2.2 AERATORS AND FLASH MIXERS

Aeration:

Aeration is a process in which water is brought in intimate contact with atmospheric airto promote exchange of gases between water and atmospheric air.

(i) Oxygen from atmospheric air is absorbed by water thereby oxygen deficiency of water is eliminated and also freshness is imparted to water.

(ii) Carbon dioxide, hydrogen sulphide and other volatile substances imparting taste and odour to water are easily expelled by aeration.

(iii) Iron and manganese present in water are oxidized to certain extent by aeration.

The following four types of aerators are generally adopted for aeration in the treatment of water:

Diffused Air Aerators:

A diffused air aerator consists of a tank or basin in which at the bottom perforated pipes are provided. The water to be aerated is filled in the tank and compressed air is blown through the perforated pipes. The air bubbles emerging from the perforations rise up from the bottom of the tank. While rising up the air bubbles come in close contact with water contained in the tank, and aeration of water is thus achieved. The tanks are generally 3 to 4.5 m deep and 3 to 9 m wide.

Cascade Aerators:

In cascade aerators water is allowed to flow downwards after spreading over inclined thin sheets and the turbulence is created by allowing water to pass through a series of steps or baffles. The number of steps is usually 4 to 6. Water is allowed to fall through a height of about 1 to 3 m. In this case removal of gas varies from 20 to 45 percent of carbon dioxide and about 35 percent of hydrogen sulphide.

Spray Aerators:

In spray aerators water is sprayed through nozzles upwards into atmosphere and broken up into either a mist of droplets. The installation consists of fixed nozzles on a pipe grid and trays for collecting the sprayed water. Nozzles usually have diameters varying from 10 to 40 mm spaced at intervals of 0.5 to 1 m or more. The pressure required at the nozzle head is usually 7m of water but it may vary from 2 to 9 m of water. The discharge rating per nozzle varies from 18to36 m^3/hour.

Multiple Tray Aerators:

A water-fall or multiple tray aerators consists of a number of trays with perforated bottoms, arranged vertically in series. Water flowing through a riser pipe is discharged through perforated pipes into the top most trays and after flowing down through each of the lower trays, it is collected in a basin provided at the base. During the downward flow through trays water comes

in contact with atmospheric air and thus aeration takes place. Usually trays about 4 to 9 in number with spacing of 300 to 750 mm are provided. In most aerators coarse media such as coke, stone or ceramic balls ranging from 50 to 150 mm in diameter are placed in the trays to increase the efficiency of aeration.

Treatment by Activated Carbon:

Activated carbon is used to remove colour, taste and odour from water. Activated carbon is produced by heating a carbonaceous material such as coke, charcoal, paper mill waste, saw dust, lignite, etc., in a closed vessel at a high temperature. It is then activated or oxidised by passing air, steam, carbon dioxide, chlorine or flue gases. The activation of the carbonaceous materials removes the hydrocarbons which might interfere with the adsorption of organic matter.

The activated carbon is available in various trade names such as Darco, Nuchar and Minchar. It is available in granular as well as powder form. The grains are of 6 mm size and below. Its weight is 4 kN per m and it is highly porous in structure. Activated carbon removes organic contaminants from water by the process of adsorption. In adsorption high surface area is the prime consideration. Granular activated carbons typically have surface areas of 500- 1400m /gm.

Activated carbon treatment has the following advantages:

(i) It helps the process of coagulation, if adopted before filtration of water.

(ii) It reduces the chlorine demand of treated water.

(iii) It removes tastes, odours and colours caused by the presence of excess chlorine, hydrogen sulphide, phenol, iron, manganese, etc.

(iv) It removes organic matter present in water.

(v) It is effective in preventing or retarding the decomposition of sludge in settling basins.

(vi) Its overdose is harmless.

Use of Copper Sulphate:

Copper sulphate $CuSO_4$ is used to serve the following two purposes:

(i) Removal of colour, odour and taste from water.

(ii) Control the growth of algae, bacteria and some types of aquatic weeds.

2.2.1 AERATION

Aeration removes odour and tastes due to volatile gases like hydrogen sulphide and due to algae and related organisms. Aeration also oxidise iron and manganese, increases dissolved oxygen content in water, removes CO2 and reduces corrosion and removes methane and other flammable gases.

Principle of treatment underlines on the fact that volatile gases in water escape into atmosphere from the air-water interface and atmospheric oxygen takes their place in water, provided the water body can expose itself over a vast surface to the atmosphere. This process continues until an equilibrium is reached depending on the partial pressure of each specific gas in the atmosphere.

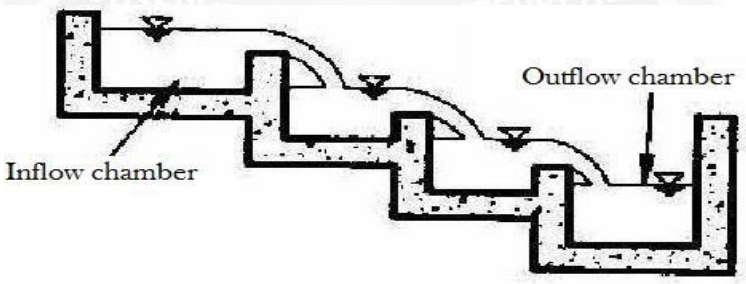
Principle of Aeration

Oxygen uptake depends on the area and duration of contact between water and air. For porous air diffusers this means that the size of the bubbles should be relatively small, since surface area is bigger in proportion to their volume and they rise slower, which gives a longer contact duration.

Types of Aerators

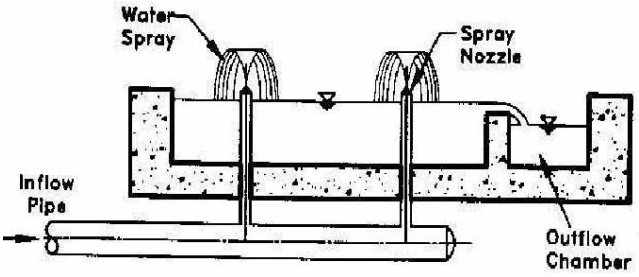
1. Gravity aerators
2. Fountain aerators
3. Diffused aerators
4. Mechanical aerators.

Gravity Aerators (Cascades): In gravity aerators, water is allowed to fall by gravity such that a large area of water is exposed to atmosphere, sometimes aided by turbulence.



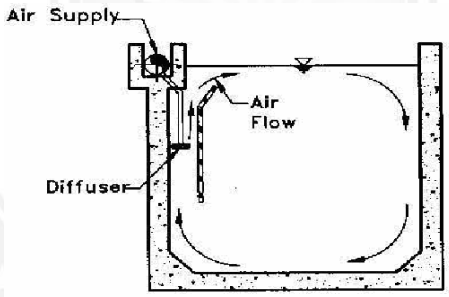
Cascade type Gravity Aerator

Fountain Aerators: These are also known as spray aerators with special nozzles to produce a fine spray. Each nozzle is 2.5 to 4 cm diameter discharging about 18 to 36 l/h. Nozzle spacing should be such that each m3 of water has aerator area of 0.03 to 0.09 m2 for one hour.



Injection or Diffused Aerators :

It consists of a tank with perforated pipes, tubes or diffuser plates, fixed at the bottom to release fine air bubbles from compressor unit. The tank depth is kept as 3 to 4 m and tank width is within 1.5 times its depth. If depth is more, the diffusers must be placed at 3 to 4 m depth below water surface. Time of aeration is 10 to 30 min and 0.2 to 0.4 litres of air is required for 1 litre of water.



Mechanical Aerators:

Mixing paddles as in flocculation are used.

Paddles may be either submerged or at the surface.

FUNCTIONS OF AERATORS

1. Aeration brings water and air in close contact in order to remove dissolved gases (such as carbon dioxide) and oxidizes dissolved metals such as iron, hydrogen sulfide, and volatile organic chemicals (VOCs). Aeration is often the first major process at the treatment plant. During aeration, constituents are removed or modified before they can interfere with the treatment processes.

2. Aeration brings water and air in close contact by exposing drops or thin sheets of water to the air or by introducing small bubbles of air (the smaller the bubble, the better) and letting them rise through the water. The scrubbing process caused by the turbulence of aeration physically removes dissolved gases from solution and allows them to escape into the surrounding air.

3. Aeration also helps remove dissolved metals through oxidation, the chemical combination of oxygen from the air with certain undesirable metals in the water. Once oxidized, these chemicals fall out of solution and become particles in the water and can be removed by filtration or flotation.

4. Oxygen is added to water through aeration and can increase the palpability of water by removing the flat taste. The amount of oxygen the water can hold depends primarily on the temperature of the water. (The colder the water, the more oxygen the water can hold).

5. Water that contains excessive amounts of oxygen can become very corrosive. Excessive oxygen can also cause problems in the treatment plant i.e. air binding of filters.