POLLUNATION

"Any undesirable change in physical, chemical or biological characteristic of air, water and land which is harmful to the main directly or indirectly through his animals, plants, industrial units or raw materials is called **pollution".**

Pollutants :- Any material or act on the part of man, or nature which leads to pollution is called pollutants.

USUALLY POLLUTANTS ARE DIVIDED INTO FOLLOWING CATEGORIES

1. **Nondegradable pollutants :-** Many of such pollutants are usually not degraded or degraded partially in environment. Such as aluminum pecks, Mercury compounds, Iron, Compounds of phenols, Glass, D.D.T. Benzene BHC pesticides etc.

   They are collected the environment and cause pollution. These pollutants are harmful even in low concentration and harm increases with their increasing concentration. No treatment is found in the ature for their recycling. There are to methods by which we can stop the pollution caused by pollutants.
   (i) Such type of substances should be banned by law,
   (ii) use their alternative substances.

2. **Biodegradable pollutants -** If mush of domestic sewage papers, woods, garbage, live stock wastes, etc. are easily degraded completely by microorganisms, it becomes useful. But if these materials enter the environment in such large quantities, that they can not be degraded completely then addition of these materials causes pollution in environment.

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1. **Primary pollutants -** These persist in the form in which they are added to the environment
   e.g. DDT, CO etc.

2. **Secondary pollutants -** These are formed by chemical reaction amongst primary pollutants
   e.g. Photochemical smog, London smog, PAN, O_3

   Synergism - Formation of secondary pollutants in known as synergism. sec. pollutants are more toxic than primary pollutions.

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1. **Quantitative pollutants :-** These are the substances which occur in nature but become pollutant when their concentration reaches beyond a threshold value in the environment
   e.g. CO_2, Nitrogen Oxide.
2. **Quantitative pollutants :-** These are the substances which do not occur in the environment but are passed in through human activity
   e.g. fungicides, herbicides, D.D.T., etc.

Other type of pollution :

1. **Natural pollution -** Caused by natural sources like, CH_4 from paddy fields and cattle, marsh, forest fire.
2. **Anthropogenic pollution -** Caused by human activities.

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1. **Negative pollution -** Loss of soil productivity e.g. Overgrazing, Soil erosion.
   Removal or absence of desirable substances at right place which results in loss of soil productivity.
2. **Positive pollution -** Presence or addition of undesirable substances at wrong place which result in reduction of soil fertility e.g. more u se of bio fertilizer, land filling by wastes.

Main sources of pollution :

(i) Point source pollution - Where the effluent discharge occur at a specific site.
e.g. factory outlet and Municipal sewage

(ii) Line source pollution - It is passed along a narrow belt, Roads.
e.g. Rods, Railway tracks

(iii) Diffuse source pollution - It is over a large area
e.g. sprayed fertilizer or pesticides through run off

(vi) Area source pollution - Industrial estate & mining area.

DIFFERENT KINDS OF POLLUTION

AIR POLLUTION

The air pollution is caused due to addition of unwanted substances or gases. The atmospheric pollution

is mainly caused by the activities of man and concentrated to the inhabited and the industrial complexes in cities.

There are two main categories of air pollutants

(i) Gases **(ii) Particulates**

Gases : The gaseous materials include various gases and vapours of volatile substances or the compound with a boiling point below 200^0C.

Particulate matter :

Particulate matter consist of solid particles or liquid droplets (aerosols) small enough to remain suspended in air e.g. soot, smoke, dust, asbestos, fibers, pesticides, some metals (including Hg, Pb, Cu and Fe) and also biological agent like tiny dust mites and flower pollenAtmospheric particles having diameter > $10\mu m$, generally settle out is less than a day, whereas particles

with diameters > $1\mu m$ or less can remain suspended in air for weeks.Suspended particulate matter in the lower atmosphere (troposphere) causes and aggravates human

respiratory illness, like asthama, chromic bronchitis etc.

MAJOR AIR POLLUTANTS ARE THEIR EFFECTS

1. **Carbon monoxide (CO)-**

   Source - it is the main air pollutant released from smoke of automobile.

   Effect - Carbon monoxide is highly toxic gas, it combines with hemoglobin of the blood and blocks the transportation of oxygen. Thus, it impairs respiration and it causes death due to asphyxiation when inhaled in large amount.

2. **Un burn Hydrocarbons - (3, 4 Benzopyrine, CH_4, Benzene)**

   Source - These are mainly released from automobiles and burning of fossil fuel (coal, petrol, diesel). Methane (CH_4) is the most abundant hydrocarbon in atmosphere and it main source is marshy area and paddy field.

   Effect - Hydrocarbons causes lungs cancer. **Note : Poly nuclear aromatic hydrocarbons -** It is an important hydrocarbons and it also causes

   lungs cancer i.e. this is carcinogenic.

3. **Ethylene -**

   Source - It main sources are .....

Effect - Falling of leaves without particular regason, falling of flowering bud before time.

4. **Nitrogen oxide - (NO, NO_2)**
   Source - Burning (combustion) of fossil fuel in automobiles.
   Effect - These nitrogen oxide form photochemical smog in atmosphere are release ozone. Nitrogen oxide also responsible for acid rain. Entry of these nitrogen oxide causes respiratory trouble such as emphysema, bronchitis, welling of lungs and lungs cancer etc.

5. **Sulphur oxide - (SO_2, SO_3)**
   Source - These are most harmful gaseous pollutants, main source of sulphur oxide are coal burning, smelters, oil refineries.
   Effect - Lichen and mosses do not grow in SO_2 polluted areas. Lichen and mosses are indicator of SO_2 pollution Oxides of sulphur produce acid rain and smog in atmosphere.

6. **Smoke - (SO_2, SO_3, NO_2, NO, CO, CO_2)**

SECONDARY POLLUTATNS

A. Smog (Smoke + Fog) -
This word was given by Desvoeux, Smog/Smoke is measured by Ringlmann method.

Smog in two types

(a) Los Angeles Smog or Photo Chemical smog -
It was first observed in Los Angeles. In this process smoke, fog, nitrogenoxide, hydrocarbons, oxygen, UV light and high temperature and essential. These components react with each other and form radish brown smog (PAN + O_3 + Nitrogen oxides) or brown haze/brown air. Los angles smog is light induced smog.

Effect –

Due to smog elastic substances (rubber/tyers) also affected. Smog causes damage in rubbers. During smog peroxyacetyl nitrate (PAN) is formed. PAN stops or inhibits the photolysis of water in hill reaction of photosynthesis and effect or inhibit the photo system - II PAN also inhibit the chlorophyll formation is plants.

- In animals PAN cause irritation is eyes and harms the lungs.
- Ozone causes harm to mucous membrane.**(b) London smog or sulphur smog -**

It was first observed in London. In this process coal, smoke, fog, sulphur oxide and low temperature are essential. These components reacts with each other and form vapour (fog) of H_2SO_4 which is known as London smog **Effect -**
Due to inhalation of H_2SO_4 vapour with fog 4000 people died in London in 1952.

B. Acid rain -
This word was given by Robert August. NO_2 and SO_2 released from different sources in form of smoke and dissolved in atmospheric water vapour to form sulphuric acid and nitric acid (H_2SO_4 + HNO_3). These acid come down on earth with rain water this is called acid rain.

Web deposition : - If acid comes down on earth with rain, fog and smog, it is known as wet deposition.

Dry deposition :- If acid settled on earth surface through solid dust particles with nitrate or sulphate, this iscalled dry deposition.

Note :

- The pH of acid rain is lesser than < 5.6
- In acid rain the ratio of H_2SO_4 and HNO_3 is 7 : 3 (70% H_2SO_4 + 30% HNO_3)

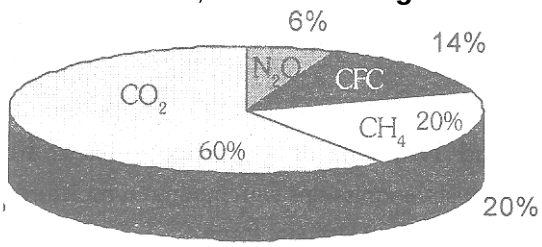
Effects -

(1) Due to acid rain acidity of soil and water increases.

(2) Acid rain also causes damages historical monuments e.g. Taj Mahal, Red Fort.

GREEN HOUSE EFFECTS

Usually carbon dioxide is not considered as pollutant, but it higher concentration forms a thick layer above the earth's surface, checks the radiation of the heat from the earth surface. Because of this, temperature of the earth's surface increases , this is called **"green-house effect"** or **global warming.**



The relative contribution of different gases to the greenhouse effect

Main green house gases are CO_2, CH_4 CFC, N_2O, excluding this SO_2, O_3, water vapour are also released from industries and agriculture which are responsible to increase the green house effect.

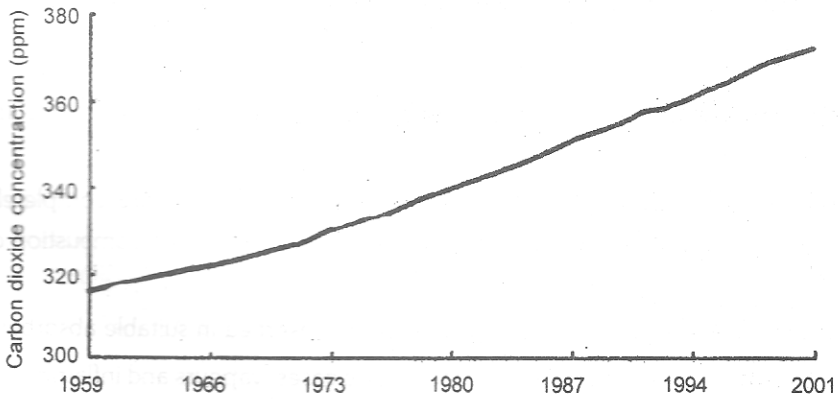


Diagram IV : Showing the increase in mean carbon dioxide concentration in the atmosphere from 1959 to 2001 based on a data from Maunaloa observatory, USA

In this phenomenon cover of CO_2 layer around the earth, allow the short wavelength incoming solar radiation to come in but does not allow the log wavelength of out going heat radiation from warm surface of earth and surface keep the earth warm. The consequent increase in the global mean temperature is referred to as **global warming.**

Note :

1. It has bee observed that in the recent past, the level of CO_2 in the atmosphere has increased from **280 ppm to 368 ppm in 1956 to 2002**. If present growth rate is continued then the amount of CO_2 will be doubled upto 2020 century, Even 2-3^0 rise in temperature will lead to melting of glaciers and ice caps of polar region and consequently the floods in rivers, rise in sea level and changes in cycle or gain. Island my be submerged in sea water.
2. **Carbondioxide fertilization effect -** Due to increased CO_2 concentration the rate of photosynthesis will increase (up to a few year). The response of the plants to elevated concentration of CO_2 is known as the CO_2 fertilization effect.
3. The global mean temperature has increased by 0.6^{0}C in 20th century.
4. Sea level has been raised by 1 to 2 mm per year during 20th century.

CONTROL OF AIR POLLUTION

(1) Control of particulate matter - Two devices are use to remove particulate air pollutants

(a) Arresters **(b) Scrubbers**

ARRESTERS :

These are used to separate particulate matters from contaminated air.

Arresters are of different types :

(i) Cyclonic separators and Trajectory separators :- These are commonly used to separate out particulate matters from industrial emission with minimum moisture content. These separators wok on the principle of duct separation by centrifugal force.

(ii) Electrostatic precipitator :- It is the most efficient device to remove fine particulate pollutants. Electrostatic precipitation device work on the principle of electrical charging of the dust particles and collecting it on a differently charged platform.

SCRUBBERS :

These are used to clean air for both dust and gases. Wet and dry two types of scrubbers are used for dut separation.

(2) Control of Gaseous pollutants - Combustion, absorption and adsorption technique are used to control gaseous pollutants.

(a) Combustion - In combustion process, oxidisable gaseous pollutants are completely burnt at a high temperature. Petrochemical, fertilizer, paints and varnish industries use combustion control of gaseous pollutants.

(b) Absorption : In this technique, gaseous pollutants are absorbed in suitable absorbent materials.

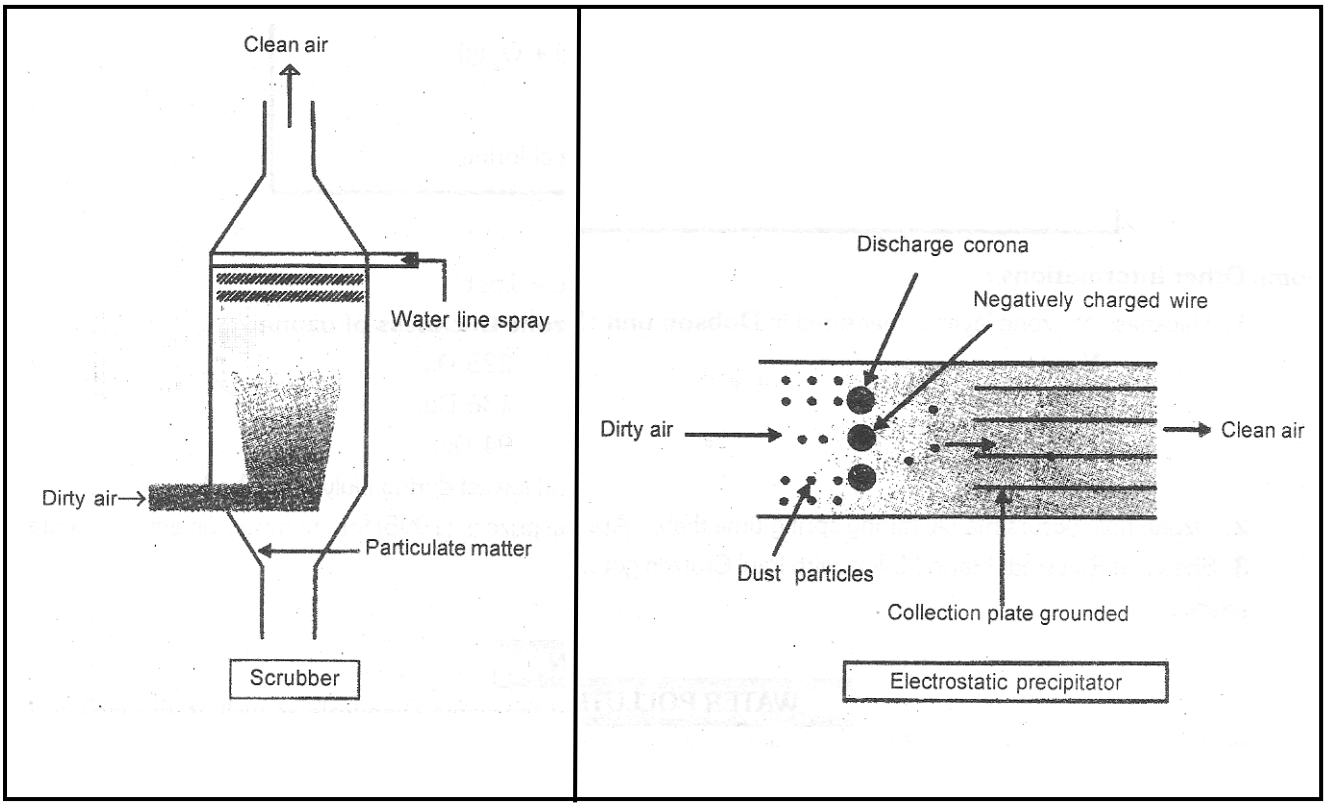
(c) Adsorption : This technique is applied to control toxic gases, vapours and inflammable compounds that could not be efficiently removed or transferred by a fore said technique. Such air pollutants are adsorbed on large solid surface.

Some other Method -

1. Engines should not be kept started when vehicle is in rest condition.
2. Barium compound mixed with petrol reduces the smoke.
3. It is also very essential to check the quality of gases released from the factories.
4. Industries should not be established at one place.

5. The smoke should be released into the atmosphere after filtration and purification (by cyclone collector or electrostatic precipitators)

To separate particles larger than $50\,\mu m$, gravity settling tanks or porous filters are being used.



OZONE DEPLETION

- Ozone is present in less quantity in atmosphere. But at the height of **16 km to 25 km** on earth, concentration of ozone is maximum is stratosphere.
- At normal temperature and pressure thickness of ozone layer is **3 mm.** (But at poles thickness of ozone layers is **4 mm**).
- Due to depletion of ozone layer harmful **UV** radiations are penetrating to the earth which causes **skin cancer (Melanoma)** and also acts as strong mutagens.
- Ozone hole was first discovered in **1985** over Antarctica by **Nimbus-7** satellite.

The aerosols like C.F.C. (Chloro flouro carbon) release into the atmosphere from the refrigerators air conditioners and jet planes deplete or reduce the ozone layer. This is called ozone depletion and these substances are called O. D.S. (ozone depleting substances). This thin layer ozone is also known as ozone holes.

$$O_3 \xrightarrow[C.F.C.]{U.V.} O_2 + O$$

Number of pollutants like **CFCs (14% of total depletion),** Nitrogen oxide [3.5 %] CH_4 and halogens(chlorine) cause depletion of ozone layer. Maximum DOP (ozone depleting potential) is of CFCs due to release of chlorine.

Note :

1. In this process of **one chlorine atom** convert one lakh O_3 molecules into O_2 byphytodissociation.
2. The life time of CF_2Cl_2 (**CFC-12**) is 139 year while that for $CFCl_3$ (**CFC = 11**) is about 77 years.

Chemical process of ozone depletion – chain reation

$$CF_2Cl_2(g) + hv \longrightarrow Cl^{\bullet}(g) + {}^{\bullet}CF_2Cl(g)$$

$$Cl(g) + O_3(g) \longrightarrow ClO^{\bullet}(g) + O_2(g)$$

$$ClO^{\bullet}(g) + O(g) \longrightarrow Cl^{\bullet}(g) + O_2(g)$$

↑

active chlorine

Some Other Information's :

1. Thickness of ozone layer is measures in **Dobson unit** (1 Du 1 ppb)

Year	Ozone thickness of ozone
1979	225 Du.
1985	136 Du.
1994	94 Du.

2. Ozone hole occurs mainly during spring time (Feb. - Apr.) and lowest during (July - October)
3. Shewood Rowland, Mario Molina with Paul Crutzen got nobel prize in (1995) for chemistry on environmental science.

WATER POLLUTION

The water pollution is caused by the addition of organic and inorganic chemicals as well as the biological materials which change the physical and chemical properties of water. This harmful process is called **water pollution.**
The water pollution is caused by many sources such as sewage matter, industrial wastage, agricultural wastage domestic wastage, hot water of thermal plant and nuclear reactors etc.

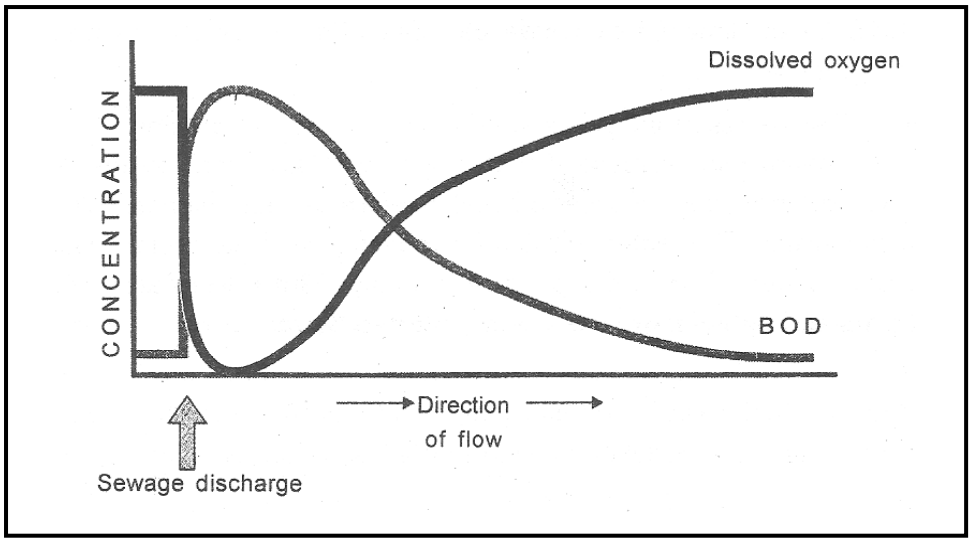
- Water having D.O. content below **8.0 mgl^{-1}** may be considered as contaminated and below **4.0 mgl^{-1}** heavily polluted.
- D.O. is measured by **oximeter**

1. Biochemical Oxygen Demand (B.O.D.) :

The water pollution by organic wastes is measured in terms of Biochemical oxygen demand. It is the amount of dissolved oxygen **(D. O. = Dissolved Oxygen)** needed by bacteria in decomposing the organix wastes present in water
B.O.D. increased = water polluted B.O.D. $\propto$ input of organic wasted
If B.O.D. is increased dissolved oxygen is decreased in water. Higher amount of organix waste increase the rates of decomposition in water. O_2 rapidly consumed by microbes, thereby causing drop in D.O. content in water.

Note :

- **Daphnia** is the indicator B.O.D.
- Biochemical oxygen demand (BOD) is the amount of oxygen taken up by the micro organisms present in water BOD is measured by keeping a sample of water containing known amount of oxygen for **5-days** at **20^0C** in the dar. At end of this period the oxygen content is again measured. A high BOD indicates intense level of microbial pollution.



2. Chemical Oxygen Demand (C.O.D.)
It is the oxygen requirement by chemical for oxidation of total organix matter (biodegradable + non biodegradable) in water.
Note : C.O.D. value is always higher than B.O.D. value.

3. Biological magnification : -
The non biodegradable pollutant like Al, Hg, Fe, D.D.T., pesticides, phenolic compound ABS (Alkyl benzene sulphonate) are nor decomposed by micro-organisms.
They get accumulated in tissue in increasing concentration along the food chain is called biological magnification. **The highest concentration occur's in top consumer.**
Note : High concentration DDT disturb calcium metabolism in birds, which cause thinning of egg shell and their premature breaking eventually causing decline in bird populations.

4. Eutrophication : -
The process of nutrient enrichment of water and consequent loss of species diversity (or death of aquation animals) is referred to as eutrophication and lake is known as eutrophic lake. In this process presence of nutrients in lake stimulates growth of algae (algal bloom) increase organic loading and bring about reduction in the oxygen content of water causing death of aquatic animals.

Note :

- Eutrophication is the natural aging of a like by biological enrichment of its water. Natural aging of a lake may span thousands of years and lake finally converted into land due to deposition of silt. Pollutants from main's activities like effluents from the industries and homes can radically accelerate the aging process, this phenomenon is called accelerated eutrophication.
- B.O.D. of Eutrophic lake is very high.

Water Pollution can be caused by the following man made sources

1. Household Detergents :- The household detergents include the compounds of phosphate, nitrate, ammonium and alkyl-benzene sulphonate etc. harmful substances which are gathered in water, Alkyl benzene sulphonate is non degradable (ABS), so its concentration increases which is harmful for aquatic life.

Inorganic phosphorus and Nitrogen :- The growth of algae is very fast due to presence of higher concentration of these substances, After the death of algae their carbonic material decomposed and deprived of oxygen, which causes death of aquatic organisms. The presence of large amount of organic material leads to eutrophication because of this, amount of oxygen is water decreases. Some of the algae also secrete toxic materials. The drinking of such polluted (toxic) water causes death of the cattles.

For the control of this pollution, like ferric chloride, etc. are used to precipitate the phosphate. **Zirconium** is considered best for this purpose.

II. Industrial waste :- The wastes of industries are discharged into the running water of rivers and canals. Industrial waste mainly contains inert suspended particles such as dust, coal, toxins like acid, base phenols, cyanides, mercury, zinc etc. inorganic reduced material like-ferrous salts sulphide, oils and other residues of organic material and hot water. The water polluted by mercury, lead etc metals when used which causes disorganisation of nervous system. It means it produces insanity. **The minamata disease was caused in Japan by eating polluted fished from the water polluted by mercury.** So many human died because of this disease.
For the control of the industrial wastes and toxic components should be purified before draining into rivers, lakes and ponds or sea. So the water pollution by industrial effluents can be controlled by suitably treating the pollutants.

IV. Sewage - Sewage contains highest amount of carbonic materials and biological material, as pollutants, these carbonic materials increase the number of decomposers like bacteria and fungus. The rate of deoxygenating is reduced as compared to deoxygenating in a water reservoirs. The acceleration of microbial activity increases BOD of water. This indicates the essential amount of oxygen for decomposition in bacteria.
BOD is very less in pure water. The higher BOD is the indication of water pollution and the water of polluted reservoir can not be utilized and very bad smell spreads around the locality. The infections or infectious diseases also takes place.

Method of water purification :

The industrial and municipal waste water are treated in “Effluent Treatment Plant” (ETP). Generally following treatments are given in ETP.

1. **Primary treatment :-** This physical process involves the separation of large debris (particle), followed by sedimentation in tanks.

2. **Secondary treatment: -** This is a biological process and is carried out by microorganism. In this process, the waste water is pumped in shallow stabilization or oxidation ponds or activated sludge chamber, where the microbes oxidise its organic matter. The process results in release CO_2 and this CO_2 is used by algae in photosynthesis. In photosynthesis process algae release O_2.

3. **Tertiary treatment :-** This physiochemical process removes turbidity in waste water caused by the presence of nutrients (nitrogen, phophorus etc.), dissolved organic matter, metals or pathogens.
This step involves chemical oxidation of waste water by strong oxidising agents, such as chlorine gas, perchlorate salts, ozone gas and UV radiations.
After tertiary treatment, the waste-water can be discharged into natural water sources or used irrigating.

Daphnia, trout fishes and larva of stone fly are sensitive to water pollution and show the intensity of water pollution.

Some animals are very specific to their habitat, other have wider choice or tolerance levels. For example **Tubifex (an annelid)** and many insect larva such as chiromonous larva lies in polluted water. They can survive in water with very low oxygen quantity and high organic content. Certain fishes like **trout** can live only in fresh water, whereas other like **Hilsa** can live in both fresh water and saline water