WATER POLLUTION

Definition

Water pollution may be defined as, "the alteration in physical, chemical and biological characteristics of water which may cause harmful effects on humans and aquatic life."

The pollutants include sewage, industrial chemicals and effluents, oil and other wastes. Besides, chemicals from the air dissolved in rain water, and fertilizers, pesticides and herbicides leached from the land also pollute water.

2.3.1 Types, effects and sources (causes) of water pollution

Water pollution is any chemical, biological (or) physical change in water quality that has a harmful effect on living organisms (or) makes water unsuitable for desired uses.

1. Infectious Agents

Example : Bacteria, viruses, protozoa and parasitic worms.

Human Sources (causes)

Human and animals wastes.

Effects

Variety of diseases.

2. Oxygen Demanding Wastes (Dissolved oxygen)

Example: Organic wastes such as animal manure and plant debris that can be decomposed by aerobic (oxygen-requiring) bacteria.

This degradation consumes dissolved oxygen in water. Dissolved oxygen (DO) is the amount of oxygen dissolved in a given quantity of water at a particular pressure and temperature. The saturated point of DO varies from 8-15 mg/lit.

Human Sources (causes)

Sewage, animal feedlots, paper mills, and food processing facilities.

Effects

Large populations of bacteria decomposing these wastes can degrade water quality by depleting water of dissolved oxygen. This causes fish and other forms of oxygen-consuming aquatic life to die.

3. Inorganic Chemicals

Example: Water soluble inorganic chemicals.

(i) acids,

(ii) compounds of toxic metals such as lead (Pb), arsenic (As) and selenium (Se) and (iii) salts such as NaCl in ocean water and fluorides(F^-) found in some soils.

Human Sources (causes)

Surface runoff, industrial effluents and household cleansers.

Effects

(i) Can make fresh water unusable for drinking (or) irrigation.
(ii) Causes skin cancers and neck damage.
(iii) Damage the nervous system, liver and kidneys.
(iv) Harm fish and other aquatic life.
(v) Lower crop yields.
(vi) Accelerates corrosion of metals exposed to such water.

4. Organic Chemicals

Examples: Oil, gasoline, plastics, pesticides, cleaning solvents, detergents.

Human Sources (causes)

Industrial effluents, household cleansers, surface runoff from farms.

Effects

(i) Can threaten human health by causing nervous system damage and some cancers.
(ii) Harm fish and wild life.

5. Plant Nutrients

Examples: Water-soluble compounds containing nitrate (NO^-_3), phosphate (PO^3_4-) and ammonium (NH^+_4) ions.

Human Sources (causes)

Sewage, manure, and runoff of agricultural and urban fertilizers. **Effects**

(i) Can cause excessive growth of algae and other aquatic plants, which die, decay, deplete dissolved oxygen in water and kill the fish.
(ii) Drinking water with excessive levels of nitrates lower the oxygen carrying capacity of the blood and can kill urban children and infants.

6. Sediment

Examples: Soil, silt, etc.,

Human Sources (causes)

Land erosion.

Effects

(i) Can reduce photosynthesis and cloud water.
(ii) Disrupt aquatic food webs.
(iii) Carry pesticides, bacteria, and other harmful substances.

(iv) Settle out and destroy feeding and spawning rounds of fish.
(v) Clog and fill lakes, artificial reservoirs, stream channels and harbours,

7. Radioactive Materials

Examples: Radioactive isotopes of iodine, radon, uranium, cesium, and thorium.

Human Sources (causes)

Nuclear power plants, mining and processing of uranium and other ores, nuclear weapons production and natural sources.

Effects

Genetic mutations, birth defects, and certain cancers.

8. Heat (Thermal Pollution)

Example: Excessive heat

Human Sources (causes)

Water cooling of electric power plants and some types of industrial plants. Almost half of all water withdrawn in United States each year is for cooling electric power plants.

Effects

(i) Lowers dissolved oxygen levels and makes aquatic organisms more vulnerable to disease, parasites and toxic chemicals.
(ii) When a power plant first opens (or) shuts down for repair, fish and other organisms adapted to a particular temperature range can be killed by the abrupt change in water temperature known as thermal shock.

9. Point and Non-point Sources of Water Pollution

(i) Point Sources

Point sources are discharged pollutants at specific locations through pipes, ditches (or) sewers into bodies of surface water.

Examples: Includes factories, sewage treatment plants, abandoned underground mines and oil tankers.

(ii) Non-point sources

They are usually large land areas (or) air sheds that pollute water by runoff, subsurface flow (or) deposition from the atmosphere. Location of which cannot be easily identified. **Examples:** Include acid deposition and runoff of chemicals into surface water from croplands, livestock feedlots, logged forests, urban street, lawn, golf courses and parking lots.

2.3.2 Characteristics (or) Testing of river water (waste water)

1. Dissolved oxygen (DO)

Dissolved oxygen (DO) is the amount of oxygen dissolved in a given quantity of water at a particular pressure and temperature.

Significance of DO

(i) DO is vital for the support of fish and other aquatic life in river water.
(ii) It determines whether the biological changes are brought about by aerobic (or) anaerobic micro-organisms.
(iii) DO determinations serve as the means of control of river pollution.
(iv) A minimum level of DO (4 mg/lit) must be maintained in rivers so as to support the aquatic life in a healthy condition. Thus, it is necessary to ensure that the treated water must have atleast 4 mg/lit of DO before its disposal into river.

2. Biochemical Oxygen Demand (BOD)

BOD is the amount of oxygen required for the biological decomposition of organic matter present in the water.

Significance of BOD

(i) It is an important indication of the amount of organic matter present in the river water.
(ii) Since complete oxidation occurs in indefinite period, the reaction period is taken as 5 days at 20°C. For all practical purposes, it is written as BOD5.
(iii) The rate of oxidation and demand depends on the amount and type of organic matter present in river water.

3. Chemical Oxygen Demand (COD)

COD is the amount of oxygen required for chemical oxidation of organic matter using some oxidising agent like $K_2Cr_2O_7$, and $KMnO_4$.

Significance of COD

(i) It is carried out to determine the pollutional strength of river water.
(ii) It is rapid process and takes only 3 hours.

2.3.3 Control (or) Preventive measures (methods) of water pollution

1. The administration of water pollution control should be in the hands of State (or) Central Government.
2. Scientific techniques are necessary to be adopted for the environmental control of catchment areas of rivers, ponds (or) streams.
3. The industrial plants should be based on recycling operations, because it will not only stop the discharge of industrial wastes into natural water sources but by products can be extracted from the wastes.
4. Plants, trees and forests control pollution and they acts as natural air conditioners.
5. Forests in and around big cities and industrial establishments are capable of reducing the sulphur dioxide and nitric oxide pollutants to a greater extent from the atmosphere. Hence the national goal should be "Conservation of Forests" and campaign should be "Plant more trees". The global destruction of forests should be discouraged (or) atleast minimized and

afforestation should be encouraged because no one on this earth will escape from the adverse effects of a balding earth.

6. It is not advisable to discharge any type of waste, either treated, partially treated (or) untreated, into treams, rivers, lakes, ponds and reservoirs. The industries are expected to develop close-loop water supply schemes and domestic sewage may be used for irrigation.
7. Highly qualified and experienced persons should be consulted from time to time for effective control of water pollution.
8. Public awareness regarding adverse effects of water pollution is a must. So there should be propaganda for water pollution control on radios, TVs etc.,
9. Suitable laws, standards and practices should be framed to regulate the discharge of undesirable flow of water in water bodies and such regulations should be modified from time to time in order to accommodate the changing requirements and technological advancements.
10. Basic and applied research in public health engineering should be encouraged.
11. The possible reuse (or) recycle of treated sewage effluents and industrial wastes should be emphasized and encouraged.

2.3.4 Waste Water (or) Sewage Treatment

Objectives of waste water treatment

The main objectives of waste water treatment are

(i) to convert harmful compounds into harmless compounds.
(ii) to eliminate the offensive smell.
(iii) to remove the solid content of the sewage.
(iv) to destroy the disease producing microorganisms.

Treatment process

The sewage (or) waste water treatment process involves the following steps. **i. Preliminary Treatment**

In this treatment, coarse solids and suspended impurities are removed by passing the waste water through bar and mesh screens. **II. Primary treatment for) Settling process**

In this treatment, greater proportion of the suspended inorganic and organic solids are removed from the liquid sewage by settling. In order to facilitate quick settling coagulants like alum, ferrous sulphate are added. These produce large gelatinous precipitates, which entrap finely divided organic matter and settle rapidly.

$$Al_2(SO_4)_3 + 6H_2O \longrightarrow 2A1(OH)_3\downarrow + 3H_2SO_4.$$

III. Secondary (or) Biological treatment

In this treatment, biodegradable organic impurities are removed by aerobic bacteria. It removes upto 90% of the oxygen demanding wastes. This is done by trickling filter (or) activated sludge process.

(a) Trickling filter process

It is a circular tank and is filled with either coarse (or) crushed rock. Sewage is sprayed over this bed by means of slowly rotating arms (Fig. 2.2).

When sewage starts percolating downwards, microorganisms present in the sewage grow on the surface of filtering media using organic material of the sewage as food. After completion of aerobic oxidation the treated sewage is taken to the settling tank and the sludge is removed. This process removes about 80-85% of BOD.

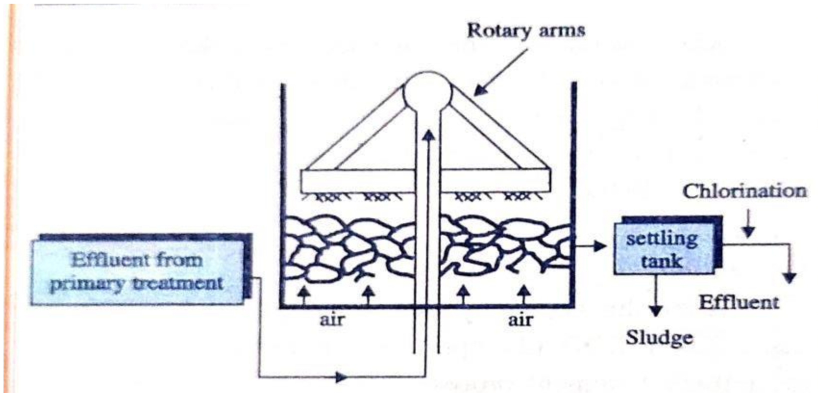


Fig. 2.2 Trickling filter

(b) Activated sludge process

Activated sludge is biologically active sewage and it has a large number of aerobic bacterias, which can easily oxidise the organic impurities.

The sewage effluent from primary treatment is mixed with the required amount of activated sludge. Then the mixture is aerated in the aeration tank (Fig. 2.3). Under these condition, organic impurities of the sewage get oxidised rapidly by the microorganisms.

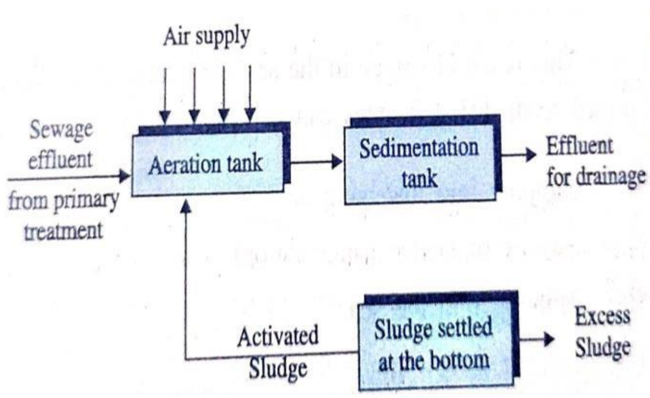


Fig. Activated Sludge Process

After aeration, the sewage is taken to the sedimentation tank. Sludges settle down in this tank, called activated sludge, a portion of which is used for seeding fresh batch of the sewage. This process removes about 90-95% of BOD.

IV. Tertiary treatment

After the secondary treatment, the sewage effluent has a lower BOD (25 ppm), which can be removed by the tertiary treatment process.

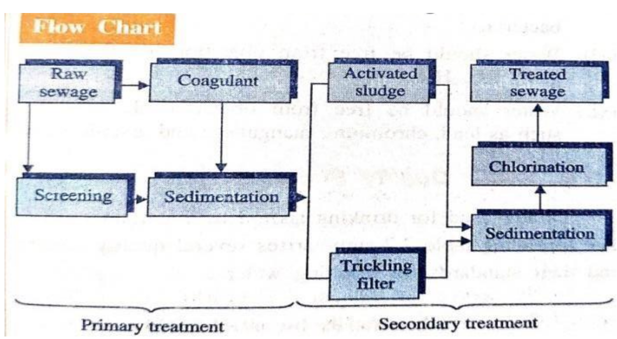
In the tertiary treatment, the effluent is introduced into a flocculation tank, where lime is added to remove phosphates. From the flocculation tank the effluent is led to ammonia stripping tower, where pH is maintained to 11 and the NH is converted to gaseous NH3. Then the effluent is allowed to pass through activated charcoal column, where minute organic wastes are adsorbed by charcoal. Finally the effluent water is treated with disinfectant (chlorine).

V. Disposal of sludge

This is the last stage in the sewage treatment. Sludge formed from different steps can be disposed by

(i) dumping into low-lying areas.
(ii) burning of sludge (incineration),
(iii) dumping into the sea,
(iv) using it as low grade fertilizers.

The flow sheet diagram of sewage treatment



2.3.5 Specifications for Drinking Water

The common specifications recommended by the U.S Public Health for Drinking Water are given below.

(i) Water should be clear and odourless.
(ii) It should be cool.
(iii) It should be pleasant to taste.
(iv) Turbidity of the water should not exceed 10 ppm.
(v) pH of the water should be in the range of 7.0 - 8.5.
(vi) Chloride and sulphate contents should be less than 250 ppm.
(vii) Total hardness of the water should be less than 500 ppm.
(viii) Total dissolved solids should be less than 500 ppm.
(ix) Fluoride content of the water should be less than 1.5 ppm.

(x) The water must be free from disease-producing bacteria.
(xi) Water should be free from objectionable dissolved gases like H_2S.
(xii) Water should be free from objectionable minerals such as lead, chromium, manganese and arsenic salts.

2.3.6 Water Quality Standards

Water used for drinking should have certain quality. The following table 2.2 summarises several quality criteria and their standards for drinking water.

Table 2.2 Standards for drinking water

S. No.	Parameter	WHO standard in mgs/litre	ISI standardin mgs/litre.
1	Colour, odour and taste.	Colourless, odourless and tasteless.	Colourless, odourless and tasteless.
2	pH	6.9	6.9
3	Total dissolved solids	1,500	-
4	Dissolved oxygen	-	3.0
5	Chloride	250	600
6	Sulphate	400	1,000
7	Nitrate	45	-
8	Cyanide	0.2	0.01
9	Fluoride	1.5	3.0
10	Chromium	0.05	0.005
11	Lead	0.05	0.1
12	Arsenic	0.05	0.1

Significance of the parameters

1. Chlorides: Although chlorides are not considered as harmful as such, their concentrations over 250 mg/lit impart peculiar taste to water, which is unacceptable for drinking purposes.

2. Sulphates: When sulphates are present in excess amount in drinking water, they may produce a cathartic effect on the people consuming such water.

3. Nitrates: Excessive concentrations of nitrates are undesirable especially for infants. The maximum contaminant level for nitrate is 10 mg/lit.

4. Fluorides: Optimum fluoride concentrations prescribed in drinking water is in the range of 0.7 to 1.2 mg/lit. Low concentration of fluoride in drinking water causes dental problem in children.

Excessive concentration causes fluorosis (discoloration and chipping of teeth).

5. Arsenic: Arsenic is a toxic heavy metal even a very small dose can result in severe poisoning. Only 0.05 mg/lit has been recommended for arsenic in drinking water.