

AIR POLLUTION



Pollutant




- There are many substances in the air which may impair the health of plants and animals (including humans), or reduce visibility.
- These arise both from natural processes and human activity.
- Substances not naturally found in the air or at greater concentrations or in different locations from usual are referred to as 'pollutants'.


Air Pollution




Perkins (1974) Defines

- Air pollution means the presence in the outdoor atmosphere of one or more contaminants such as dust, fumes, gas, mist, odor, smoke or vapor in quantities or characteristics and of duration such as to be injurious to human, plant or animal life or to property or which unreasonably interferes with the comfortable enjoyment of life and property.

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- The presence in the atmosphere of a substance or substances added directly or indirectly by an act of man (**Arora 1999**)

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- According to **Bureau of Indian Standards IS 4167 (1980)** air pollution is the presence in ambient atmosphere of substances generally resulting from the activities of man in sufficient concentration present for a significant time and under circumstances such as to interfere with comfort, health or welfare of persons or with reasonable use of enjoyment of property.

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- **The Air Act of Govt. of India (amendment 1987)** defines air pollution as “Air pollution means any solid, liquid or gaseous substances present in the atmosphere in such concentration that may tend to be injurious to human beings or other living creatures or plants or property or enjoyment.




OR

- It may be defined as any atmospheric condition in which certain substances are present in such concentrations that they can produce undesirable effects on man and its environment.



CONCEPT

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- Sources and Sinks
 - Receptors
 - Transport and Diffusion
 - Significant Deterioration of Air Quality
 - Polluted Atmosphere

Sources and Sinks

- **Sources:**

The places from which pollutants emanate are called *sources*.

- *Types of Sources:* natural & anthropogenic sources

- **Sinks:**

The places to which pollutants disappear from the air are called *sinks*.

Sinks include the soil, vegetation, structures, and water bodies, particularly the oceans.

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- **Scavenging Mechanisms:**

The mechanisms whereby pollutants are removed from the atmosphere are called *scavenging mechanisms*.

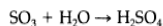
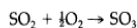
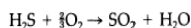
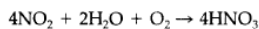
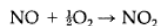
- The measure used for the aging of a pollutant is its *half-life*.

- **Half Life:**

The time it takes for half of the quantity of pollutant emanating from a source to disappear into its various sinks.

- Most pollutants have a short enough half-life (i.e., days rather than decades)
- **CFCs** are chemically very stable compounds in the troposphere and have half-lives from **10 of years to over 100 years**.
- One of the sinks for CFCs is transport to the stratosphere, where shortwave UV radiation photo dissociates the molecules, releasing chlorine (Cl) atoms.
- These Cl atoms are projected to reduce the steady-state stratospheric ozone Concentration, in turn increasing the penetration of harmful UV radiation to the earth's surface.

- Oxidation, either atmospheric or biological, is a prime removal mechanism for inorganic as well as organic gases.
- Inorganic gases, such as nitric oxide (NO), nitrogen dioxide (NO₂), hydrogen sulfide (H₂S), sulfur dioxide (SO₂), and sulfur trioxide (SO₃), may eventually form corresponding acids:



- Oxidation of SO₂ is slow in a mixture of pure gases, but the rate is increased by light, NO₂/ oxidants, and metallic oxides which act as catalysts for the reaction.
- The formed acids can react with particulate matter or ammonia to form salts.

Receptors

- A **receptor** is something which is adversely affected by polluted air.
- A receptor may be a **person or animal** that breathes the air and whose health may be adversely affected thereby, or whose eyes may be irritated or whose skin made dirty.
- It may be a **tree or plant** that dies, or the growth yield or appearance of which is adversely affected.

- It may be some **material such as paper, leather, cloth, metal, stone, or paint** that is affected.
- Some properties of the atmosphere itself, such as its ability to transmit radiant energy, may be affected.
- Aquatic life in lakes and some soils are adversely affected by acidification via acidic deposition.

Transport and Diffusion

- *Transport* is the mechanism that moves the pollution from a source to a receptor.
- The simplest source-receptor combination is that of an isolated point source and an isolated receptor.

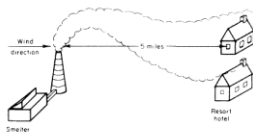


Fig. 24. Transport and diffusion from source to receptor.

Significant Deterioration of Air Quality

Polluted Atmosphere

SOURCES OF AIR POLLUTION

SOURCE CLASSIFICATION

SOURCE

NATURAL SOURCE

- Arising due to natural causes like volcano, oceans, forest fire, dust storm, wind, etc.

ANTHRO-PROGENIC SOURCE

- Arising due to man made activities like industrial activities, vehicular emission, etc.

SOURCE

Stationary Source

Mobile Sources

A. Natural Sources

- Volcano
- Accidental fire
- Dust storms
- Ocean
- Plant and Trees
- Hot Springs

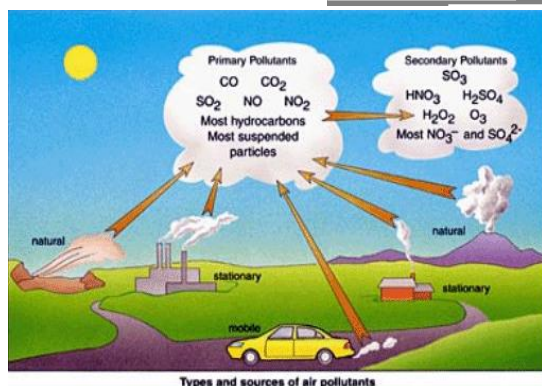
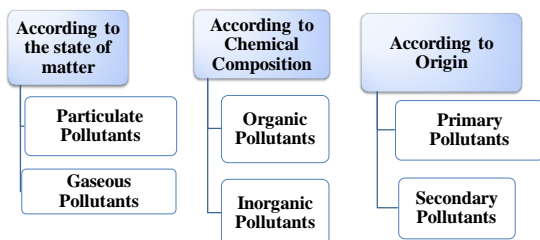
AIR POLLUTANTS



Air Pollutant

It is a substance or effect dwelling temporarily or permanently in the air , which adversely alters the environment by interfering with the health, the comfort, or the food chain, or by interfering with the property values of people.

Classification of air pollutants



- **Primary air pollutants** - Materials that when released pose health risks in their unmodified forms or those emitted directly from identifiable sources.
- **Secondary air pollutants** - Primary pollutants interact with one another, sunlight, or natural gases to produce new, harmful compounds

Primary pollutants

Primary pollutants are those emitted into the atmosphere as a result of some specific process and remain for a long time in the chemical form in which they are emitted.

- **e.g.** Particulates, SO_2 , CO, H/C, H_2S , NH_3 ,

Secondary pollutants

- **Secondary pollutants** are not emitted directly. These are the pollutants those formed in the atmosphere as a result of some reactions.
- This reaction may be photochemical or nonphotochemical and may take place between two pollutants or between a single pollutant and natural constituents of the atmosphere.
- derive from the oxidation of primary gases such as sulfur and nitrogen oxides into sulfuric acid (liquid) and nitric acid (gaseous).
- **e.g.** Ozone, NO_x , Peroxy acetyl nitrate (PAN)

- Sulphur trioxide, Nitrogen dioxide, PAN (Peroxyacetyl nitrate), ozone, aldehydes, ketones and various sulphate and nitrate salts
- **Note** that some pollutants may be both primary and secondary: that is, they are both emitted directly and formed from other primary pollutants

According to the state of matter

Gaseous Pollutants:

- Contaminants in the form of gases behave much as the air itself, without being settle out,
- e.g. SO_2 , CO_2 , NO_x , H_2S , NH_3 , Cl_2 , H/C etc.
- These may be organic or inorganic.

Particulate Pollutants:

- These are finely divide **solids or liquids**.
- The larger particles tend to get settle out quickly and are called **settleable or dustfall particulates (particles more than 1 micron)**, while
- The smaller particles remain suspended for a longer period and are called **suspended particulate matter (SPM, particle size less than 1 micron)**
- The smaller particles may behave almost like a gas and are readily transported by wind currents for longer distances without being deposited
- **Solid particulates:** Dusts, Smoke and Fumes
- **Liquid particulates:** Mist, Sprays

According to Chemical Composition

Organic Pollutants

- They are organic nature and contain mainly carbon and hydrogen, but may also contain some other elements.
- e.g. H/C, Chlorinated H/C, aldehydes and alcohols etc.
- **NOTE:** (CO , CO_2 are excluded from this category as these contains only C and O_2 but no hydrogen)

Inorganic Pollutants

- Contaminants in the form of simple inorganic are compounds like CO, CO₂, NO₂, NO, SO₂, HF, H₂S, metals etc.

Criteria Pollutants

- Air pollutants arise from both manmade and natural processes.
- The ambient air quality may be defined by the concentration of a set of pollutants which may be present in the ambient air we breathe in.
- These pollutants may be called **criteria pollutants**.

Criteria Air Pollutants

- Based on health effects with measured air quality levels that violate the National Ambient Air Quality Standards (NAAQS)

-CO
 -NO_x
 -SO_x
 -VOCs
 -Particulate Matters: PM_{2.5}, PM₁₀
 -Pb



Non-Criteria Pollutants

- In essence, all pollutants not included in the NAAQS and HAP lists
- Examples:
 - NaCl



Hazardous Air Pollutants

- Predecessor: National Emission Standards for Hazardous Air Pollutants (NESHAPs)
- Clean Air Act Amendments of 1990 directed EPA to establish emission controls for 189 chemicals listed in the Act.
- -NOT based on health criteria
 - Based on Maximum Achievable Control Technology (MACT)
