ENVIRONMENTAL CHEMISTRY

ENVIRONMENTAL POLLUTION

- Effect of undesirable changes in our surroundings- harmful effects on plants, animals and human beings.
- **Pollutants**- substance which causes pollution (can be solid/ liquid/ gaseous).
- Pollutants → Degradable- discarded vegetable
  → Non- degradable- DDT, Plastic etc.

ATMOSPHERIC POLLUTION

- **Troposphere**- Lowest region in which all organisms live (10 km above sea level).
- **Stratosphere**- Lies (10- 50km) above troposphere.
- Ozone in stratosphere prevents about 99.5% of the sun's harmful ultraviolet (UV) radiations from reaching the earth's surface.

TROPOSPHERIC POLLUTION

- **Gaseous air pollutants**- oxides of S, N and C, HS, hydrocarbons, ozone and other oxidants.
- **Particulate pollutants**- dust, mist, fumes, smoke, smog.

GASEOUS POLLUTANTS- Oxides of Sulfur

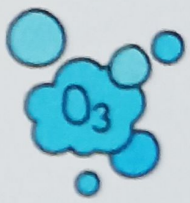
- Produced when fossil fuels are burnt.
- Causes respiratory diseases (asthma, bronchitis)

- SO_2 causes irritation to the eyes, resulting in tears and redness.
- Particulate matter catalyzes oxidizes SO_2

  $2SO_2\,(g) + O_2\,(g) \rightarrow 2SO_3\,(g)$
- Ozone, hydrogen peroxide also promotes the reaction.

  $SO_2\,(g) + O_3\,(g) \rightarrow SO_3\,(g) + O_2\,(g)$

  $SO_2\,(g) + H_2O_2\,(l) \rightarrow H_2SO_4\,(aq)$



Oxides of Nitrogen-

- Lightening helps combining O_2 and N_2 forming oxides

  $N_2\,(g) + O_2\,(g) \xrightarrow{1483K} 2NO(g)$

  $2NO\,(g) + O_2\,(g) \rightarrow 2NO_2\,(g)$
- Presence of ozone fastens rate of form. of NO_2-

  $NO\,(g) + O_3\,(g) \rightarrow NO_2\,(g) + O_2\,(g)$

- NO_2 is oxidized to nitrate ion (fertilizer).
- High conc. of NO_2- damages plants, reduces rate of photosynthesis, respiratory diseases in humans

Hydrocarbons- Formed by incomplete combustion of fuel used in automobiles.

- Carcinogenic

Oxides of Carbon-

- **CO-** Released by automobile exhaust, incomplete combustion of coal, petrol etc.
- It binds to hemoglobin- form carboxyhemoglobin (300x more stable than oxy-hemoglobin.)
- 3-4% of CO in blood- reduces carrying capacity of hemoglobin- headache, weak eyesight, nervousness.
- Pregnant women- induce premature birth, spontaneous abortions, deformed babies.

- CO_2- released by respiration, burning fossil fuels, limestone decomposition, volcanic eruptions, deforestation.
- Causes global warming.

GLOBAL WARMING + GREEN HOUSE EFFECT

- Heat trapped by gases such as CO_2, CH_4, O_3, CFCs and water vapor in the atmosphere, which adds to the heating of the atmosphere.
- Avg. global temperature increases- leads to melting of polar ice caps, flooding of low lying areas all over the earth.

ACID RAIN

- When pH of rain is < 5.6

$$H_2O\,(l) + CO_2\,(g) \rightleftharpoons H_2CO_3\,(aq)$$

$$H_2CO_3\,(aq) \rightleftharpoons H^+\,(aq) + HCO_3^-\,(aq)$$

- It is mainly due to oxides of nitrogen and sulfur in atmosphere.

$$2SO_2\,(g) + O_2\,(g) + 2H_2O\,(l) \rightarrow 2H_2SO_4\,(aq)$$

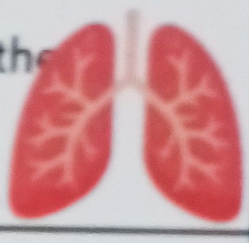
$$4NO_2\,(g) + O_2\,(g) + 2H_2O\,(l) \rightarrow 4HNO_3\,(aq)$$

- **Wet deposition-** Aerosol particles of oxides/ ammonium salts in rain.
- Acid rain washes away soil nutrients, corrodes water pipes, damages buildings.

PARTICULATE POLLUTANTS- Minute solid particles or liquid droplets in air.

- **SMOKE PARTICLES**- mix. of solid, liquid particles formed during combustion of organic matter.

- **DUST**- fine solid particles, produced during crushing, grinding, attribution of solid materials.
- **MISTS**-particles of spray liquids and by condensation of vapors in air. Eg- Herbicides, Insecticides.
- **FUMES**- condensation of vapors during sublimation, distillation, boiling.
- **Particulate > 5 microns**- likely to lodge in the nasal passage.
- **Particles** = 10 micron enter into lungs easily.



NOTE- Lead is the major automobile air pollutant (Leaded petrol).

SMOG- Smoke + Fog

- Classical smog/ reducing smog- **smoke+ fog + SO_2.**
- Photochemical smog/ Oxidizing smog- **action of sunlight on unsaturated hydrocarbons + NO- by automobiles, factories**.

FORMATION OF PHOTOCHEMICAL SMOG

- Unburnt fuels + NO start a chain reaction in presence of sunlight.

  $NO_2(g) \longrightarrow NO(g) + O(g)$

  $NO(g) + O_3(g) \rightarrow NO_2(g) + O_2(g)$
- NO_2 and O_3 react with the unburnt hydrocarbons, to produce chemicals such as formaldehyde, acrolein and peroxyacetyl nitrate (PAN).

EFFECTS OF PHOTOCHEMICAL SMOG

- Both ozone + PAN- powerful eye irritants.

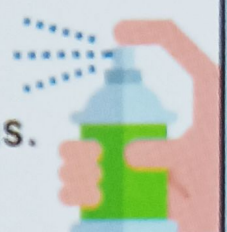
- Ozone + nitric oxide- irritate nose, throat; headache, chest pain, dryness of the throat, cough, difficulty in breathing.
- Smog- cracking of rubber, corrosion of metals, stones, building materials.

STRATOSPHERIC POLLUTION

OZONE (FORMATION + BREAKDOWN)

$O_2(g) \longrightarrow O(g) + O(g)$ [In presence of sunlight]

$O(g) + O_2(g) \longrightarrow O_3(g)$



- Ozone layer depletion- due to release of chlorofluorocarbon compounds (CFCs)- freons.

$CF_2Cl_2(g) \xrightarrow{UV} \dot{C}l(g) + \dot{C}F_2Cl(g)$

$\dot{C}l(g) + O_3(g) \rightarrow ClO(g) + O_2(g)$

- Chloride mono radicals form chloride radicals, which causes ozone depletion.

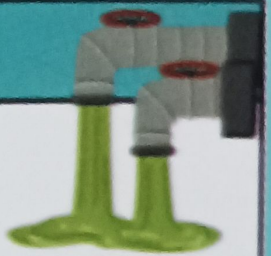
OZONE HOLE

- Unique conditions responsible-
- NO_2 and CH_4 react with ClO and Cl atoms (in summers)- forming chlorine sinks- preventing ozone depletion
- In winters- polar stratospheric clouds (over Antarctica) - provide surface for chlorine nitrate formation- leading to formation of Cl- ozone depletion.

EFFECTS OF Ozone depletion-

- ageing of skin, cataract, sunburn, skin cancer, killing of phytoplanktons, damage to fish productivity

WATER POLLUTION



CAUSES-

- **Pathogens**- bacteria and other microbes
- **Organic waste**- Leaves, grass, trash, phytoplankton. Conc of dissolved O_2 < 6ppm- inhibits fish growth. Ageing of skin, cataract, sunburn, skin cancer, killing of many phytoplankton- damage to fish productivity.

Note- **Biological Oxygen Demand (BOD)**-measure of organic material in the water (oxygen will be required to break it down biologically). Clean water- BOD<5ppm; Polluted water> 17ppm.

- **Chemical pollutants**- Heavy metals (Cd, Hg, Ni)- these damage kidneys, CNS and liver. Acids, org. chemicals, pesticides, detergents, fertilizers.

Note- **Eutrophication**- Nutrient enriched water bodies support a dense plant population- killing animal life by depriving it of O_2.

INTERNATIONAL STANDARDS OF DRINKING WATER

- Fluoride- F^- deficiency- tooth decay

$[3(Ca_3(PO_4)_2.Ca(OH)_2]$ ⟶ $[3(Ca_3(PO_4)_2.CaF_2]$

Enamel — fluorapatite (harder)

- Lead- Upper limit is 50ppb. Excess lead can damage liver, kidney and reproductive system.
- Sulphate- Excess sulphate causes a laxative effect.
- Nitrate- upper limit- 50 ppm. Excess nitrate causes blue baby syndrome.

SOIL POLLUTION

CAUSES- DDT, pesticide, herbicides

Note- **Biomagnification**- With increase in each tropic level, the toxicity of the pollutant increases to about 10 times.

- Industrial waste → Biodegradable (paper, food)
  → Non- biodegradable (ash, drugs)

CONTROLLING ENVT. POLLUTION

Waste Management-

- 'Swachh Bharat Abhiyan' or 'Clean India Mission' launched by the Government of India.
- 2 programmes - Swachh Bharat Mission–Urban (SBM–U) and Swachh Bharat Mission Gramin (SBM–G).
- SBM–U= aims at making India free from open defecation + achieving 100% scientific management of solid waste.
- SBM–G= improvement in the general quality of life in rural areas by promoting cleanliness and hygiene by 2 October, 2019.

Collect and Disposal

GREEN CHEMISTRY

- It is a way of thinking + utilising the existing knowledge and principles of chemistry and other sciences to reduce the adverse impact on environment.
- It is a production process that would bring about minimum pollution or deterioration to the environment

APPLICATIONS

DRY- CLEANING CLOTHES-

- Tetra chlroroethene ($Cl_2C=CCl_2$) was used for dry cleaning, which is replaced by liq. CO_2.
- H_2O_2= used for bleaching clothes.

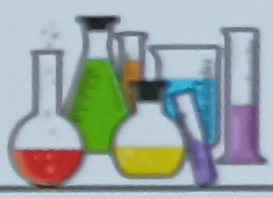
BLEACHING PAPER-

- Chlorine gas used earlier is replaced by H_2O_2.

SYNTHESIS OF CHEMICALS-

- Ethanal prep-

$$CH_2=CH_2 + O_2 \xrightarrow[Pb(II)/\ Cu(II)]{Catalyst} CH_3CHO$$



CLEAN TURBID WATER-

- Powder of kernel of tamarind seeds is used to make municipal and industrial waste water clean.