

Chapter-3

Air Pollution

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Topics to be covered

- Introduction
- Sources of air pollutant
- Classification of air pollutant
- Effects of air pollutants
- Control of air pollutants

Definition of Air pollution

- “Air pollution is defined as the presence of unwanted and undesirable foreign particles and gases (in sufficient quantity and duration) in the air which may have adverse effects on human being, animals, plants, vegetation's and important structure.



Sources of Air Pollution

Sources of air pollution can be mainly classified into

(a) Natural

(b) Man- made

(1) Natural Sources

- Pollen grains
- Volcanic eruption
- Forest fire
- Salt spray from oceans
- Dust storms
- Marshy land
- Bacteria and other microorganisms
- Photochemical reaction

Sources of Air Pollution

(2) Man made sources

- Industrial units
- Thermal power plants
- Automobile exhaust
- Fossil fuel burning
- Agricultural activities
- Mining
- Air crafts
- Nuclear explosion
- Domestic burning of woods

Sources of Air Pollution

Man made sources can be generally classified into

(a) Point or stationary sources:

- Industrial unit which add pollutant to air at particular points from their tall chimney.

b) Line or mobile Sources:

- This sources of air pollution are the automobile as these add pollutants along a narrow belts and over long distance.

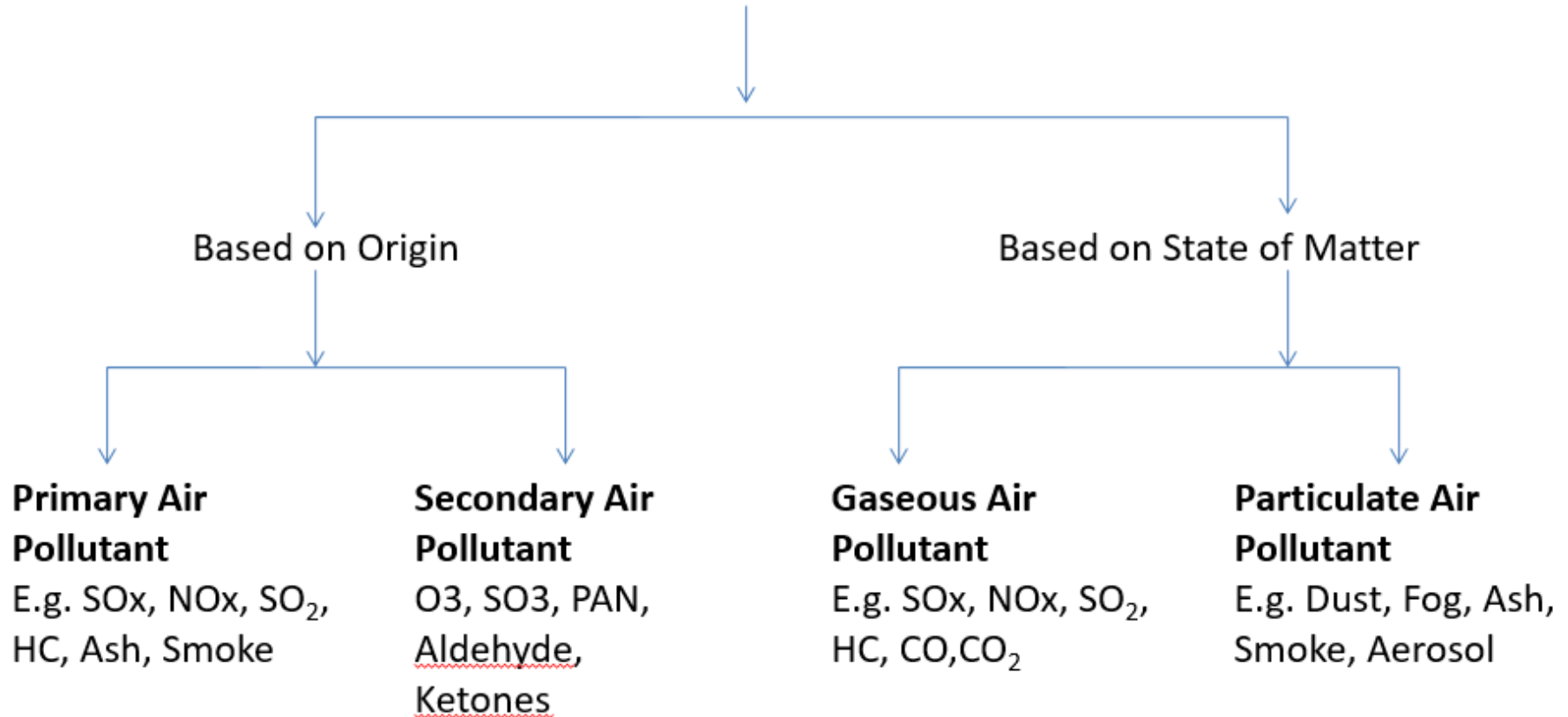
(C) Area sources:

- Town and cities add smoke and gases over wide areas.



Classification of Air pollutants

Air Pollutants



Classification of Air pollutants

A. Classification based on origin of air pollutants

(1) Primary pollutants

(2) Secondary pollutants

(1) Primary pollutants:

- These are emitted directly from the sources and are found in the atmospheres.
- For Example SO_2 , NO_2 , HC, ash, smoke, dust, mist etc

(2) Secondary pollutants:

- These are formed in the atmosphere by chemical interactions between primary pollutants and atmospheric constituents.
- For Example Ozone, Sulphur trioxide, PAN, aldehydes, ketones etc.

Classification of Air pollutants

B) According to the state of matter

- (1) Gaseous air pollutants
- (2) Particulate air pollutants

(1) Gaseous air pollutants:

- These pollutants are in gaseous state at normal temperature and pressure.
- For Example CO, CO₂, NO_x, SO_x, HC, Photochemical oxidants

(2) Particulate air pollutants:

- These include suspended droplets, solid particles or their mixtures in the atmosphere.
- For Example aerosols, dust, smoke, fumes, mist, fog, flyash, soot, and natural particulates such as pollen grains, protozoa, fungal spores and volcanic dust.

Classification of Air pollutants

(B) According to the state of matter

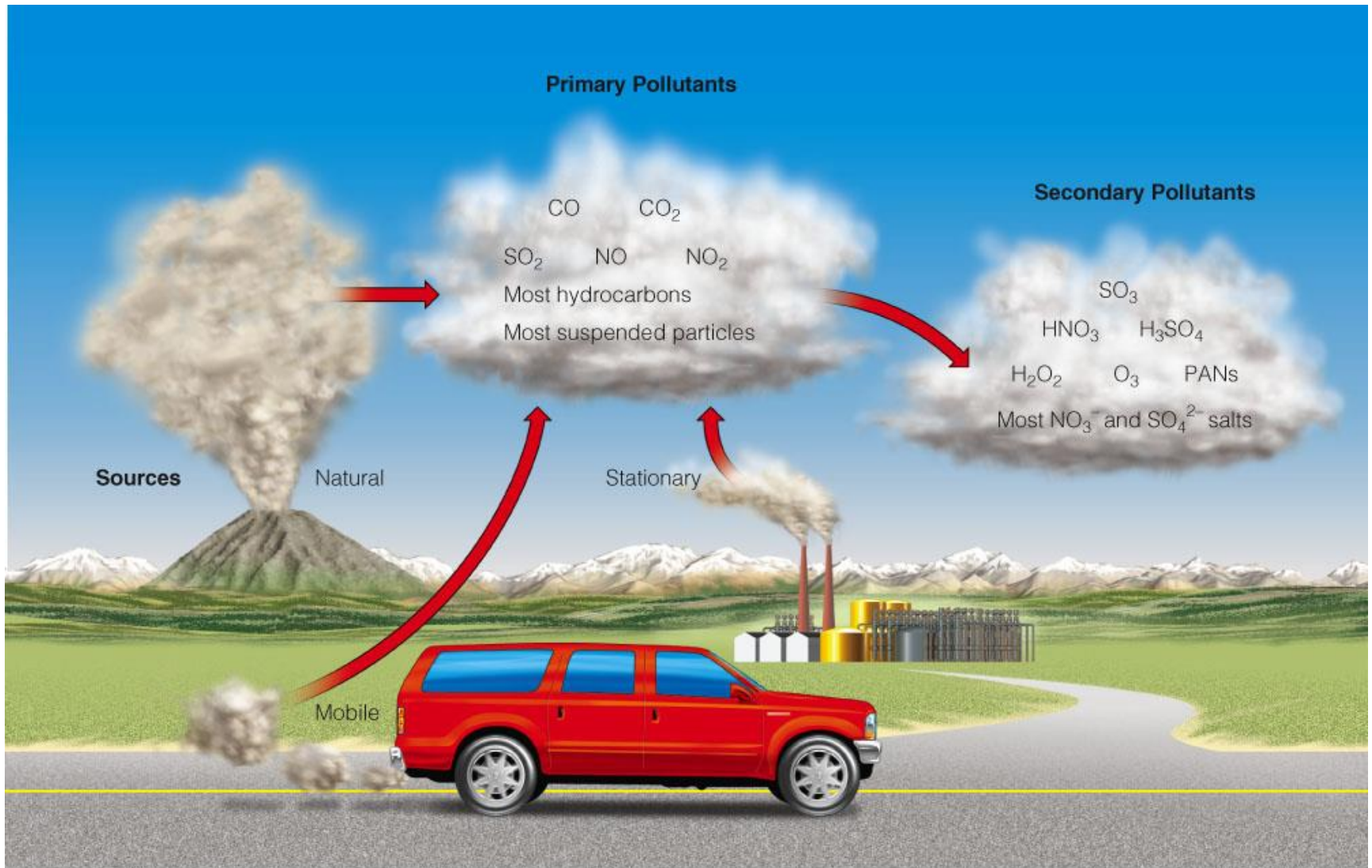
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Air Pollutants- Sources and effect

1. Carbon monoxide (CO)

- It is **colourless, odourless**, tasteless gas.
- It has no effect at normal concentration (0.1 ppm) but at higher conc. It seriously affects the human metabolism.

Sources:

- Volcanic eruption
- natural gas emissions
- electrical discharge during cloud forming
- marsh gas production etc.
- **Transportation sources** contribute about 64% of CO in air.
- Forest fire and agricultural burning contribute about 17 % of in air.

Air Pollutants- Sources and effect

- Industrial processes such as electric furnace and blast furnaces in iron and steel industries
- Petroleum refining
- Paper industry
- Gas manufacture
- Coal mining

Effects:

- **It reduces the oxygen carrying** capacity of the blood by selectively combining with hemoglobin forming carboxy hemoglobin. This causes giddiness, laziness, and exhaustion.
- It reduces vision and causes cardiovascular disorders.
- CO is a very dangerous asphyxiant and its high levels are fatal to human life.

Air Pollutants- Sources and effect

(2) Carbon dioxide (CO₂):

- The content of carbon dioxide in the air has increased by **approximately 15% during the last century** in spite of the fact that photosynthesizing green plants balance the CO₂ - O₂ ratio to a large extent.

Sources:

- Fossil fuel burning
- Agricultural practices (eg. Deforestation)
- Forestry.

Effects:

- its major effect is on the climate of earth (Green House effect).
- CO₂ is less dangerous than CO and causes nausea and headache.

Air Pollutants- Sources and effect

(3) Oxides of Nitrogen (NO_x):

- Nitric oxide and nitrogen oxide are very important pollutant.
- NO is colourless, odourless gas but is NO₂ reddish brown and have suffocating odour.

Sources:

- Fuel combustion in automobiles and industries.
- Lightening
- Forest fire
- Bacterial decomposition of organic matter

Effects:

- Nitric oxide combine with hemoglobin and reduces the oxygen carrying capacity of blood.

Air Pollutants- Sources and effect

- NO_2 is more toxic than NO and may affect lungs and cause bronchitis.
- NO_2 reacts with atmospheric moisture to form nitric acid, causes acid rain and affects vegetables and metals.

(4) Oxides of sulphur (SO_x)

- SO_x include SO_2 and SO_3 .
- SO_2 is a colourless gas having a pungent and suffocating odour.

Sources:

- most of the SO_x pollution (67%) is due to volcanic activities and other natural sources.
- Burning of solid and fossil fuels
- Transportation
- Industries like paper manufacturing plants, refineries, sulphuric acid plant
- Open burning of refuse and municipal incinerator

Air Pollutants- Sources and effect

Effects:

- It causes cardiac diseases, asthma, bronchitis, eye irritation, throat troubles etc..
- Long term exposures to high levels of sulphur dioxide gas causes respiratory illness and heart diseases.
- Oxides of sulphur attacks building materials especially marbles and lime stone. (eg. Taj Mahal at agra)
- SO_2 react with moisture in atmosphere to form sulphuric acid which causes acid rain affects vegetables and metals.
- Oxides of sulphur may affect clothes, leather, paper and plants.

(5) Hydrocarbon (HC):

- the gaseous and volatile hydrocarbons are mainly responsible for air pollution.
- Common HC includes methane, ethane, acetylene etc.

Air Pollutants- Sources and effect

Sources:

- Coal fields
- Natural fires
- Incomplete combustion from car engines
- Industrial sources (refineries)
- Forest fires
- Agricultural burning
- Coal waste fires

Effects:

- Some aromatic HC may cause cancer.
- Unburned HC with oxides of nitrogen in the presence of sunlight form Photochemical oxidants (like ozone, PAN) which are harmful.

Air Pollutants- Sources and effect

(6) Photochemical oxidants:

- The major photochemical oxidant is ozone.
- Ozone is produced in the upper atmosphere by solar reaction, small concentrations of this gas diffuse downwards and become the major concern in the air pollution.
- In the presence of sunlight, the oxides of nitrogen react with the unburned HC released by the exhausts of automobiles and following a series of complex reactions produce secondary pollutants like PAN, Ozone, aldehydes and Ketones etc.



Unburnt HC + NO_x

Photochemical smog

Sources:

- Automobile exhausts

Air Pollutants- Sources and effect

Effect:

- Photochemical oxidants cause irritation of eye, nose and throat, headache etc.
- Ozone damage chromosomes.
- Ozone and PAN cause damage to plants by interfering with plant cell metabolism especially in leafy vegetables. Premature fall and yellowing of leaves are due to this pollutant.
- Photochemical oxidants also effect the materials like rubber, plants, textile fibers etc.

(7) Particulate Air pollutants:

- These are small, solid particles and liquid droplets present in the atmosphere in fairly large numbers and sometimes pose serious air pollution problems.
- The size of particulate ranges from 0.02μ to 500μ .

Air Pollutants- Particulate Matter

(1) Aerosols:

- These include all air borne suspensions of solid or liquid particles smaller than 1 mm.

(2) Dust:

- It consist of small solid particles (size 1 to 200 μm) and are generated by material crushing, grinding or blasting.

(3) Smoke:

- it consist of fine solid particles (size 0.1 to 1 μm) resulting from the incomplete combustion of organic particles like coal, wood, tobacco or other chemical processes.

(4) Fumes:

- These are fine solid particles (size 0.1 to 1 μm) formed by the condensation of vapors of solids materials.

(5) Mist:

- It consist of liquid droplets formed by the condensation of vapours in the atmosphere or are released from industrial operation.

Air Pollutants- Particulate Matter

(6) Fog:

- it the mist is made up of water droplets whose concentration is high and dense enough to obscure vision then the mist is called fog.

(7) Flyash:

- This consists of finely divided non combustible particles present in the gases arising from fuel combustion.

(8) Soot:

- Incomplete combustion of carbon containing materials release carbon particles.

Air Pollutants- Particulate Matter

Sources:

- Volcanic eruption
- Dust storms
- Spraying of salts by oceans
- Fly ash from combustion of fossil fuels
- Smoke from vehicles
- Mining
- Agriculture burning

Effect:

- Health effects - Particulates less than 10 μm can enter deep into the lungs and may also get into blood streams. It can cause problems like irritation, asthma, chronic bronchitis and other lung diseases.

Air Pollutants- Particulate Matter

- Particulates accelerate corrosion of metals, damages buildings, paints etc.
- Aerosols (Fluorocarbons, NO_x , SO_x) released from emissions from jet and supersonic planes deplete the ozone layer in higher atmosphere.
- Dust coating on leaves affects photosynthesis and reduces plant growth.
- Fly ash reduces pH balance and potability of water.
- Metal dust containing heavy metals and cotton dust may also cause respiratory problem.

Effects of Air Pollution on Human Health

- Carbon monoxide (CO) and nitric oxide (NO) combine with hemoglobin to form carboxy hemoglobin (COHb) which reduces oxygen carrying capacity of blood.
- Oxides of nitrogen (NO_x) and oxides of sulphur (SO_x) cause irritation to eye, throat and nose. They can cause diseases like asthma and bronchitis.
- Pollen can initiate asthmatic attacks.
- Secondary pollutant (O₃, PAN) produced by hydrocarbons and NO_x, results in the formation of photochemical smog, which causes irritation of eyes, nose, throat and respiratory diseases.
- Some aromatic hydrocarbons may cause cancer.
- Exposure to dust, smoke, smog and soot may include several respiratory diseases like asthma, bronchitis and lung cancer.

Effects of Air Pollution on Human Health

- Heavy metals like lead may cause poisoning effects on nervous system, damage to kidney and vision problem.
- Nickel particulates in tobacco smoke result in respiratory damage.
- Radioactive substances cause lung diseases and affect kidney , liver, brain and sometimes may cause cancer.
- Atmospheric dust containing silica may cause silicosis.

Effects of Air Pollution on plants and vegetation:

- Air pollutants affect plants by entering through stomata (leaf pores through which gases diffuse), destroy chlorophyll and affect photosynthesis.
- Pollutants also erode waxy coating of the leaves called cuticle. Cuticle prevents excessive water loss and damage from diseases, pests, drought and frost. Damage to leaf structure causes dropping of leaves.
- Particulate like dust, fog, soot deposit on plant leaves, block stomata and affect the rate of transpiration.

Effects of Air Pollution on Property/Material:

- SO_2 in the presence of oxygen and moisture is converted into H_2SO_4 acid. Deposition of this acid on metal parts of building roofs, railway tracks, metal on bridges cause corrosion.
- H_2SO_4 acid deposition reacts with limestone, marble and other building materials to cause deterioration and disfigure the building material.
- Pollutants like SO_2 , O_3 , H_2S and aerosols damage protective coating and paints of the surface.
- Damage of textile dyes and textile fibers is caused by SO_x , NO_x and O_3 .
- Ozone and PAN cause cracking of rubber tyres and various forms of electrical insulation.
- Deterioration of lather and paper due to H_2SO_4 decomposition.
- Soiling increases cost of cleaning shirts and other wears, windows, building surface.

Effects of Air pollutants on Climate:

- Due to man made activities like industrialization, automobiles, deforestation etc., concentration of CO₂ and other green house gases in atmosphere will increases.
- About 50% of Green House Effect may be attributing to CO₂, which resulted in the increase in temperature of earth. This increase in temperature caused the melting of ice caps and glaciers. Thus the increase in ambient air temperature will increase the mean sea level.
- The thinning of the ozone layer in the stratosphere by the action of aerosols will increase the penetration of harmful ultraviolet rays to earth and this will cause blindness, Sunburn, inactivation of proteins, RNA and DNA.

Effects of Air pollutants on Aesthetic Beauty:

- The most noticeable effect of air pollution on the properties of atmosphere is the reduction in visibility, which may lead to safety hazard.
- Visibility is reduced by adsorption and scattering of light by air borne particles (0.1 to 1 μm size).
- Industrial and automobiles emissions, sewage and garbage emit foul odours causing further loss of aesthetic beauty.

Factors affecting Air pollutant

The factors which affect air pollution are as follows:

1. **Metrological parameters or characteristics:**

- Wind direction
- Wind Speed
- Relative Humidity, etc.

2. **Topographical features:**

- Unevenness of land forms and barriers like mountains valleys.

3. **Characteristics of pollutants:**

- Type and size of pollutants
- Interaction among pollutants

4. **Mode of release of pollutants:**

- Intermittent, continuous, cyclic
- From single sources or multiple sources
- From point sources or area sources