

Particulate matter in the atmosphere and atmospheric aerosols

1. Particulate Pollution

Suspension of microscopic solids and liquids particles present in the form of droplets floating in the air or atmosphere refers to as particulate pollution. Particulate pollution is caused by particulate matter (PM). The source of the particle can either be natural or anthropogenic.

Particulate matter pollution or particulate pollution is one of the deadliest types of air pollution on a global level. The primary reason for the rise in particulate pollution, type of air pollution, is because of human activities. Major sources of particulate matter emission are factories, power stations, incinerators, industries, automobiles, and diesel generators. All of this is anthropogenic sources or due to human activities.

Particulate matter can be present in the atmosphere in the same form it is released from the source. Sometimes PM can undergo complex chemical reactions in the atmosphere. It is the deadliest type of air pollution because particulate matter can easily penetrate deep into the lungs and bloodstreams of human body unfiltered. Moreover, these particles vary from each other in shape, size, and composition.

2. Particulate matter based on size can fall into two different categories

A. Inhalable coarse particles

- The diameter of the particles ranges from 2.5 to 10 micrometers
- Inhalable coarse particles are present in the nearby regions of dusty industries and roadways.

B. Fine particles

- Usually found in haze and smoke and the size can range up to 2.5 micrometers.
- Fine particles originate from forest fires. Moreover, they can also originate on a reaction of air with gases released from the industries, automobiles and power plants.

3. Particulate Pollutants

A particulate pollutant is a microscopic liquid and solid particles present in the form of the suspension in the air. Particulate matter can be released from different types of human activities such as vehicle emissions, smoke particles, dust particles, and ash from industries. Particulate matter present in the air is mainly of two types- Viable particles and non-viable particles.

A. Viable Particulate Matter: These particles include lower living organisms such as algae, bacteria, molds, fungi, etc. They are dispersed into the air. Human beings are allergic to these microorganisms and they can also cause different types of diseases in plants and animals.

B. Non-Viable Particulate Matter: We can classify these particles based on size and their nature. These particulates include smoke, dust, mists, and fumes.

i. Smoke Particles

Smoke particulates contain a mixture of liquid and solid particles. Combustion of any kind of organic matter leads to the formation of smoke particles. Examples include the release of smoke from a cigarette, burning of garbage and dry leaves, burning of fossil fuel, oil, etc.

ii. Dust

The size of dust particulates is more than 1 micrometer (μm) in diameter. Dust particulate matter originates from grinding, crushing, and attribution of solid substances. Examples of this type of particulate emission include the release of sawdust during wood works, release of sand particles during sandblasting, pulverization of coal, release of fly ash and cement from factories, dust storms, etc.

iii. Mists

Vapors in air undergo condensation to form a mist. Production of mist is also possible by particles of spray liquids. For instance, herbicides and pesticides are used in the form of sprays in agriculture but sometimes it is possible to miss the spray target and enter the atmosphere and form mists. Another example is the sulfuric acid mist.

iv. Fumes

Formation of fumes is possible by the condensation of vapors during different processes such as boiling, distillation, sublimation, and other types of chemical reactions. Organic solvents, metallic oxides, and metals undergo a chemical reaction to generate fume particles.

4. Effects of Particulate Matter

A particulate pollutant is very dangerous to human health, plants, and to the entire climate. Children and elderly people are prone to diseases caused by particulate pollution. However, normal persons can also experience temporary problems.

The adverse effect of the particulate pollutants will vary according to the particle size. Therefore, airborne particles like fumes, dust, mist, etc are harmful to human health. Larger particles of size more than 5 microns can enter and block the nasal passage. However, particles of the approximate size of 10 microns can directly enter the lungs and affect it severely.

i. Effects on Health

Exposure to particulate pollution can cause irritation of eyes, throat, and nose. It can also cause tightness in chest, difficulty in breathing and decrease in lung function.

ii. Effect on Vegetation and Plants

Particulate pollutants can block stomatal openings. Therefore, it can retard the photosynthesis process. Hence, air pollutants can damage the plant, reduce crop and vegetation yield, and increase their mortality rate.

iii. Effect on Climate

The rise of particulate pollution is disturbing the environmental balance. Therefore, it is predicted that it can be the precursor of many climatic disasters such as volcanic eruptions. Reports suggest particulates matter can negatively impact weather on a regional level. PM decreases the levels of evaporation of water in the Indian Ocean. It is linked to the lack of Indian monsoon or reduction of the Indian monsoon.

Nowadays droughts occur more often on a global scale than it used to. Aerosol haze and particulate pollution can push tropical rainfall and are the reason for a number of droughts human's

experiences on a global level. PM causes the decrease in rainfall. It is also responsible for the increase in greenhouse gases and global warming.

Atmospheric aerosols

1. Introduction

Atmospheric aerosols (or particulate matter) are solid or liquid particles or both suspended in air with diameters between about 0.002 μm to about 100 μm . Aerosol particles vary greatly in size, source, chemical composition, amount and distribution in space and time, and how long they survive in the atmosphere.

2. Types of atmospheric aerosols

i. Primary atmospheric aerosols

Primary atmospheric aerosols are particulates that emitted directly into the atmosphere (for instance, sea-salt, mineral aerosols (or dust), volcanic dust, smoke and soot, some organics).

ii. Secondary atmospheric aerosols

Secondary atmospheric aerosols are particulates that formed in the atmosphere by gas-to particles conversion processes (for instance, sulfates, nitrates, some organics). A significant fraction of the atmospheric aerosols is anthropogenic in origin.

3. Major physical properties of atmospheric aerosols

- Can scatter, absorb and emit electromagnetic radiation
- Can serve as cloud nuclei

Major chemical properties of atmospheric aerosols

Serve as media upon which chemical reactions can occur

4. Some criteria used in atmospheric aerosol classification

i. Particle size

Particle size ranges between about 0.002 μm to about 100 μm .

ii. Chemical composition

Sulfate (SO_4^{2-}), nitrate (NO_3^-), soot (elemental carbon), sea salt (NaCl); etc.

iii. Geographical location

Marine, continental, rural, industrial, polar, desert aerosols, etc.

iv. Location in the atmosphere

Stratospheric and tropospheric aerosols