MODULE-5

Quality and Quantity of Surface Water and Their Usefulness for Public water Supplies

Quantity.

- The quantities of available surface waters are dependent upon rainfall. Since on an average, in India, rainfall is sufficient and considerable, there should, therefore, be no scarcity of water in these surface sources.
- But since the rainfall is not uniformly and regularly spread throughout the year, considerable variations in the available flows do occur during the year or years, Thus, the available flow in a stream channel or a river may be too high to be controlled or may be too less to fulfill the demand.
- Storage reservoirs, therefore, provide good means of storing and utilizing rain waters.

Quality.

- The rain water, though pure in the beginning, gets considerably polluted till it reaches the river streams. The gases, dusts, etc., from the atmosphere, get added to the rain water till it reaches the ground; from where onward, it flows on earth's surface and also through drains, channels, etc., which add a lot of organic as well as inorganic impurities to it. Many a times, sewage and industrial wastes get added to this water, making it s contaminated.
- Inorganic impurities like silt, clay, etc., get added due to erosion from the beds of the stream channels. The organic impurities get added in the form of vegetable washings, dead organic matters, and dead animals, etc.
- The inorganic suspended matter, though largely present in direct river or stream waters, get settled considerably in still waters of lakes, ponds and reservoirs. However, the algae weed and plant growth in still waters increase enormously, thus giving colors and tastes to these waters. Surface waters are, however, generally soft and less corrosive than ground waters.
- On the whole, it can be stated that the surface supplies are generally contaminated and cannot be used with minor treatment or without any treatment.
- They, therefore, need building up of proper water treatment plants (WTP s)and other connected works before being used for public supplies. They are useful for big cities and large industrial towns where huge quantities of water are required by the public.

Quality and quantity of sub-surface or underground sources

- The water which gets stored in the ground water reservoir through infiltration is known as the underground water. This water is generally pure, because it undergoes natural filtration during the percolation through the soil pores. Moreover, these waters are less likely to be contaminated by bacteria. However, they generally rich in dissolved salts, minerals, gases, etc. the extent of the salts and minerals present in the ground water depends upon the type and extent of geological formations through which the water is passing before joining the water table.

- Sometimes, the ground water is brought to the surface by some natural processes like springs, and sometimes theses waters are tapped by artificial means by constructing wells, tube wells, infiltration galleries, etc.,
- The replenishment (i.e., filling up) and drainage (i.e., tapping out) of the ground water reservoir is a full topic in itself, involving the hydrological concepts of ground water flow, the possible yields, the construction details of wells, tube wells, galleries, etc.
- Since the ground water is largely tapped in our country for water supplies and there is a scope for its development in future also.

OR

SURFACE SOURCES OF WATER SUPPLIES

Surface sources are those sources of water in which the water flows over the surface of the earth, and is thus directly available for water supplies. The important of these sources are these sources are:

(i) Natural ponds and lakes;
(ii) Streams and rivers; and
(iii) Impounding reservoirs.

These sources are discussed below:

a) Ponds and Lakes as Surface Sources of supplies

- A natural large sized depression formed within the surface of the earth, when gets filled up with water, is known as a pond or a lake. The difference between a pond and a lake is only that of size.
- The quality of water in a lake is generally good and does not need much purification. Larger and older lakes, however, provide comparatively purer water than smaller and newer lakes.
- Self-purification of water due to sedimentation of suspended matter, bleaching of color, removal of bacteria, etc. makes the lake's water purer and better. On the other hand, in still waters of lakes and ponds, the algae, weed and vegetable growth take place freely, imparting bad smells, tastes and colors to their waters.
- The quantity of water available from lakes is, however, generally small. It depends upon the catchment area of the Lake Basin, annual rainfall, and geological formations. Due to the smaller quantity of water available from them, lakes are usually not considered as principal sources of water supplies. They are, therefore, useful for only small towns and hilly areas.
- However, when no other sources are available, larger lakes may become the principal sources of supplies. For example, in Bombay city, water is supplied and brought from lakes about 70 km from there.

b) Streams and Rivers as Surface Sources of Supplies

- Small stream channels feed their waters to the lakes or rivers. Small streams are, therefore, generally not suitable for water supply schemes, because the quantity of water available in them is generally very small, and they may even sometimes go dry.
- They are, therefore, useful as sources of water only for small villages, especially in hilly regions.

- Rivers are the most important sources of water for public water supply schemes. It is a well known fact that most of the cities are settled near the rivers, and it is generally easy to find a river for supplying water to the city.
- The quality of water obtained from rivers is generally not reliable, as it contains large amounts of silt, sand and a lot of suspended matter.
- The disposal of the untreated or treated sewage into the rivers is further liable to contaminate their waters. The river waters must, therefore, be properly analysed and well treated before supplying to the public.

c) Storage Reservoirs as Surface sources of supplies

- A water supply scheme drawing water drawing water directly form a river or a stream may fail to satisfy the consumer demands during extremely low flows; while during high flows, it may again become difficult to carry out its operations due to devastating floods.
- A barrier in the form of a dam may, therefore, sometimes be constructed across the river, so as to form a pool of water on the upstream side of the barrier. This pool or artificial lake formed on the upstream side of the dam is known as the storage reservoir.
- The quality of this reservoir water is not much different from that of a natural lake. The water stored in the reservoir can be used easily not only for water supplies but also for other purposes.
- Generally, multipurpose reservoirs are planned these days and operated so as to get optimum benefits. The subject of design and planning of dams and reservoirs is a big topic in itself, and is generally dealt under the subject of Irrigation.
- However, its salient features such as, Selection of dam site and types of dam ; Storage capacity of reservoirs, Reservoir sedimentation, Reservoir losses, etc. are, however being reproduced here.

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.

Selection of site

The following points should be considered in selecting a suitable site for the intake structure:

1. The site should be so selected that it may admit water even under worst condition of flow in the river, or under lowest possible water level in a lake or reservoir, if possible, intake should be located sufficiently inside the shore line.
2. Its site should be as near to the treatment work as possible.
3. It should be so located that it admits relatively pure water free from mud, sand or other floating materials. It should be located at a place protected from rapid currents.
4. It should be so located that it is free from the pollution. River intakes should be constructed well upstream of points of discharge of sewage and industrial wastes. If located near a city, it should be located to the upstream of the city so that water is not contaminated.
5. It should not interfere with river traffic, if any.

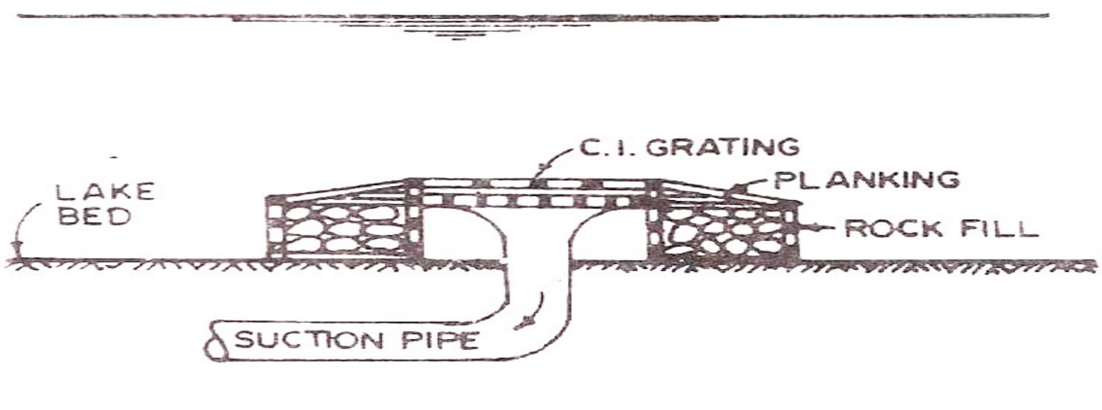
6. The intake should be so located that good foundation conditions are available and the possibility of scouring is the least.
7. Site should be so selected that its further expansion is possible.

Types of intake

a) Depending upon their position. (*Submerged and Exposed intake)*

1. Simple Submerged Intake

- *Submerged intake* is the one which is constructed entirely under water. Such an intake (Fig.a) is commonly used to obtain supply from a *lake.*
- A pipe is buried in a dredged channel across the bed of the river and the pipe is covered with soft earth. The remaining depth of the trench is covered with gravel and stone.
- Pipes are jointed with watertight joints and end with a bell-mouth, protected by a timber or concrete crib. The crib protects the conduit against damage and it is covered with rocks or rip-rap. The bell-mouth is covered with a coarse screen to eliminate the entry of submerged objects, debris, ice etc.
- Sometimes a fine screen is also provided to avoid the entry of fish and small floating objects. The conduit draws water from the source into a wet-well. Inspection of water-quality in the wet-well, shows the performance of the screens. From the wet-well, water is drawn by gravity or pumping to the treatment plant or distribution centre, as the case may be the area of the openings of the crib satisfy the entry velocity of not more than 15cm/s, to avoid the carrying of settleable particles into the intake pipe.
- The crib and the bell-mouth are submerged in water. This type of intake is cheap and there is no obstruction to navigation. They are therefore used for small water supply projects. But, there is a possibility of choking of the crib openings and bell-mouth. It is difficult to inspect and repair and allows draw water only from one level.



(Fig.a) *Submerged intake*

Prof. SAKALA. B.T, Department of Civil Engineering, SVIT, Bangalore-64.

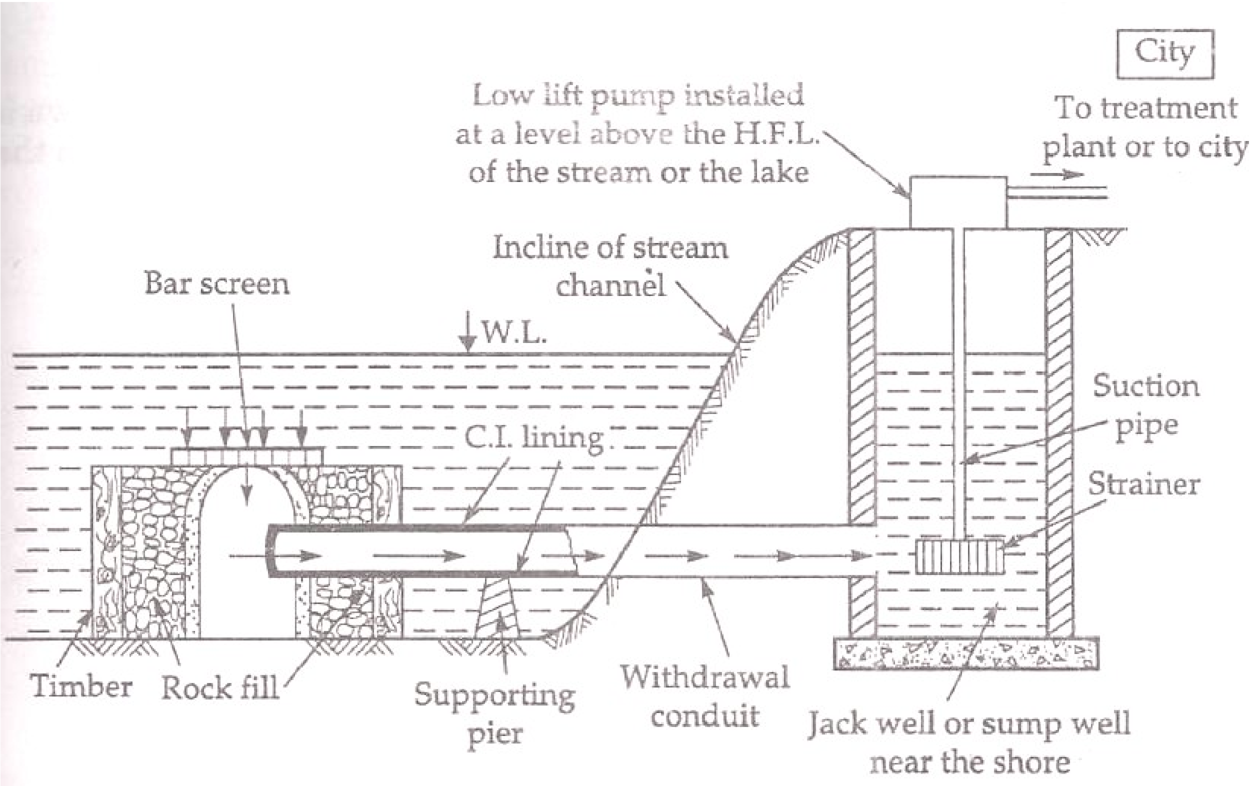


Fig.a-1: Simple Concrete block- *Submerged intake*

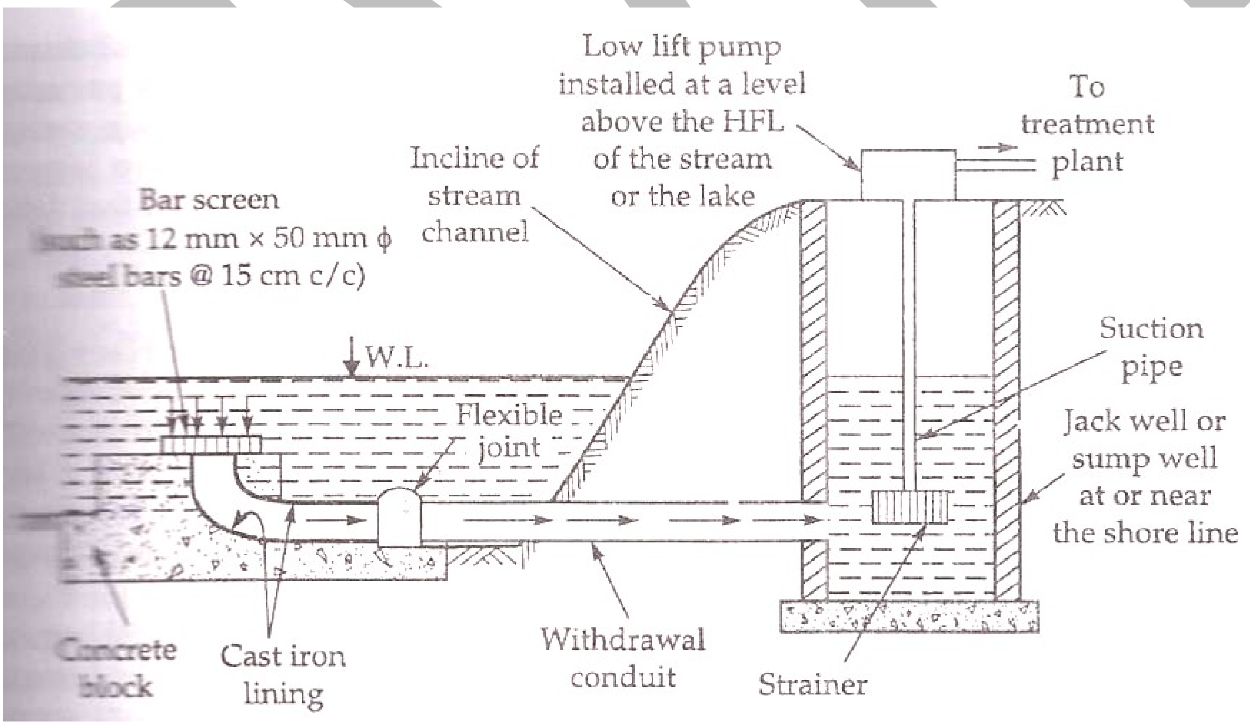
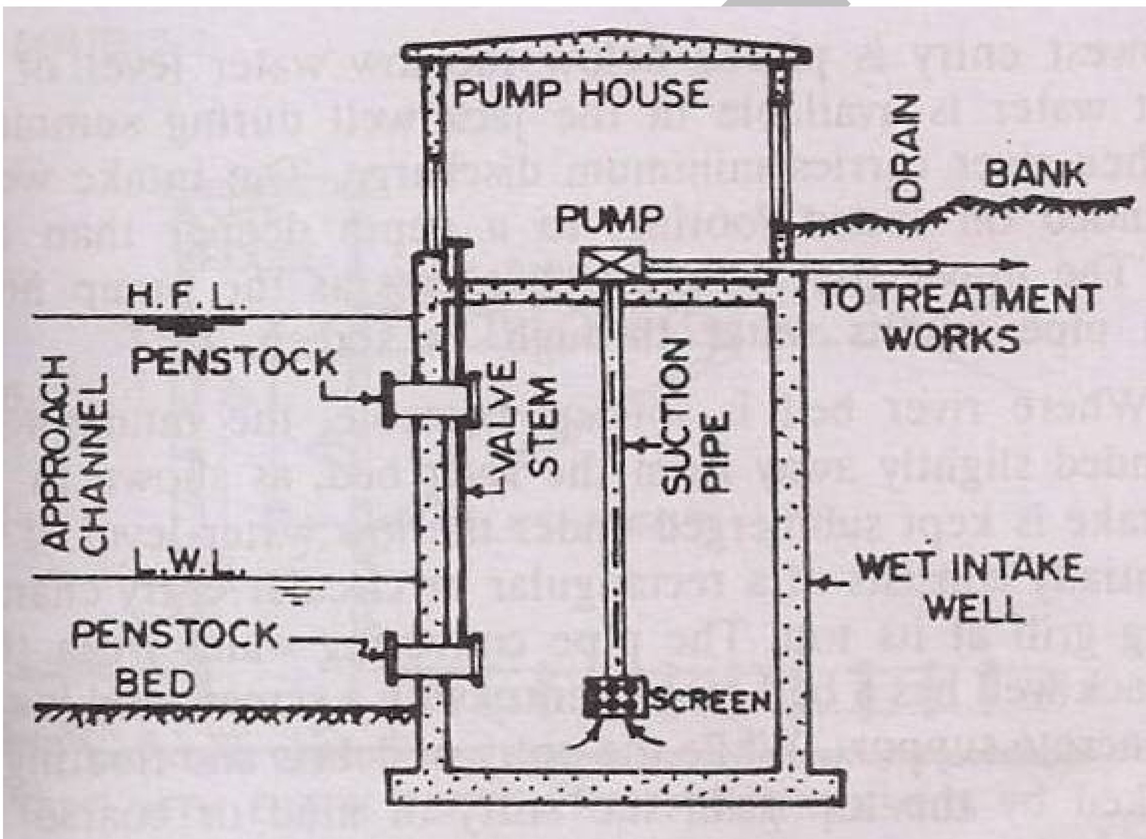


Fig.a-2: Rock filled timber crib- *Submerged intake*

Prof. SAKALA. B.T, Department of Civil Engineering, SVIT, Bangalore-64.

2. **Exposed intake**

- *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 bank.
- This type of intake may be used for tapping water from reservoirs, lakes or rivers. Exposed intakes are more common due to ease in its operation **(Fig b).** They are located (a) in the dams of reservoirs as a part of the dam, or (b) on the banks or rivers and lakes.
- An exposed intake can be called as "gate-house" or "valve-tower" in the case of a reservoir. It is easier to inspect and operate then a submerged intake. Water can be drawn at any desired level.



(Fig b). ***Exposed intake***

(b) Intake towers

3. **Wet intake**

- *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.
- A typical section of a wet intake tower is shown in **(Fig.c).** It may consist of a concrete circular shell filled with water up to the reservoir level and has a vertical inside shaft which is connected to the withdrawal pipe. The withdrawal may be taken directly to the treatment plant in case no lift is required (such as in reservoir) or to the sump well in case a low lift is required (such as in case of a river).

- Openings are made into the outer concrete shell, as well as, into the inside shaft as shown. Gates are usually placed on the shaft, so as to control the flow of water into the shaft and the withdrawal conduit.
- The water coming out of the without conduit may be taken to pump house for lift, if the water treatment is at higher elevation , or may be taken directly to WTP if it is situated at lower elevation.

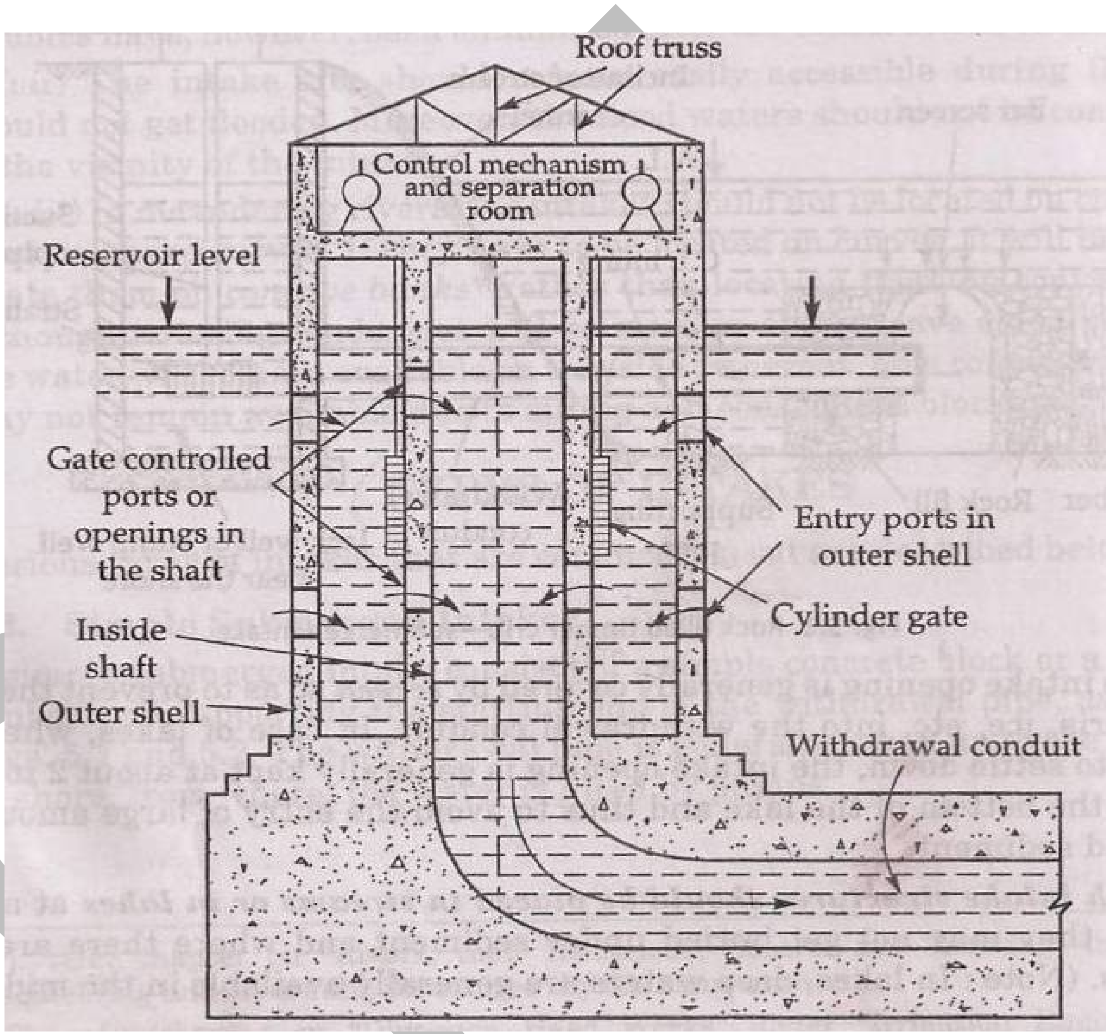


Fig.c : Wet intake

4. Dry intake.

- In the case of dry intake, Water enter enters through entry port directly into the conveying pipes.
- Whereas the entry ports are closed, a dry intake tower will be subjected to additional buoyant forces and hence, must be of heavier construction than the wet intake owners. However, the dry intake towers are useful and beneficial in the sense that water can be withdrawn from any selected level of the reservoir by opening the port at that level.
- The essential difference between a dry intake tower and a wet intake tower is that, whereas in a wet intake tower, the water enters from the entry ports into the tower and then it enters into the conduit pipe through separate gate controlled openings; in a dry intake tower, the water is directly drawn into the withdrawal conduit through the gated entry ports, as shown in (Fig.d).

- A dry intake tower will, therefore, have no water inside the tower if its gates are closed, whereas the wet intake tower will be full of water even if its gates are closed.

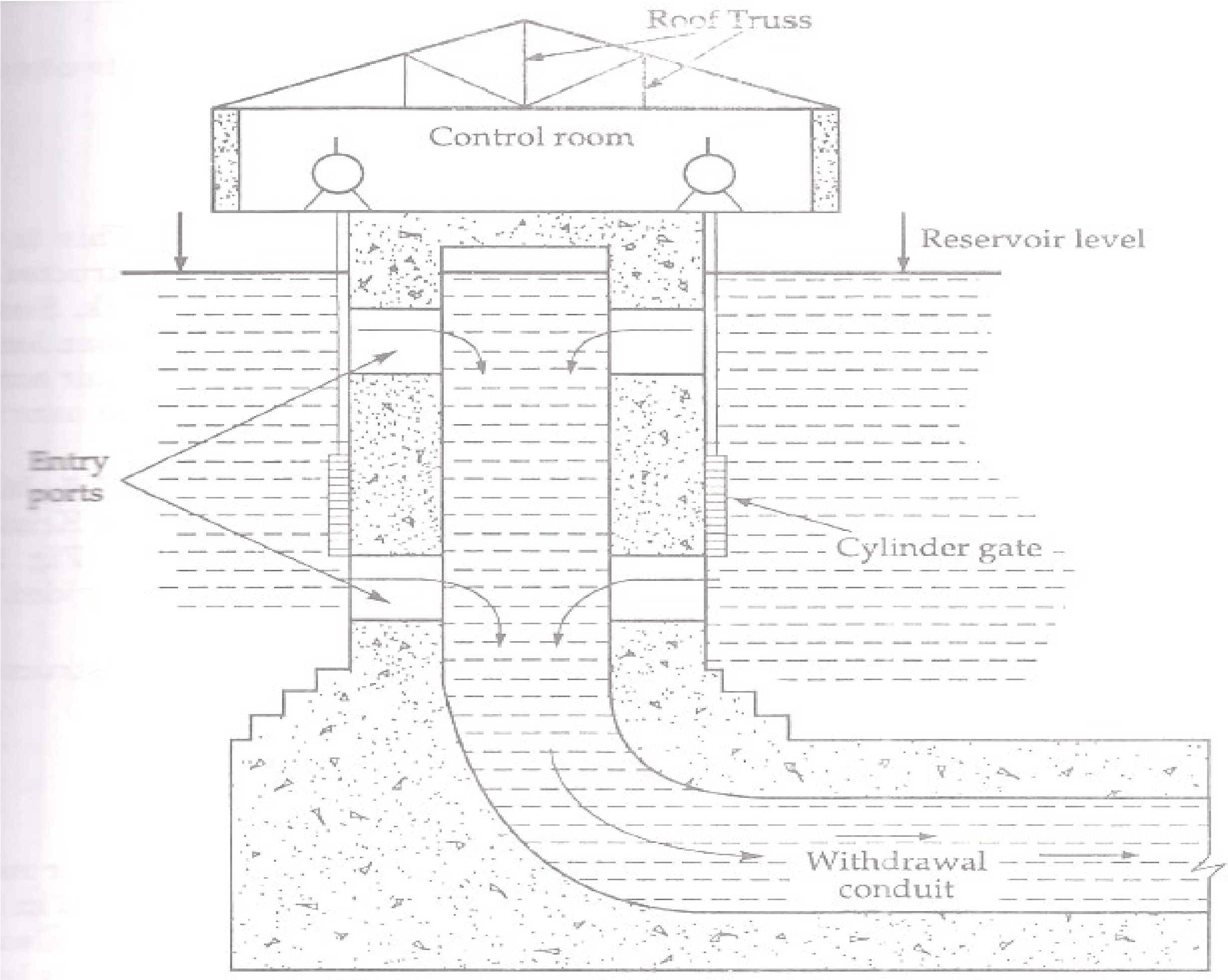


Fig.d : Dry intake

5. River Intakes

- 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 within 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. (Fig.1) shows a wet type intake well founded on river bed.
- The intake tower permits entry of water through several entry ports located at various levels to cope with the fluctuations in the water level during different seasons. These entry ports are sometimes known as penstocks and are provided with suitable designed screens to exclude debris and floating material from entry.

- The entry ports contain valves which can be operated from the upper part of the well. The lowest entry is placed below the low water level of the river so that water is available in the jack well during summer season also when river carries minimum discharge.
- The intake well should be founded on sound footing, to the depth deeper than the scour depth. The upper part of the well serves as the pump house. The suction pipe admits water through a screen.

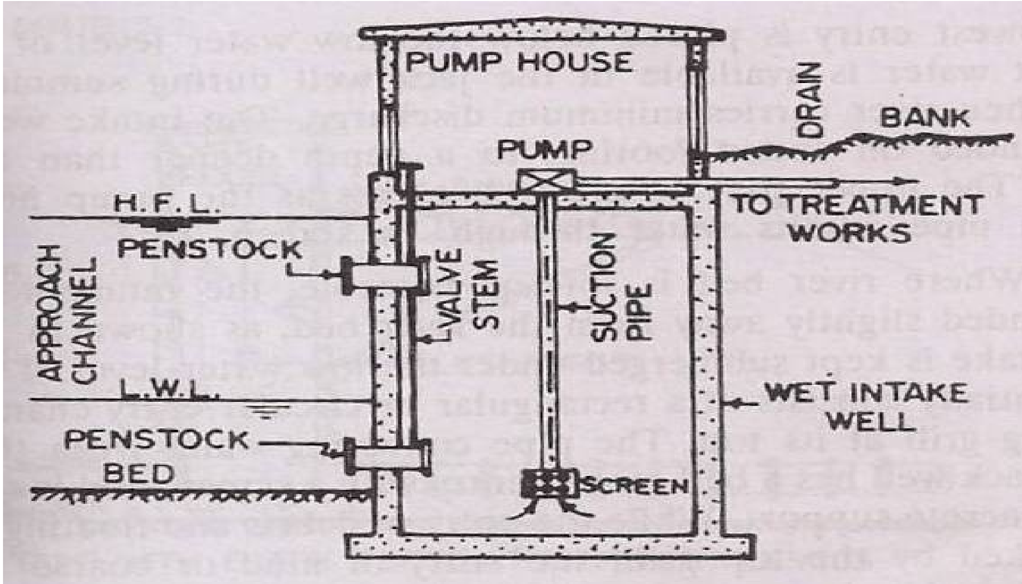


Fig:1

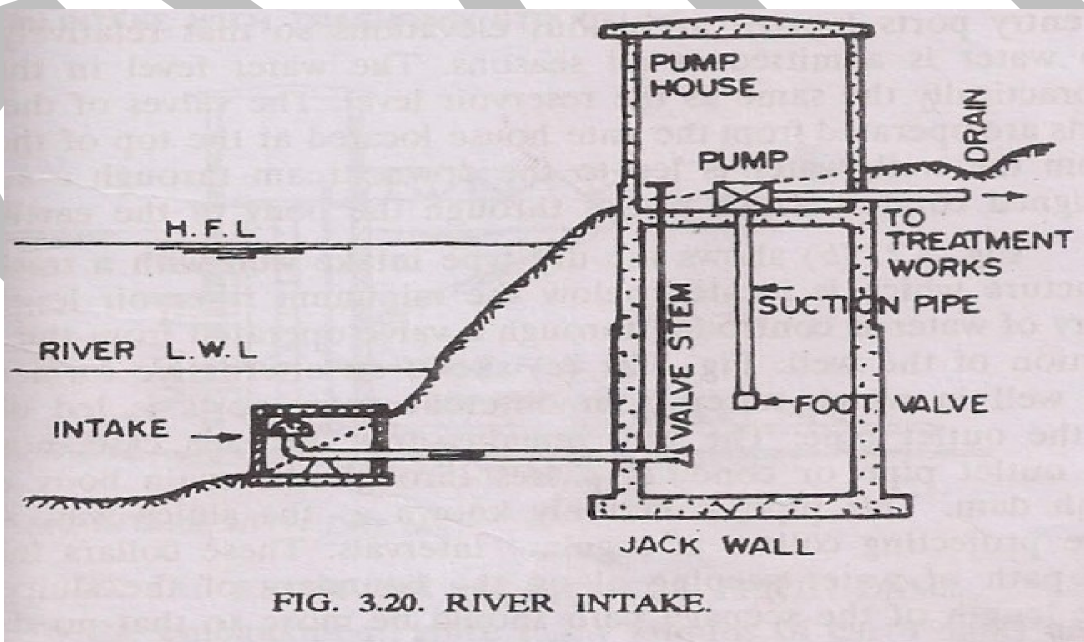


FIG. 3.20. RIVER INTAKE.

Fig:2

Fig:1 and 2 – River Intakes

6. Lake Intake

- Lake intakes are similar to reservoir intakes if the depth to water near the banks is reasonable. 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, as shown in (Fig.f).
- Submerged intakes are constructed as cribs or bell mouths. The cribs are made of heavy timber frame work which is partly or wholly filled with rip-rap to protect the intake conduit against damage by waves etc. the top of the crib is covered with cast iron or mesh grating.

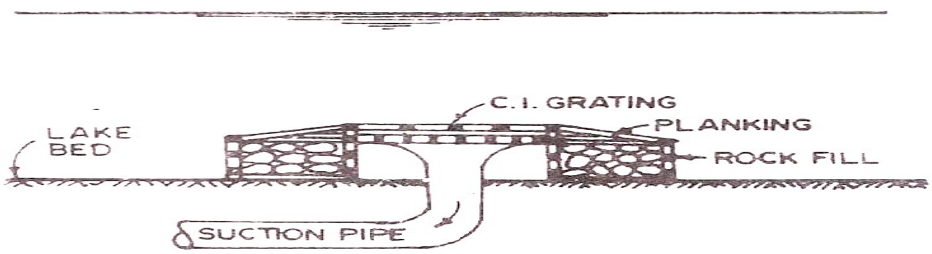


Fig:f – Lake Intake

7. Canal Intake

- Sometimes, the source of water supply to a small town may be an irrigation canal passing near the town. The canal intake is shown is **(Fig. g).**
- It 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 it does not offer any appreciable resistance to normal flow in the canal. The flow velocity through the outlet conduit is generally kept at about 1.5m/Sec, and this helps in determining the area and dia of the withdrawal conduit.

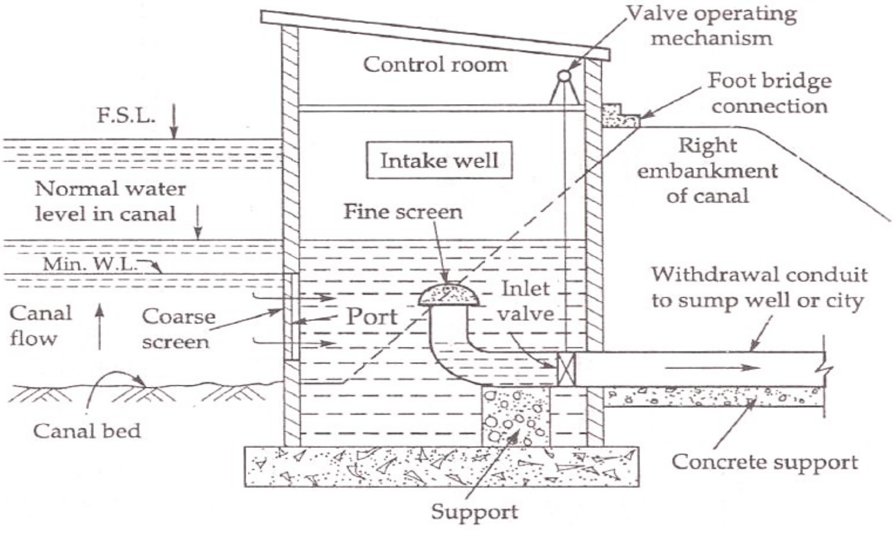


Fig:g – Canal Intake

8. Reservoir intake:

- When the floe in the river is not guaranteed throughout the year, a dam is constructed across it to store water in the reservoir so formed. These intakes are constructed near the toe of the dam where maximum depth is obtained usually at upstreams.
- This is also known as a *valve tower* (fig.h) it is a circular chamber of masonry or concrete with its flow sufficiently below the low water level in the reservoir, so they water can be drawn from the reservoir even from the lowest level.
- In masonry dams, it is built as a part of the dam. Intake ports or penstocks with screens are provided at intervals of one to two metres from the high water level to the low water level, so that clean water can be drawn from one or more penstocks, for various fluctuations of the level in the reservoirs.
- All the penstocks are connected to a vertical down take pipe, which is connected to the intake outlet conduit, at the bottom of the well. The outlet conduit can be controlled by a gate valve/ Stop valve, which can be operated from the top RCC cover of the intake-well.
- Penstocks are also provided with control valves. A foot-bridge is provided between the top of the dam and the value tower, for approach. A steel ladder is provided at the bottom of the well, so that inspecting personnel can enter it.
- The lowest penstock is located below the low water level, and the highest is below the high water level. A cabin is provided over the well, for the protection of all control valves and also as a shelter for personnel.

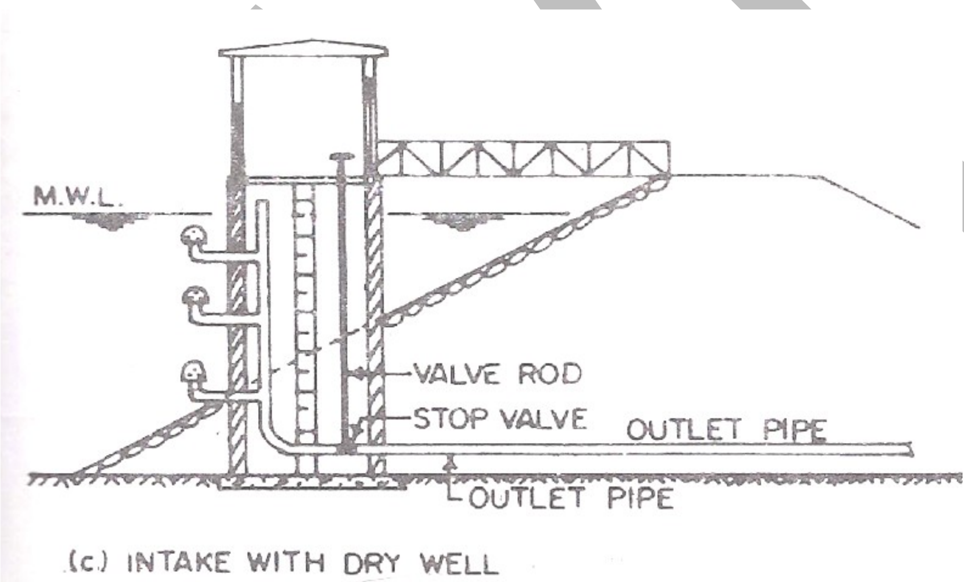


Fig:h – Reservoir Intake

PUMPS

A pump is a device which converts mechanical energy into hydraulic energy. It lifts water form a lower to a higher level and delivers it at high pressure. Pumps are employed in water supply projects at various stages.

Pumps are needed for the following purpose

1. To lift raw water from wells.
2. To deliver treated water to the consumer at desired pressure.
3. To supply pressured water for fire hydrants.
4. To boost up pressure in the water mains.
5. To fill elevated overhead tanks for distribution of water.
6. To back-wash filters.
7. To de-water tanks, basins, sumps, etc.
8. To pump chemical solutions needed for the treatment of water.

THE SELECTION OF TYPE OF PUMP DEPENDS ON THE FOLLOWING FACTORS

1. Capacity of pumps .
2. Initial costs.
3. Maintenance cost, including depreciation.
4. Cost of energy and labor.
5. Efficiency of pumps.
6. Space required for locating of pumps.
7. Suction and delivery heads.
8. Nature of liquid to be pumped.
9. Total quantity of water
10. Type of service-intermittent or continuous
11. Type of power available.
12. Variation in the rate of pumping and pumping head.

CLASSIFICATION OF PUMPS

a) Based on the principle of operation, pumps may be classified as follows.

1. Displacement pumps (reciprocation, rotary)
2. Velocity pumps (centrifugal, turbine and jet pumps)
3. Buoyancy pumps (air lift pumps)
4. Impulse pumps (hydraulic rams)

b) Based on the type of service, pumps are classified as follows.

1. Deep well pumps
2. High lift pumps
3. Low lift pumps
4. Booster pumps
5. Stand-by pumps

c) Based on the power required classified as follows.

The various sources of power for pumps are the following.

1. **Steam engines:** They consume a lot of fuel and there is loss of energy. They are outdated and used only for large installations where fuel is cheaply available.
2. **Diesel engines:** Theses are not used for centrifugal pumps, since the speeds are not sufficient. They require more initial cost and skilled personnel. They are less reliable and make a lot of noise during working.
3. **Gasoline engines:** They are costly and are not used for low heads. They need stand-by pumps.
4. **Electric driven pump:** They are suitable for medium and small plants. Their initial cost is low and they are compact in design. They run smoothly and occupy less space. But in case of failure of power supply, the whole water supply comes to a standstill, so that stand-by power-lines always need to be provided.

a) Based on the <u>principle of operation</u>, pumps may be classified as follows.

1) Displacement pumps

These work on the principle of mechanical induction of a vacuum in a chamber so that water can be drawn into it. Then this water is mechanically displaced and delivered through a pipe. Displacement pumps are of two types,

(i) Reciprocating pumps
(ii) Rotary pumps

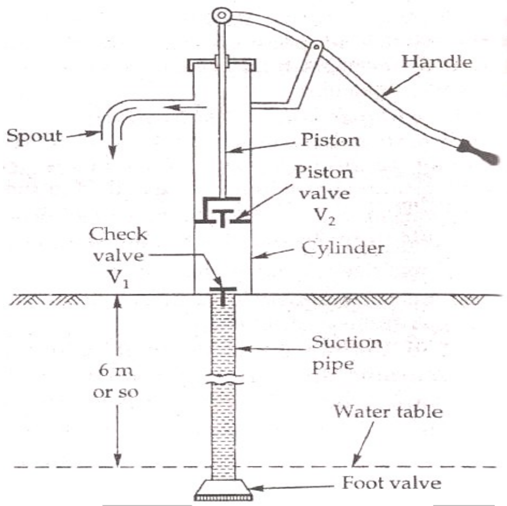


Fig: Hand operated reciprocating pump.

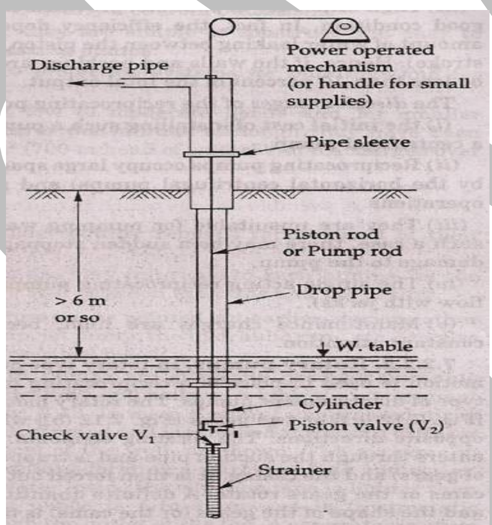


Fig: Deep well reciprocating pump.

Prof. SAKALA. B.T, Department of Civil Engineering, SVIT, Bangalore-64.

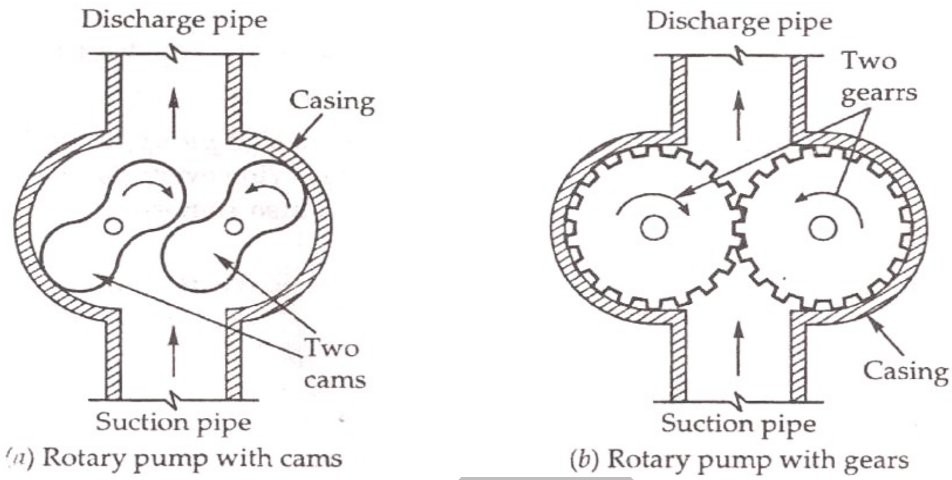


Fig: Deep well Rotary pump.

Advantages

1. They do not require any printing
2. They require no valves
3. Rate of flow is uniform.

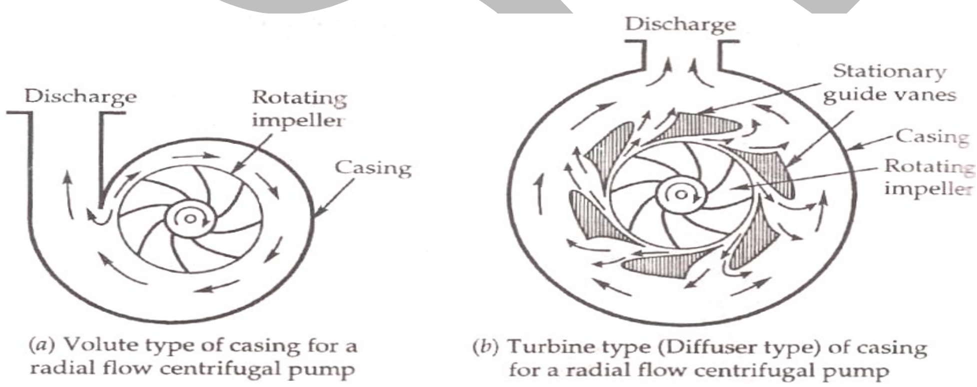
Disadvantages

1. The initial cost of these pumps is high
2. Gears need to be replaced frequently
3. They cannot pump water containing silt and sand.

2) Centrifugal pumps

In centrifugal pumps, water entering the pump-casing is made to revolve at high speed by means of an impeller. The impeller induces a centrifugal force, which pushes the water to the periphery and to the delivery pip. Centrifugal pumps can be classified into two types,

1. Volute type centrifugal pump
2. Turbine type centrifugal pump.



(Fig. 4.12)- Centrifugal pumps

Advantages

1. They are high speed pumps and can be directly connected to the electric motor.
2. Discharge and power requirements are uniform for a head

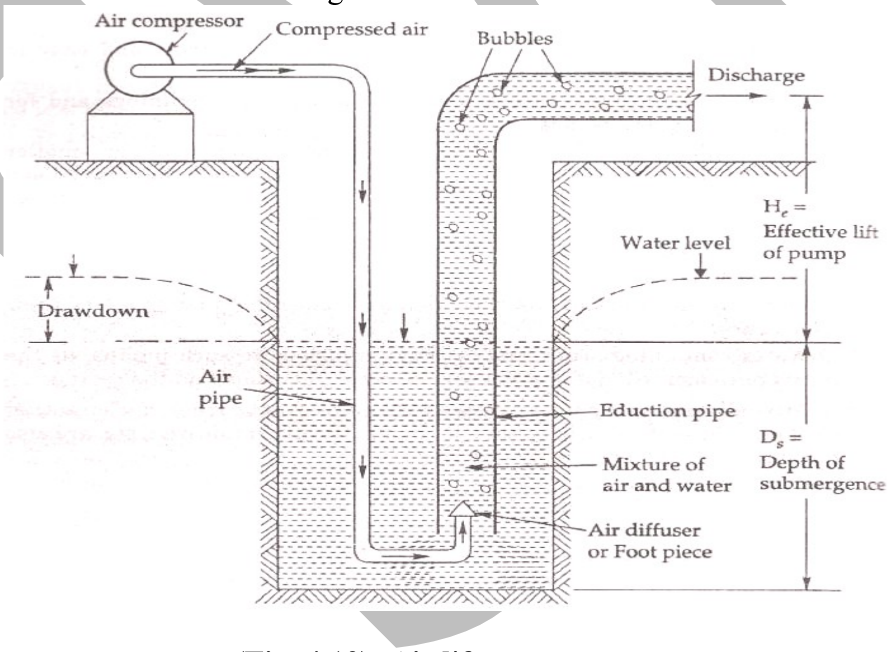
3. They are compact in design and occupy less floor space
4. Initial cost, as well as maintenance costs are less
5. Working is simple and reliable
6. They are easier to start than other pumps
7. They do not have valves, and have few moving parts
8. They can be used for water containing grit and sand
9. Elaborate foundation is not required
10. Discharge can be varied and shut whenever necessary.

Disadvantages

1. For high lifts, efficiency is less
2. Suction head is limited to7.0 m
3. Priming it required before starting.

1) Air lift pumps

- An air lift pump is an apparatus for raising water from wells through discharge or reduction pipes (Fig. 4.13). These pipes are extended from ground level into the well to a proposed depth.
- Compressed air is forced with an air pipe to the bottom into a reduction pipe which is enclosed in a casing pipe. The mixture of air and water at the bottom of the pipe has a low specific gravity. The air-water mixture rises through the education pipe and moves up-ward. The air bubbles continue to expand until the outlet is reached and atmospheric pressure prevails. The efficiency of the pump depends on the submergence. Maximum efficiency is secured when the submergence is 2.25 times the lift.



(Fig. 4.12)- Air lift pumps

Advantages

1. They are cheap, reliable and simple to operate
2. There are no moving parts inside water, so they can be used for acid and alkaline waters as well as water with sand or grit
3. Discharge can be increased by using more compressed air
4. Greater the air lift capacity, the greater its efficiency.

Disadvantages

1. To have greater depth of submergence, the well needs to the deep, leading to higher costs
2. Efficiency is relatively low
3. Flow may not be continuous
4. They are not very flexible, since they cannot cope up with variations in demand.

2) Miscellaneous pumps

Hydraulic ram: A hydraulic ram is a type of pump where 'the energy of water flowing in a pipe' is used to raise a small quantity of water to a higher elevation. Water enters the ram through an inlet pipe. When the ram is full, the waste valve opens sand the delivery valve closes. Water from the waste valve opens and delivery valve closes. Water from the waste valve flows out and water attains maximum velocity in the ram. Now the waster valve closes suddenly and the delivery valve opens. Water from the ram enters the air chamber and goes to the outlet through the delivery pipe. After some time, pressure in the ram falls, the delivery valve closes, the waster valve opens, and the cycle repeats itself. There may be 50 – 200 cycles/minute depending on the design of the ram. Hydraulic rams may be used for small water supplies. Some are,

1) Jet pumps
2) Hydraulic Ram

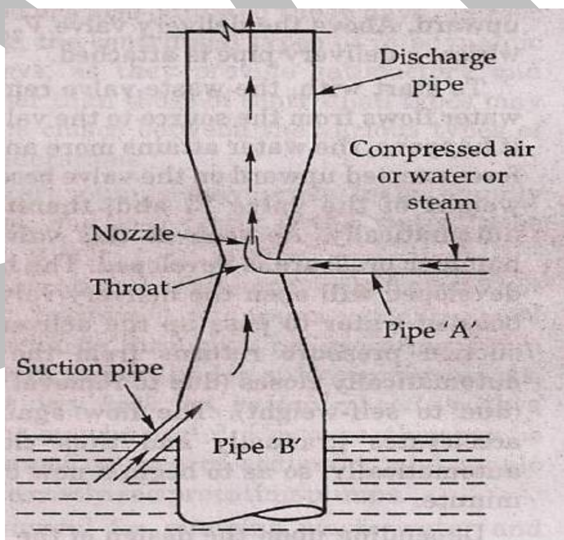


Fig. - Jet pumps

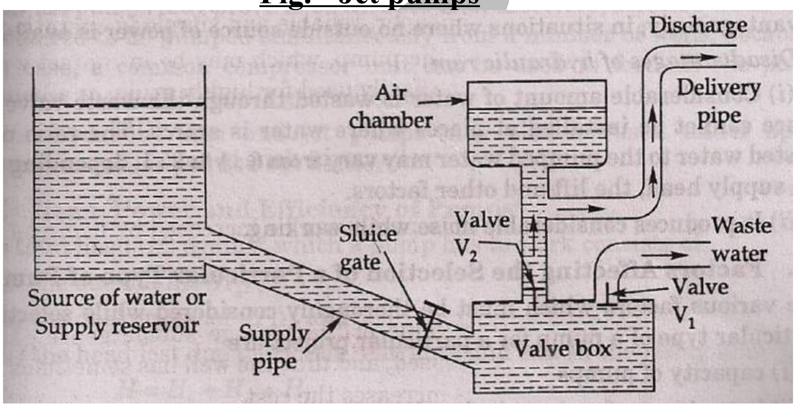


Fig. - Hydraulic Ram pumps

Advantages

d) Working is simple and no attention is required
e) It is durable
f) It is cheap and does not require fuel for working

Disadvantages

1. There is considerable wastage of water through waste valves
2. It creates lot of noise while working.

3. Based on the type of service, pumps are classified as follows.

1) Deep well pumps: these are used to pump water from tube wells. The pump essentially consists of two parts.

(i) Driving motor, head assembly and delivery connection

(ii) Pumping unit installed under the head assembly to depth of about 24 to 30 m, below round level.

2) High lift pumps: They are sued for lifting water for high heads.

3) Low lift pumps: They are used for low heads.

4) Booster pumps: Booster pumps serve low purposes:

1. To increase the carrying capacity of a main, so as to avoid enlargement of diameter
2. To increase the head in the main, where it is insufficient for supply.

Booster pumps work during times of maximum water demand. When the booster pump works, the slope of the hydraulic gradient in the pipe steepens, thereby increasing the discharge and pressure head in it, Reflux valve and check valve are used in the boostered main. Booster pumps are also used to lift water to multistoried buildings.

PIPES

Pipe is a circular closed conduit through which the water may flow either under gravity or under pressure. When pipes do not run full, they run under gravity, such as in sewer lines. However, in supply, pipes mostly run under pressure. Pipes may be made of the following materials:

1. Cast iron.
2. Wrought iron.
3. Steel.
4. Galvanized iron.
5. Cement concrete.
6. Asbestos cement.
7. Plastic.
8. copper.

9. Woods.

Economical Diameter of the Pumping Mains

- As pointed out in the previous chapter, the diameter of a pipe can be reduced (for passing a certain fixed discharge) by increasing the flow velocity through the pipe. But, however, the increased velocity will lead to higher frictional head loss, and thus increased cost of pumping.
- Hence, although the dia and the cost of pipe can be reduced by choosing a higher flow velocity, the horse power of the pump required will increase, thus increasing the cost of pumping. For optimum conditions, we must choose such a diameter, the minimum.
- The diameter which provides such optimum conditions is known as the **economical diameter** of the pipe.
- Hence, if the diameter chosen is less than the economical diameter, the cost of pipe will be less, but the head loss will be high and the cost of pumping shall be much more than the resultant saving in the pipe cost. Similarly, if the diameter chosen is more than the economical dia, the cost of pumping will be less but the increase in the cost of pipe will be much more than the resultant saving obtained in the cost of pumping.

An empirical formula given by Lea, connecting the dia and the discharge, which is commonly used in practice is given as:

$$\mathbf{D = 0.97 \text{ to } 1.22\sqrt{Q}}$$

Where D = economical dia in meters.

Q = discharge to be pumped in cumecs.

This relationship gives optimum flow velocity varying (between 1.35 to 0.8 m/sec)

For a rigorous analysis, total cost of pipe and pumping should be worked out at different assumed velocities(between 0.8 to 1.8) and a graph plotted between the yearly cost and the size of the pipe **(Fig. a).**

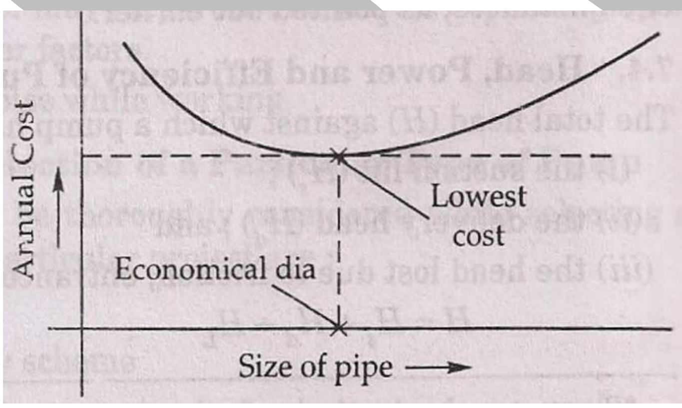


Fig.(a).

The economical size is the one which gives the least cost, and thus selected by inspection, as shown in **Fig. (a).**

Horse power of the pump motor. The power of a motor is given by the equation

Power=wQ.H/ η kW,

where 1HP = 0.735 kW

then, HP= wQ.H/0.735 η

Where Q= Discharge to be delivered in m^3/s

H= Total lift, i.e. the head against which the motor has to work, in m

w= Unit weight of water in k N/m^3= 9.81 kN/m^3

η = Efficiency of the pump set, and is generally taken as 65% (i.e. 0.65)

Pipe Appurtenances

In order to isolate and drain the pipe line sections for tests, inspections, cleaning and repairs; a number of appurtenances such as gates, valves, manholes, insulation joints, expansion joints, anchorages, etc., are provided at various suitable places along the pipe lines, as described below.

Gates and Valves in Pipe Lines. A large number of different types of valves are required for the proper functioning of the pipe line, as described below and shown in Fig.(b)

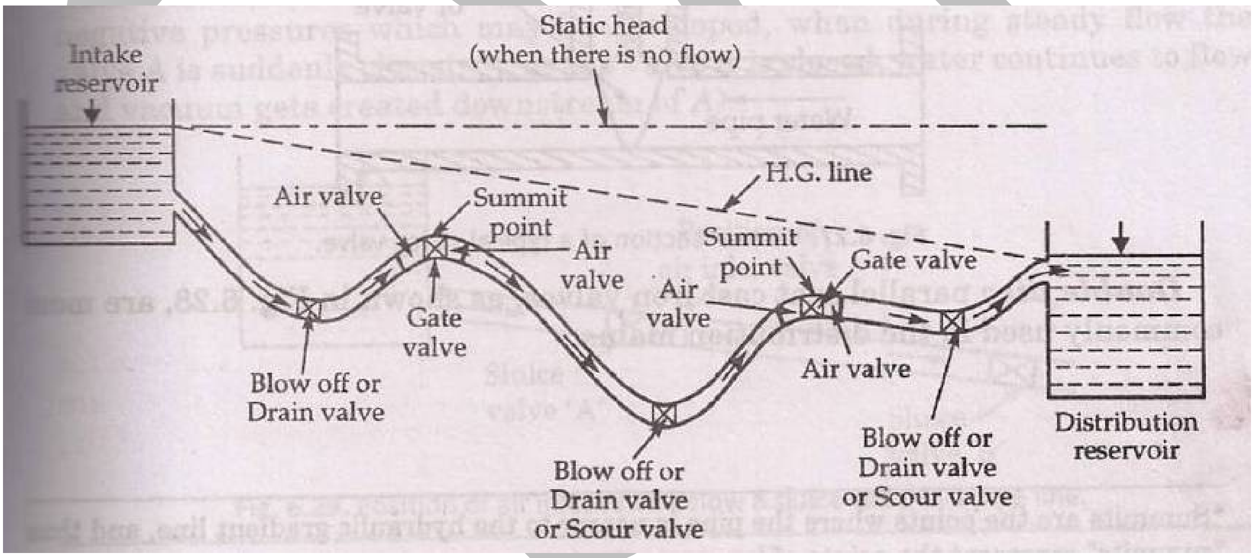


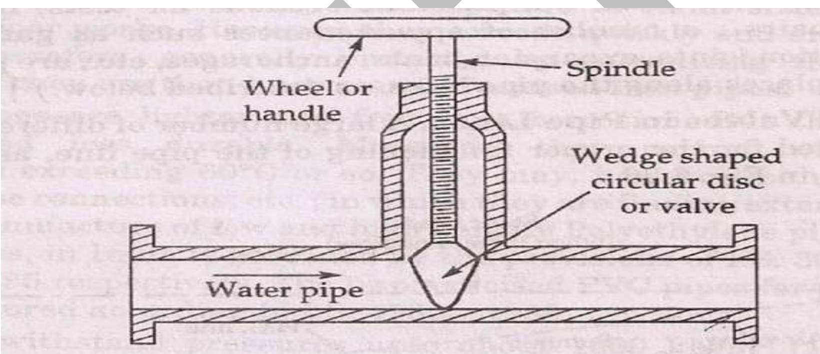
Fig.(b)-Profile of the pressure pipe showing the location of the gates and valves

(a) Gate valves or Sluice valves.

- Gates or sluice valves are used to regulate the flow of water through the pipes. They are similar to gate valves used in dams but are not so large.
- In large pipe lines, bringing water from the source to the city, they are generally located along the pipe line at intervals of about 3 to 5 kilometers, so as to divide the pipe line into different sections.

- Thus, during repairs, only one section can be cut off at a time, by closing the gate at both ends of the section.
- The gate valves are usually placed at the summits (Fig. b) of the pressure conduits, because when so placed at these points of low pressures, they can be of cheaper and less stronger materials, and also, they can be operated easily with less force.
- For economy. In large diameter pipes, valves of smaller diameter than the pipe itself are generally used.
- However, the saving in the valves cost must be balanced against the increased head loss through the valve (because head loss through the valve increase with the reduction in the size of its opening because of higher velocity of flow) including the extra loss in contraction and re-expansion.

The most commonly used type of a gate valve or a sluice valve is shown in Fig.c.

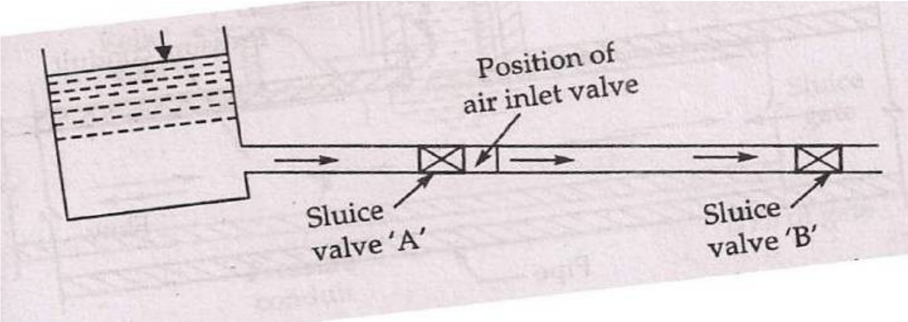


<u>Fig.c- Gate valves or Sluice valves</u>

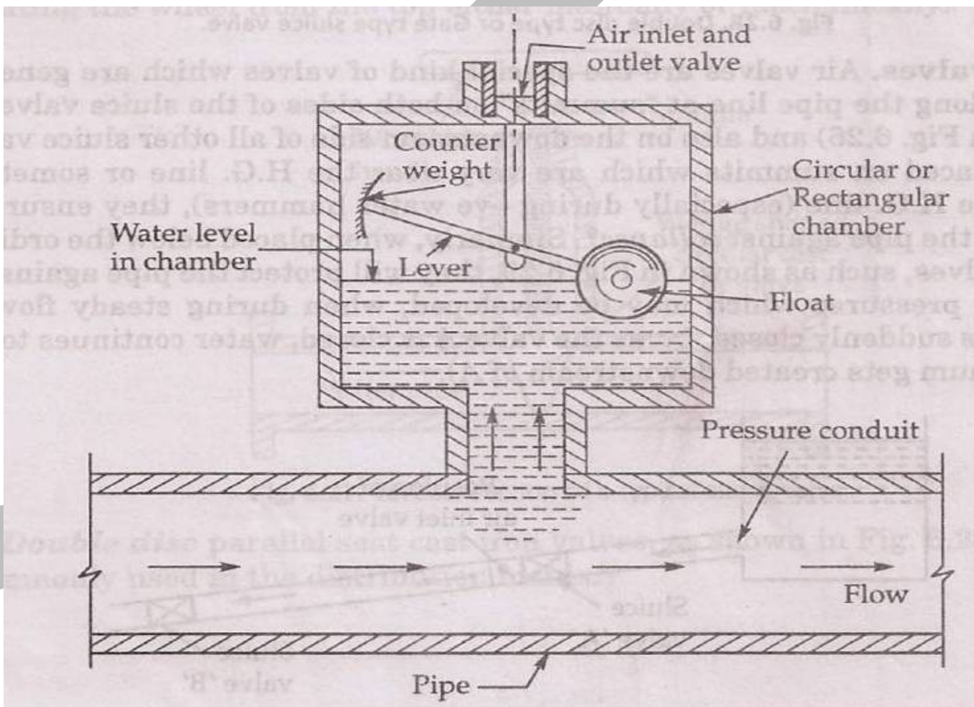
- The valve is made of cast iron with brass, bonze or stainless steel mountings. The ends of the valve are properly jointed on both sides of the pipe lengths, by suitable standard joints (described earlier).

(b)**Air valves.**

- Air valves are the special kind of valves which are generally placed along the pipe line at "summits" on both sides of the sluice valves (as shown in Fig. a)and also on the downstream side of all other sluice valves.
- When placed on summits which are very near the H.G. line or sometimes above the H.G. lin (especially during –ve water hammers), they ensure the safety of the pipe against collapse.
- Similarly, when placed below the ordinary sluice valves, such as shown in (Fig. d), they will protect the pipe against the negative pressures which may be developed, when during steady flow the valve A is suddenly closed. (because as the valve A is closed, water continues to flow and vacuum gets created downstream of A).



(Fig. d) – Position of air inlet valve below a sluice valve in a pipe line.



(Fig.) – Vertical section of poppet type Air valves

(b) Blow off valves or Drain valves or Scour valves.

- In order to remove the entire water from within a pipe (after closing the supply), small gated off takes are provided at low points, as shown in (Fig.a).
- These valves are known as blow off valves or drain valves or scour valves. These valves, are necessary at low level points for completely emptying the pipe for inspection, repairs, etc. when opened, water comes out of these valves quickly under gravity and they are made to discharge water into some natural drainage channel or into a sump from which the water can be pumped out.
- It may, however, be stressed that here should be no direct connection between the valve and the sewer or the drain, so as to avoid the possibility of pollution travelling into the water pipe. Fore safety, two drain valves are generally placed in series. So as to reduce the chances of such pollution reaching the water in conduit.

(d)**Pressure-relief valves.**

Prof. SAKALA. B.T, Department of Civil Engineering, SVIT, Bangalore-64.

- Water hammer pressures in pressure pipes can be reduced by using pressure relief valves. Such a valve is adjusted to open out automatically as soon as the pressure in the pipe exceeds a certain fixed predetermined value.
- Due to the opening of this valve, certain water will get out of the pipe, and thus, reducing the pressure in the pipe. As soon as the water hammer pressure reduces, and the pressure in the pipe falls up to the fixed value, the valve will closed automatically.
- Such type of valves are useful on small pipelines, where the escape of a relatively smaller amount of water will alleviate water hammer pressures. A simple sketch of a pressure relief valve is shown in **Fig.e**.

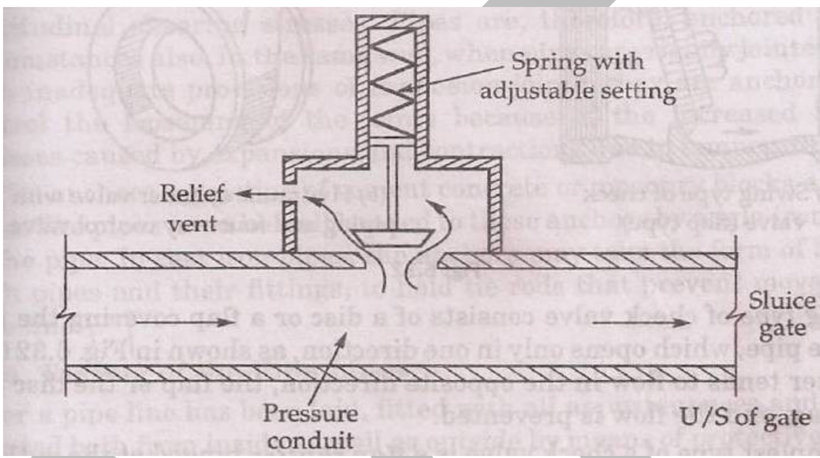
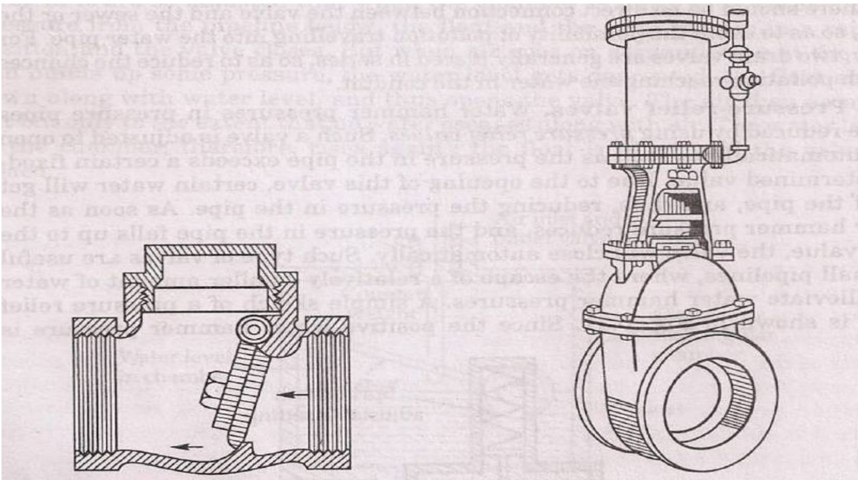


Fig.e - Pressure-relief valves.

- Since the positive water hammer pressure is developed due to the sudden closure of a sluice valve on its upstream side, such relief valves may be provide on the upstream side of the sluice valves.
- Even if not provide specifically for water hammer, such valves are often placed along the pipe line at suitable intervals (especially at low points where the pressures are high), so as to function during emergencies, when pressure rises in the pipe above the design value, and thus to help protecting the pipe joints from getting loosened or the pipes from getting **burst.**

(e) check valves or Reflux valves.

- Check valves are also sometimes called **non-return valves** because they prevent water to flow back in the opposite direction. They may be installed on the delivery side of the pumping set, so as to prevent the back flow of stored or pumped water, when the pump is stopped.
- Check valves are also installed on pump discharges to reduce water hammer forces on the pump.
- Such a valve may be a simple swing check or ball devices **(Fig. f)** in small lines ; but in large installations, they should be designed to close slowly, usually with discharge of some water through a bypass.



(a) Swing type of check valve (flap type)

(b) Hydraulic cylinder valve with piping and four-way control valve.

Fig. f - check valves or Reflux valves.

2) Manholes.

- Manholes are provided at suitable intervals along he pipe line, so as the help its laying, and to serve for inspections and repairs. They are generally provided on large pipe lines bringing water from the source to the city at intervals of about 300 to 600 meters or so.
- They are usually provided in case of steel, hume steel, or R.C.C. pipes (which are commonly used for conveyance of water from the source to the city) and are less common on cast iron pipes.

3) Insulation Joints.

- Insulation joins are provided along the pipe lines at suitable intervals, so as to insulate the pipe against the flow of stray electric currents, and thus, to check electrolysis.
- Rubber gaskets or rings can be provided as insulators, in between the pipe lengths, so as to prevent the flow of electric current between them. Similarly, sometimes, sufficient length of the pipe is covered with rubber covering, so as to provide appreciable resistance to the lfow of current.

4) Anchorages.

- As pointed out earlier, the pipes try to pull apart and get out of the alignment at bends and other points of unbalanced pressures.
- At such places, the forces exerted on the joints due to longitudinal shearing stresses caused by these unbalanced pressures are enormous, and the joints may get loosened, ultimately leading to excessive leakage or failure of the pipe.
- In all such circumstances, in order to prevent the pipes from pulling apart, pipes are anchored by firmly embedding these portions in massive blocks of concrete or masonry, which absorbs the side thrusts.
- Similarly, when pipes are laid on steep slopes, they try to slip and thereby pull apart, and the resistance of their joints may be insufficient to balance the longitudinal shearing stresses. Pipes are, therefore, anchored under such circumstances also. The anchors consisting of cement concrete or masonry blocks are generally used.