# Chapter-5

Environmental pollution

# Air pollution

# Air Pollution

- The presence of material in the air in such a concentration which is harmful to man and his environment.

**POLLUTANT:** Substances causing damage to target or receptor.

Target may be man, animal, plant, tree, building or material which is adversely affected by pollutants.

- Sulphur oxides ( $SO_2$,$SO_3$ = SOx)
- Nitrogen oxides($N_20$, NO, $NO_2$, $N_2O_3$, $N_2O_4$, $N_2O_5$)

**NOx ($N_20$, NO, $NO_2$)**

- Carbon monoxide
- Suspended particulate matter (SPM)

# Sources of Air pollutant

| Sulphur oxides | Nitrogen oxides | Carbon monoxide |
|---|---|---|
| **Burning of fossil fuels** | **Nitric acid plant** | **Combustion processes** |
| Petroleum refinery operations | Fertilizer industry | Vehicular emission |
| Smelting of sulfide ores | Automobile exhaust | Cigarette smoking |
| Sulphuric acid plants | | |
| Paper making | | |

# Effects of pollutants on plants

1. Necrosis
2. Chlorosis
3. Abscission
4. Epinasty
5. Leaf spotting
6. Premature ageing of plants
7. Leaf curling, leaf drop and also reduces the nitrogen fixing efficiency of bacteria

# Effects of pollutants on humans

- Irritation in eye, nose and throat and increases susceptibility to viral infection.
- Irritation of respiratory system leading to asthma, emphysema etc
- Hypertension, Chest pain, coughing, drying of mouth
- Nerve, brain, liver and kidney damage
- The oxygen carrying capacity of the blood is due to an affinity of the haemoglobin for oxygen. Hb and $O_2$ combine, forming $HbO_2$, which releases oxygen to various organs.

$$Hb + O_2 \rightarrow HbO_2$$

If CO is present ,it combines with Hb and form carboxyhaemoglobin which reduces oxygen carrying capacity of blood. Hb has about 210 times more affinity for CO than $O_2$.

$$Hb + CO \rightarrow COHb$$

It increases the burden on heart and respiratory system which leads to headach, heart and respiratory diseases and it is highly poisonous and lead to abdomen pain, loss of vision, nausea etc. Higher concentration of CO on blood leads to death.

# Effects of pollutants on materials

- Building stones, particularly carbonate-based stones, suffer severe erosion. This phenomenon is called stone leprosy.
- The rate of corrosion of metallic structures increases.
- Fabric and leather become discolored and weathered.
- Deterioration of electrical equipment
- Cracking of rubber
- Discoloration of paints

# Control measures for Sulphur oxides (Sox)

1. Fuel desulphurisation techniques.
2. Flue gas desulphurisation techniques.

**Fuel desulphurisation techniques.**

**a)** **Physico-chemical method-** About half of the sulphur present in coal is in inorganic form. The remaining half is organically bound. To remove inorganic sulphur, the coal is grinded and subjected to washing, being heavier, inorganic sulphur tends to settle down under the influence of gravity. while the inorganic sulphur-free coal floats on the surface from where it is collected.

The organically bound sulphur in coal is removed by passing hydrogen over the fuel in the presence of catalyst. the organic sulphur is converted into $H_2S$, which is absorbed in a solution of diethylanolamine. It can be regenerated and oxidized to sulphur.

# Control measures for Sulphur oxides (Sox)

**b)** **Microbial method-** in this method organic sulphur is removed with the help of bacterial stain (IGT-57). The stain IGT-57, removes sulphur from coal without degrading coal itself.IGT-57 is cultured in a sulphur-limited chemostat, that is, a bacterial growth culture which supplies all nutrients except sulphur. The needed sulphur is extracted from coal. Thus, IGT-57 metabolizes sulphur from coal, without simultaneously degrading coal.

## Flue gas desulphurisation techniques.

**a)** **Catalytic reduction of sulphur dioxide-**

Direct reduction of sulphur dioxide to elemental sulphur is also fesible.

$$2CO + SO_2 \rightarrow 2CO_2 + S$$

Such a rex. Can be carried out over a catalyst.

# Control measures for Nitrogen oxides (Nox)

a) **<u>NOx out technology-</u>** It is a relatively modern technique which uses urea to rid flue gases of nitrogen oxides.

$$NH_2CONH_2 + NO + NO_2 \rightarrow 2N_2 + CO_2 + 2H_2O$$

b) **<u>Selective catalytic reduction technology-</u>** It involves addition of ammonia to the flue gases and passing the mixture over the selective reduction catalyst.

$$6NO + 4NH_3 \rightarrow 5N_2 + 6H_2O$$

$$6NO_2 + 8NH_3 \rightarrow 7N_2 + 12H_20$$

# Control measures for Carbon monoxide

- Catalytic Converter

| 2 way catalytic converter | 3 way catalytic converter |
|---|---|
| Removes hydrocarbons and carbon monoxide | Removes hydrocarbons, carbon monoxide and nitrogen oxides. |
| Operates at a temp. -700 K | 700-900 K |
| Oxidation catalysis | Oxidation-reduction catalysis |
| Efficiency- 50% | 90% |

# Air quality standard(ug/$m^3$)

| zone | SPM | $SO_2$ | CO | $NO_X$ |
|---|---|---|---|---|
| INDUSTRIAL | 500 | 120 | 5000 | 120 |
| RESIDENTIAL | 200 | 80 | 2000 | 80 |
| SENSITIVE | 100 | 30 | 1000 | 30 |

# Water pollution

# Water pollution

- Alteration in physical, chemical and biological properties of water which may cause harmful effects on humans and other living organisms.

Types of water pollution

1. Physical water pollution
2. Chemical water pollution
3. Biological water pollution

# BIOLOGICAL AMPLIFICATION

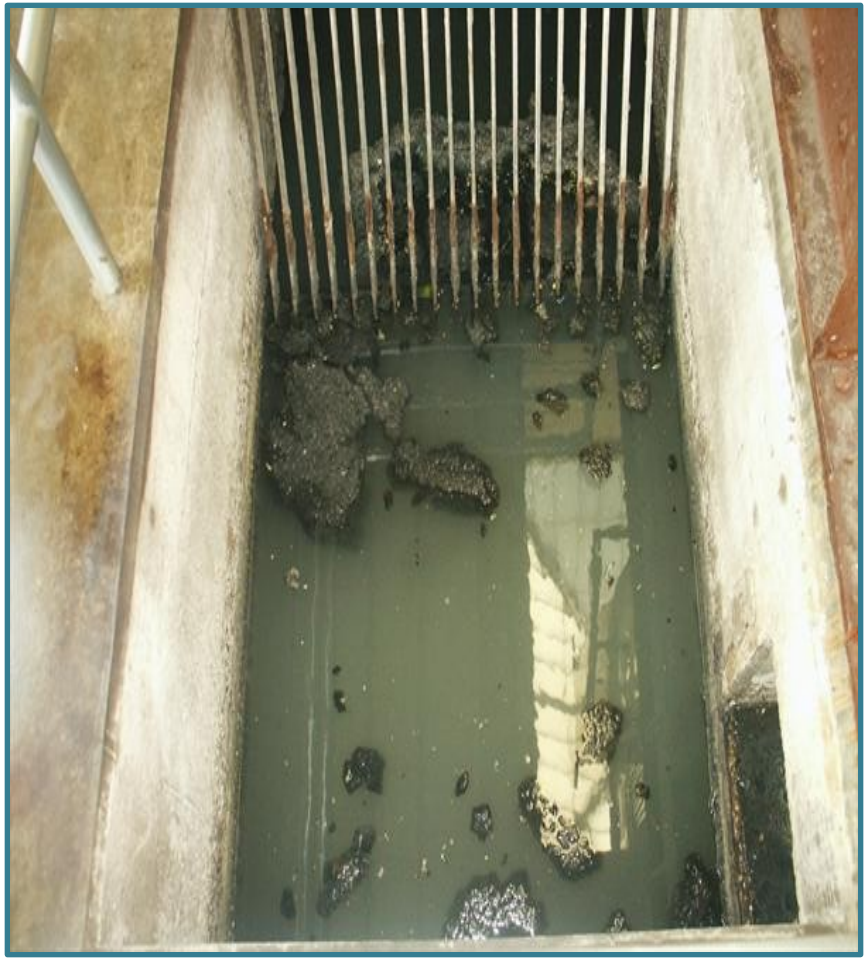
| .00002ppm | Water bodies |
|---|---|
| .04ppm | phytoplanktons |
| .08ppm | zooplanktons |
| .23ppm | Small fishes |
| .5ppm | Large fishes |
| 1ppm | Human beings |

- This is the process of increase and accumulation of toxic substances in successive trophic levels of the food chain. E.g.-The pesticides enter the food chain as these are washed out from field into water bodies and then absorbed by various organisms from here they travel in food chain and get accumulated and concentrated at each successive trophic level and highest in top most level.

# Water Treatment

1. Preliminary Treatment (Screening, Skimming)
2. Primary Treatment (Sedimentation, Flocculation etc.)
3. Secondary Treatment (Trickling filters, Oxidation pond etc.)
4. Tertiary Treatment (Chlorination, Absorption etc.)

# Preliminary Treatment



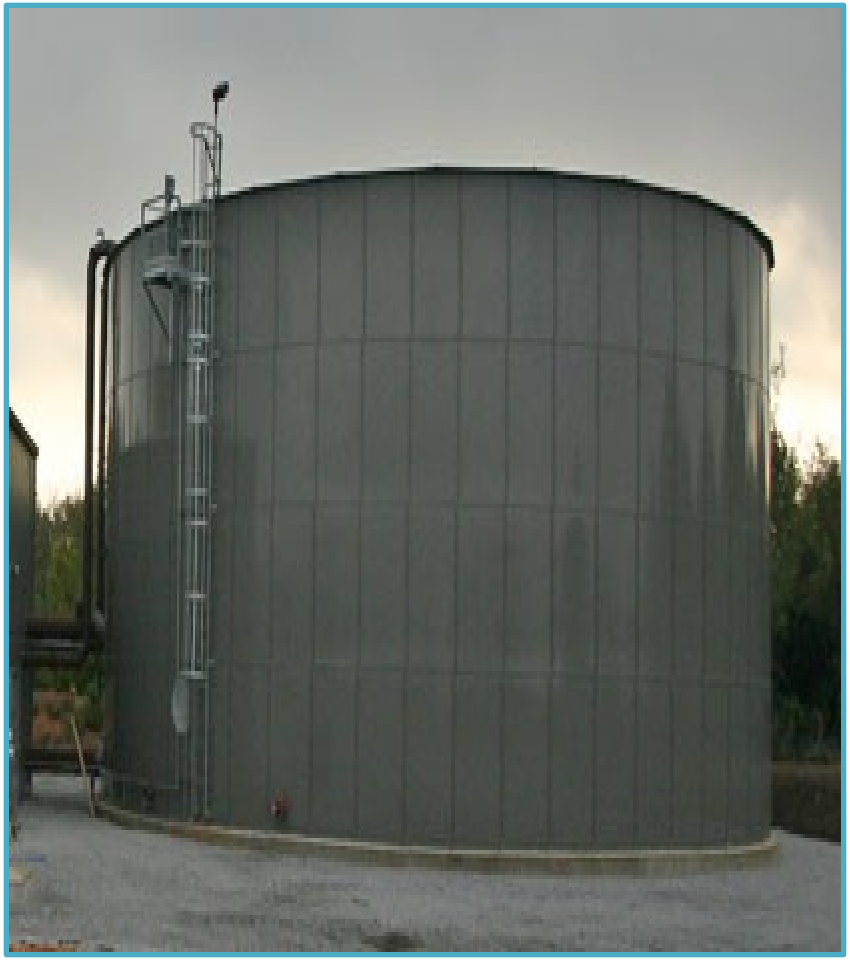
- **Screening** – impure water is made to pass through screens made up of rows of iron bars with a spacing of 1-2 inch. The iron bars are periodically cleaned to prevent clogging.

# Preliminary Treatment

- **Skimming**- oil, grease and other impurities which are lighter than water rise to the surface and can be removed by mechanical skimming.
- Also remove impurities  heavier than water-blow compressed air to polluted water-bubbles  are formed-attach to grit particle-lift to surface-removed
- The efficiency of skimming technique can be increased by adding collecting and activating agent-potassium xanthates.

# Primary treatment

- **Sedimentation-**
  Impurities are removed by allowing them to settle down under the influence of gravity. Polluted water is retained in the tank for 1-3 hours, during which period the impurities settle down.



# Primary treatment

- **Flocculation**- It is meant to rid water of the extremely fine particles.
- The rates of settlement of these particles can be enhanced by addition of flocculating agents eg- $Al_2(SO_4)_3$, $FeSO_4$, $FeCl_3$ etc.
- The fine particles in the polluted water bear either positive or negative charge.
- when flocculating agents are added -positive charge neutralized by $SO_4^{2-}$,$Cl^-$ions. Negative charge is neutralized by $Al^{3+}$,$Fe^{2+}$,$Fe^{3+}$ - charges nullified-particles come closer and coalesce.

# Secondary Treatment

- Oxidation of dissolved and colloidal organic compounds in the presence of microorganisms.
- **Trickling filter-** circular or rectangular beds with brick or concrete walls-beds are packed with clinker, slag, stones, coal, gravel etc. such a medium is intended to serve as a habitat of microorganism.
- Microorganism in the presence of dissolved oxygen-break down impurities into carbon dioxide, water, nitrates and phosphates.

# TRICKLING FILTER

# Secondary treatment-oxidation pond

Purify polluted water through an interaction between bacteria and algae -polluted water is made to flow through the pond at slow speed-bacteria decompose the biodegradable organic matter-DO is used and $CO_2$,nirtates and phosphates are generated-nitrates and phosphates are consumed as food by algae-carbon dioxide is utilized in photosynthesis.-dissolved oxygen is released during photosynthesis which is used by bacteria.

# Tertiary Treatment

- **Chlorination-** Addition to the impure water of gaseous chlorine or compounds containing active chlorine such as bleaching power CaO(OCl),sodium hypochlorite. In aqueous solution, these compounds generate hypochlorous acid, which act as a purifying agent.

  $Cl_2 + H_2O \rightarrow HOCl$

  $NaOCl + H_2O \rightarrow NaOH + HOCl$

# Noise standards

| zone | Day time 6a.m -9 p.m | Night time 9 p.m- 6 a.m |
|---|---|---|
| Industrial area | 75 db | 70db |
| Commercial area | 65db | 55db |
| Residential area | 55db | 45db |
| Silence area | 50db | 40db |

# Solid waste management

# Solid waste

- Discarded material that is not a liquid or a gas.
- Material that is cheaper to throw away then to store and use.
- It is a complex mixture of diverse materials.

Composition of solid waste

- Agricultural waste
- Industrial waste
- Biomedical waste
- Institutional waste
- Municipal waste
- Construction and demolition waste

# Solid waste management

- There are four broad methods for the disposal of solid waste.

1. landfilling
2. Incineration
3. Recycling
4. Source reduction

# landfilling

- To burry the waste below the earth surface.
- It is a large garbage pit in which the waste is spread out in thin layers, compacted and covered daily with a layer of clay or plastic form.
- The daily covering must be at least 6 inches thick.

**An ideal landfill site**

- It should be cheap, accessible and reasonable distance.
- It should be used for at least 3 years.
- It should be as impermeable as possible.
- It should be well above the ground water table so that the underground water supplies are not possible.

Once the pit is filled to its capacity, it is covered with successive layers of clay, sand, gravel and soil, the land may then be used for any recreational purpose.

Building construction on a filled-up pit should be avoided. Modern landfills are equipped with vent pipes and pumps.

# Incineration

- Burning of waste material at high temperature

**(1200-1400k).**

Incinerators operate under two conditions:

1. **Mass burn-** The entire waste is fed into the furnace and burnt.
2. **Refuse derived fuel-** The waste, is screened to isolate those components that are non combustible or that can be recycled.

# Incineration

- Ash(product of combustion), is generated during incineration in two varieties.

**Bottom ash and fly ash**

| Bottom ash | Fly ash |
|---|---|
| Constitutes about 90% of the leftover. | Constitutes about 10% of the incinerated waste. |
| Heavier particles and settles down at the bottom of combustion chamber | Being lighter, it has the tendency to become airborne. |
| Negligible quantities of toxic compounds. | Contains toxic chemicals. (mercury, lead, cadmium etc.) |

In order to combat the ill effects of fly ash, the incinerators are endowed with electrostatic precipitators. At the end of the operation, the fly ash is mixed with the bottom ash and the whole lot is buried in a landfill.

It drastically reduces the amount of waste upto 80% by volume and 75%by weight.

# Recycling

**Recycling:** Processing of a waste item into usable forms.

Benefits of recycling:

-Reduce environmental degradation

-Making money out of waste

-Save energy that would have gone into waste handling & product manufacture

**Types:**

**Closed loop recycling-**

the waste is recycled to produce an article of same type.

**Open loop recycling-**

the waste is recycled to produce an article of different type.

# Source reduction

Landfilling, incineration and recycling methods of waste disposal suffer from one common drawback : these address the waste after it has been produced.

Source reduction on the other hand, emphasizes that the industrial processes should be so designed as to produce less waste during manufacturing stage itself.

# Source reduction

Source reduction is normally carried out in one of the following ways.

1. **The products may be redesigned so that these consume less material.**
2. **The products may be redesigned so as to last longer**
3. **The products may be packaged into light weight material.**