



# **Total dissolved salts (TDS) and its determination**

- TDS are the inorganic matters and small amounts of organic matter, which are present in molecular, ionized or micro-granular (colloidal sol) suspended form in water.
- TDS concentrations are often reported in parts per million (ppm).
- Water TDS concentrations can be determined using a digital meter.
- TDS is generally measured for drinking water to know the quality of the water and the water quality for streams, rivers and lakes.
- The most common chemical constituents are calcium phosphates, nitrates, sodium, potassium and chloride.


The two principal methods of measuring total dissolved solids are gravimetric analysis and conductivity.

The measurements of TSS and TDS in water samples were carried out according to the standard methods by the filtration process.

A fixed volume of water sample is poured on a preweighed glass fiber filter of a specified pore size before starting the vacuum filtration process.

Remove the filter after the completion of the filtration process and then place in an aluminium dish in an oven at 100°C for 2-3 hours to completely dry off the remaining water.

The filter is then weighed, and the gain in filter weight represented the TSS contents, expressed in mass per volume of sample filtered (mg/L).



The TDS of the water samples are determined by the gravimetric method.

After filtration for TSS analysis, the filtrate was heated in oven at above 100°C until all the water is completely evaporated. The remaining mass of the residue represents the amount of TDS in a sample.

This method is generally the best, although it is time-consuming. If inorganic salts comprise the great majority of TDS, gravimetric methods are appropriate.

Electrical conductivity of water is directly related to the concentration of dissolved ionized solids in the water.

Ions from the dissolved solids in water create the ability for that water to conduct an electric current which can be measured using a conventional conductivity meter or **TDS meter**.

When correlated with laboratory TDS measurements, conductivity provides an approximate value for the TDS concentration usually to within ten-percent accuracy.

The relationship of TDS and specific conductance of groundwater can be approximated by the following equation:

$$TDS = k_e EC$$

where TDS is expressed in mg/L and EC is the electrical conductivity in microsiemens per centimeter at 25 °C.

The correlation factor  $k_e$  varies between 0.55 and 0.8.

Water can be classified by the level of total dissolved solids (TDS) in the water:

Fresh water: TDS is less than 1,000 mg/L

Brackish water: TDS = 1,000 to 10,000 mg/L

Saline water: TDS = 10,000 to 35,000 mg/L

Hypersaline: TDS greater than 35,000 mg/L

Drinking water generally has a TDS below 500 mg/L.


Higher TDS Fresh Water is drinkable but taste may be objectionable.

- The analyses of heavy metals and trace elements such as Cu, Zn, Mg, Fe, Cd, Pb, Cr, As, Hg, and Sn
- Can be measured using Flame Atomic Absorption Spectrometer
- For analysis of Cd, Cr, and Pb, direct extraction/air-acetylene flame method
- while manual hydride generation AAS method is used in determination of As in the samples.
- Cold-vapor AAS method can be applied in determination of Hg and for Sn direct air-acetylene flame method.
- The standard solution for each tested element is prepared according to its concentration and used to calibrate the system before analyzing each water sample.



soil pollution



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- What is soil pollution ?
  - How is it caused ?
  - What are the effects of soil pollution ?
  - How can we control soil pollution ?

# What is soil pollution?

It is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health.

For example, exposure to soil containing high concentrations of benzene increases the risk of contracting leukaemia.

# How is it caused?

- Seepage from a landfill
- Percolation of contaminated water into the soil
- Rupture of underground storage tanks
- Excess application of pesticides, herbicides or  
fertilizer
- Solid waste seepage
- Deforestation and Soil erosion
- Agriculture (excessive/improper use of pesticides)
- Excessive industrial activity
- Discharge of industrial waste into the soil
- Poor management or inefficient disposal of waste

# What are the Processes that Cause Soil Pollution?

Soil pollution can be broadly classified into two categories –

- Naturally caused soil pollution
- Anthropogenic soil pollution (caused by human activity)

## Natural Pollution of Soil

In some extremely rare processes

- Occur due to the differential deposition of soil by the atmosphere.
- Another manner is via transportation of soil pollutants with precipitation water.

□ For example, perchlorates can be formed in soils containing chlorine and certain metals during a thunderstorm.

## **Anthropogenic Soil Pollution**

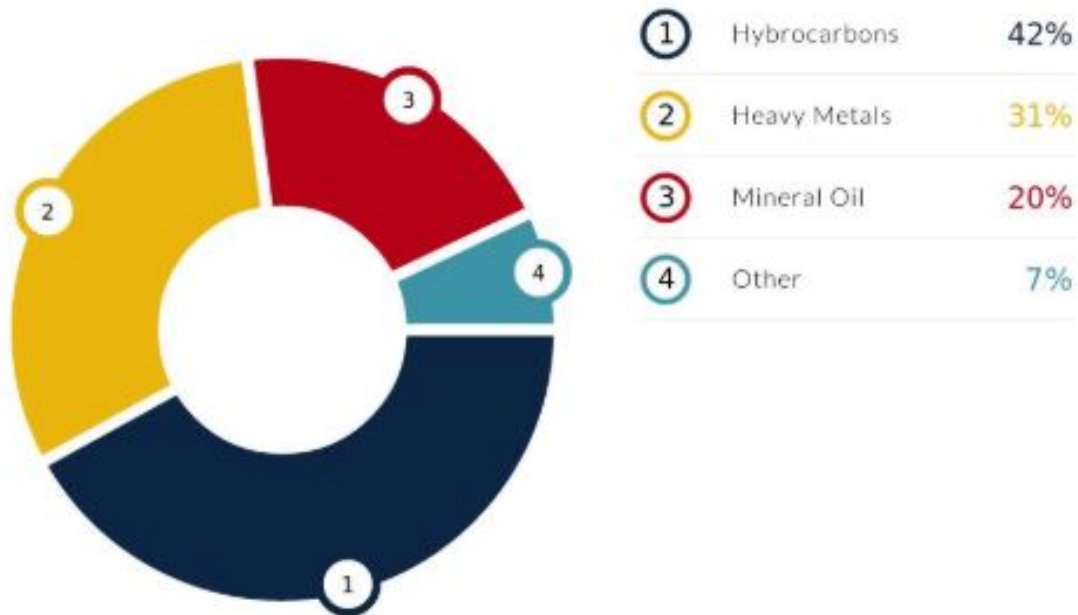
Almost all cases of soil pollution are anthropogenic in nature. A variety of human activities can lead to the contamination of soil. Some such processes are listed below.

- The demolition of old buildings –asbestos contamination.
- Usage of lead-based paint.
- Spillage of petrol and diesel.
- Activities associated with metal casting factories (foundries
- Underground mining activities –contaminates the land with heavy metals.
- Improper disposal of highly toxic industrial/chemical waste.
- Chemical pesticides contain several hazardous substances.
- Sewage produced in urbanized areas can also contaminate soil. These wastes may also contain several carcinogenic substances.
- Other forms of waste that can pollute soil include nuclear waste, e-waste, and coal ash.

# What are the common contaminants of soil pollution?

- ✓ Polycyclic Aromatic Hydrocarbons
- ✓ Industrial Waste
- ✓ Plasticizers/dispersants
- ✓ Pesticides
  - Herbicides – used to kill/control weeds and other unwanted plants.
  - Insecticides – used to kill insects.
  - Fungicides – used to kill parasitic fungi or inhibit their growth.
- ✓ Mercury-containing compounds
- ✓ Thiocarbamates and Copper sulfate
- ✓ Radioactive substances resulting from explosions of nuclear testing laboratories and industries.

These chemicals pose several health risks to humans. Examples of health hazards related to pesticides include diseases of the central nervous system, immune system diseases, cancer, and birth defects.



### Toxic Metals that Cause Soil Pollution

Arsenic

Antimony

Cadmium

Thallium

Mercury

Zinc

Selenium

Chromium

Lead

Nickel

Beryllium

Copper

# Effects of soil pollution

## **After-Effects of Soil Pollution**

Soil pollution is not only the problem in India but it is a global problem. It causes harmful effect on the soil and the environment at large. Contamination of soil will decrease the agricultural output of a land. Major soil pollution after effects are:

### **Inferior Crop Quality**

It can decrease the quality of the crop. Regular use of chemical fertilizers, inorganic fertilizers, pesticides will decrease the fertility of the soil at a rapid rate and alter the structure of the soil. This will lead to decrease in soil quality and poor quality of crops. Over the time the soil will become less productive due to the accumulation of toxic chemicals in large quantity.

### **Harmful Effect on Human Health**

It will increase the exposure to toxic and harmful chemicals thus increasing health threats to people living nearby and on the degraded land. Living, working or playing in the contaminated soil can lead to respiratory diseases, skin diseases, and other diseases. Moreover, it can cause other health problems.



The short term effects of human exposure to polluted soil include:

- ☐ Headaches, nausea, and vomiting.
- ☐ Coughing, pain in the chest, and wheezing.
- ☐ Irritation of the skin and the eyes.
- ☐ Fatigue and weakness.

A variety of long-term ailments have been linked to soil pollution. Some such diseases are listed below.

- ☐ Exposure to high levels of lead can result in permanent damage to the nervous system.
- ☐ Children are particularly vulnerable to lead.
- ☐ Depression of the CNS (Central Nervous System).
- ☐ Damage to vital organs such as the kidney and the liver.
- ☐ Higher risk of developing cancer.

It can be noted that many soil pollutants such as petroleum hydrocarbons and industrial solvents have been linked to congenital disorders in humans

## **Water Sources Contamination**

The surface run-off after raining will carry the polluted soil and enter into different water resource. Thus, it can cause underground water contamination thereby causing water pollution. This water after contamination is not fit for human as well as animal use due to the presence of toxic chemicals.

## **Negative Impact on Ecosystem and Biodiversity**

Soil pollution can cause an imbalance of the ecosystem of the soil. The soil is an important habitat and is the house of different type of microorganisms, animals, reptiles, mammals, birds, and insects. Thus, soil pollution can negatively impact the lives of the living organisms and can result in the gradual death of many organisms. It can cause health threats to animals grazing in the contaminated soil or microorganisms residing in the soil.

# Methods to control soil pollution

Soil erosion can be controlled by a variety of forestry and farm practices.

1. Planting trees on barren slopes: Contour cultivation and strip cropping may be practiced instead of shifting cultivation. Terracing and building diversion channels may be undertaken. Reducing deforestation and substituting chemical manures by animal wastes also helps arrest soil erosion in the long term.
2. Proper dumping of unwanted materials: Excess wastes by man and animals pose a disposal problem. Open dumping is the most commonly practiced technique. Nowadays, controlled tipping is followed for solid waste disposal. The surface so obtained is used for housing or sports field.

3. Production of natural fertilizers: Bio-pesticides should be used in place of toxic chemical pesticides. Organic fertilizers should be used in place of synthesized chemical fertilizers. Ex: Organic wastes in animal dung may be used to prepare compost manure instead of throwing them wastefully and polluting the soil.
4. Proper hygienic condition: People should be trained regarding sanitary habits. Ex: Lavatories should be equipped with quick and effective disposal methods.
5. Public awareness: Informal and formal public awareness programs should be imparted to educate people on health hazards by environmental education. Ex: Mass media, Educational institutions and voluntary agencies can achieve this.

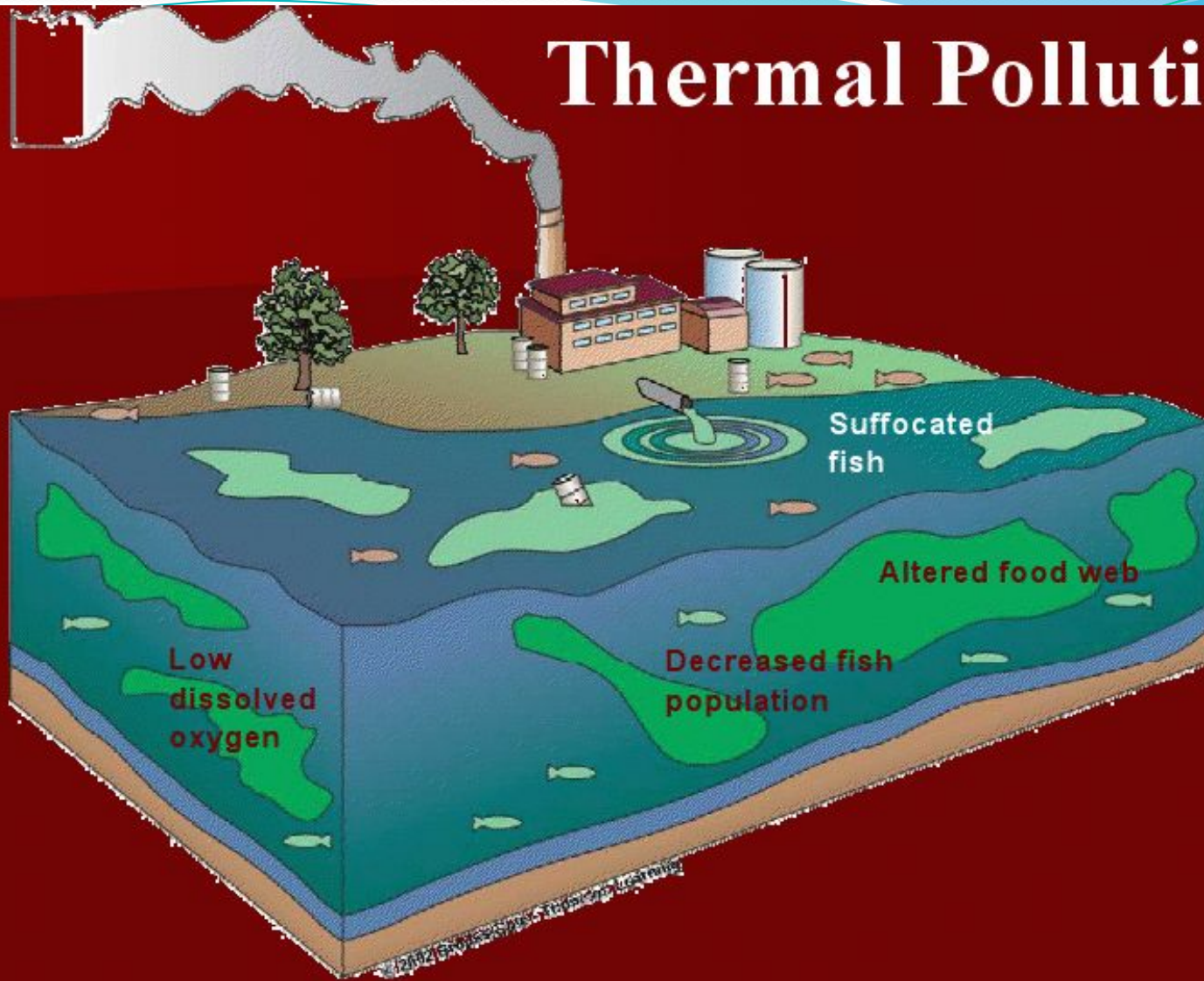
6. Recycling and Reuse of wastes: To minimize soil pollution, the wastes such as paper, plastics, metals, glasses, organics, petroleum products and industrial effluents etc should be recycled and reused. Ex: Industrial wastes should be properly treated at source. Integrated waste treatment methods should be adopted.
7. Ban on Toxic chemicals: Ban should be imposed on chemicals and pesticides like DDT, BHC, etc which are fatal to plants and animals. Nuclear explosions and improper disposal of radioactive wastes should be banned.
8. Embrace technological research and development  
The government should integrate the resources from various research institutions and universities to support relevant research on soil and promote research on common technologies that relate to soil pollution diagnosis, research, and development of advanced data collection and mapping equipment, and soils contamination risk management and control.

# INTRODUCTION

- Thermal Pollution is the harmful increase in water temperature in streams, rivers, lakes, or occasionally, coastal ocean waters.
- It is the degradation of water quality by any process that changes ambient water temperature.
- A temperature increase as small as 1 or 2 Celsius degrees (about 2 to 4 Fahrenheit degrees) can kill Native fish, shellfish, and plants, or drive them out in favor of other species, often with undesirable effects.



# Thermal Pollution



# SOURCES

The major sources of thermal pollution are discharge of heated water or hot waste material into water bodies

Main causes are :

- Nuclear power plant.
- Industrial effluents
- Domestic sewage
- Hydro-electric power
- Coal fired power plants
- Thermal shock

Other causes are :

- Deforestation
- Soil erosion



# Nuclear Power Plants

- ✓ Nuclear power plants use water as a cooling agent.
- ✓ After the water is used, it is put back into a water supply at 9-20°C warmer .
- ✓ Emission from nuclear reactors increase the temperature of water bodies.

# Coal Field Power Plants

- ✓ Coal is utilized as a fuel.
- ✓ Condenser coils are cooled with water from nearby lake or river.
- ✓ The heated effluents decrease the DO of water.
- ✓ Damages the marine organisms.

# Industrial Affluents

- ✓ Discharged water from steam-electric power industry using turbo generators will have a higher temperature ranging from 6 -9°C than the receiving water.
- ✓ In modern stations, producing 100 MW, nearly one million gallons are discharged in an hour with increase in temperature of the cooling water passing by 8 to 10 °C .

## Sewage

- ✓ Sewage is commonly discharged into lakes, canals or streams.
- ✓ Municipal sewage normally has a higher temperature than the receiving water.
- ✓ Increase in temperature of the receiving water decreases the dissolved oxygen of water

## Deforestation

- ✓ Streams and small lakes are naturally kept cool by trees and other tall plants that block sunlight. People often remove this shading vegetation in order to harvest the wood in the trees, to make room for crops, or to construct buildings, roads, and other structures.

# Soil Erosion

- ✓ Removal of vegetation far away from a stream or lake can contribute to thermal pollution by speeding up the erosion of soil into the water, making it muddy, which increases the light absorbed .

# Thermal Shock

- ✓ When a power plant first opens or shuts down for repair or other causes, fish and other organisms adapted to particular temperature range can be killed by the abrupt change in water temperature known as "thermal shock."

# EFFECTS

- Elevated temperature typically decreases the level of dissolved oxygen of water.
- Increases the metabolic rate of aquatic animals, as enzyme activity, resulting in these organisms consuming more food in a shorter time , which increases their need for oxygen.
- High temperature limits oxygen dispersion into deeper waters, contributing to anaerobic conditions.
- This lead to increased bacteria levels when there is ample food supply. Many aquatic species will fail to reproduce at elevated temperatures.
- Primary producers are affected by warm water because higher water temperature increases plant growth rates, resulting in a shorter lifespan and species overpopulation.

# Biotic Effects

Changes in the environment may also result in a migration of organisms to another, more suitable environment, and tin-migration of organisms that normally live in warmer waters. As a result , there arises a problem of compromising food chain, which results in reduction of biodiversity.

Changes of even 1 or 2 degrees Celsius can cause significant changes in organism metabolism and other adverse cellular biology effects. Principal adverse changes can include rendering cell walls less permeable to osmosis, coagulation of cell proteins, and alteration of enzyme metabolism. These cellular level effects can adversely affect mortality and reproduction



# CONTROL MEASURES OF THERMAL POLLUTION

# Cooling towers and artificial lakes

- Industries which generate excess heat release the heated water into water channels. This water affects the normal temperature of the water bodies affecting the ecosystem adversely. An economic solution to the problem is using cooling ponds to let the heated water lose its temperature with time. Once the temperature is in equilibrium with the surroundings, it can be released into water bodies or recycled for further use. Artificial lakes work on the same principle and can help check thermal pollution by using natural processes to minimize heat transfer to natural water bodies.

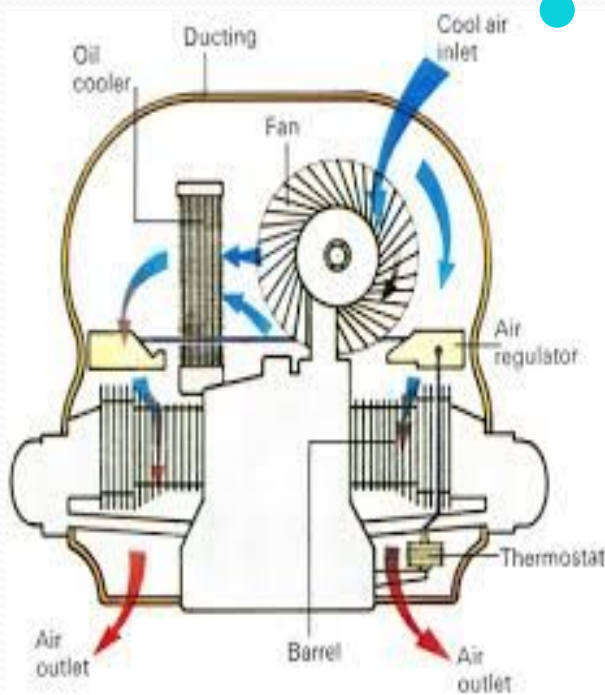


## 2. Save Electricity

- Electricity was never a cheap commodity. Its production involves burning of coal in thermal power plants, which is used to heat up water and in turn, the steam produced is used to power turbines which generate electricity. However, the waste heat generated from thermal power plants is in large quantities and can cause excess thermal pollution. Hence, when we save electricity, we indirectly prevent thermal pollution.



### 3. Use of alternative cooling agents other than water.



- A majority of our infrastructure surrounds around the use of water as a coolant. The primary reason behind it is the ease of availability and easy disposal once the cooling purpose is fulfilled. However, the heated water disturbs the ecosystem of water bodies. Hence, emphasis should be laid on using coolants other than water. Air-cooled systems are the best alternative to water-based cooling systems. For smaller units, oil-based cooling systems would fulfill the task of cooling. Well, the oil is reusable and can be used for multiple cooling cycles.

## 4. Release heated water in less vulnerable regions

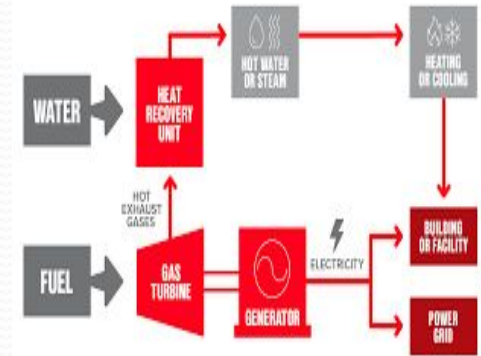
- Several heavy scale industries are established close to water bodies. It helps with an easy discharge of waste in an economic way. However, several natural water bodies have a sensitive ecosystem. In other words, the vegetation of the particular water body would not survive a sudden rise in temperature. Hence, steps should be taken to prevent the release of heated water in less vulnerable regions.

## 5. Tree planting along the shorelines

The most economic way to control any form of pollution is afforestation. Tree plantation along shorelines would help the soil to retain its texture and productivity. Additionally, the trees would help control air pollution and result in a better and more stable ecosystem.

# 6. Cogeneration

- Cogeneration works on the principle of 'reuse', where the residue heat from the generation of electricity is used to provide heat to homes and buildings. Hence, Cogeneration or Combined Heat and Power is an effective measure to prevent thermal pollution.



## 7. Use of alternative sources of energy

Electricity generation through conventional thermal power plants is the major source of pollution. Thermal power plants use steam-driven turbines to generate electricity. Hence, it results in thermal pollution. As a precaution, solar energy or hydropower plants could be used to prevent the thermal pollution in the production of electricity.

# 8.Environmental Awareness

- In the present set of conditions, the issues of thermal pollution are set to increase over a period. The only viable solution would be raising environmental awareness and making people familiar with the ill-effects of rapid industrialization.



# **Radiation Pollution: Types, Sources, Effects, Control of Radiation Pollution**

Radiation is the process by which radiant energy is transferred from one place to another in the form of electro-magnetic waves. The various types of radiation differ from one another by their frequency or wavelength. Higher the frequency or lower the wave-length of a radiation, higher will be its energy. Again, higher the energy of the radiation, it will cause higher damage to the living organisms.

### **Non-ionising Radiation:**

These are the radiations which induce the ionisation of atoms and molecules. An atom is ionised when energy supplied to it separates one or more of its electrons. Ionisation of a molecule produces two fragments. The radiation pollution is mainly caused by non-ionising radiation.

Alpha ( $\alpha$ ), beta ( $\beta$ ), and gamma ( $\gamma$ ) radiations are mainly responsible for radiation pollution. Alpha radiation contains energetic  $\alpha$  particles. Each alpha particle carries two units of positive charges and interacts strongly with living tissues.

Beta radiation is made up of energetic electrons. Each beta particle carries one unit of negative charge and interacts strongly with matter. Gamma radiations are made up of high energy photons. Photons bring about strong electro-magnetic interaction with matter.



## **Sources of Radiation Pollution:**

Radiation sources are mainly natural but partly manmade

**The natural sources of radiation may be:**

1. Radioactive minerals;
2. Cosmic rays;
3. Radio nuclides.



## **1. Radioactive Minerals:**

The minerals containing Uranium- 235 ( $\text{U}^{235}$ ), Uranium-238 ( $\text{U}^{238}$ ), Thorium-232 ( $\text{Th}^{232}$ ), Plutonium- 239 ( $\text{Pu}^{239}$ ) etc. are capable of emitting energetic radiations causing pollution.

## **2. Cosmic Rays:**

The cosmic rays containing highly energetic particles reach the surface of the earth causing pollution. The intensity of cosmic rays depends on latitudes and altitude of the place. The intensity is maximum at the poles and minimum at the equator.

## **3 .Radio nuclides:**

The unstable radio-nuclides in the atmosphere can be splitted up into smaller parts emitting energetic radiation. The smaller radio-nuclides enter into the body of organism along with air during respiration.



# **The various sources of manmade radiation pollutions may be:**

1. Nuclear power plants;
2. Radio-active wastes;
3. Nuclear explosions; and
4. Radio-isotopes.

## **1. Nuclear Power Plants:**

Nuclear power plants emit radiation to a very smaller extent except accidental leaks (Chernobyl accident of undivided USSR).

## **2. Radio-active Wastes:**

The nuclear power plants produce a lot of nuclear radio-active wastes. The disposal of these wastes has become a global problem. Some countries producing large quantity of nuclear wastes dump them in ocean near other countries.

### **3. Nuclear Explosion:**

During nuclear explosion, a large number of radio-nuclides are generated in the atmosphere. The radio -nuclides settle down with rain contaminating the soil and water bodies. Finally, these enter into food chain causing serious problem to the living organisms.

### **4. Radio-isotopes:**

Radio-isotopes are also prepared artificially either by nuclear fusion or by nuclear fission. If these radio-isotopes are not properly handled, these emit radiations causing pollution.

### **5. Television Set:**

Television sets produce radiations which can also cause cancer.

## **Effect of Radiation Pollution:**

**When radiation passes through different living organisms the following disorders take place:**

1. Radiation splits the molecules of the tissues into ions and free radicals and causes mutation by breaking DNA (Deoxy ribo-nucleic acid) molecules in the nucleus.
2. Radiation in bone marrow may cause leukemia.
3. Radiation may cause skin burns which may lead to skin cancer.
4. Radiation at pelvic regions of pregnant ladies, cause damage to the foetus.



## **Control of Radiation Pollution:** **Radiation pollution can be controlled in the following ways:**

1. Care should be taken to check manmade radiation pollution at source.
2. Nuclear reactor should be perfectly maintained to avoid accidental leakage.
3. Nuclear tests should be banned