

UNIT III - AIR AND NOISE POLLUTION

3.1 AIR POLLUTION & AIR POLLUTANTS

Air pollution is the presence of harmful substances in the atmosphere that can adversely affect human health, the environment, and the climate. These substances may be solid particles, liquid droplets, or gases, and they can originate from natural sources (such as volcanoes and wildfires) or anthropogenic (human-made) sources (such as vehicles, industrial facilities, and agriculture).

3.1.1 SOURCES OF AIR POLLUTION

Natural Sources

1. **Volcanic Eruptions**

- Release ash, sulfur dioxide (SO₂), and other gases into the atmosphere.

2. **Wildfires**

- Produce smoke containing particulate matter (PM), carbon monoxide (CO), and volatile organic compounds (VOCs).

3. **Dust Storms**

- Lift vast amounts of dust and sand, contributing to airborne particulate matter.

4. **Biological Processes**

- Emission of pollen, mold spores, and other allergens from plants and animals.

5. **Oceanic Sources**

- Sea spray and natural marine emissions can release salt particles and sulfur compounds.

Anthropogenic (Human-Made) Sources

1. **Transportation**

- **Vehicles:** Cars, trucks, buses, and airplanes emit nitrogen oxides (NO_x), carbon monoxide (CO), hydrocarbons, and particulate matter.
- **Ships:** Maritime shipping can release sulfur compounds and nitrogen oxides.

2. **Industrial Activities**

- Factories and power plants emit sulfur dioxide (SO₂), nitrogen oxides (NO_x), carbon monoxide (CO), volatile organic compounds (VOCs), and heavy metals.

3. **Power Generation**

- Burning fossil fuels (coal, oil, natural gas) generates emissions such as carbon dioxide (CO₂), sulfur dioxide (SO₂), and nitrogen oxides (NO_x).

4. **Agricultural Practices**

- Use of fertilizers and pesticides releases ammonia (NH₃) and VOCs. Livestock farming contributes methane (CH₄).

5. **Waste Disposal and Landfills**

- Decomposition of organic waste produces methane (CH₄) and other gases. Incineration can release dioxins, furans, and particulate matter.

6. Household Activities

- Cooking, heating, and using certain cleaning products can emit VOCs and particulate matter.

7. Construction and Demolition

- Dust and emissions from machinery contribute to particulate matter and other pollutants.

3.1.2 AIR POLLUTANTS

Air pollutants are harmful substances in the air that can affect human health and the environment. They are classified based on their origin, chemical nature, and impact.

SOURCES OF AIR POLLUTANTS

1. Natural Sources

- Volcanic Eruptions: Emit ash and sulfur dioxide.
- Forest Fires: Release particulate matter and carbon monoxide.
- Dust Storms: Contribute to airborne particulate matter.
- Biological Processes: Emission of pollen, mold spores, and other allergens.

2. Anthropogenic (Human-Made) Sources

- Transportation: Cars, trucks, and airplanes emit nitrogen oxides (NO_x), carbon monoxide (CO), and hydrocarbons.
- Industry: Factories release sulfur dioxide (SO₂), volatile organic compounds (VOCs), and particulate matter.
- Power Generation: Burning of fossil fuels contributes to sulfur dioxide, nitrogen oxides, and carbon dioxide (CO₂).
- Agricultural Activities: Use of fertilizers and pesticides can release ammonia (NH₃) and VOCs.
- Waste Disposal: Landfills emit methane (CH₄) and other gases.

3.1.3 CLASSIFICATION OF AIR POLLUTANTS

1. Primary Pollutants: Directly emitted into the atmosphere.

- Examples: Carbon monoxide (CO), sulfur dioxide (SO₂), nitrogen oxides (NO_x), particulate matter (PM), and volatile organic compounds (VOCs).

2. Secondary Pollutants: Formed in the atmosphere through chemical reactions.

- Examples: Ozone (O₃), formed from NO_x and VOCs in the presence of sunlight; smog, formed from various pollutants.

3. Criteria Pollutants: Commonly monitored pollutants due to their health and environmental effects.

- Particulate Matter (PM10 and PM2.5)
- Nitrogen Dioxide (NO₂)
- Sulfur Dioxide (SO₂)
- Carbon Monoxide (CO)
- Ozone (O₃)
- Lead (Pb)

3.1.4 EFFECTS OF AIR POLLUTANTS ON HUMAN HEALTH

1. Respiratory Issues
 - Irritation of airways, increased asthma attacks, and chronic bronchitis.
 - Fine particulate matter (PM_{2.5}) can penetrate lung tissue and enter the bloodstream.
2. Cardiovascular Problems
 - Air pollution can lead to heart disease, hypertension, and increased risk of heart attacks.
3. Neurological Effects
 - Some studies suggest links between pollution and neurological diseases, including cognitive decline and conditions like Alzheimer's.
4. Cancer
 - Long-term exposure to certain air pollutants (e.g., benzene, formaldehyde) is associated with increased cancer risk.
5. Developmental Issues
 - Exposure during pregnancy can affect fetal development, leading to low birth weight, preterm births, and developmental disorders.
6. Overall Mortalities
 - Studies show that long-term exposure to high levels of air pollution is linked to premature deaths.

3.1.5 AMBIENT AIR QUALITY

Definition: Ambient air quality refers to the condition of the air in the surrounding environment. It is measured by the concentration of pollutants present in the air.

Major Pollutants:

- **Particulate Matter (PM):** Tiny particles or droplets in the air (e.g., PM_{2.5}, PM₁₀).
- **Nitrogen Dioxide (NO₂):** A gas produced from vehicle emissions and industrial processes.
- **Sulfur Dioxide (SO₂):** Emitted from burning fossil fuels and industrial activities.

- **Carbon Monoxide (CO):** A colorless, odorless gas from incomplete combustion of fuels.
- **Ozone (O₃):** A secondary pollutant formed by the reaction of sunlight with pollutants like NO_x and VOCs.
- **Volatile Organic Compounds (VOCs):** Organic chemicals that can evaporate into the air and contribute to smog.

Importance of ambient air quality: Monitoring ambient air quality is critical for assessing public health, environmental impacts, and regulatory compliance.

3.1.6 EMISSION STANDARDS

Definition: Emission standards are regulatory limits set to control the amount of pollutants released into the atmosphere from various sources.

Significance of emission standards

- **Purpose:** To protect public health and the environment by reducing harmful emissions from industrial processes, vehicles, and other sources.
- **Types of Standards:**
 - **Primary Standards:** Protect human health (e.g., limits on CO, NO_x, PM).
 - **Secondary Standards:** Protect the environment (e.g., limits on sulfur dioxide for protecting wildlife)

Common Standard Agencies:

- **United States Environmental Protection Agency (EPA):** Sets national air quality standards in the U.S.
- **European Environment Agency (EEA):** Develops air quality standards in Europe.
- **World Health Organization (WHO):** Provides guidelines for air quality to protect global public health.

Major concepts involved

1. **Air Quality Index (AQI):** A numerical scale that communicates air quality levels to the public. It reflects the level of major pollutants.
2. **Monitoring:** Ambient air quality is monitored using networks of air quality stations that measure pollutant concentrations in real-time.
3. **Compliance:** Industries must comply with emission standards to avoid penalties and protect the environment.
4. **Mitigation Strategies:** Measures taken to reduce emissions include cleaner technologies, transitioning to renewable energy, and enforcing stricter regulations.

Need for ambient air quality and emission standards

- Ambient air quality is essential for understanding pollution levels in the environment.
- Emission standards are crucial for regulating pollutants released by various sources to protect health and the environment.
- Monitoring air quality and ensuring compliance with standards are fundamental to improving overall air quality.

3.1.7 PARTICULATE MATTER

Definition of Particulate Matter (PM)

- **Particulate Matter (PM)** refers to tiny solid or liquid particles suspended in the air.
- Can consist of a variety of substances, including dust, dirt, soot, and smoke.

Types of Particulate Matter

1. PM₁₀:

- Diameter of 10 micrometers or smaller.
- Can be inhaled into the respiratory system.
- Sources: Dust from roads, pollen, mold spores, and some industrial processes.

2. PM_{2.5}:

- Diameter of 2.5 micrometers or smaller.
- More dangerous because it can penetrate deeper into the lungs and even enter the bloodstream.
- Sources: Combustion processes, vehicle emissions, industrial discharge, and organic compounds.

Sources of Particulate Matter

1. Natural Sources:

- Wildfires
- Volcanoes
- Dust storms
- Sea spray

2. Anthropogenic (Human-Made) Sources:

- Vehicle emissions
- Industrial activities
- Construction sites
- Agricultural practices (e.g., tilling, burning of fields)
- Residential heating (wood burning)

Health Effects of Particulate Matter

- **Respiratory Issues:** Can cause asthma, bronchitis, and other respiratory diseases.

- **Cardiovascular Problems:** Linked to heart attacks, strokes, and other heart diseases.
- **Premature Death:** Long-term exposure can increase risks of serious health conditions.

Environmental Impact

- Affects air quality and visibility.
- Contributes to the formation of smog and acid rain.
- Harms wildlife and ecosystems.

Regulation and Standards

- **Air Quality Standards:** Governments set limits for acceptable levels of PM in the air (e.g., EPA and WHO guidelines).
- **Monitoring:** Air quality monitors are installed in various locations to track PM levels and inform public health measures.

Ways to Reduce Particulate Matter

1. **Reduce Emissions:** Encourage the use of cleaner technologies and fuels.
2. **Promote Public Transport:** Decrease reliance on personal vehicles.
3. **Control Dust:** Implement dust control measures in construction and mining.
4. **Increase Green Spaces:** Planting trees and vegetation helps absorb PM.

