Notes

34

WATER POLLUTION

Water is essential for the existence of all life forms. In addition to household uses, water is vital for agriculture, industry, fishery and tourism etc. Increasing population, urbanisation and industrialisation has led to the decreased availability of water. The quality of water used is also being deteriorated as it is getting more and more polluted. You may be aware of at least some health hazards and harmful effects of water pollution. In this lesson a detailed account of various types, sources and effects of water pollutants is given. Some methods of water pollution control and legislatures involved have also been discussed.

Objectives

After reading this lesson, you will be able to:

- list earth's water resources;
- define water pollution and its different parameters;
- list the major types of water pollutants, their sources and effects;
- distinguish between natural and man -made pollutants;
- use the concept of biological oxygen demand (BOD) and account for the changes in a water body;
- state methods for the prevention of water pollution;
- compare primary, secondary and tertiary treatment of sewage and
- know necessary legislative measures for prevention of water pollution in the country.

34.1 Water Resources on Earth

You may be aware that about three fourths of our planet earth's surface is covered by water. However, very little of it is available for consumption. Most (about 97%) of the water on earth is present in the seas and oceans. It is too salty to be of any use for

drinking, agriculture and industrial purposes. The remaining 3% is fresh water; 75% of which is locked up in the polar ice caps and in glaciers and quite deep under the earth's surface as underground water. The fresh water, which we can use, comes to us from two sources:

i) Surface water

ii) Ground water

Let us learn about these in detail.

(i) Surface Water: Rain and snow are good natural resources of fresh water. It is estimated that of all the precipitation (rain water and snow) that falls on the earth, about one-third is absorbed by the plants and another one-third seeps down into the soil and the remaining one third runs off the surface into streams and rivers. This part of precipitation, which runs off to form streams, rivers and lakes, is called the **surface** water.

Precipitation (rain or snow) that runs-off into stream, rivers and lakes is called surface water.

The small fraction of usable surface water is continuously replenished by means of the hydrological cycle, Fig 33.1.

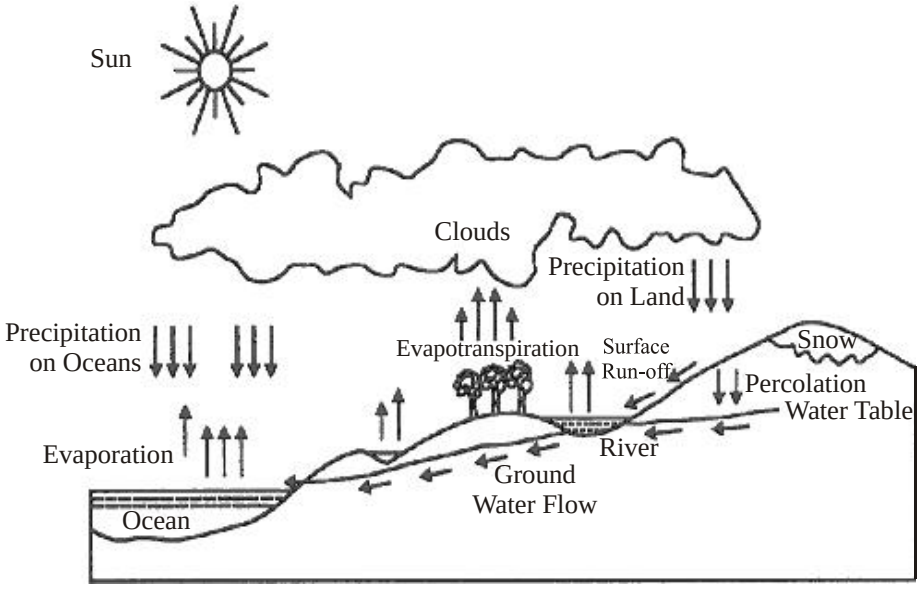


Fig. 34.1: *A schematical representation of Hydrological cycle*

The hydrological cycle involves evaporation of water from oceans, rivers and other sources to form clouds. The clouds on saturation with water vapours cause precipitation falling back on earth's surface. On surface, the water runs off to rivers and finally to oceans. The water again evaporates and the cycle continues.

Surface water has a natural tendency to clean itself as it contains certain organisms that break down pollutants into harmless substances.

(ii) Ground Water: The part of precipitation that seeps into the ground as a result of gravity and fills the pores between soil particles and rocks under it is called **ground**

water. The water bearing layers of soil and rocks are called **aquifers**. Ground water is very important for agricultural and industrial purposes. Ground water in the form of wells and springs is often the only source of water supply especially in villages and small towns.

In spite of a good number of water resources, we have shortage of usable water. This is due to increasing population, urbanisation and industrialisation. There is a need to optimise use of water and also conserve surface run off of water by means of rainwater harvesting, groundwater conservation, making use of recycling methods etc.

34.2 Water Pollution – Parameters

A large amount of water is discharged back after domestic and industrial usage. This is contaminated with domestic waste and industrial effluents. When this contamination reaches beyond certain allowed concentrations, it is called **pollution** and the contaminants are called the **pollutants**. **Water pollution** may be defined as the contamination of streams, lakes, seas, underground water or oceans by substances, which are harmful for living beings. If the concentration of substances naturally present in water increases then also the water is said to be polluted.

Water pollution may be defined as the contamination of streams, lakes, seas, underground water or oceans by substances, which are harmful for living beings. Industrialisation and population explosion are two important factors for water pollution.

Water may be called polluted when the following parameters stated below reach beyond a specified concentration in water.

i) **Physical parameters**. Colour, odour, turbidity, taste, temperature and electrical conductivity constitute the physical parameters and are good indicators of contamination.

   For instance, colour and turbidity are visible evidences of polluted water while an offensive odour or a bitter and difference than normal taste also makes water unfit for drinking.

ii) **Chemical parameters**: These include the amount of carbonates, sulphates, chlorides, fluorides, nitrates, and metal ions. These chemicals form the total dissolved solids, present in water.

iii) **Biological parameters**: The biological parameters include matter like algae, fungi, viruses, protozoa and bacteria. The life forms present in water are affected to a good extent by the presence of pollutants. The pollutants in water may cause a reduction in the population of both lower and higher plant and animal lives. Thus, the biological parameters give an indirect indication of the amount of pollution in water.

34.3 Water Pollution – Sources

Water pollutants refer to the substances which are capable of making any physical, chemical or biological change in the water body. These have undesirable effect on living organisms. As mentioned earlier, the water used for domestic, agricultural and industrial purposes is discharged with some undesirable impurities in it. This contamination leads to the pollution

of water, which is generally called the **fresh water pollution**. Fresh water pollution may be classified into two types: **surface water pollution** and **ground water pollution**.

34.3.1 Surface Water Pollution

When pollutants enter a stream, river or lake these gives rise to surface water pollution. The surface water pollution has a number of sources. These can categorised as:

- Point and Non-point Sources
- Natural and Anthropogenic Sources

(i) Point and Non-point Sources

The well-defined sources that emits pollutants or effluents directly into different water bodies of fresh water are called **point sources**. Domestic and industrial waste are examples of this type. The point sources of pollution can be effectively checked. On the other hand, the **non-point sources** of water pollution are scattered or spread over large areas. This type of sources deliver pollutants indirectly through environmental changes and account for majority of the contaminants in streams and lakes. For example, the contaminated water that runs off from agriculture farms, construction sites, abandoned mines, enters streams and lakes. It is quite difficult to control non-point sources.

(ii) Natural and Anthropogenic Sources

As mentioned earlier, an increase in the concentration of naturally occurring substances is also termed pollution. The sources of such an increase are called **natural sources**. S**iltation** (which includes soil, sand and mineral particles) is one such natural source. It is a common natural phenomenon, which occurs in most water bodies. Indiscriminate deforestation makes soil loose and flood waters bring silt from mountains into streams, rivers and lakes.

On the other hand, the human activities that result into the pollution of water are called **anthropogenic** or man made sources of water pollution**.** For example, domestic (sewage and waste water), industrial and agricultural wastes that goes into the rivers, lakes, streams and seas are anthropogenic sources. Certain materials that are leached from the land by run-off water and enter the various water bodies also belong to this category. The anthropogenic sources of water pollution are shown in Fig. 34.2.

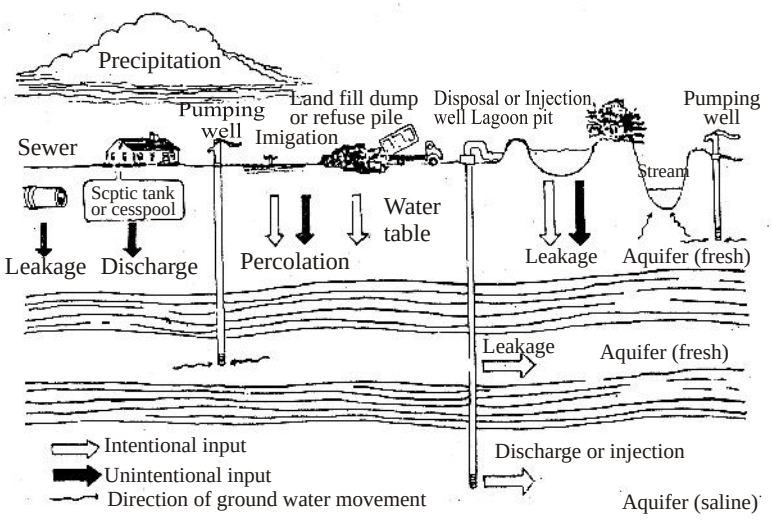


Fig. 34.2 : *Anthropogenic Sources of water pollution*

Notes

34.3.2 Ground Water Pollution

When the polluted water seeps into the ground and enters an aquifer it results into **ground water pollution**. The most of our villages and many townships, ground water is the only source of drinking water. Therefore, pollution of groundwater is a matter of serious concern. Groundwater gets polluted in a number of ways. The dumping of raw sewage on soil, seepage pits and septic tanks cause pollution of groundwater. Fig. 34.3. The porous layers of soil hold back solid particles while the liquid is allowed to pass through. The soluble pollutants are able to mix with the groundwater. In addition to these, the excessive use of nitrogenous fertilizers and unchecked release of toxic wastes and even carcionogenic substances by industrial units many ressult in slow trickling down through the earth's surface and mixing with the groundwater. This problem is very serious especially in areas where water table is high (i.e., where water is available near surface of earth).

The ground water can move over large distances by virtue of the large empty space available below the earth's surface. This way if some impurities seep into the ground water at one point, they may be observed at a different point far removed from the point of source. In such a case it is difficult to estimate the source of water pollution. However, suspended impurities and bacterial contaminants are removed in the process of seepage by the soil acting as an absorbent and filter, and water acting as a solvent.

Since the movement of groundwater through the porous rock is very slow, pollutants which get mixed with the groundwater are not readily diluted. Furthermore, groundwater does not have access to air (in contrast to surface water) therefore, oxidation of pollutants into harmless products in groundwater does not occur.

34.4 Water Pollutants

You have read the various sources from where pollutants enter the water bodies. Let us now learn about the various types of pollutants arising out of these sources. These can be broadly put under the following types.

(i) Sewage Pollutants (Domestic and Municipal Waste)

(ii) Industrial Pollutants

(iii) Agricultural Pollutants

(iv) Radioactive and Thermal Pollutants

(i) Domestic and Municipal Pollutants : The sewage contains garbage, soaps, detergents, waste food and human excreta and is the single largest sources of water pollution. Pathogenic (disease causing) microogranisms (baccteria, fungi, protozoa, algae) enter the water system through sewage making it infected. Typhoid, chloera, gastroenteritis and dysentery are commonly caused by drinking infected water. Water polluted by sewage may carry certain other bacteria and viruses cannot grow by themselves, but reproduce in the cells of host organisms. They cause a number of diseases, such as, polio, viral hepatitis and may be cancer which are resistant to like the organic matter are oxygen demanding substances. They are responsible for deoxygenation of water-bodies which is harmful for aquatic life.

Other ingedients which enter the various water bodies are the plant nutrients, i.e., nitrates and phosphates. They support growth of algae, commonly called **algal bloom** (blue-green species). This process is called **eutrophication** and is discussed in

details in the next section.

(ii) Industrial Pollutants : Many industries are located near rivers or fresh water streams. These are responsible for discharging their untreated effluents into rivers like highly toxic heavy metals such as chromium, arsenic, lead, mercury, etc. along with hazardous organic and inorganic wastes (e.g., acids, alkalies, cyanides, chlorides, etc.). River Ganges recives wastes from textile, sugar, paper and pulp mills, tanneries, rubber and pesticide industries. Most of these pollutants are resistant to breakdown by microorganisms (called nonbiodegradable), therefore damage the growth of crops and the polluted water is unsafe for drinking purposes.

Factories manufacturing plastic, caustic soda and some fungicides and pesticides release mercury (a heavy metal) along with other effluents in nearby water body. Mercury enters the food chain through bacteria, algae, fish and finally into the human body. The toxicity of mercury became evident by the Minamata Bay tragedy in Japan during the period 1953-60. Fish died due to mercury consumption and those who ate fish were affected by mercury poisoning and quite a few died. The milder symptoms of mercury poisoning are depression and irritability but acute toxic effects can cause paralysis, blindness, insanity, birth defects and even death. The high concentration of mercury in water and in fish tissues results from formation of soluble monomethylmercury ion, (CH_3, Hg^+) and volatile dimethylmercuty [$(CH_3)_2$ Hg] by anaerobic bacteria in sediments.

(iii) Agricultural Waste: Manure, fertilizers, pesticides, wastes form farms, slaughterhouse, poultry farms, salts and silt are drained as run-off from agricultural lands. The water body receiving large quantities of fertilizers (phosphates and nitrates or manures becomes rich in nutrients which leads to eutrophication and consequent depletion of dissolved oxygen. Consumption of water rich in nitrates is bad for human health especially for small children.

Pesticides (DDT, dieldrin, aldrin, malathion, carbaryl etc.) are used to kill insect and rodent pests. Toxic pesticide residues enter the human body through drinking water or through food chain (biomagnification). These compounds have low solubility in water but are highly soluble in fats. For example, the concentration of DDT in river water may be very low but some fish over a period of time accumulate so much of DDT that they become unfit for human consumption. The use of pesticides in our country is increasing very rapidly.

Some of these chemicals which are highly toxic become metabolised by animals that graze on fields. Therefore, these poisonous chemicals have been often observed in the humanfood chain. The presence of these chemicals in humans even in minute amounts can cause hormonal imbalance and may lead to cancer.

(iv) Physical Pollutants: Physical pollutants can be of different types. Some of them are discussed below :

(a) Radioactive Wastes : Radionucleides found in water are radium and potassium-40. These isotopes originate from natural sources due to leaching from minerals. Water bodies are also polluted by accidental leakage of waste material from uranium and thorium mines, nuclear power plants and industries, research laboratories and hospitals which use radioisotopes. Radioactive materials enter human body through water and food, and may be accumulated in blood and certain vital organs. They cause tumours and cancer.

(b) **Thermal Sources**: Various industries, nuclear power plants and thermal plants require water for cooling and the resultant hot water is often discharged into rivers or lakes.

This results in thermal pollution and leads to the imbalance in the ecology of the water body. Higher temperature lowers the dissolved oxygen level (which is very essential for marine life) by decreasing the solubility of oxygen in water. Fish and other aquatic organism can get affected by a sudden change in water temperatures.

(c) **Sediments** : Soil particles carried to streams, lakes or oceans form the sediments. The sediment become polluting due to their large amount. Soil erosion defined as the soil carried by flood water from crop land, is responsible for sedimentation. The sediments may damage the water body by introducing a large amount of nutrient matter.

(v) Petroleum Products: Petroleum products are widely used for fuel, lubrication, plastics manufacturing, etc. and happen to be poisonous in nature. Crude oil and other related products generally get into water by accidental spillage from ships, tankers, pipelines etc. Besides these accidental spills, oil refineries, oil exploration sites and automobile service centres pollute different water bodies. Oil slick which floats on the water surface causes death of marine life and severely affects the ecosystem of the ocean.

A list of various types of water pollutants, their sources and effects have been summarised in Table 34.1.

Table 34.1: Types of water pollutants, their sources and effects

	Pollutant	Sources of Pollutants	Effects and Significance
1	Pathogens	Sewage, human and animal wastes, natural and urban runoff from land, industrial waste	Depletion of dissolved oxygen in water (foul odour) health effects (outbreaks of water borne diseases)
2	Organic pollutants ● Oil and grease ● Pesticides and weedicides ● Plastics ● Detergents	Automobile and machine waste, tanker spills, offshore oil leakage Chemicals used for better yield from agriculture Industrial and household waste Industrial and household waste	Disruption of marine life, aesthetic damage Toxic effects (harmful for aquatic life), possible genetic defects and cancer; kills fish Eutrophication, aesthetics
3	Inorganic pollutants Fertilizers (phosphates and nitrates)	Agricultural runoff	Algal bloom and eutrophication, nitrates cause methemoglobenemia
	Acids and alkalies	Mine drainage, industrial wastes, natural and urban runoff	Kill fresh water organisms, unfit for drinking, irrigation and industrial use.
4	Radioactive materials	Natural sources, uranium mining and processing, hospitals and research laboratories using radioisotopes	Cancer and genetic defects
5	Heat	Cooling water for industrial, nuclear and thermal plants	Decreases solubility of oxygen in water, disrupts aquatic ecosystems
6	Sediments	Natural erosion, runoff from agricultural land and construction sites	Affects water quality, reduces fish population

Intext Questions 34.1

1. Define water pollution.

   .....

2. What do you understand by surface water?

   .....

3. List any three anthropogenic sources of water pollution?

   .....

4. List the parameters indicating water pollution.

   .....

5. Name the element which causes Minamata disease?

   .....

34.5 Water Pollution and Some Biological Effects

The natural source of water in the form of precipitation or rain is the purest form available in nature. However after reaching the surface and then underground it gets contaminated by a number of pollutants. There are some biological factors also mentioned earlier responsible for spoiling the quality of water. These include the lower plants like algae and bacteria which are the causes of nutrient accumulation in aquatic systems. This nutrient accumulation gives rise to a condition called eutrophication explained below.

34.5.1 Eutrophication

Eutrophication is a process by which a water body slowly becomes rich in plant nutrients such as nitrates and phosphates due to soil erosion and run off from the surrounding land. Let us try to understand this phenomenon. A water system like a lake or any reservoir may get a large inflow of organic matter from domestic wastes and run off from the surrounding land. Increasing human population, intensive agriculture and rapid industrial growth have led to an increasing release of domestic waste, agricultural residues, industrial wastes and land run-off into various water bodies. Nutrients are released from organic waste by aerobic (oxygen requiring) bacteria which start decomposing it. Dissolved oxygen is consumed in this process. As more and more organic matter enters a water body, more is the deoxygenation of the water body and larger is the production of nutrients. These nutrients fertilize an abnormal growth of algae and other large water plants such as duckweed. As more plants grow, some of them die also due to larger oxygen demand and therefore oxygen deficiency in the water body (i.e., deoxygenation of the water body). Such a water body is said to be **eutrophied** and the process is called **eutrophication**. The word eutrophication is derived from the Greek word which means well nourished as (eu:true, trophos:feeding)

Eutrophication of a water body results due to the release of large amount of nutrients by the action of aerobic bacteria on organic wastes entering a water body naturally or by human activity.

The above discussion leads us to a concept called biological oxygen demand (BOD). Let us try to understand by the description given below.

34.5.2 Biological Oxygen Demand (BOD)

The quality of oxygen used up by microorganisms at 27ºC and in darkness during 3 days in breaking down organic wastes in a water body is called its **biological oxygen demand (BOD).**

It can be explained in the following manner.

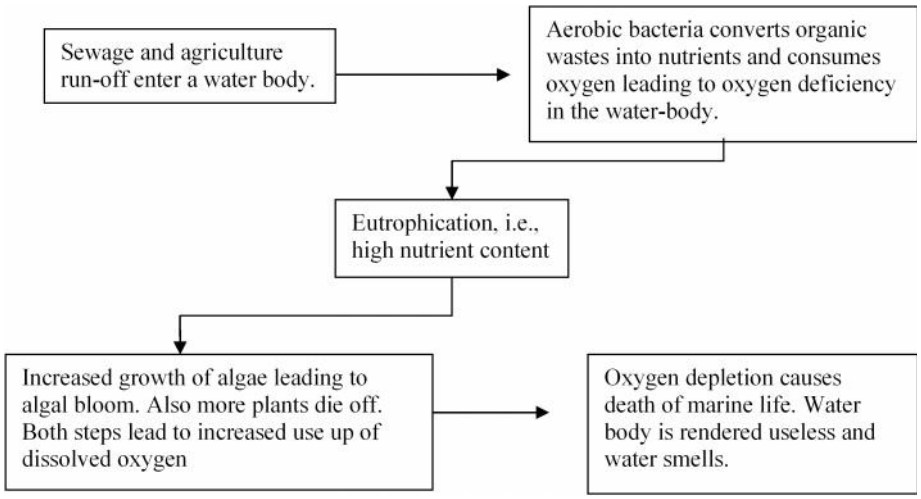
You know that there are many organic compounds or waste present in a water body. The microorganisms present in the system act upon this waste for their own consumption and growth. In the process the metabolic activity requires oxygen which is met by the dissolved oxygen present in water. It is this amount of oxygen which is defined as **biological oxygen demand (BOD).** The BOD value of an aquatic system depends upon:

- the type and amount of organic waste
- the organisms acting on it
- temperature and pH

The greater the amount of organic waste in the water body, the greater is the amount of oxygen required to break it down biologically and therefore higher is the BOD value of water. This value is a good measure in evaluating the degree of pollution in a water body. The less polluted water shows comparatively low value of BOD. Its value is used as a criterion for managing water pollution of a water body. An evaluation is made by determining oxygen concentration in water before and after incubation at 20**ºC** in dark for 5 days.

34.5.3 Biomagnification

A variety of toxic chemicals move through food chains. Toxic pesticides may be sprayed for controlling insect pests, fungi, herbs, but they concentrate in the food chain and harm to other (non target) organisms. For example, DDT was sprayed in the U.S. to control mosquitoes at a concentration expected to be harmless to non target organisms like fish and birds. DDT accumulated in the marshes and planktons. Planktons were eaten by fish and the fish had a higher concentration of DDT in its body. Further, when birds ate the fish, they accumulated still higher concentration. This increase in concentration of accumulated toxic chemicals as one goes higher in the food chain is termed **biomagnification.** Biomagnification has at times threatened the reproduction and survival of carnivores (secondary consumers) who occupy the highest level of the food chain.



34.6 Water Pollution – Some Control Measures

Waste water generated by household activity, industries or garbage landfills is called **sewage** which is classified as the municipal water pollution. Sewage contains solid matters in the form of suspended colloidal and dissolved organic matter, detergent, mineral matter, nutrients and gases. Sewage is one of the major causes of water borne diseases and therefore the treatment of sewage is one of the important tasks. For a long time treatment of municipal waste in the form of sewage involved mainly of the removal of suspended solids, oxygen demanding materials and harmful bacteria. Now the disposal of the solid residue from sewage has been improved by applying municipal treatment processes.

The treatment of this waste water is carried out in the following three stages:

(i) Primary treatment

(ii) Secondary treatment, and

(iii) Tertiary treatment

Primary Treatment: When the waste water is to be dumped off into a river or flowing steam, the treatment is carried out by sedimentation, coagulation and filtration. This is known as primary treatment. If the water is required for drinking purposes, it has to undergo further treatment called secondary and tertiary treatments. The following steps are performed to do primary treatment of water:

(i) Sedimentation: This step is carried out in large tanks specially built for this purpose in sewage treatment plant. The polluted water is allowed to settle so that silt, clay and other matter settle to be bottom and water is slowly allowed to move out. Fine particles do not settle and are thus required to be removed in the next step.

(ii) Coagulation: Fine particles and colloidal suspension are combined into large particles by a process called coagulation. This step is carried out by the addition of special chemicals called coagulants (flocculants) such as potash alum. The large particles either settle to the bottom or are moved in the next step.

(iii) Filtration: Suspended particles, flocculants, bacteria and other organisms are filtered by passing the water through a bed of sand or finely divided coal or through some fibrous materials. The total impurities collected in these steps are called **sludge**. It is used as a valuable fertilizer. On composting (i.e. the action of anaerobic bacteria), it releases sludge gas. It consists mainly of methane gas which is used for cooking purposes.

Secondary or Biological Treatment: The water after primary treatment is not fit for drinking purposes and has to undergo further treatment. This is done through secondary or biological treatment. A commonly used method is to allow polluted water to spread over a large bed of stones and gravel so that the growth of different microorganisms needing nutrients and oxygen is encouraged. Over a period of time a fast moving food chain is set up. For example, bacteria consume organic matter from the polluted water; protozoa live on bacteria. Every form of life including algae and fungi help in the cleaning up process. This is called secondary treatment of water. It involves the following processes

(i) Softening : By this treatment undesirable cations of calcium and magnesium are removed from hard waters. Either water is treated with lime and soda ash to precipitate Ca^{2+} ions as carbonates or it is passed through cation exchangers. This makes water soft.

(ii) Aeration: In this process, soft water is exposed to air by forcing air through it to add oxygen to water. This encourages bacterial decomposition of organic matter into harmless products such as carbon dioxide and water. The addition of oxygen reduces carbon dioxide. sulphide etc.. The water is as yet not fit for drinking purposes. The pathogenic and other microorganisms need to be killed. This is done in the next treatment.

Tertiary Treatment : The tertiary treatment is actually disinfecting water. Chlorine is the most commonly used disinfectant used for killing bacteria. However, chlorine also reacts with traces of organic matter present in water and forms undesirable chlorinated hydrocarbons (toxic and potentially carcinogenic). It is therefore desirable to reduce the organic matter in water before passing chlorine gas. Other methods of disinfection such as ultraviolet radiation, ozone gas treatment or reverse osmosis are preferred over chlorine treatment. But these methods are more expensive. Fig.34.3 gives a clear picture of the process of sewage treatment in total.

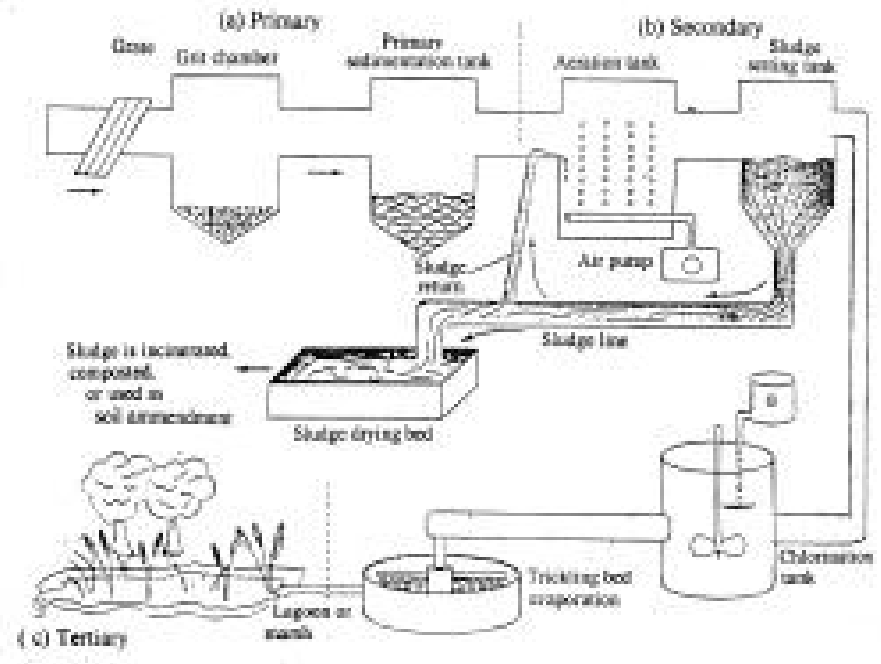


Fig 34.3 : *Treatment process of sewage*

In a treatment plant, the waste is passed through a series of screens, chambers and chemical processes to reduce its bulk and toxicity. During primary treatment a large percentage of suspended solids and inorganic material is removed from sewage. The secondary stage reduces organic material by accelerating natural biological processes. Tertiary treatment is done when water is to be reused. Here 99% of solids are removed and various chemical processes are used to ensure that water is free from infecting materials.

Intext Questions 34.2

1. Define eutrophication.

.....

2. Why does aquatic life get killed in an eutrophied pond?

.....

3. What is the significance of BOD?

.....

4. What is biomagnification?

.....

34.7 Legislative Measures for Preventing Water Pollution

It is important to utilise a good quality and unpolluted water. The quality criteria may vary depending on the use. Individual efforts do pay in this regard, however, a common policy in the form of legislation is always more effective. The enactment of 'Prevention and Control of Water Pollution Act' in 1974 has helped in the prevention of water pollution. The standards have been prescribed for water pollution under Environment (Protection) Act 1986. These are given as follows.

- General standards for water pollutants for discharge of effluents in water bodies on land (inland surface water, public sewers, irrigated land and coastal areas)
- Standards specific for each type of industry
- Standards defined for the amount of waste water to be discharged for different industries
- Standards limiting the amount of a particular pollutant on the basis of production capacity of an industrial unit

The state pollution control boards have also been empowered to grant/renew consent to new/existing water polluting industries under water 'Prevention and Control of Pollution Act-1974.' They have been empowered to shut down any industrial unit which fails to meet the prescribed standards under this Act. The state governments have also been authorized to take punitive measures against defaulting industries.

It becomes imperative to act upon the above mentioned rules and regulations and also follow measures at individual end to improve the quality of water used for various purposes.

Intext Questions 34.3

1. How is sludge utilized?

.....

2. Mention the steps by which polluted water is made fit for drinking purpose?

.....

3. Why is chlorination not the most desirable method of disinfecting polluted water?

.....

What You Have Learnt

- Water pollution refers to any physical, chemical or biological change that has an undesirable affect on living organisms.
- Sewage, industrial, agricultural pollution and physical pollutants are the various sources of water pollution. These sources may be limited to a point sources or spread over large areas (non-point sources).
- Sewage, fertilizers, detergents, toxic wasters released by industries are some of the sources of groundwater pollution.
- Phosphatic, and nitrogenous fertilizers cause algal bloom and severe oxygen depletion in water body. The water body is said to be eutrophied.
- The quantity of oxygen needed by micro-organisms in degrading organic wastes in a water body is defined in terms of its biological oxygen demand (BOD).
- Biological magnification of toxic materials released into water bodies poses a serious threat to aquatic life and eventually to human life.
- Polluted water may be made useful for human consumption by subjecting it to various treatments.
- Legislative measures have been enacted in our country to restrict the pollution of various water bodies.

Terminal Exercise

1. What are the various types of water pollutants? State their consequences.
2. What are the effects of detergents on fresh water bodies?
3. What are the various sources of groundwater pollution?
4. How is the disease 'methaemoglobinaemia' caused?
5. suggest steps to stop eutrophication of water body.
6. What was Minamata Bay tragedy?
7. Which precaution is necessary before purifying the drinking water through chlorination?

Answers to Intext Questions

34.1

1. Nitrate ions are converted by intestinal bacteria into nitrities. These ions combine with haemoglobin to form methaemoglobin thus inhibting the supply of oxygen. This causes & disease known as methaemoglobinaemia.
2. Refer to section 34.4

Notes

3. Refer to section 34.3.1.
4. Refer to section 34.1
5. Mercury

34.2

1. Refer to section 34.5.1
2. Refer to section 34.5.1
3. Refer to section 34.5.2
4. Refer to section 34.5.3

34.3

1. As fertilizer.
2. Primary treatment including sedimentation, coagulation, filtration Secondary treatment including softening and aeration and Tertiary treatment involving disinfection of water.
3. Because chlorine reacts with organic matter to produce highly toxic chlorinated hydrocarbons which can cause cancer.