



BHARATHIDASAN UNIVERSITY

Tiruchirappalli- 620024, Tamil Nadu, India

Programme: M.Sc., Biotechnology(Environment)

Course Title :Air Pollution and its Management

Course Code :CC05

Unit-I

**Air pollutants and Chemical reactions in the
atmosphere**

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Air pollutants are classified based on their origin, state, chemical composition, and source.

- **1. Classification by Origin**

- **Primary Pollutants:** Directly emitted from sources (e.g., CO, SO₂, NO).
- **Secondary Pollutants:** Formed in the atmosphere by chemical reactions (e.g., ozone, peroxyacetyl nitrate).

- **2. Classification by State**

- **Gaseous Pollutants:** Exist in the gaseous state (e.g., CO, NO₂, SO₂).
- **Particulate Pollutants:** Suspended as solid or liquid particles (e.g., dust, smoke, aerosols).

- **3. Classification by Chemical Composition**

- **Organic Pollutants:** Contain carbon (e.g., hydrocarbons, volatile organic compounds).
- **Inorganic Pollutants:** Do not contain carbon (e.g., oxides of sulfur, nitrogen).

- **4. Classification by Source**

- **Natural Sources:** Volcanoes, forest fires, and natural decay.
- **Anthropogenic Sources:** Industrial activities, vehicles, and fossil fuel combustion.

Sources and Effects of Major Air Pollutants

- *1. Oxides of Carbon (CO and CO₂)*

- **Sources:**

- Incomplete combustion of fossil fuels (CO).
- Combustion of organic matter (CO₂).
- Vehicle emissions and industrial processes.

- **Effects:**

- **CO:** Binds with hemoglobin, reducing oxygen transport in the body, causing fatigue and respiratory issues.
- **CO₂:** Contributes to global warming and climate change by enhancing the greenhouse effect.

2. Oxides of Nitrogen (*NO and NO₂*)

- **Sources:**

- High-temperature combustion processes (vehicles, power plants).
- Lightning and microbial action in soil.

- **Effects:**

- Formation of photochemical smog and acid rain.
- Irritation of respiratory systems and reduced lung function.
- Contributes to eutrophication in water bodies.

3. Oxides of Sulfur (SO_2 and SO_3)

- **Sources:**

- Burning of sulfur-containing fossil fuels (coal, oil).
- Industrial emissions (smelting, refineries).

- **Effects:**

- Respiratory and cardiovascular diseases.
- Formation of acid rain, leading to soil and water acidification.
- Damage to vegetation, buildings, and ecosystems.

4. *Halogenated Compounds*

- **Sources:**

- Industrial chemicals (e.g., chlorofluorocarbons - CFCs, halons).
- Solvents, refrigeration, and aerosol propellants.

- **Effects:**

- Depletion of the ozone layer, increasing UV radiation exposure.
- Toxicity to humans and ecosystems, contributing to climate change.

Ions in the Atmosphere

- Atmospheric ions are charged particles formed by ionization processes in the Earth's atmosphere. They play a critical role in atmospheric chemistry, weather phenomena, and pollution dynamics.

- *Types of Atmospheric Ions*

- 1. Positive Ions (Cations):**

- Formed by the loss of electrons from atoms or molecules (e.g., Na^+ , K^+ , H_3O^+).

- 2. Negative Ions (Anions):**

- Formed by the gain of electrons (e.g., O_2^- , OH^- , Cl^-).

Sources of Atmospheric Ions

- **Natural Sources:** Cosmic rays, UV radiation, lightning, and radioactive decay.
- **Anthropogenic Sources:** Combustion processes, industrial activities, and pollutants.
- *Importance of Ions*
 - Facilitate cloud condensation and precipitation.
 - Influence the electrical conductivity of the atmosphere.
 - Participate in chemical reactions, such as ozone formation and pollutant transformation.

Meteorological Parameters

Meteorological conditions significantly influence atmospheric composition, pollution dispersion, and chemical reactions.

- **1. Wind Speed**

- Determines the dispersion and transport of pollutants.
- Higher wind speeds reduce local pollution concentrations but can spread pollutants over large areas.

- **2. Wind Direction**

- Affects pollutant transport and deposition.
- Helps identify pollutant sources and areas at risk of contamination.

Photochemical Processes

Photochemical processes involve the interaction of sunlight with atmospheric constituents, leading to the formation or transformation of pollutants.

- ***Oxidation Processes***

- Involve the reaction of atmospheric compounds with oxidizing agents (e.g., ozone, hydroxyl radicals).
- Example: $\text{CH}_4 + \text{OH} \rightarrow \text{CH}_3 + \text{H}_2\text{O}$
- These reactions degrade pollutants but can also produce secondary pollutants.

- ***Acid-Base Reactions***

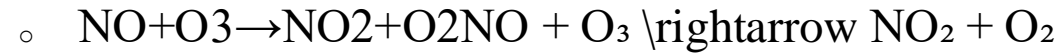
- Occur between acidic oxides (SO_2 , NO_x) and water vapor, forming acids.
- Example: $\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3$
- Contribute to the formation of acid rain.

Photochemical Smog

- Photochemical smog is a mixture of pollutants formed under sunlight, primarily in urban areas.
- **Components**
 - Ground-level ozone, peroxyacetyl nitrate (PAN), aldehydes, and fine particulates.
- **Formation Mechanism**
 - Involves the reaction of nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight:
$$\text{NO}_2 + \text{UV} \rightarrow \text{NO} + \text{O} \quad \text{O} + \text{O}_2 \rightarrow \text{O}_3$$
 - Secondary reactions produce smog components.
- **Effects**
 - Reduces visibility and causes respiratory and cardiovascular issues.
 - Damages crops, vegetation, and materials.

Smog-Forming Reactions

1. Ozone Formation:



2. PAN Formation:

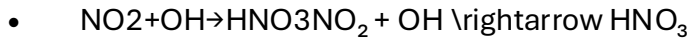
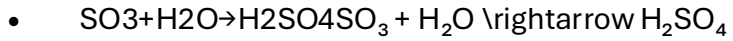
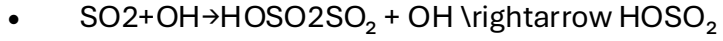
- VOCs react with NO_x and oxygen under sunlight to form PAN:



- **Acid Rain**

- Acid rain occurs when acidic oxides (SO₂, NO_x) react with atmospheric water, oxygen, and other chemicals to form acidic compounds.

- **Key Reactions**



- **Effects**

1. **Environmental:**

- Acidifies water bodies, harming aquatic life.
- Damages forests and soil by leaching nutrients.

2. **Structural:**

- Corrodes buildings, monuments, and infrastructure.

3. **Health:**

- Aggravates respiratory and cardiovascular diseases

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THANK YOU

