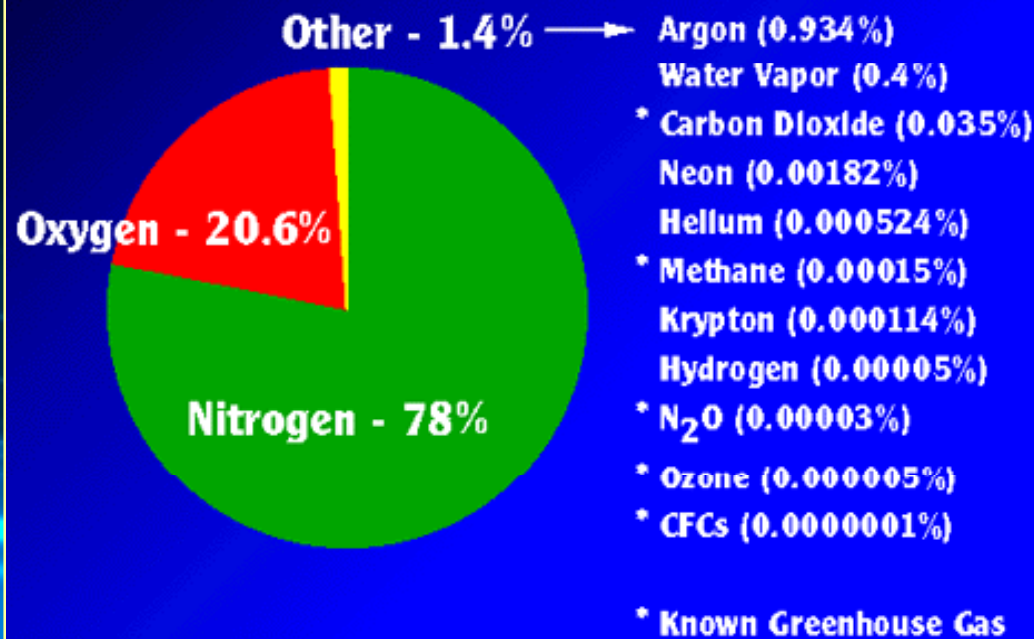


# Environmental Pollution

## Composition of the Earth's Atmosphere (Gases - Percent by Volume)



UNIT-II

# **Environment Pollution - Definition**

- **Any undesirable change in the physical, chemical or biological characteristics of any component of the environment (air, water, soil), which can cause harmful effects on various forms of life or property**

## **Environment Pollution: Classifications**

- **Air Pollution, Water Pollution, Soil Pollution**
- **Marine Pollution, Noise Pollution**
- **Thermal Pollution & Nuclear Hazards**

# About Air Pollution

- **Atmospheric condition:** Changes due to the presence of certain substances (including normal constituents in excess), thus causing undesirable effects on man and his environment.
- **Substances include** gases, particulate matter, radio-active substances etc.
- **Gaseous pollutants include** oxides, of sulphur ( $\text{SO}_3$ ,  $\text{SO}_2$ ), nitrogen ( $\text{NO}$ ,  $\text{NO}_2$  or  $\text{NO}_x$ ), Carbon monoxide ( $\text{CO}$ ), Volatile organic compounds (hydrocarbons)
- **Particulate pollutants include** smoke, dust, soot, fumes, aerosols, liquid droplets, pollen grains etc.
- **Radioactive pollutants include** radon-222, iodine-131, strontium-90, plutonium-239 etc.

# Classification – Air Pollution

Various forms: Gaseous or particulate form, Organic or Inorganic in nature

- Primary Pollutants: These are emitted directly from the point source (identifiable source)  
e.g. carbon monoxide, oxides of nitrogen & sulphur, hydrocarbons, radioactive substances etc.
- Secondary Pollutants: These are formed by interaction of primary pollutant(s) with other primary pollutant(s) or with some natural constituents of atmosphere.  
e.g. ozone (O<sub>3</sub>), peroxyacetyl nitrate (PAN), photochemical smog, etc.

# Causes of Air Pollutants

- **Sources:** Natural and man-made (anthropogenic)
- **Natural sources:**
  - (i) Volcanic eruption, (ii) Forest fires, (iii) Sea salt sprays, (iv) Biological decay, (v) Photochemical oxidation of terpenes (vi) Extra terrestrial bodies, (vii) Pollen grains of flowers & spores, (viii) Radioactive materials present in earth crust, etc.
- **Man-made sources:**
  - (i) Thermal power plants, (ii) Industries (Smelters, Fertilizers, textile, tanneries, refineries, paper & pulp), (iii) Vehicular emission, (iv) Fossil fuel burning, (v) agriculture based activities, etc.

# Few examples of pollutants

- Thermal power plant & metallurgical plant – produce **fly ash** and **SO<sub>2</sub>** – burning of coal
- Automobile Exhaust – **CO (77%), NO<sub>x</sub> (8%), Hydrocarbon (14%)**
- Heavy duty diesel vehicles - emit more **NO<sub>x</sub>** and suspended particulate matter (**SPM**),
- Petrol vehicles - emit more of CO and volatile hydrocarbon



# Indoor Air Pollution:

**Sources: Radon, Coal, Dung-cake, wood & kerosene**

- The most important indoor air pollutant is radon gas. Radon and its radioactive daughters are responsible for a large number of lung cancer.
- **Radon gas emits from the building materials** like bricks, concrete, tiles.
- Soil, ground water, natural gas contains Radium.
- Fuels like coal, dung-cakes wood and kerosene emits  $\text{CO}_2$
- Coal containing various amount of sulphur produces  $\text{SO}_2$ , soot, and other pollutants like HCHO and benzene  $\alpha$ - pyrene (BAP).
- BAP also found in cigarette smoke causes cancer.
- House wife using wood as fuel inhales BAP equivalent to 20 packets of cigarette a day.



# Effects of Air Pollution

- **Human Health:**

- ❖ **Pollutants damage to human respiratory system**
- ❖ **Bigger particles – trapped and eliminated through nose hair & mucus present in nose liner**
- ❖ **Smaller particles – reach tracheobronchial system – trapped by mucus – eliminated by spitting or swallowing**

- **Long term exposure:**

**SO<sub>2</sub> (coal):** constriction of respiratory passage, bronchitis

**SO<sub>2</sub> (with SPM):** forms acid sulphate particles – affects lungs

**NO<sub>x</sub> (NO<sub>2</sub>):** lung irritation, chronic bronchitis, emphysema

**CO:** Binds with haemoglobin of blood – carboxyhaemoglobin – resulting in suffocation due to non-transport of oxygen – dizziness, unconsciousness, death



**Cigarette smoke:** Lung cancer, asthma, bronchitis, emphysema (damage to air sacs – loss of lung elasticity & acute shortness of breath)

**Suspended particle (with toxins):** lung tissue damage, asthma, bronchitis & cancer

**Benzene, HCHO, Polychlorinated biphenyls, toxic metals, dioxins:** mutation, cancer, reproduction problems

**Hazardous materials:** Asbestos, beryllium, mercury, arsenic, radioactive materials cause lung diseases and/or affects kidney, liver, spleen, brain etc.

# Effects on plants



- **Air pollutants** enter through stomata (leaf pores where gases diffuse) – destroying chlorophyll and reducing photosynthesis
- **Pollutants** – erode waxy coating of the leaves called cuticle, which prevents excess  $H_2O$  loss and damage from diseases, pests, drought and frost
- Damage to leaf structure causes necrosis (dead area of leaf), chlorosis (loss or **reduction of chlorophyll causes yellowing of leaf**) or epinasty (downward curling of leaf) & abscission (dropping of leaves)
- **Particulates** - plug stomata thus reduces sunlight availability
- **$SO_2$**  - bleaching, chlorosis, necrosis of leaves
- **$NO_2$**  - increased abscission and suppressed plant growth
- **$O_3$**  - flecks on leaf surface, premature aging, necrosis and bleaching
- **Peroxyacetyl nitrate (PAN)** – silverying of lower surface of leaf, damage to young and sensitive leaves, suppress growth
- **Fluorides** - necrosis of leaf tip;
- **Ethylene** - epinasty, leaf abscission and dropping of flowers

## Effects on aquatic life

- Air pollutants ( $\text{SO}_2$  /  $\text{NO}_x$ ) mixes with rain resulting in high acidity (low pH) in fresh water lakes – thus affecting fishes – resulting in injuries & death

## Effects on materials

- $\text{SO}_2$  /  $\text{NO}_x$  - with moisture ( $\text{H}_2\text{SO}_4$  /  $\text{HNO}_3$ ) - corrosion
- Corrodes - metal parts of buildings, vehicles, bridges, railway tracks etc.
- Disfigurement of statue and monuments made of marble and limestone (e.g. Taj Mahal)
- Brittling of pages and leather binding
- $\text{SO}_2$  affects leather, fabrics, paints and paper
- $\text{O}_3$  - cracking of rubber, nylon
- $\text{NO}_x$  &  $\text{O}_3$  - Fading of cotton and rayon fabrics

# Control of Air Pollution

- Setting of industries after proper environmental impact assessment studies
- Modification of process and/or equipments
- Use of appropriate materials
- Use of low sulphur coal in industries or removing sulphur from coal
- Removing  $\text{NO}_x$  during combustion and controlling flow of air and fuel in industrial boilers
- Vehicular pollution checking – catalytic converters – reducing carbon monoxide and hydrocarbon emission
- Slow and cooler fuel burning – reduces  $\text{NO}_x$  emission
- Use of mass transport system, bicycles etc
- Use of clean fuels (hydrogen gas)
- Use of non-conventional sources of energy
- Planting more trees
- Reducing pollution at its source

# **Ways of reducing Pollution at its source**

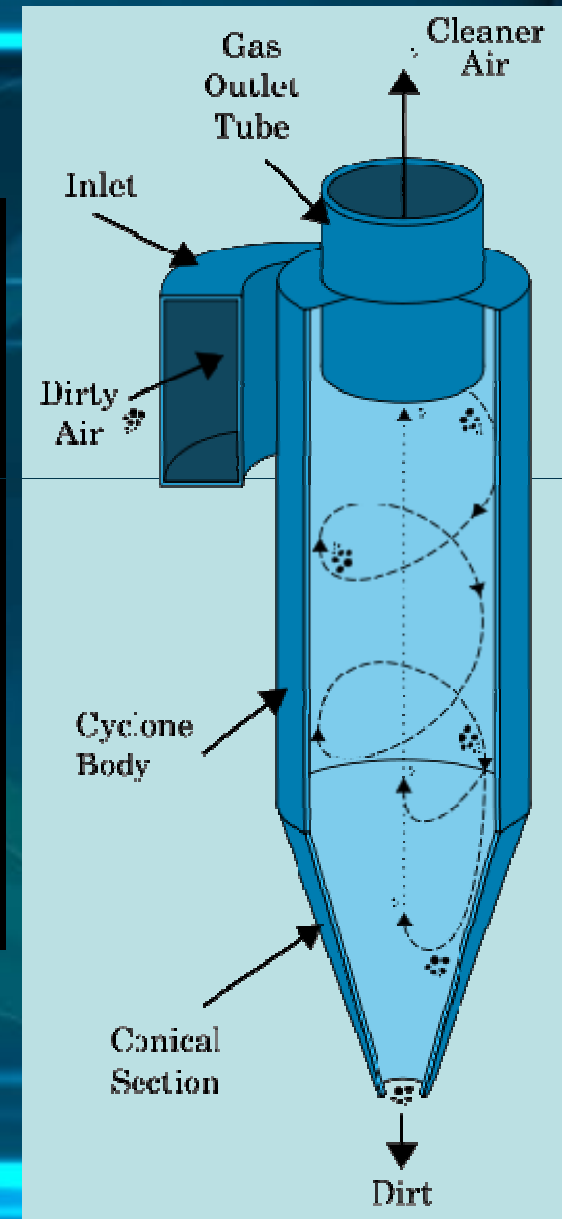
- **Gaseous pollutants: Physical adsorption on porous solid materials – activated charcoal, silica gel, fuller earth, etc.**
- **Effluent gases are trapped in liquid absorbent ( $\text{SO}_2$  trapped in  $\text{NH}_3$  solution)**
- **Combustion at optimal conditions of oxygen and temperature - reduces pollution**
- **Particulate matters: Improved trapping devices with controllable flow rate, collective efficiency, costs, particle characteristics.**

# Devices for Particulate Matter

- **Cyclones** - for larger particles ( $>10\text{ }\mu\text{m}$ )
- **Bag house filters** - for smaller particles
- **Wet Scrubbers** - for toxic and acidic gases
- **Electrostatic precipitator** - nanosize particle
  - (i) parallel-plate type
  - (ii) wire and pipe type

# Cyclones

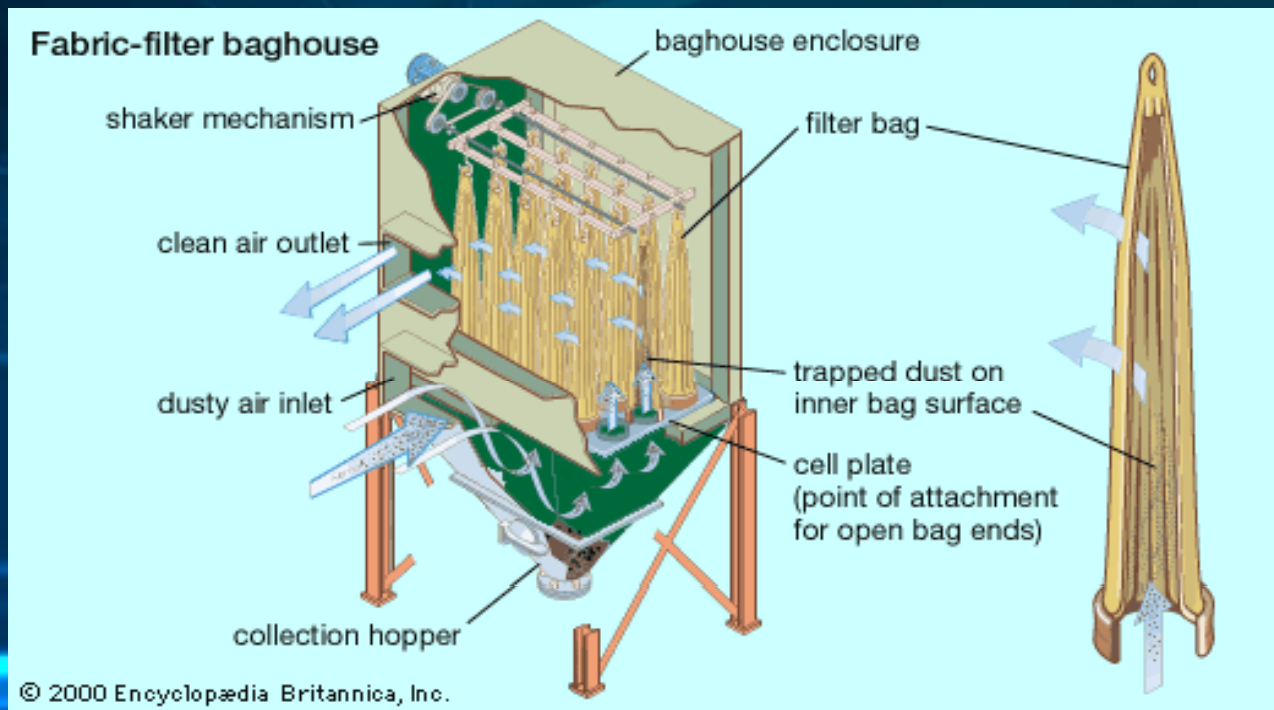
- ✓ **Cylinder with an inverted cone**
- ✓ **Dirt gases enter tangentially at the top – spins forms a vortex.**
- ✓ **Centrifugal force – brings the particles down and collected in the hopper due to gravity**
- ✓ **Spinning gases forms an inner vortex and leaves the chamber from the top with a special vent**





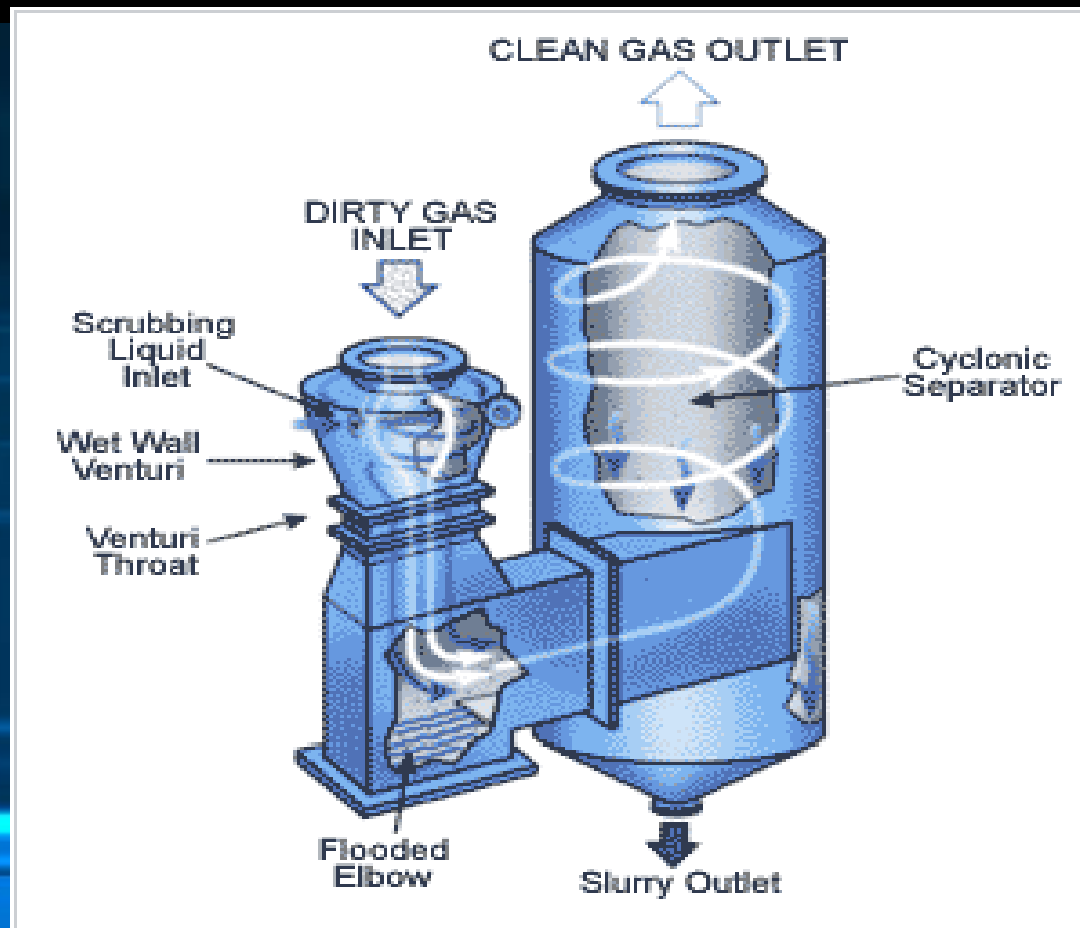
# Bag house filters

- Series of bags filter made of fabric
- Dirt gases passes through the bags
- Dirt collected in the bag and the gas diffuses through the pores
- Collected dirt in the form of cakes are removed by shaking
- Bag house filter is relatively expensive compared to cyclones



# Wet Scrubber

- Dirty gases pass through water in chamber or water is sprayed on the gas
- Particles are made wet and are removed from the gas stream



# Electrostatic Precipitator

- A negative voltage is applied to ionize the dust particles (negatively charged)
- The charged particles are collected at the positively charged surface (plate/cylindrical body)
- The clean gas is removed from the top

