

FILTRATION OF WATER:

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

THEORY OF FILTRATION:

The following are the mechanisms of filtration

1. Mechanical straining – Mechanical straining of suspended particles in the sand pores.
2. Sedimentation – Absorption of colloidal and dissolved inorganic matter in the surface of sand grains in a thin film.
3. Electrolytic action – The electrolytic charges on the surface of the sand particles, which opposite to that of charges of the impurities are responsible for binding them to sand particles.
4. Biological Action – Biological action due to the development of a film of microorganisms layer on the top of filter media, which absorb organic impurities.

Filtration is carried out in three types of filters

1. Slow sand filter
2. Rapid sand filter Gravity filters
3. Pressure filter

1. 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. The effective size, D_{10} , which is the sieve in millimeters that permits 10% sand by weight to pass. The uniformity coefficient is calculated by the ratio of D_{60} and D_{10} .

CONSTRUCTION

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 is the retains for 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 outlet chamber.

OPERATION

The water from sedimentation tanks enters the slow sand filter through a submersible inlet. This water is uniformly spread over a sand bed without causing any disturbances. The water passes through the filter media at an average rate of 2.4 to 3.6 m³/m²/day. This rate of filtration is continued until the difference between the water level on the filter and in the inlet chamber is slightly less than the depth of water above the sand. The difference of water above the sand bed and in the outlet chamber is called the loss of head. During filtration as the filter media gets clogged due to the impurities, which stay in the pores, the resistance to the passage of water and loss of head also increases. When the loss of head reaches 60cm, filtration is stopped and about 2 to 3 cm from the top of bed is scrapped and replaced with clean sand before putting back into service to the filter. The scrapped sand is washed with the water, dried and stored for return to the filter at the time of the next washing. The filter can run for 6 to 8 weeks before it becomes necessary to replace the sand layer.

USES

The slow sand filters are effective in removal of 98 to 99% of bacteria of raw water and completely all suspended impurities and turbidity is reduced to 1 N.T.U. Slow sand filters also removes odours, tastes and colors from the water but not pathogenic bacteria which requires disinfection to safeguard against water-borne diseases. The slow sand filters require large area for their construction and high initial cost for establishment. The rate of filtration is also very slow.

2. RAPID SAND FILTER

Rapid sand filter are replacing the slow sand filters because of high rate of filtration ranging from 100 to 150m³/m²/day and small area of filter required. The main features of rapid sand filter are as follows.

Effective size of sand - 0.45 to 0.70mm

Uniformity coefficient of sand - 1.3 to 1.7

Depth of sand - 60 to 75cm Filter gravel - 2 to 50mm size (Increase size towards bottom)

Depth of gravel - 45cm

Depth of water over sand during filtration - 1 to 2m

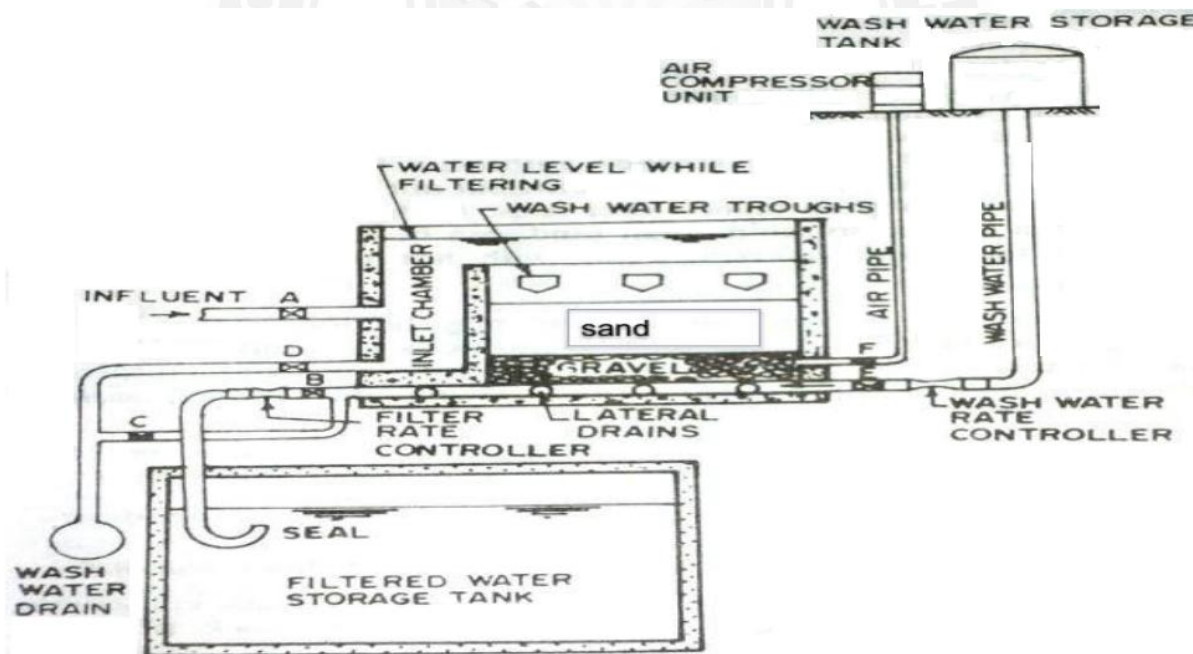
Overall depth of filter including 0.5m free board - 2.6m

Area of single filter unit - 100m^2 in two parts of each 50m^2

Loss of head - Max 1.8 to 2.0m

Turbidity of filtered water - 1 NTU

CONSTRUCTION



Rapid sand filter consists of the following five parts

1. Enclosure tank – A water tight tank is constructed either masonry or concrete
2. Under drainage system – may be perforated pipe system or pipe and stracher system
3. Base material – gravel should free from clay, dust, silt and vegetable matter. Should be durable, hard, round and strong and depth 40cm.

4. Filter media of sand – The depth of sand 60 to 75cm
5. Appurtenances – Air compressors useful for washing of filter and wash water troughs for collection of dirty water after washing of filter. Washing process is continued till the sand bed appears clearly. The washing of filter is done generally after 24 hours and it takes 10 minutes and during back washing the sand bed expands by about 50%. Rapid sand filter bring down the turbidity of water to 1 N.T.U. This filter needs constant and skilled supervision to maintain the filter gauge, expansion gauge and rate of flow controller and periodical backwash.

OPERATION

The water from coagulation sedimentation tank enters the filter unit through inlet pipe and uniformly distributed on the whole sand bed. Water after passing through the sand bed is collected through the under drainage system in the filtered water well. The outlet chamber in this filter is also equipped with filter rate controller. In the beginning the loss of head is very small. But as the bed gets clogged, the loss of head increases and the rate of filtration become very low. Therefore the filter bed requires its washing.

3. PRESSURE FILTER

Pressure filter is type of rapid sand filter in closed water tight cylinder through which the water passes through the sand bed under pressure. All the operations of the filter are similar to rapid gravity filter; except 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. Backwash is carried by reversing the flow with valves. The rate of flow is 120 to 300m³/m²/day.

ADVANTAGES

1. It is a compact and automatic operation
2. These are ideal for small estates and small water works
3. These filters requires small area for installation
4. Small number of fittings is required in these filters
5. Filtered water comes out under pressure no further pumping is required.

6. No sedimentation and coagulant tanks are required with these units.

DISADVANTAGES

1. Due to heavy cost on treatment, they cannot be used for treatment large quantity of water at water works
2. Proper quality control and inspection is not possible because of closed tank
3. The efficiency of removal of bacteria & turbidity is poor.
4. Change of filter media, gravel and repair of drainage system is difficult.



