ACTIVATED SLUDGE METHOD:

Wastewater flows continuously into an aeration tank where air is injected into the wastewater. About eight cubic feet of air are required for every cubic foot of wastewater. A variable and mixed community of microorganisms is added in the aeration tank to facilitate the aerobic decomposition reaction which is termed as **activated sludge method**. In this method, biological sludge is used that is nothing but the microorganisms. The mixture of wastewater and activated sludge is called mixed liquor. The term "**activated**" comes from the fact that the ***particles are teeming*** with bacteria, and protozoa. These organisms are employed to break down the biodegradable organic matter present in the wastewater in present of ample quantity of oxygen ie., aerobic microbial decomposition reaction takes place in the aeration tank.

These organisms and remaining undecomposed material reaches to a secondary clarifier where they settled down at the bottom of the tank. Usually 20-30% of the settled sludge is returned to the aeration tank (and hence is called **return sludge**) to maintain a high population of microbes to break down the organics. Activated sludge is different from primary sludge in that the sludge contains many living organisms which can feed on the incoming wastewater. When more activated sludge is produced than is needed for return sludge, the excess sludge is removed and disposed of.

For the diagram, also see the flowchart already sent to you.

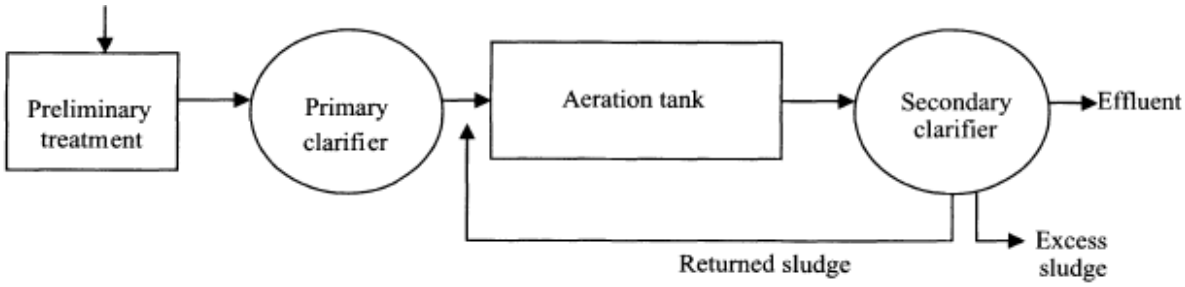


FIGURE 11.1. Conventional activated sludge system.

ACID RAIN :

In polluted regions the main causes for acid rain are sulphur dioxide and nitrogen oxides in the atmosphere. Acid rain results when these gases are oxidised in the atmosphere and return to the ground dissolved in rain drops. Sulfur dioxide is one of the pollutants that can react with water in clouds to form acid rain and some of the oxides of nitrogen can react with water to form nitric acid. SO_2 falls as H_2SO_3 and H_2SO_4 while NO_x falls as HNO_3. The formation and effects of acid rain are discussed below.

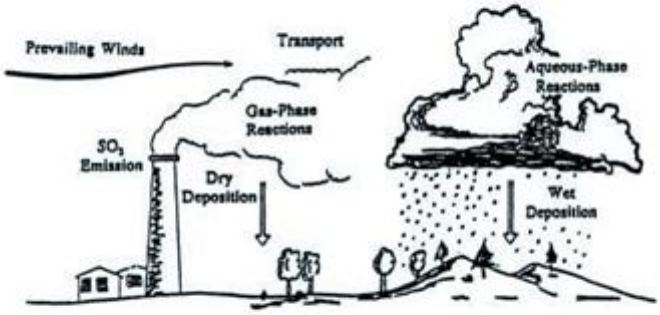
$$SO_2 + H_2O \rightarrow H_2SO_3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

$$SO_2 + \frac{1}{2}O_2 + H_2O \xrightarrow[\text{(soot particle metal oxide)}]{} H_2SO_4 \ldots$$

$$NO_2 + H_2O \rightarrow \tfrac{1}{2}HNO_2 + \frac{1}{2}HNO_3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

$$NO_2 + O_3 \rightarrow NO_3 \xrightarrow{X-H} HNO_3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

SO_2 is converted to sulfuric acid, H_2SO_4, in clouds and falls to the ground as acid rain.



Acid rain was first observed in Scandinavia in the 1950s; in the United States in the 1960s.

pH (acid rain) < 5.6

Effects of Acid rain

(1) can upset the ecology in lakes and streams. Fish can't live in water with pH < 4.5.

(2) Attacks plant foliage and roots:

Removes the protective coating on leaves. Plant becomes susceptible to pests, disease, and other pollutants such as ozone.

Dissolves and carries away nutrients in the soil. Also dissolves toxic materials that enter roots and water supply

(3) Damages materials, especially stone monuments and buildings.

$$CaCO_3(s) + H_2SO_4(aq) \dashrightarrow CaSO_4(s) + H_2O + CO_2(g)$$

limestone, marble — sulfuric acid — gypsum slowly dissolved by rain water.