industrial effluent is mixed, it give characteristics odor to sewage

4. Turbidity:

- Sewage is highly turbid.
- Turbidity of sewage is due to dissolved substances, colloidal matters, suspended solids and microbial cells.

II. Chemical characteristics of sewage:

1. Organic matter:

- In general sewage contains large amount of organic matters. However amount of organic matter depends on types and condition of sewage.
- Organic matter in sewage may be found in the form of dissolved substances, colloidal matter, suspended or sedimented form.

2. Chloride:

- Human beings discharge large amount (8-15gm/day) of chloride in the form of NaCl, especially through urine and sweat. So domestic sewage from toilet and bathroom contains higher level of chloride.
- Sulfite:
- In sewage sulfite in the form of H2S (hydrogen sulfite) is generated during anaerobic decomposition of organic matters by anaerobic bacteria.
- H2S gives putrid odor to sewage.

3. Biological oxygen demand (BOD):

- Sewage usually have high BOD due to presence of large amount of organic matters.
- Value of BOD ranges from 100mg/ltr for very dilute sewage to 600mg/ltr or more for concentrated sewage containing industrial effluent mix.

4. Dissolved oxygen (DO):

- Due to high level of microbial cells and biodegradable organic matters, sewage have very low level of dissolved oxygen.
- In some sewage, DO is completely absent.
- Level of Do depends on age and condition of sewage. Low level DO is also due to lower solubility of oxygen in sewage. Oxygen is only 95% soluble in sewage than in pure water).

5. pH:

- sewage is slightly alkaline in pH
- In sewage nitrogen is found in variety of form like organic nitrogen, ammonia, nitrite, nitrate etc
- Fresh sewage mainly contains organic nitrogen and very little inorganic form of nitrogen. On the other hand organic septic sewage contains high inorganic nitrogen and low organic nitrogen.
- In sewage nitrite never accumulate in concentration greater than 1mg/ltr because it is intermediate product during conversion of ammonia into nitrate (NO3).
- In sewage treatment plant, NH3 and NO2 are finally converted to NO3.

7. Oxidation-Reduction (O-R) potential:

- Oxidation-Reduction potential indicates energy state of sewage in terms of its oxidizing or reducing potential.
- O-R potential is very valuable index to monitor sewage treatment plant.
- In aerobic treatment process like tripling filters, positive OR potential of about +2—to +600 is needed. In anaerobic treatment process like sludge digestion, negative OR potential of about -100 to -200 is needed.

III. Biological characteristics of sewage:

1. Bacteria:

- Two types of bacteria are found in sewage.

- **Intestinal bacteria:**
  - Non-pathogenic intestinal bacteria are normal flora of gastointestinal tract of human and animals and enter into sewage together with stool. Examples; faecal coliform, faecal streptococci, Clostridium perfingens, et
  - Pathogenic intestinal bacteria such as Salmonella, Shigella, Vibrio cholera, Yersenia enterocolitica etc enter into sewage through stool of patients.
- **Real sewage bacteria**
  - The natural habitat of these bacteria is sewage.
  - Both aerobic as well as anaerobic are found in sewage.
  - Aerobic bacteria play important role in oxidation of organic matter during aerobic process.
  - Common anaerobic bacteria includes;
    - Clostridium sporogens
    - Bifidobacterium
    - Peptococcus
    - Methanogenic bacteria like Methanobacterium, methanosarcina
  - Common aerobic bacteria includes;
    - Zeoglea remigera
    - Noacrdia
    - Flavobacterium
    - Achromobacter
    - Nitrosomonas
  - ** Zeoglea remigera is the main organism found in trickling filter.

2. Algae:

- Some algae found in sewage includes Chlorella phormidum, Ulothrix etc
- Algae are used in trickling filter in sewage treatment plant

3. Fungi:

- Fungi like Fusarium and Sporotricum are found in sewage which play important role in trickling filter.

4. Virus:

- Some viruses causing human disease such as Poliovirus, Rotavirus, Hepatitis A and E etc are found in sewage which get access through stool of patients.

5. Protozoa:

- Some protozoa that cause disease of intestinal tract enter into sewage together with stool of patient.
- Examples: Entamoeba histolytica, Giardia, Balantidium coli etc. are pathogenic protozoa
- Few protozoa such as Vorticella and Opercularia are found in trickling filter.

questions

1.what is sewage ?

2.what is domestic sewage ?

3. what is industrial sewage ?

4.what are the sources of sewage ?

5.what are the characteristics of sewages ?

Sewerage system

When you think of sewage you likely think of a putrid sludge moving through the pipes under the road outside, and you wouldn't be totally wrong. However, there are a few different types of sewer systems and they each have a unique purpose for catching waste and wastewater.

The three types of sewers are sanitary sewers, storm sewers, and combined sewers. All three of these sewer systems play important roles in ensuring that the waste we produce is transported and treated properly.

Sanitary Sewer System

The main purpose of a sanitary sewer is to carry waste away from homes and businesses to wastewater treatment plants. These systems are specifically designed to handle human waste and easily degradable manufactured solids such as toilet paper and tissues. These systems consist of many miles of piping, manholes, and pumping stations to propel the waste through the system.

How these sanitary sewage systems work is by carrying human waste through small plumbing pipes in the home, to gradually bigger pipes outside, until it reaches the main sewer line in the street. From here the sewage is transported to a wastewater treatment plant to be treated and returned safely to the environment.

Storm Sewer System

Storm sewers, also known as surface or runoff sewers, are designed to collect and carry rainwater, snowmelt, and irrigation runoff into storm drains located in parking lots, streets, and gutters. These drains are connected through a series of underground pipes that carry this water directly to rivers, lakes, and other bodies of water without having been treated at a treatment plant.

Unlike the sanitary sewer that carries waste to a treatment plant, the storm sewer system carries untreated runoff water straight into our environment. All the water that goes into that storm drain is discharged into our waterways.

Combined Sewer Systems

These types of sewer systems are exactly what they sound like. They are a combination of sanitary sewer systems and storm sewer systems. They typically aren't used anymore due to their potential health hazards to people and the environment.

How combined sewers work is by collecting all the water from rain and snow into a pipe and then adding human waste into the same pipe. In ideal circumstances, this system would pump these combined wastes to a treatment plant where it would then return safely to the environment.

However, in times of extreme rainfall or flooding, these systems can back up and overflow causing untreated wastewater to flow directly into the environment. This allows for dangerous pathogens and pollutants to make their way into the environment, posing a serious threat to people's health.

SCADA Monitoring: Sewage and Wastewater

In order to ensure that these sewer systems operate properly and minimize the overall risk of overflow and malfunction, a supervisory control and data acquisition (SCADA) system can help. A SCADA system can be implemented at multiple levels in the wastewater collection and treatment process.

Whether it's booster pump monitoring or treatment tank monitoring, a SCADA system can help mitigate equipment damages, overflows, and quickly report any malfunctions. Check out High Tide Technologies to learn more about the applications of SCADA in wastewater treatment and how it can help make your system more efficient.

Different Shapes of Sewers

A sewer is an underground pipe used to carry wastewater. Or, we can say it is an underground system used to carry sewage. In this post, I will show you 10 different shapes of sewers with diagrammatic images as well. Mostly circular-shaped sewer is preferred for most places and is suitable for all types of sewage

1. Circular Shaped Sewer

Circular sewer is mostly used sewer and is preferred for all types of sewage. This shape of sewer is easy to construct, requires less construction materials and is economical.

2. Standard Egg-shaped Sewer

In the same flow condition, a standard egg-shaped sewer gives higher velocity as compared to a circular-shaped sewer. Therefore, it is suitable for low flow conditions. The construction process of such types of sewers is difficult and requires more amount of construction materials. Hence, it is costly. A Standard egg-shaped sewer is preferred for combined sewer.

3. New Egg-shaped Sewer

The new egg-shaped sewer is also preferred for the combined sewer. The advantages and disadvantages are the same as I said for standard egg-shaped sewer. **Read Also – Sewer Appurtenances.**

4. Horse Shoe Shaped Sewer

As the name suggests, its shape looks like a Horseshoe. Horse-shoe shaped sewer is a large size of sewer mostly preferred for the location where heavy discharge is required. The invert portion may be circular, parabolic or flat. The height of such types of sewer is more than its wide. As the size is large, maintenance work is also so easy.

5. Parabolic Shaped Sewer

Parabolic-shaped sewer is used for lower quantities of sewage discharge. This is small in size and the upper edge of the sewer is made like a parabola. The invert section of this sewer may be parabolic or elliptical in shape. It is economical as well. **Read Also: – Brick Sewer**.

6. Semi-Elliptical Shaped Sewer

Semi elliptical shape sewers are mostly preferred for carrying large amounts of sewage. The upper arch of this sewer forms an elliptical shape. The invert of this sewer may be parabolic or elliptical.

7. Rectangular Shaped Sewer

A rectangular-shaped sewer is a large sewer mostly used for carrying a large quantity of sewage, it is also used for discharging stormwater. Construction and maintenance work is very easy for this type of sewer. This section is very stable as compared to others. As they are rectangular in shape, the upper and invert both portions are flat.

8. U-shaped Sewer

As the name suggests, its shape is similar to the English capital letter "U". The U-shaped sewer is used for heavy discharge of sewage. As it is large in size, it is also used for carrying stormwater as well. The invert portion for such types of sewer is semi-circular in shape. It is also used as a combined sewer. As is it large in size, its maintenance works are also easy. **Read Also: – Plastic Sewer**.

9. Semi-circular Shaped Sewer

It is suitable for the location where a large sewer is required. The upper arch of the sewer forms a semi-circular shape. It has a large section and is used for heavy sewage discharge. But, it is old and outdated. Hence, it is not preferred at the present time.

Basket Handle Shaped Sewer

Basket Handel shaped sewer is used for the small amount of sewage discharge. Its upper portion is like a basket Handel and its lower portion got the shape of a narrow channel. But its outer surface is circular. It is also an outdated sewer.

Laying and Testing of Sewers:

The various steps involved in the laying and testing of sewers are: 1. Setting out Sewer Centre Line 2. Alignment and Gradient of Sewers 3. Excavation of Trenches, Timbering and Dewatering 4. Laying and Jointing of Pipe Sewers 5. Testing of Pipe Sewers 6. Backfilling of Trenches.

Step # 1. Setting out Sewer Centre Line:

This is the first step in the laying of sewers. The laying of sewers is generally carried out by starting from the tail end or the outfall end, and proceeding upwards. The advantage of starting the laying of sewers from the tail end is that the tail sewers may be utilized even during the initial period of construction. On the other hand if the laying of sewers is started from the head end the functioning of the sewerage scheme has to wait till the completion of the entire scheme.

From the longitudinal section of the sewer line, the positions of manholes are located on the ground because it is the general practice to lay sewer line between two manholes at a time. The sewer centre line is marked on the ground by driving the pegs at an interval of 7.5 m or 15 m as per convenience. The sewer centre line should be properly maintained during the construction.

In the first method a line parallel to the sewer centre line is marked on the ground. This line is known as offset line and it is usually marked at a distance of 2 to 3 m or half the trench width +0.6 m from the centre line of the sewer. Along the offset line pegs are driven at an interval of 7.5 to 15 m.

The offset line helps in locating the sewer centre line when excavation is carried out to lay sewers. Further along the offset line temporary bench marks with respect to GTS bench mark should be established at suitable intervals to carry forward the levels.

In the second method two vertical posts called uprights are driven into the ground at nearly equal distance from the centre line peg. A horizontal wooden board known as sight rail is fixed between these posts at a convenient height above the ground. Such posts are erected at suitable interval say 30 m or so along the sewer alignment. The centre line of the sewer is marked on the sight rails and a cord is drawn between the consecutive sight rails.

The first method is adopted for short duration of time, mainly to avoid inconvenience to traffic when excavation of trench is going on. The second method is to be adopted in all cases for taking the levels of invert of proposed sewer line.

Step # 2. Alignment and Gradient of Sewers:

The sewers should be laid to the correct alignment and gradient by setting the positions and levels of sewers so as to ensure a smooth gravity flow. This is done with the help of suitable boning rods and sight rails, and a dumpy level. Modified levels of invert are first obtained by adding a suitable vertical length to the invert levels mentioned on the longitudinal section.

These modified levels of invert are marked on the sight rail. These levels are marked either by fixing nails on sight rails or by adjusting the top of sight rails to the modified invert levels of sewer line. Thus an imaginary line parallel to the proposed sewer line is obtained on the ground.

In order to check the invert level of sewer boning rod or traveller is used. The boning rod is a vertical wooden post fitted with a cross-head or tee at top and an iron shoe at bottom. The boning rod is moved to and fro in the trench so as to obtain the invert-line of the sewer on the prepared bed of the trench.

As such the length of the boning rod has to be equal to the height of the sight rail above the invert-line of the sewer which, however, varies along the sewer line, and hence boning rods of various lengths are prepared. Both the boning rod and the sight rail have their centre lines accurately marked with thin saw-cut and painted black and white for proper visibility.

A dumpy level (or other suitable level) is used in levelling along the invert-line of the sewer. The use of sight rails, boning rods and dumpy level for laying sewers at the desired gradient.

Step # 3. Excavation of Trenches, Timbering and Dewatering:

The work of excavation is usually carried out in the form of open cut trenches but in certain situations as indicated later tunnelling is also adopted. The excavation is made so as to have trenches of such lengths, widths and depths which would enable the sewers to be properly constructed.

In busy streets and localities the length of the trench to be excavated in advance of the end of the constructed sewer and left open at any time is usually not more than 18 m.

The width of the trench to be excavated is chosen on the basis of two considerations:

(i) To facilitate laying and joining of pipe lengths, and

(ii) To permit thorough ramming of the backfill material around the pipe. At least 20 cm of clear space should be left on each side of the barrel of the pipe so that the minimum clear width of the trench is equal to the external diameter of the pipe plus 40 cm. For other types of sewers the minimum clear width should be the greatest external width of the structure to be built therein.

The depth of the trench should be such as to enable the sewer to be laid at proper grade on the bed of the trench. Suitable recesses are left on the bed of the trench in order to accommodate the socket-end of the pipe sewer. However, where the soil is soft it is usual to provide a bed of concrete or a bed of compacted granular material and to rest the sewer thereon, in which case the trench is excavated upto the bottom of such bed to be provided below the sewer.

Dewatering of Trenches:

Where the sub-soil water level is very near the ground surface, the trench becomes wet and muddy because of water oozing in the trench from the sides and bottom. In such cases the construction of sewer becomes difficult. As such trenches for sewer construction needs to be dewatered to facilitate the placement of concrete and laying of pipe sewer or construction of concrete or brick sewer and kept dewatered until the concrete foundations, pipe joints or brick work or concrete have cured.

The various methods adopted for dewatering of trenches are:

(i) Direct drainage,

(ii) Drainage by an under-drain,

(iii) Sump-pumping and

(iv) Well-point drainage.

Direct drainage is possible by giving a uniform slope to the bottom of the trench and taking out water at some forward point. However, this method is not satisfactory as some water always remains in the trench which, therefore, becomes muddy.

For drainage by under-drain, an open-jointed tile drain is laid in a small trench 30 cm x 30 cm constructed below the usual trench bed. The under-drain ultimately discharges into a natural water course or into a sump from where water can be pumped. This method is useful provided the trench is not very deep and the under-drain can withstand the load without giving away.

Step # 4. Laying and Jointing of Pipe Sewers:

Before laying the pipe sewer it should be ensured that the trench has been excavated up to the level of the bottom of the bed of concrete or the bed of compacted granular material if such a bed is to be provided, or up to the invert level of the pipe sewer if no such bed is to be provided.

Along the trench sight rails are set at intervals of 30 m or so. After setting the sight rails over the trench the centre line of the sewer is transferred to the bottom of the trench by driving small pegs at an interval of 3 m or so. For laying the sewer at the desired gradient invert-line of the sewer is set up. This is done by first adjusting the uprights which may be carried out as explained by the following illustration.

Long questions

1.what are the types of sewerage system ?

2.what are the shapes of sewer ?

3. Described laying of sewer and sewer alignment .

SEWER APPURTENANCES AND SWAGES DISPOSAL

The structures, which are constructed at suitable intervals along the sewerage system to help its efficient operation and maintenance, are called as sewer appurtenances. These include:

(1) Manholes,	(2) Drop manholes,	(3) Lamp holes,
(4) Clean-outs,	(5) Street inlets called Gullies,	(6) Catch basins,
(7) Flushing Tanks,	(8) Grease & Oil traps,	(9) Inverted Siphons, and
(10) Storm Regulators.		

8.1 Manholes

The manhole is masonry or R.C.C. chamber constructed at suitable intervals along the sewer lines, for providing access into them. Thus, the manhole helps in inspection, cleaning and maintenance of sewer. These are provided at every bend, junction, change of gradient or change of diameter of the sewer. The sewer line between the two manholes is laid straight with even gradient. For straight sewer line manholes are provided at regular interval depending upon the diameter of the sewer. The spacing of manhole is recommended in IS 1742-1960. For sewer up to 0.3 m diameter or sewers which cannot be entered for cleaning or inspection the maximum spacing between the manholes recommended is 30 m, and 300 m spacing for pipe greater than 2.0 m diameter (Table 8.1). A spacing allowance of 100 m per 1 m diameter of sewer is a general rule in case of very large sewers (CPHEEO, 1993). The internal dimensions required for the manholes are provided in Table 8.2 (CPHEEO, 1993). The minimum width of the manhole should not be less than internal diameter of the sewer pipe plus 150 mm benching on both the sides.

8.1.1 Classification of Manholes

Depending upon the depth the manholes can be classified as:

(a) Shallow Manholes, (b) Normal Manholes, and (c) Deep Manholes

Shallow Manholes: These are 0.7 to 0.9 m depth, constructed at the start of the branch sewer or at a place not subjected to heavy traffic conditions (Figure 8.1). These are provided with light cover at top and called inspection chamber.

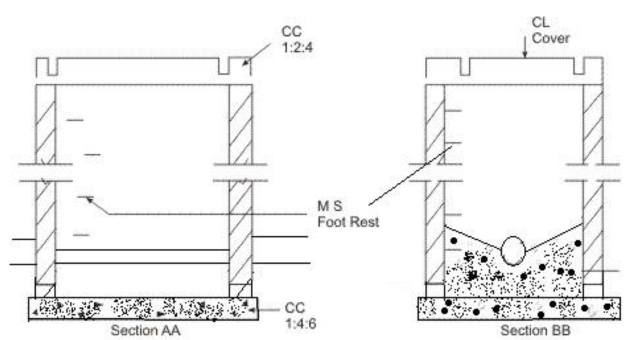


Figure 8.1 Shallow manhole

Normal Manholes: These manholes are 1.5 m deep with dimensions 1.0 m x 1.0 m square orrectangular with 1.2 m x 0.9 m (Figure 8.2). These are provided with heavy cover at its top to support the anticipated traffic load.

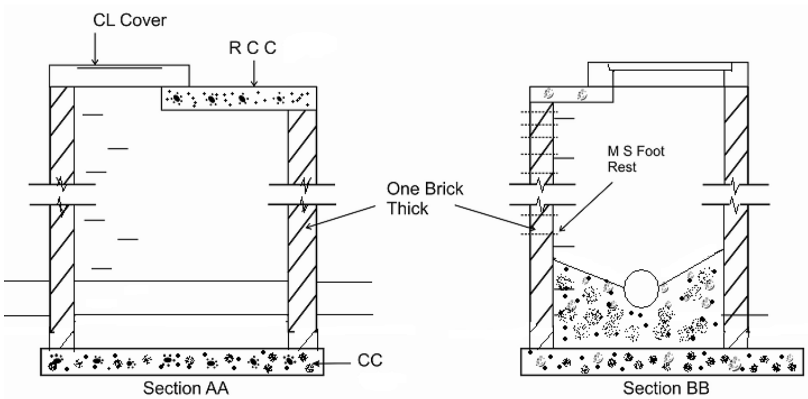
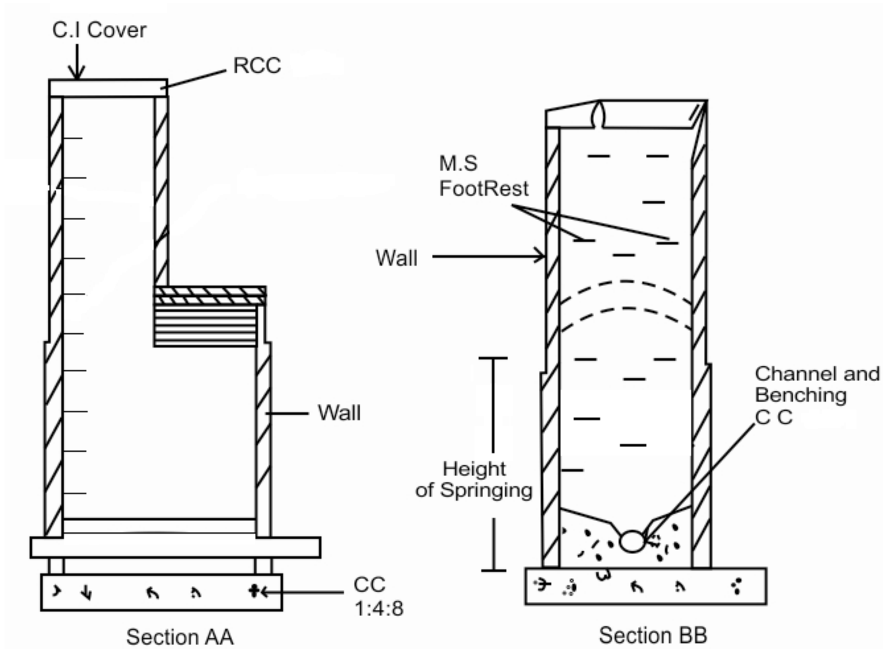
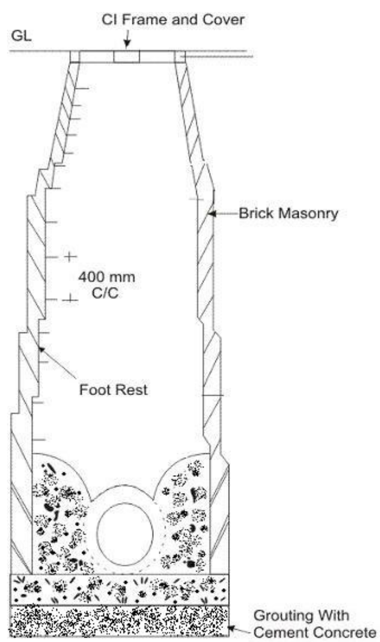


Figure 8.2 Rectangular manhole for depth 0.9 m to 2.5 m

Deep Manholes: The depth of these manholes is more than 1.5 m. The section of such manhole is not uniform throughout (Figure 8.3). The size in upper portion is reduced by providing an offset. Steps are provided in such manholes for descending into the manhole. These are provided with heavy cover at its top to support the traffic load.





(a)

(b)

Figure 8.3 (a) Rectangular and (b) Circular deep manhole

8.1.2 Other Types of Manholes

Straight – Through Manholes

This is the simplest type of manhole, which is built on a straight run of sewer with no side junctions. Where there is change in the size of sewer, the soffit or crown level of the two sewers should be the same, except where special conditions require otherwise.

Junction Manholes

This type of manholes are constructed at every junction of two or more sewers, and on the curved portion of the sewers, with curved portion situated within the manhole. This type of manholes can be constructed with the shape other than rectangular to suit the curve requirement and achieve economy. The soffit of the smaller sewer at junction should not be lower than that of the larger sewer. The gradient of the smaller sewer may be made steeper from the previous manhole to reduce the difference of invert at the point of junction to a convenient amount.

Side entrance Manholes

In large sewers where it is difficult to obtain direct vertical access to the sewer from the top ground level due to obstructions such as, other pipe lines like water, gas, etc., the access shaft should be constructed in the nearest convenient position off the line of sewer, and connected to the manhole chamber by a lateral passage. The floor of the side entrance passage which should fall at about 1 in 30 towards the sewer should enter the chamber not lower than the soffit level of the sewer. In large sewers necessary steps or a ladder (with safety chain or removable handrail) should be provided to reach the benching from the side entrance above the soffit.

Drop Manholes

When a 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 than 0.6 m, a manhole may be built either with vertical or nearly vertical drop pipe from higher sewer to the lower one (Figure 8.4). The drop manhole is also required in the same sewer line in sloping ground, when drop more than 0.6 m is required to control the gradient and to satisfy the maximum velocity i.e., non-scouring velocity.

The drop pipe may be outside the shaft and encased in concrete or supported on brackets inside the shaft. If the drop pipe is outside the shaft, a continuation of the sewer should be built through the shaft wall to form a rodding and inspection eye, provided with half blank flange (Figure 8.4). When the drop pipe is inside the shaft, it should be of cast iron and provided with adequate arrangements for rodding and with water cushion of 150 mm depth at the end. The diameter of the drop pipe should be at least equal to incoming pipe.

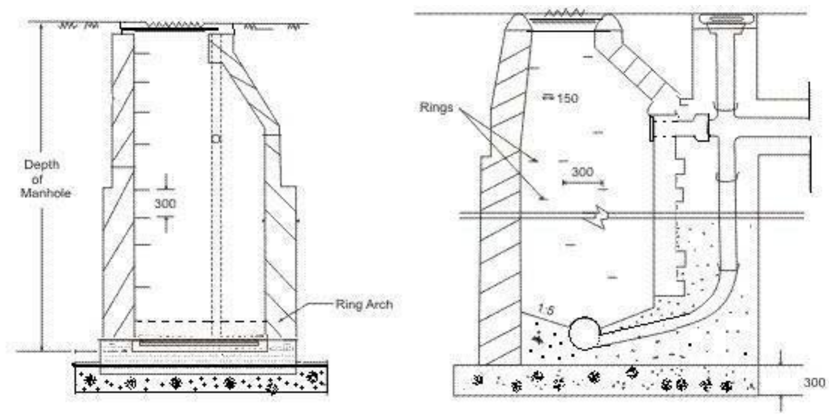


Figure 8.4 Drop manhole

Scraper (service) type manhole

All sewers above 450 mm in diameter should have one manhole at intervals of 110 to 120 m of scraper type. This manhole should have clear opening of 1.2 m x 0.9 m at the top to facilitate lowering of buckets.

Flushing Manholes

In flat ground for branch sewers, when it is not possible to obtain self cleansing velocity at all flows, due to very little flow, it is necessary to incorporate flushing device. This is achieved by making grooves at intervals of 45 to 50 m in the main drains in which wooden planks are inserted and water is allowed to head up. When the planks are removed, the water will rush with high velocity facilitating cleaning of the sewers. Alternatively, flushing can be carried out by using water from overhead water tank through pipes and flushing hydrants or through fire hydrants or tankers and hose.

Flushing manholes are provided at the head of the sewers. Sufficient velocity shall be imparted in the sewer to wash away the deposited solids. In case of heavy chocking in sewers, care should be exercised to ensure that there is no possibility of back flow of sewage into the water supply mains.

8.2 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. Inverted siphons are used to pass under obstacles such as buried pipes, subways, etc (Fig. 8.5). This terminology 'siphon' is misnomer as there is no siphon action in the depressed sewer. As the inverted siphon requires considerable attention for maintenance, it should be used only where other means of passing an obstacle in line of the sewer are impracticable.

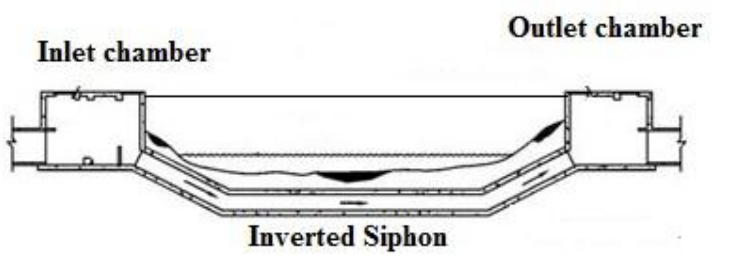


Figure 8.5 Inverted siphon

8.3 STORMWATER INLETS

Storm water inlets are provided to admit the surface runoff to the sewers. These are classified in three major groups viz. curb inlets, gutter inlets, and combined inlets. They are provided either depressed or flush with respect to the elevation of the pavement surface. The structure of the inlet is constructed with brickwork with cast iron grating at the opening confirming to IS 5961. Where the traffic load is not expected, fabricated steel grating can be used. The clear opening shall not be more than 25 mm. The connecting pipe from the street inlet to the sewer should be minimum of 200 mm diameter and laid with sufficient slope. A maximum spacing of 30 m is recommended between the inlets, which depends upon the road surface, size and type of inlet and rainfall.

Curb Inlet: These are vertical opening in the road curbs through which stormwater flow enters the stormwater drains. These are preferred where heavy traffic is anticipated (Figure 8.6a).

Gutter Inlets: These are horizontal openings in the gutter which is covered by one or more grating through which stormwater is admitted (Figure 8.6b).

Combined Inlets: In this, the curb and gutter inlet both are provided to act as a single unit. The gutter inlet is normally placed right in front of the curb inlets.

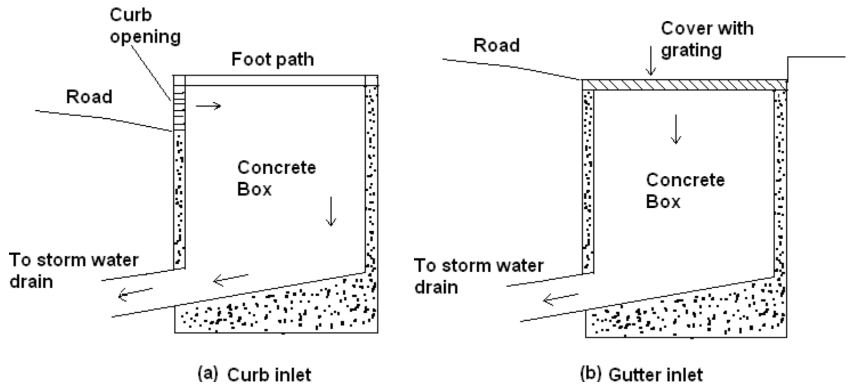


Figure 8.6 (a) Curb inlet and (b) Gutter inlet

8.4 CATCH BASINS

Catch basins are provided to stop the entry of heavy debris present in the storm water into the sewers. However, their use is discouraged because of the nuisance due to mosquito breeding apart from posing substantial maintenance problems. At the bottom of the basin space is provided for the accumulation of impurities. Perforated cover is provided at the top of the basin to admit rain water into the basin. A hood is provided to prevent escape of sewer gas (Figure 8.7).

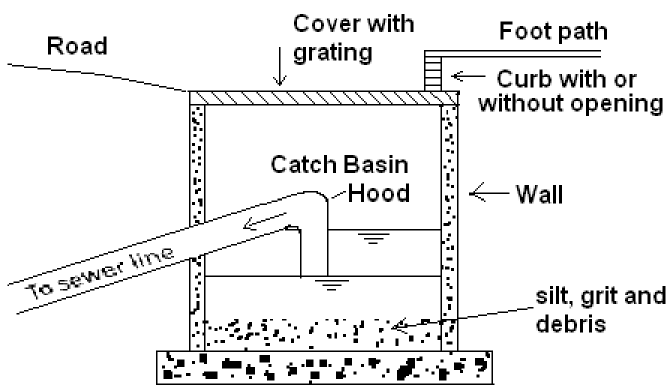


Figure 8.7 Catch basin

8.5 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 (Figure 8.8). A clean-out is generally provided at the upper end of lateral sewers in place of manholes. During blockage of pipe, the cover is taken out and water is forced through the clean-out pipe to lateral sewers to remove obstacles in the sewer line. For large obstacles, flexible rod may be inserted through the clean-out pipe and moved forward and backward to remove such obstacle.

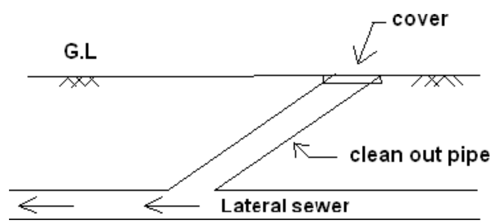


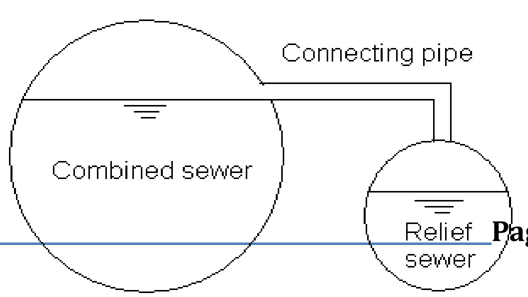
Figure 8.8 Clean-out

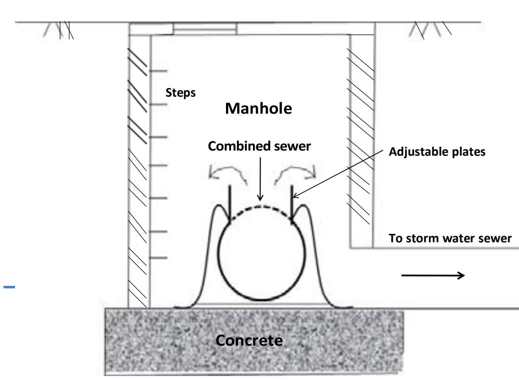
8.6 REGULATOR OR OVERFLOW DEVICE

These are used for preventing overloading of sewers, pumping stations, treatment plants or disposal arrangement, by diverting the excess flow to relief sewer. The overflow device may be side flow or leaping weirs according to the position of the weir, siphon spillways or float actuated gates and valves.

8.6.1 Side Flow Weir

It is constructed along one or both sides of the combined sewer and delivers the excess flow during storm period to relief sewers or natural





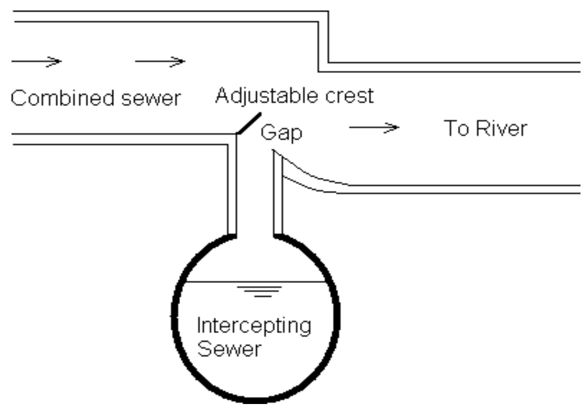
drainage courses (Figure 8.9). The crest of the weir is set at an elevation corresponding to the desired depth of flow in the sewer. The weir length must be sufficient long for effective regulation of the flow.

(a) (b)

Figure 8.9 (a) Side flow weir (b) Overflow weir arrangement

8.6.2 Leaping Weir

The term leaping weir is used to indicate the gap or opening in the invert of a combined sewer. The leaping weir is formed by a gap in the invert of a sewer through which the dry weather flow falls and over which a portion of the entire storm leaps. This has an advantage of operating as regulator without involving moving parts. However, the disadvantage of this weir is that, the grit material gets concentrated in the lower flow channel. From practical consideration, it is desirable



to have moving crests to make the opening adjustable. When discharge is small, the sewage falls directly into the intercepting sewer through the opening. But when the discharge exceeds a certain limit, the excess sewage leaps or jumps across the weir and it is carried to natural stream or river. This arrangement is shown in the Figure 8.10.

Figure 8.10 Leaping weir with adjustable crest

8.6.3 Float Actuated Gates and Valves

The excess flow in the sewer can also be regulated by means of automatic mechanical regulators. These are actuated by the float according to the water level in the sump interconnected to the sewers. Since, moving part is involved in this, regular maintenance of this regulator is essential.

8.6.4 Siphon Spillway

This arrangement of diverting excess sewage from the combined sewer is most effective because it works on the principle of siphon action and it operates automatically. The overflow channel is connected to the combined sewer through the siphon. An air pipe is provided at the crest level of siphon to activate the siphon when water will reach in the combined sewer at stipulated level (Figure 8.11).

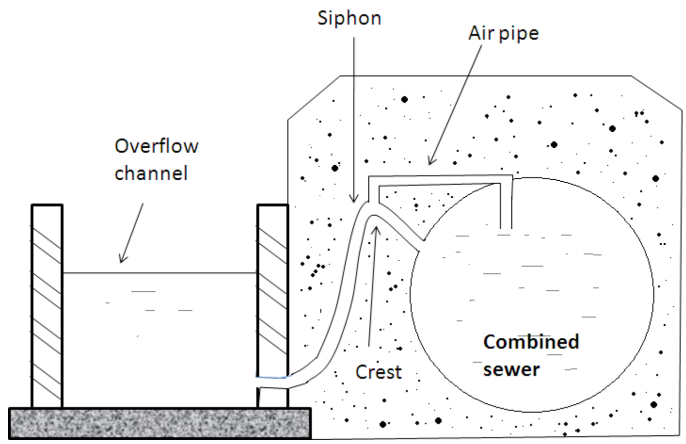


Figure 8.11 Siphon spillway

8.7 FLAP GATES AND FLOOD GATES

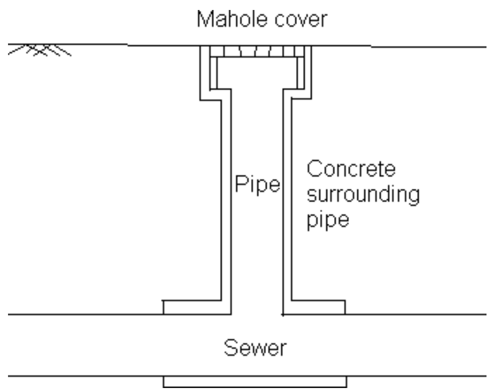
Flap gates or backwater gates are installed at or near sewer outlets to prevent back flow of water during high tide, or at high stages in the receiving stream. These gates can be rectangular or circular in shape and made up of wooden planks or metal alloy sheets. Such gates should be designed such that the flap should get open at a very small head difference. Adequate storage in outfall sewer is also necessary to prevent back flow into the system due to the closure of these gates at the time of high tides, if pumping is to be avoided.

8.8 SEWER VENTILATORS

Ventilation to the sewer is necessary to make provision for the escape of air to take care of the exigencies of full flow and to keep the sewage as fresh as possible. In case of stormwater, this can be done by providing ventilating manhole covers. In modern sewerage system, provision of ventilators is not necessary due to elimination of intercepting traps in the houseconnections allowing ventilation.

8.9 LAMP HOLE

It is an opening or hole constructed in a sewer for purpose of lowering a lamp inside it. It consists of stoneware or concrete pipe, which is connected to sewer line through a T-junction as shown in the Figure 8.12. The pipe is covered with concrete to make it stable. Manhole cover of sufficient strength is provided at ground level to take the load of traffic. An electric lamp is inserted in the lamp hole and the light of lamp is observed from manholes. If the sewer length is unobstructed, the light of lamp will be seen. It is constructed when construction of manhole is difficult. In present practice as far as



possible the use of lamp hole is avoided. This lamp hole can also be used for flushing the sewers. If the top cover is perforated it will also help in ventilating the sewer, such lamp hole is known as fresh air inlet.

Figure 8.12 Lamp hole

Sewage farming

IT Allows use for irrigation of water which might otherwise be wasted. Some of the nutrients and organic solids in wastewater can be usefully incorporated into soil and agricultural products rather than fouling natural aquatic environments.

Majorly, four methods of sewage water treatment are followed – **physical, biological, chemical, and sludge water treatment**. By following these methods, the wastewater is disinfected from all the sewage materials and converted into treated water that is safe for both human usage and the environment.

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. This **phenomenon of soil getting clogged** is known as sewage sickness of the land.

As a fertilizer, **it's popular with some farmers** because most wastewater treatment plants give it away for free or sell it at prices that are below the cost of synthetic fertilizers. The use of biosolids in agriculture is increasingly coming under fire as a potential health and environmental threat, however.

LONG QUESTIONS

1.what is man holes & Explain its types .
2.what is lamp holes ?

3.what is inlet ,grease & oil trap ?

4.what is storm regulators & inverted siphon ?

5 .what sewage farming and explain its application .

6.what is sewage sickness ?

SEWAGE TREATMENT

Sewage contains a huge amount of organic matters which are toxic. **Microorganisms are widely used in the sewage treatment plant for removing this toxic organic matter**. Sewage or wastewater treatment plant consists of two stages.

wastewater treatment, also called **sewage treatment**, the removal of impurities from wastewater, or sewage, before it reaches aquifers or natural bodies of water such as rivers, lakes, estuaries, and oceans. Since pure water is not found in nature (i.e., outside chemical laboratories), any distinction between clean water and polluted water depends on the type and concentration of impurities found in the water as well as on its intended use. In broad terms, water is said to be polluted when it contains enough impurities to make it unfit for a particular use, such as drinking, swimming, or fishing. Although water quality is affected by natural conditions, the word *pollution* usually implies human activity as the source of contamination. Water pollution, therefore, is caused primarily by the drainage of contaminated wastewater into surface water or groundwater, and wastewater treatment is a major element of water pollution control.

Flow diagram of conventional treatment

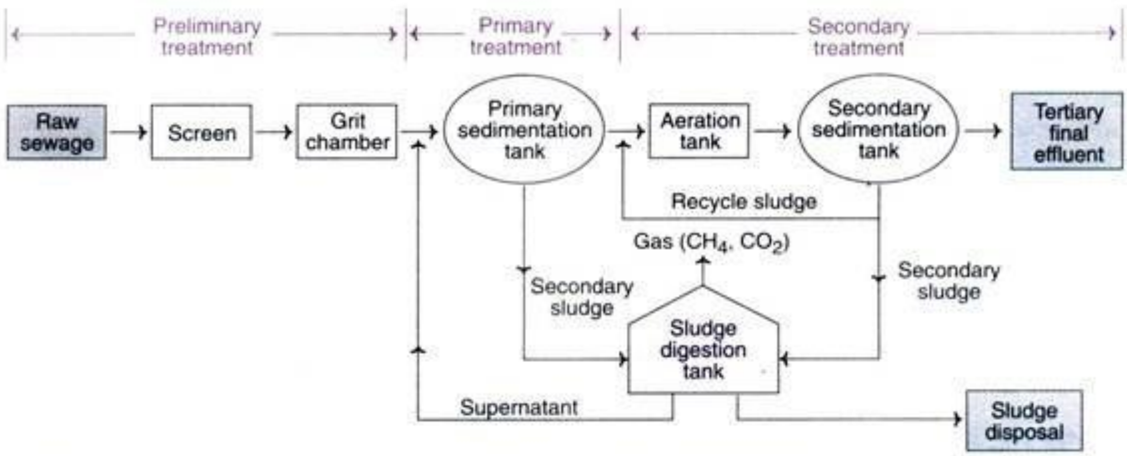


Fig. 57.18 : A diagrammatic representation of a flow chart of conventional sewage treatment plant.

Waste water treatment and disposal

The size and capacity of wastewater treatment systems are determined by the estimated volume of sewage generated from residences, businesses, and industries connected to sewer systems as well as the anticipated inflows and infiltration (I&I). The selection of specific on-lot, clustered, or centralized treatment plant configurations depends upon factors such as the number of customers being served, the geographical scenario, site constraints, sewer connections, average and peak flows, influent wastewater characteristics, regulatory effluent limits, technological feasibility, energy consumption, and the operations and maintenance costs involved.

The predominant method of wastewater disposal in large cities and towns is discharge into a body of surface water. Suburban and rural areas rely more on subsurface disposal. In either case, wastewater must be purified or treated to some degree in order to protect both public health and water quality. Suspended particulates and biodegradable organics must be removed to varying extents. Pathogenic bacteria must be destroyed. It may also be necessary to remove nitrates and phosphates (plant nutrients) and to neutralize or remove industrial wastes and toxic chemicals.

Primary treatment

It removes material that will either float or readily settle out by gravity. It includes the physical processes of screening, comminution, grit removal, and sedimentation. Screens are made of long, closely spaced, narrow metal bars. They block floating debris such as wood, rags, and other bulky objects that could clog pipes or pumps. In modern plants the screens are cleaned mechanically, and the material is promptly disposed of by burial on the plant grounds. A comminutor may be used to grind and shred debris that passes through the screens. The shredded material is removed later by sedimentation or flotation processes.

Grit chambers are long narrow tanks that are designed to slow down the flow so that solids such as sand, coffee grounds, and eggshells will settle out of the water. Grit causes excessive wear and tear on pumps and other plant equipment. Its removal is particularly important in cities with combined sewer systems, which carry a good deal of silt, sand, and gravel that wash off streets or land during a storm.

Suspended solids that pass through screens and grit chambers are removed from the sewage in sedimentation tanks. These tanks, also called primary clarifiers, provide about two hours of detention time for gravity settling to take place. As the sewage flows through them slowly, the solids gradually sink to the bottom. The settled solids—known as raw or primary sludge—are moved along the tank bottom by mechanical scrapers. Sludge is collected in a hopper, where it is pumped out for removal. Mechanical surface-skimming devices remove grease and other floating materials.

Secondary treatment

Secondary treatment removes the soluble organic matter that escapes primary treatment. It also removes more of the suspended solids. Removal is usually accomplished by biological processes in which microbes consume the organic impurities as food, converting them into carbon dioxide, water, and energy for their own growth and reproduction. The sewage treatment plant provides a suitable environment, albeit of steel and concrete, for this natural biological process. Removal of soluble organic matter at the treatment plant helps to protect the dissolved oxygen balance of a receiving stream, river, or lake.

There are three basic biological treatment methods: the trickling filter, the activated sludge process, and the oxidation pond. A fourth, less common method is the rotating biological contacter.

Trickling filter

A trickling filter is simply a tank filled with a deep bed of stones. Settled sewage is sprayed continuously over the top of the stones and trickles to the bottom, where it is collected for further treatment. As the wastewater trickles down, bacteria gather and multiply on the stones. The steady flow of sewage over these growths allows the microbes to absorb the dissolved organics, thus lowering the biochemical oxygen demand (BOD) of the sewage. Air circulating upward through the spaces among the stones provides sufficient oxygen for the metabolic processes.

Settling tanks, called secondary clarifiers, follow the trickling filters. These clarifiers remove microbes that are washed off the rocks by the flow of wastewater. Two or more trickling filters may be connected in series, and sewage can be recirculated in order to increase treatment efficiencies.

Flow rates

There is a wide variation in sewage flow rates over the course of a day. A sewerage system must accommodate this variation. In most cities domestic sewage flow rates are highest in the morning and evening hours. They are lowest during the middle of the night. Flow quantities depend upon population density, water consumption, and the extent of commercial or industrial activity in the community. The average sewage flow rate is usually about the same as the average water use in the community. In a lateral sewer, short-term peak flow rates can be roughly four times the average flow rate. In a trunk sewer, peak flow rates may be two-and-a-half times the average.

longQuestions

1. **What sewage treatment ?**
2. **What is primary treatment ? Describe its functions and principle .**
3. **What is secondary treatment ? Describe its functions and principle.**

SANITARY PLUMBING FOR BUILDING

BUILDING DRAINAGE

Building drainage is part of the drainage system at the lowest piping network which receives the discharge from waste, soil, and other drainage pipes and conveys it to the sewer from the line of building walls.

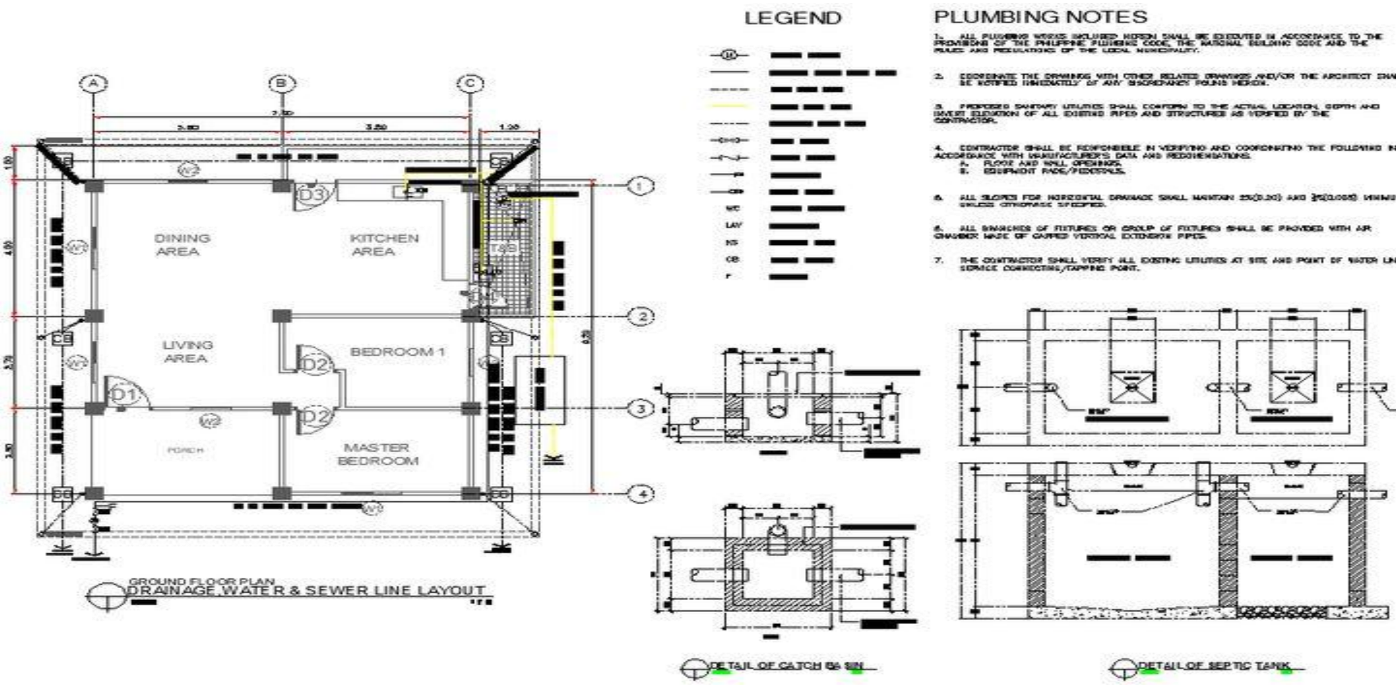
Aims of building drainage:

- Building drainage maintains the healthy condition of the building
- Wastewater can be disposed of daily condition and quickly
- Gives us the facility to remove foul matter.
- Avoid the gases coming from foul matter

Requirements for building drainage:

- Building drainage is required as it allows foul matter to drain out quickly.

- All the materials and fittings of this drainage should be strong, and resistive to corrosion.
- Rainwater pipes drain out it directly to the street gutters and from that is connected to the stormwater.
- The drainage should be constructed at a slope that should have its cleansing velocity.
- Drains should be aligned between inspection chambers.
- The drains should be of a size to handle maximum discharge.



PLUMBING

Designing plumbing systems for multiple dwellings and multi-story housing units requires careful attention to factors that are substantially more complicated than those for single-story dwellings. The following overview of some of these important factors can help you understand the what needs to be considered when designing a plumbing system for multi-story dwellings.

Definitions

Multiple dwellings refer to structures that house more than one individual or family in separate units. These types of dwellings can be apartment buildings, hotels, military barracks buildings, tenements, boarding schools, nursing homes and other locations where multiple people live in relatively close proximity to each other. Multi-story dwellings are structures with more than one floor, but in the context of plumbing, a multi-story building is one that can't be fully and adequately served by the municipal water supply because the pressure is too limited. Multi-story buildings also require drainage, sewage and venting systems that can accommodate many people living in a generally vertical arrangement.

Increasing Water Pressure for Multi-Story Buildings

In multi-story buildings, water pressure will often need to be increased to ensure that water is reaching the upper levels of the structure. This can be accomplished in several different ways:

- **Installation of booster pumps:** A series of staged pumps or variable-speed pumps can be installed to provide increased pressure for water drawn from the municipal water supply or from gravity storage tanks. These pumps supplement pressures from existing water supply sources.
- **Using a gravity-based roof tank:** Water is pumped from a ground-level or basement-level storage tank into a roof tank that attains adequate water pressures through gravity.
- **Use of hydro-pneumatic storage tanks:** Water is pumped from municipal supply lines or gravity storage tanks into hydro-pneumatic storage tanks that use internal air pressures to increase the water supply line pressure.

Avoidance of Cross-Contamination

Multi-occupancy, multi-story buildings must have plumbing system designs that prevent the possibility of cross-contamination of drinking water from one dwelling to another. Carelessness or unsanitary behavior from one resident or tenant should not affect the water quality of any other tenant. This is also true if the building houses commercial facilities, as well as residential units.

Installation of Control Valves

Multi-dwelling units should have control valves installed to control water supplies to each individual unit. This will help with preventing cross contamination. It will also ensure that water supplies to separate units can be shut off during maintenance or repairs without affecting the water supply to other dwellings. Control valves also give building managers and owners the option to stop water flow to unoccupied units. In cold weather, for example, this could reduce the chance of pipes freezing in vacant units.

Sewage and Waste Systems

Waste disposal, sewage systems and drainage must be designed to accommodate a larger and more consistent flow of greywater and human waste. These systems can be designed and implemented using multiple principles, including:

One-pipe systems, in which all solid waste and waste water from all units are directed to a single common pipe stack that carries material to the municipal waste system or other underground drains. All branches are ventilated to sustain proper air pressures. One-pipe systems are commonly used if there's a risk of frost or freeze damage to the pipes, or where the building plumbing system is especially large and complex.

Two-pipe systems, in which solid waste and greywater are handled by separate pipe installations. Two-pipe systems are generally discharged into gullies or other geographical features.

Plumbers should **use proper scaffolding when the plumbing work is carried out on the external face or at the height more than 2m**. Scaffolding should be thoroughly inspected to stability. While using ropes/zulas, sufficient care should be taken to prevent accidents. They should be secured properly without fail.

There are three types of Plumbing systems. **Potable water, sanitary, and stormwater system**. Each of these plays a vital role in keeping the city clean and hygienic. All the residential, industrial, and commercial buildings have each of these plumbing systems installed.

INTRODUCTION

You must have seen plumbing and sanitary fittings and fixtures installed in the kitchen, bathroom or toilets of your home, school or other buildings. Many people confuse the words plumbing fittings and plumbing fixtures. A plumbing fixture is a part that is connected to a plumbing system and carries water through a building. The most common plumbing fixtures are bathtubs, sinks, showers, tubs, toilets and faucets. While a fixture can be fixed into walls or the floor, a fitting is an item that can be hung by a hook, screw or nail.

Plumbing fittings

Various types of pipe fitting are available in plumbing systems for different purposes and functions. A pipe fitting is used in the plumbing system to join multiple pipes of same size or different sizes, to regulate the flow or to measure the flow. They are made, up of different materials like copper, iron, brass, PVC, etc.

There are many different kinds of fittings, made from a variety of materials. Some of the most common types are as follows.

Types of fittings

1. Collar
2. Elbow
3. Gasket
4. Union
5. Reducer
6. Tee
7. Nipple
8. Trap

For a building, the plumbing system should be designed in a way that water is distributed uniformly, throughout the day. It should be ensured that a combination of fittings and fixtures is selected in such a way that uniform

supply of water and discharge of water is maintained.

Collar

While joining two pipes in the same length, collar isused. It is fitted at the end of the pipe (Fig. 4.1).

Elbow

It is installed at the time of joining two pipes. With the help of an elbow, the direction of liquid is changed. Normally a 45 degree or 90 degree elbow is used. When the two sides of pipes differ in size, an elbow of reducing size is used. This is called reducing type elbow or reducertype elbow.
Elbows are categorised as follows.

Long Radius (LR) elbows

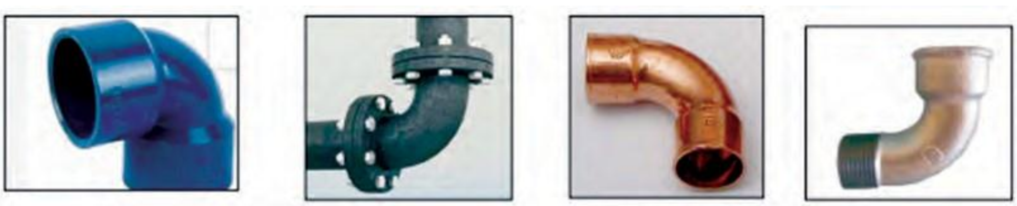
Here, the radius is 1.5 times the diameter of pipe.

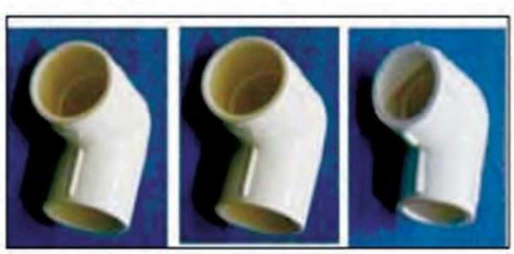
Short Radius (SR) elbows

In this, the radius is 1.0 times the diameter of pipe.

45-degree elbow

This is used when the change in direction required is 45 degrees





required is90 degrees (Fig. 4.3).

Fig. 4.3: Bend 90 degree

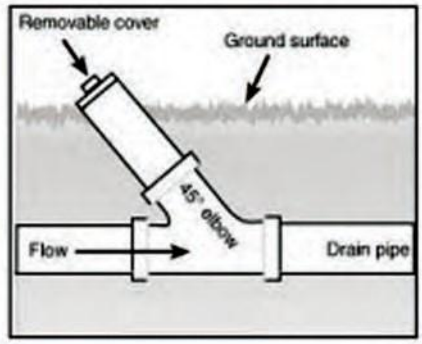
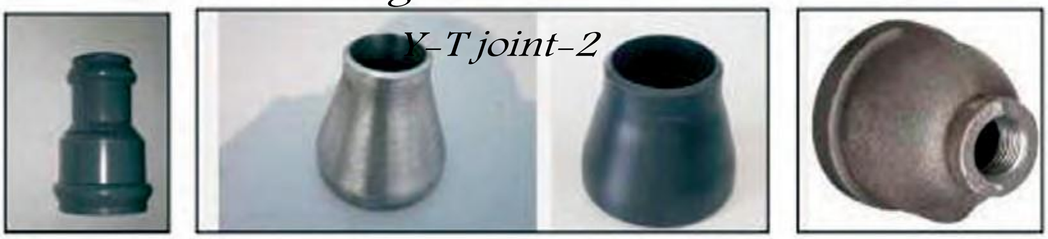


Fig. 4.5: Double Y-T joint-1

Fig. 4.4: Y–T joint

Fig. 4.6: Double Y–T joint–2



Important points before installation

Read the plumbing drawing

Study the drawing of the bathroom, washroom, kitchen or other places where installation is to be done. The drawing will help the Plumber General to understand various aspects of plumbing fittings, fixtures, distance and height to be maintained during installation.

Install the basic sanitary fixture

Fittings (faucets and valves) are used more often than any other part of the plumbing system. The best modern fittings selected should use chrome-plated brass as it

bears the effect of water quality and has a high durability. They can be cleaned easily with soap and warm water.

Protection against backflow

The supply lines and fittings for every plumbing fixture should be installed in such a way that there is no backflow. There may be a backflow due to improper design.

Access for cleaning

Plumbing fixtures should be installed in such a way that they can have easy access for cleaning, for both the fixture and the area around the fixture.

Check for alignment and setting

The fixtures must be set level in proper alignment with the adjacent walls. As per the Indian Plumbing Association Code, a water closet, lavatory or bidet should not be set closer than 15 inches (381 mm) from its centre to any sidewall, partition, vanity or other obstruction, or closer than 30 inches (762 mm) centre-to-centre between toilets or adjacent fixtures. An 18-inch (457 mm) distance must be in front of the water closet or bidet to any wall, fixture or door. Water closet compartments should not be less than 30 inches (762 mm) wide and 60 inches (1524 mm) deep. There must be at least 18 inches (457 mm) clearance in front of a lavatory to any wall, fixture or door. A urinal shall not be set closer than 15 inches (381 mm) from the centre of the urinal to any sidewall, partition, vanity or other obstruction, or closer than 30 inches (762 mm) centre-to-centre between urinals.

Make floor and wall drainage connections

Connections between the drain and floor outlet plumbing fixtures must be made with a floor flange. The flange shall be attached to the drain and anchored to the structure. Connections between the drain and wall-hung water closets should be made with an approved extension nipple or horn adapter. The water closet must be bolted to the hanger with corrosion-resistant bolts or screws. Joints should be sealed with an approved elastomeric gasket or setting compound.

Check for floor flanges

Floor flanges for water closets or similar fixtures shall not be less than 1/8 inch (3.2 mm) thick for brass, 1/4 inch (6.4 mm) thick for plastic, and not less than a 2-inch (51 mm) caulking depth for cast-iron or galvanised malleable iron. Floor flanges of hard lead shall weigh not less than 0.7 kg and shall be composed of lead alloy with not less than 7.75 percent antimony (a chemical element which is a brittle, silvery-white metalloid) by weight. Closet screws and bolts shall be of brass. Flanges shall be secured to the building structure with corrosion-resistant screws or bolts.

Secure floor outlet fixtures

Floor outlet fixtures must be secured to the floor or floor flanges by screws or bolts of corrosion-resistant material.

Secure wall-hung water closet bowls

Wall-hung water closet bowls should be supported by a concealed metal carrier that is attached to building the structural members so that strain is not transmitted to the closet connector or any other partof the plumbing system.

Make water-tight joints

All the joints of fixtures close to the wall or floor mustbe sealed to prevent water from entering or passing through.

Plumbing in mental health centres

In mental health centres, pipes or traps should not be exposed, and fixtures must be bolted through walls.

Design of overflows

Where any fixture is provided with an overflow, the waste should be designed and installed in such a waythat standing water in the fixture will not rise in the overflow when the stopper is closed, and no water will remain in the overflow when the fixture is empty.

Connection of overflows

The overflow from any fixture should be discharged into the drainage system on the inlet or fixture side of the trap. The only exception exists in case of the overflow from a flush tank serving a water closet or urinal, which should be discharged into the fixture served.

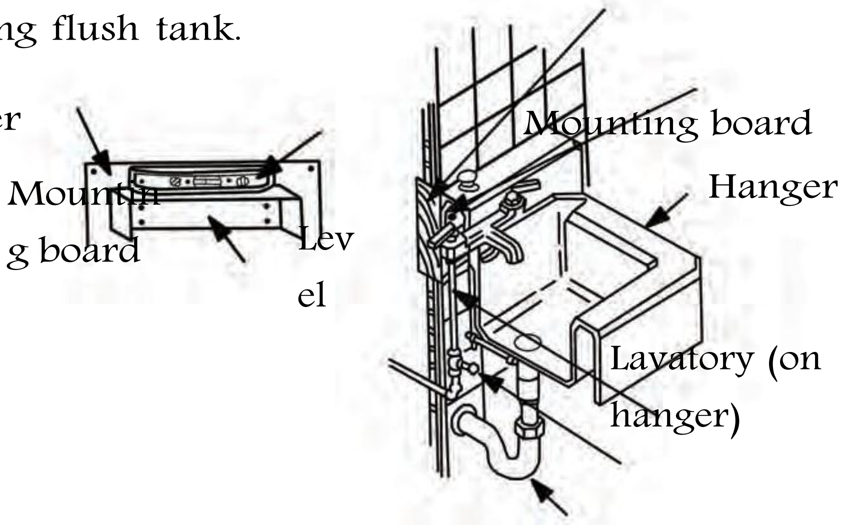
Access to concealed connections

Fixtures with concealed slip-joint connections should be provided with an access panel or utility space at least 12 inches (305 mm) in its smallest dimension or other approved arrangement so as to provide access to the slip connections for inspection and repair. Where such access cannot be provided, access doors shall not be required, provided that all joints are soldered, solvent cemented or screwed so as to form a solid connection.

Installation of a wall hung fixture

Step 1. Install the mounting board between the studs at the proper height, using the same method as for a wall-hung flush tank.

Step 2. Attach a hanger bracket on the finished wall using the proper length of wood screws at the recommended height. The metal bracket must be level.



Step 3. Place the lavatory on the bracket and push down. Make sure the lavatory is level.

Fig. 4.25: Wall-hung lavatory installation

Joining of pipes

Proper solvent cementing techniques are fundamental to the successful installation of pipes. Such techniques provide the basis for strong and durable solvent cementjoints.

Solvent cementing

Also known as solvent welding, solvent cementing is a chemical process that uses a primer, or the cement itself, to soften the surface of a plastic pipe and fittings in order to weld, or fuse them together. When applied, the solvents soften and dissolve the top layer of the pipe and fitting material, loosening its molecular structure. A taper in the fitting socket creates an interference fit that ensures contact between the pipe and fitting. This allows the material to fuse to itself when the two pieces are connected. Solvent cementing is a fast, easy and highly reliable process that produces a joint, stronger than either the pipe or fitting alone.

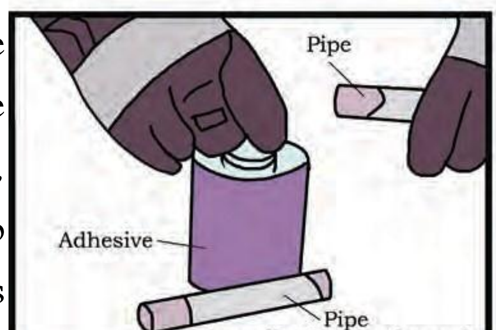
PVC glue is used as a solvent cement. It is an adhesive that is used to create an airtight seal that holds the PVC pipe and connection fittings together. Considering that the majority of piping installation failures are the result of improper cementing techniques, an understanding of the proper techniques required for joining, saves both time and money.

Procedure for solvent cementing

Inspect the pipe and fittings for overall appearance and compatibility. Obvious defects such as cracks, burrs and incompatible materials must be addressed as required. The joining surfaces must be clean and dry. In addition, the cement for the type and size of pipe and fittings should be determined. Also, remember both temperature and humidity may be issues to consider. Another detail that is often overlooked is the need to have the correct size applicator for the size of pipe. The size of the applicator should be about half the size of the pipe diameter in order to ensure proper and timely solvent cement coverage.

1. Cut the pipe with a cutter or saw in square to provide optimal bonding area. See Fig. 4.26.

2. De-burr the pipe with a chamfering tool or file to ensure proper contact between pipe and fitting. Remove all burrs from both the inside and outside of the pipe with a knife, file or reamer. Burrs can scrape channels into pre-softened surfaces or create hang-ups inside surface walls. Remove dirt, grease



Putting adhesive on pipe ends

Joining of pipe

and moisture. A thorough wipe with a clean dry rag is usually sufficient.

3. Apply a heavy, even coat of CPVC primer (if necessary) to the fitting. Use the right applicator for the size of pipe or fittings being joined. The applicator size should be equal to 1/2 the pipe diameter. It is important that a satisfactory size applicator be used to help ensure that sufficient layers of cement are applied.

4. Apply a heavy, even coat of primer (if necessary) to the pipe end. The purpose of a primer is to pierce through and soften the surfaces so they can fuse together. The proper use of a primer and checking its softening effect provides assurance that the surfaces are prepared for fusion in a wide variety of conditions. Check the piercing or softening on a piece of scrap before you start the installation or if the weather changes during the day. Using a knife or other sharp object, drag the edge over the coated surface.

Water closet means a plumbing fixture having a water-containing receptor which receives liquid and solid body waste and, upon actuation, conveys the waste through an exposed integral trap seal into a gravity drainage system, except such term does not include fixtures designed for installation in prisons.

Different Types of Water Closets:

- One Piece Water Closet:
- Two Piece Water Closet:
- Wall Mounted Water Closet:
- Floor Standing Water Closet:
- Extended Wall Mounted Water Closet:
- Close Coupled Water Closet:
- Pedestal Water Closet: The pedestal water closet has its tank mounted on top of an elevated support base.

flushing cistern means **a cistern with a discharging apparatus for flushing a water closet, slop sink, urinal or drain**. flushing cistern means a cistern provided with a device for discharging the stored water rapidly into a water closet pan or urinal.

They are in **two main forms**, namely: the fully concealed cistern based within a partition wall and a furniture-based version which is hidden in furniture or a storage unit.

A **urinal** is **a sanitary plumbing fixture designed for urination only**. It is typically used in the standing position. Urinals are most frequently placed in male public toilets, in particular those found in commercial or institutional settings.
A urinal is a container used **to collect urine**. It is shaped to fit either a man or a woman. But some women might find it easier to use a bedpan. If you are helping someone with a urinal,

try to be relaxed.
Although there are many different brands and models of urinal, there are only two basic types: **trough urinals and bowl urinals**.

An **inspection chamber** is **smaller than a manhole and is necessary to maintain the sewer system** (e.g. cleaning, flushing the system). It is normally installed at a junction where several pipes are connected or where small diameter pipes are connected to pipes with a bigger diameter.

Inspection Chambers are available in sizes **315mm & 600mm** and suitable for invert depth.

intercepting trap is provided in to the Interceptor Manhole (Interceptor Chamber). An Interceptor manhole is provided at the interception of building sewer and Public sewer. Intercepting trap is provided to prevent the foul gases from public sewers entering in to the building sewer by providing water seal.

Anti-siphonage pipe means **any pipe or portion of a pipe provided for the protection by ventilation of the water seal or trap against unsealing by siphonage or backpressure.**

In order to prevent this from happening, **fixture drainage pipes are equipped with traps, which contain seal water**. Seal water plays an important role to stop drainage gas from entering the room. However, seal water may be lost for many reasons leading to a condition called seal break.

To test for the effect of self-siphonage the appliance should be filled to overflowing level and discharged by removing the plug; WC pans should be flushed. The seal remaining in the trap should be measured when the discharge has finished.

QUESTIONS

1.What is plumbing ?

Plumbing may be defined as the practice, materials, and fixtures used in installing, maintaining, and altering piping, fixtures, appliances, and appurtenances in connection with sanitary or storm drainage facilities, a venting system, and public or private water supply systems.

2.What is building drainage ?

Building drainage generally refers to **all necessary means for drainage that are used to protect buildings against damage from humidity or moisture from the surrounding soil**. Importance. Building drainage is of great economic importance! 90% of all structural damage to basement areas can be prevented by proper drainage.

3.What is water closets ?

- **Water closet** means a plumbing fixture having a water-containing receptor which receives liquid and solid body waste and, upon actuation, conveys the waste through an exposed integral trap seal into a gravity drainage system, except such term does not include fixtures designed for installation in prisons.
-

4.What is flushing cisterns ?

- **flushing cistern** means **a cistern with a discharging apparatus for flushing a water closet, slop sink, urinal or drain**. flushing cistern means a cistern provided with a device for discharging the stored water rapidly into a water closet pan or urinal.
-

5.What is urinals?

- A **urinal** is **a sanitary plumbing fixture designed for urination only**. It is typically used in the standing position. Urinals are most frequently placed in male public toilets, in particular those found in commercial or institutional settings.

6.What is inspection chambers ?

- An **inspection chamber** is **smaller than a manhole and is necessary to maintain the sewer system** (e.g. cleaning, flushing the system). It is normally installed at a junction where several pipes are connected or where small diameter pipes are connected to pipes with a bigger diameter.

7.What is anti syphonage pipe ?

Anti-siphonage pipe means **any pipe or portion of a pipe provided for the protection by ventilation of the water seal or trap against unsealing by siphonage or backpressure.**

LONG QUESTIONS

1. What are the requirements of building drainage ?
2. What are the plumbing arrangement of single storied & multi storied building ?
3. What are the sanitary features ?

THANK YOU