Various actions involved in the self purification process of a stream:

Self purification of natural streams:

When the waste water or the effluents discharged in to a natural stream, the organic matter is broken by bacteria to ammonia, nitrate, sulphate, carbon dioxide etc In this process of oxidation, the DO content of natural water is utilized. Due to this, deficiency of DO is created. As the excess organic matter is stabilized, the normal cycle will be restabilised in a process known as self purification where in the oxygen is replenished by its reaeration by wind.

Water quality standards are often based upon maintenance of some minimum dissolved oxygen concentration which will protect the natural cycle in the stream while taking advantage of its natural assimilative capacity.

Actions involved in the self purification are physical, chemical and biological in nature

1. Dilution

2. Dispersion due to currents

3. Sedimentation

4. Oxidation

5. Reduction

6. Temperature

7. Sunlight

1. Dilution

When waste water is discharged in to the receiving water,dilution takes place due to which the concentration of organic matter is reduced and the potential nuisance of sewage is also reduced. When the dilution ratio is high, large quantities of DO are always available which will reduce the chances of putrefication and pollutional effect.Aerobic condition will always exist because of dilution.

2. Dispersion due t o currents

Self purification of stream largely depends on currents which will readily disperse the wastewater in the stream preventing locally the high concentration of pollutants. High velocity improves reaeration which reduces the concentration of pollutants. High velocity improves reaeration which reduces the time of recovery, though length of stream affected by waste water is increased.

3. Sedimentation

If the stream velocity is lesser than the scour velocity of particles, sedimentation of the particles will take place which will have two effects,

a. The suspended particles will contribute largely to oxygen demand which will be removed by settling and hence water quality to the downstream will be increased.

b. Due to settled solids, Anaerobic decomposition may take place.

4. Oxidation

The organic matter present in the waste water by aerobic bacteria utilizing DO of the natural water, This process prevails till complete oxidation of organic matter. The stream which is capable of absorbing more oxygen rapidly through reaeration etc. and purify heavily polluted water in a short time.

5. Reduction

The reduction occurs in the streams due to hydrolysis of the organic matter biologically or chemically.Anaerobic bacteria split the organic matter in to liquids and gases thus paving way for their ultimate stabilization by oxidation.

6. Temperature

At low temperature the activities of bacteria is slow and hence rate of decomposition will also be slow though DO will be more because of increased solubility of oxygen in water. At higher temperature, however the self purification takes lesser time though t he quality of DO will be less.

7. Sunlight

It helps certain microorganisms to absorb co2 and give out oxygen, though assisting in self purification. Sunlight act as a disinfectant and stimulate the growth of algae which produce oxygen during day light but utilize oxygen at night hence wherever there is algal growth, the water may be supersaturated in DO during daylight hours though anaerobic condition exist in it.

STANDARDS OF EFFLUENT:

SL. NO	PARAMETERS	STANDARDS			
		Inland surface water	Public sewers	Land of irrigation	Marine / coastal areas
1	Suspended solids mg/l, max.	100	600	200	a. For process waste water 100 b. For cooling water effluent 10 percent above total suspended matter of influent
2	Particle size of suspended solids	Shall pass 850 micron IS Sieve	-	-	a. Floatable solids, Solids max. 3 mm. b. Settleable solids. Max 856 microns
3	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
4	Temperature	Shall not exceed 5^0C above the Receiving water temperature.	-	-	Shall not exceed 5^0C above the receiving water temperature.
5	Oil and grease, Mg / l max.	10	20	10	20

6	Total residual chlorine, mg/l max	1.0	-	-	1.0
7	Total nitrogen (as N); mg/l, max.	100	-	-	100
8	Biochemical oxygen demand (3 days at 27oC), mg/l, max.	30	350	100	100
9	Chemical oxygen demand, mg/l,	250	-	-	250
10	Mercury (As Hg), mg/l, max.	0.01	0.01	-	0.01
11	Copper (as Cu) mg/l, max.	3.0	3.0	-	30

OXYGEN SAG CURVE AND ITS IMPORTANCE:

In a running polluted stream exposed to the atmosphere, the deoxygenation as well as there-oxygenation goes hand in hand. If de-oxygenation is more rapid than the reoxygenation, an oxygen deficit results. (Note; if the D.O content becomes zero, anaerobic conditions will no longer be maintained and putrefaction will set in) The amount of resultant oxygen deficit can be obtained by algebraically adding the de-oxygenation and re-oxygenation curves. The resultant curve so obtained is called the oxygen sag curve or the oxygen deficit curve. From this curve the oxygen deficit (D) and oxygen balance (i.e 100-D) percent in a steam after a certain lapse of time, can be found out.

It can also be seen that when the de-oxygenation rate exceeds the reoxygenation rate, the oxygen sag curve shows increasing deficit of oxygen, but when both the rate becomes equal, the critical point is reached, and then finally when the rate of de-oxygenation falls below that of re-oxygenation, the oxygen deficit goes on decreasing till becoming zero.

DEOXYGENATION AND REAERATION:

In the polluted stream, the D.O content goes on reducing due to decomposition of volatile organic matter. The rate of deoxygenation depends upon the amount of the organic matter remaining to be oxidisied at he given time as well as on the temperature of reaction. In order to counter- balance the consumption of DO due to de-oxygenation, atmosphere supplies oxygen to the water, and the process is called re-oxygenation. The rate at which the oxygen is supplied by the atmosphere depends.

1. The depth of the receiving water
2. The condition of the body of water
3. The saturation deficit or the oxygen deficit
4. The temperature of water

Self Purification Process:

When sewage is discharges into a natural body of water, the receiving water gets polluted due to waste products, present in sewage effluents. But the conditions do not remain so for ever, because the natural process of purification such as dilution, sedimentation, oxidation-reduction in sunlight, etc, go on acting upon the pollution elements, and bring back the water in to its original condition. The automatic purification of polluted water, in due course is called the self purification phenomenon. However if the self purification is not achieved successfully due to either too much of pollution discharge in to it or due to other causes, the river water itself will get polluted, which in turn, may also pollute the sea where the river outfalls.

Factors influencing self purification process:

1. Temperature

2. Turbulence

3. Hydrography such as the velocity and surface expanse of the river stream.

4. Rate of reaeration etc.

Temperature:

Besides affecting the dilution and sedimentation rates, the temperature also affects the rate of biological and chemical activities, which are enhanced at high temperatures and depressed at lower temperatures. The dissolved oxygen content of water, which is very essential for maintaining aquatic life and anaerobic conditions (so as to avoid the anaerobic decomposition and subsequent nuisance caused by the eruption of foul odors) is also influenced by temperature. At higher temperature the capacity to maintain the D.O concentration is low.

Turbulence:

while the rate of biological and chemical activities are high, causing thereby rapid depletion of D.O this is likely to lead to anaerobic conditions, when the pollution due to putrescible organic matter is heavy. The turbulence in the body of water helps in breaking the surface of the stream of lakes, and helps in rapid re-aeration from the atmosphere. Thus it helps in maintaining aerobic conditions in the river stream, and in keeping it clean. Too much of turbulence, however is not desirable, because it cannot be at the bottom sediment increases the turbidity and retards algae growth, which is useful in reaeration process. Wind and under current in lakes and oceans cause turbulences which affect their self-purification.

The hydrography:

Affects the velocity and surface expanse of the river stream, High velocities cause turbulence and rapid reaeration, while large surface expanse(for the same cubic contents) will also have the same effects.

Dissolved oxygen:

The large amount of dissolved oxygen present in water, the better and earlier the self purification will occur. The amount and type of organic matter and biological growth present in water will also affect the rate of purification. Algae which absorbs carbon dioxide and gives out oxygen, is thus very helpful in the self purification process.

The rate of Reaeration:

The rate at which the D.O deficiency is replenished, will considerably govern the self purification process. The greater is the rate, the quicker will be self-purification, and there will be no chances of development of anaerobic conditions.

SEWAGE DISPOSAL BY DILUTION:

Disposal by dilution is the process whereby the treated sewage or the effluent from the sewage treatment plant is discharged into a river stream, or a large body of water, such as a lake or sea. The discharged sewage in due course of time, is purified by what is known as self purification process of natural waters. The degree and amount of treatment given to raw sewage before disposing it off into the river stream in question, will definitely depend not only upon the quality of raw sewage but also upon the self purification capacity of the river stream and the intended use of its water.

Dilution Factor:
The ratio of the quantity of the diluting water to that of the sewage is known as the Dilution Factor.

Conditions favouring Disposal by dilution:
The dilution methods for disposing of the sewage can favourably be adopted under the following conditions.

- When sewage is comparatively fresh (4 to 5 hr old) and free from floating and settleable solids. (or are easily removed by primary treatment)
- When the diluting water (is the source of disposal) has a high dissolved oxygen (0-0) content.
- Where diluting waters are not used for the purpose of navigation or water supply for at least some reasonable distance on the downstream from the point of sewage disposal.
- Where the flow currents of the diluting waters are favourable, causing no deposition, nuisance or destruction of aquatic life.
- When the out fall sewer of the city or the treatment plant is situated near some natural water having large volumes.

SEWAGE DISPOSAL METHODS:

SEWAGE DISPOSAL ON LAND:

Disposal of Sewage Effluents on land for irrigation in this method the sewage effluent (treated or diluted) is generally disposed of by applying it on land.

The percolating water may either soon the water table or is collected below by a system of under drains. This method can then be used for irrigating crops.

This method in addition to disposing of the sewage may help in increasing crop yields (by 33% or so) as the sewage generally contains a lot of fertilizing minerals and other elements.

However the sewage effluent before being used as irrigation water must be made safe. In order to lay down the limiting standards for sewage effluents, and the degree of treatment required, it is necessary to study as to what happens when sewage is applied on to the land as irrigation water.

The pretreatment process may be adopted by larger cities which can afford to conduct treatment of sewage when sewage is diluted with water or disposal for irrigation too large volumes of dilution water are generally not needed, so as not to require too large areas for disposal.

DISPOSAL BY DILUTION:

Disposal by dilution is the process whereby the treated sewage or the effluent from the sewage treatment plant is discharged into a river stream, or a large body of water, such as a lake or sea. The discharged sewage in due course of time, is purified by what is known as self purification process of natural waters. The degree and amount of treatment given to raw sewage before disposing it off into the river stream in question, will definitely depend not only upon the quality of raw sewage but also upon the self purification capacity of the river stream and the intended use of its water.

Dilution Factor:

The ratio of the quantity of the diluting water to that of the sewage is known as the Dilution Factor.

Conditions favouring Disposal by dilution:

The dilution methods for disposing of the sewage can favourably be adopted under the following conditions.

- When sewage is comparatively fresh (4 to 5 hr old) and free from floating and settleable solids. (or are easily removed by primary treatment)

- When the diluting water (is the source of disposal) has a high dissolved oxygen (0-0) content.
- Where diluting waters are not used for the purpose of navigation or water supply for at least some reasonable distance on the downstream from the point of sewage disposal.
- Where the flow currents of the diluting waters are favourable, causing no deposition, nuisance or destruction of aquatic life.

When the out fall sewer of the city or the treatment plant is situated near some natural water having large volumes.

SEWAGE SICKNESS:

When sewage is applied continuously, once the Piece of land, the soil pores or void may get filled up and clogged with sewage matter retained in them. The time taken for such a clogging will, of course depend upon the type and the load prevent in sewage. But when once these voids are clogged, free circulation for air will be prevented and anaerobic conditions will develop on the pores. Due to this the aerobic decomposition of organic matter will stop, and anaerobic decomposition will start. The organic matter will there, of course, be minor load but with the evolution of foul gases like H2S, CO2, CH4. This phenomenon of soil getting clogged is known as sewage sickness of land

Preventive measure in adopted for sewage sickness

1. Primary treatment of sewage
2. Choice of land
3. Under-drainage of soil.
4. Giving rest to the land.
5. Rotation of crops
6. Applying shallow depths.

SEWAGE FARMING:

When sewage is applied on agricultural land for the growth of crops, then it is termed as sewage farming. The sewage contains much fertilizing elements such as nitrates,sulphates and phosphates.These elements are extracted from the soil by the roots of the plants.

Conditions of sewage farming:

The following conditions should be remembered while providing the method of sewage farming

a. The farm should be located far away from the locality, because it may create bad smell and insanitary condition.
b. The raw sewage should never be supplied to the farm.
c. It is better to apply the sewage after primary treatment.
d. Precautions should be taken to avoid sewage sickness.

Sewage is discharged on vacant land which is provided underneath with a system of properly laid under drains. These under drains basically consist of 15 to 20 cm river process tile pipes, load open founded at a spacing of 12 to 30 m. The effluent collected in these drains after getting filtered through the pores is a generally small (as a large quantity gets evaporated) and well stabilized, and can be early disposal into some natural water courses, without any further treatment.

In case of sewage farming, however the trees are load upon the use of sewage efficient for irrigation crops and increasing the fertility of the soil. The pre-treatment of sewage in removing the ingredients which may prove harmful and toxic to the plant is therefore, necessary in this case.

Application of sewage:

The sewage may be applied on the land by the following methods

1. Surface irrigation system
2. Sub-surface irrigation system
3. Sprinkler irrigation system

1. Surface irrigation system

This system may be of following types

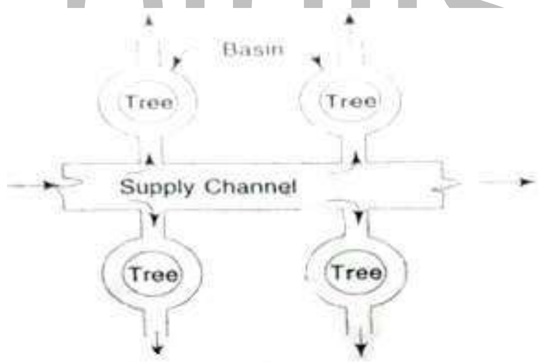
a) Basin method

b) Furrow method

c) Flooding method

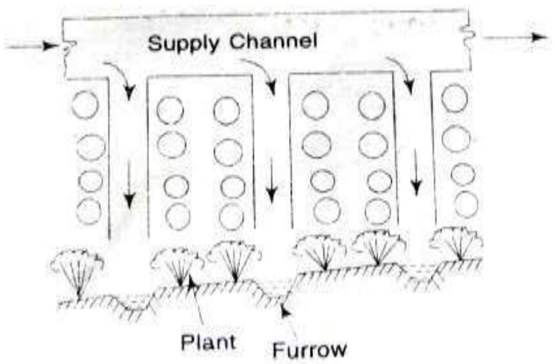
a) Basin method

In this method, each tree or group of trees are enclosed by circular channel through which sewage flows. This circular channel is known as basin. The basins are connected to the supply channel. When the basins are filled up, the supply is cut-off.



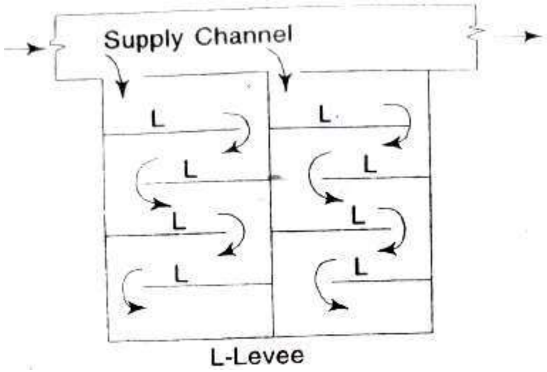
b) Furrow method

In this method, the sewage is supplied to the land through narrow channels, which are known as furrows. This method is suitable for the crops which are sown in rows. The crops are potato, ground nut, sugar cane, etc.



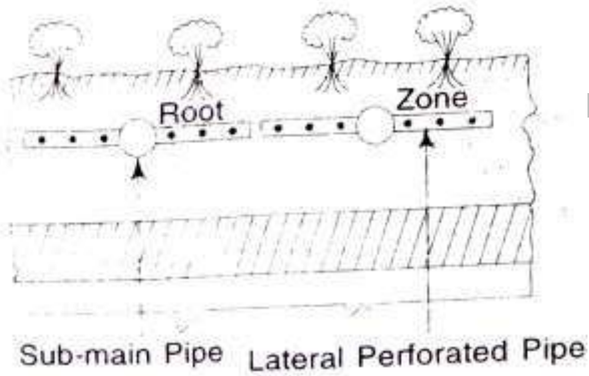
c) Flooding method

In this method, agricultural land is divided into small plots by levees (i.e. low bunds). The sewage is supplied to the plots through the supply channel. The sewage covers the entire area by flowing in Zigzag way.



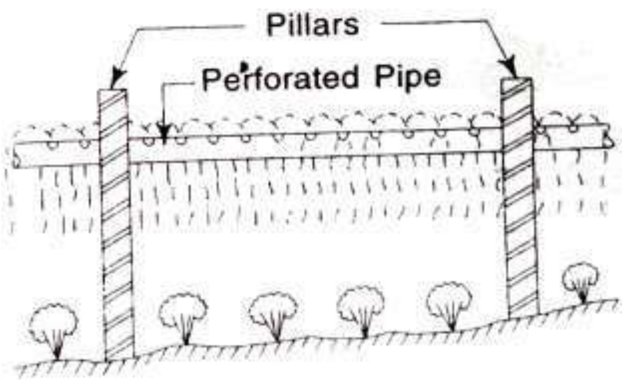
2. Sub-surface irrigation system

In this method, sewage is applied to root zone of crops by underground network of pipes. It consists of lateral perforated pipes which are connected to sub-main pipe line. The perforated pipe allows the sewage to drip out slowly and the soil below the root zone absorbs the sewage continuously.



3. Sprinkler irrigation system

In this method, sewage is applied to the land in the form of spray. The system is achieved by the network of main pipes and lateral pipes are perforated through which the sewage comes out.



ZONE OF POLLUTION IN THE RIVER:

The self purification process of a stream polluted by the effluent or waste water discharged in to it can be divided into following four zones.

1. Zone of degradation

2. Zone of active decomposition

3. Zone of recovery

4. Clean water zone

1. Zone of degradation

This zone is situated just below the outfalls sewer when discharging its content in to the stream. In this zone, water is dark and turbid having the formation of sludge deposits at the bottom. The DO is reduced to 40% of the saturation values. There is an increase in the co2 content and reaeration is much slower than deoxygenation though conditions are unfavorable for aquatic life, fungi at higher point and bacteria at lower points breed small worms will work over and stabilize the sewage slugde.The decomposition of solid matter takes place in this zone and anaerobic decomposition prevails.

2. Zone of active decomposition

This zone is just after the degradation zone and is marked by heavy pollution. Water in this zone becomes greyish and darker than the previous zone. The DO concentration in this zone falls down to zero. Active anaerobic organic decomposition takes place with the solution of methane, Hydrogen sulphide, carbon dioxide and nitrogen bubbling to the surfaces with masses of sludge forming black scum. Fish life is absent this zone but bacteria flora will flourish in this zone with the presence of anaerobic bacteria at the lower end. Protozoa and fungi will first disappear. However near the end of this zone, as the decomposition slackens reaeration sets in and DO again rises to its original level of 40%

3. Zone of Recovery

In this zone, the process of recovery starts, from its former condition. The stabilization of organic matter takes place in this zone, Due to this most of the organic matter settles down as sludge, BOD falls and DO content rises above 40% value. Mineralization is active with the resulting formation of products like Nitrates,Sulphides and Carbonates.Near the end of this zone, microscopic aquatic life reappear,fungi decrease and algae reappears.

4. Clear water zone

In this zone the natural condition of the zone is restored with a result that

1. Water becomes clearer and attractive in appearance

2. DO rises to the saturation level and is much higher than BOD.

3. Oxygen balance is attained

Thus the recovery is said to be complete in this zone, though some pathogenic organisms may be present in this zone.