

TOPIC: -

AIR POLLUTION.

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INTRODUCTION: -

The air we breathe is an essential ingredient for our wellbeing and a healthy life. Unfortunately, air has been polluted. There is no doubt that air pollution existed in ancient times, but it was much less severe and less widespread than today. Three factors account for this, (i) less human population, (ii) small consumption per person and (iii) very basic types of materials used. Today, however, it has reached massive proportions and threatens to change the global environment. According to Mishra (2003) rapid growth in urban population, increasing industrialization, and rising demands for energy and motor vehicles are the worsening air pollution levels. He added other factors, such as poor environmental regulation, less efficient technology of production, congested roads, and age and poor maintenance of vehicles, also add to the problem. He further added that air pollution is caused of ill health and death by natural and man-made sources, major man-made sources of ambient air pollution include tobacco smoke, combustion of solid fuels for cooking, heating, home cleaning agents, insecticides industries, automobiles, power generation, poor environmental regulation, less efficient technology of production, congested roads, and age and poor maintenance of vehicles. The natural sources include incinerators and waste disposals, forest and agricultural fires (European Public Health Alliance, 2009). The sources of air pollution are many and are often completely related to the environment. However, there is no doubt about the root cause: a world population of more than 7.5 billion growing by more than 80 million a year. Most of these people will be in developing countries where air pollution will likely reach unprecedented levels with higher levels of fossil – fuel burning relation to consumption of goods from factories, home heating, cooking and transportation. Approximately 50 - 70% of all air pollution arises from transportation-combustion sources, 15-25% from heavy industrial stationary sources and as much as 25% from other stationary sources.

“Air is polluted when one or several pollutants are present in the atmosphere at such a concentration and for so long a time that they are harmful to man, animals, plants or material property, cause harm or reduce well-being or disturb appreciably its application” (World Health Organisation).

“Any deviation from the natural combination of gases in our atmosphere” (NSW Protection of the Environment Operations Act). What this definition fails to mention is that the natural combination of gases in our atmosphere must be taken as dry air at sea level. This is necessary as it is not possible to quantitatively define pure air because it will change according to altitude and location. This also means that theoretically air pollution can also arise from the removal of gases from the atmosphere.

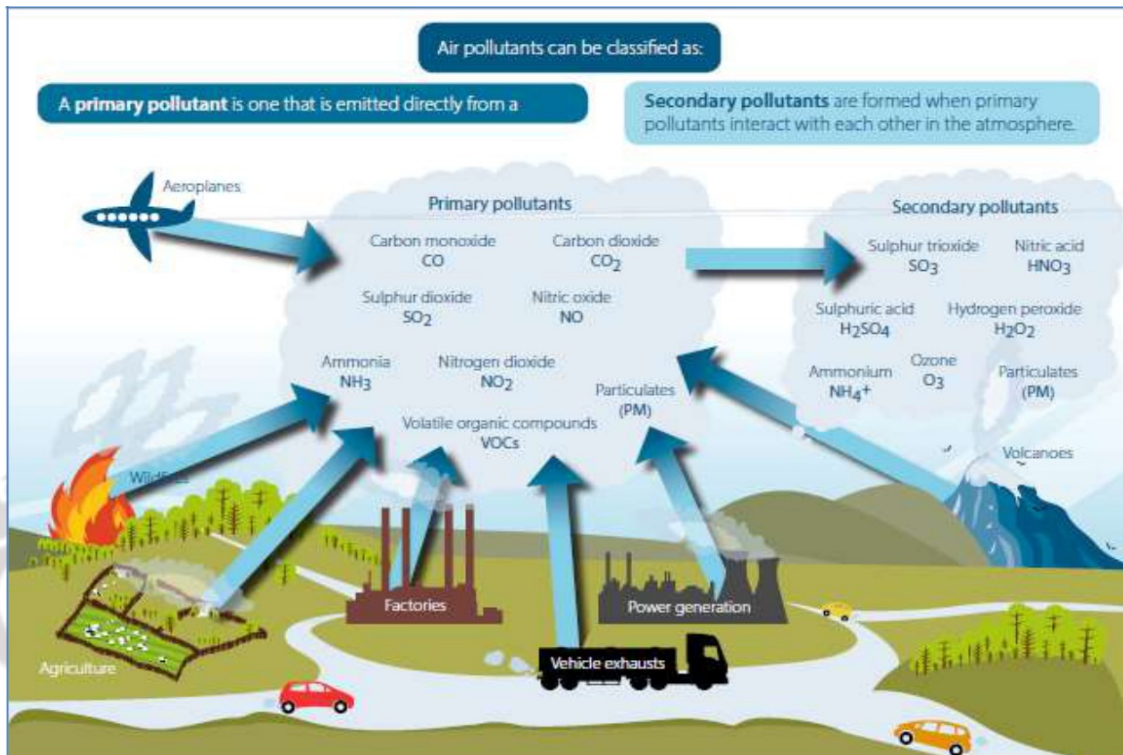
FACTORS LIKELY TO INCREASE THE LEVELS OF AIR POLLUTION: -

Certain conditions help make air pollution worse. Basically these are factors which prevent air circulation, and concentrate air effluent into areas. Examples of these include; calm conditions, low level emission sources, temperature inversions, buildings and narrow streets. By contrast other conditions are known to lower air pollution levels in general. These are those conditions that encourage circulation or remove pollutants from the atmosphere. These include windy or turbulent conditions, high levels of vegetation, high level emission sources such as smoke stacks and rain.

TYPES OF AIR POLLUTION: -

Air pollution occurs due to the presence of undesirable solid or gaseous particles in the air in quantities that are harmful to human health and the environment. Air may get polluted by natural causes such as volcanoes, which release ash, dust, sulphur and other gases, or by forest fires that are occasionally naturally caused by lightning. However, unlike pollutants from human activity, naturally occurring pollutants tend to remain in the atmosphere for a short time and do not lead to permanent atmospheric change.

Pollutants that are emitted directly from identifiable sources, produced both by natural events (for example, dust storms and volcanic eruptions) and human activities (emission from vehicles, industries, etc.) are referred to as **primary pollutants**. There are five primary pollutants that together contribute about 90 per cent of the global air pollution. These are carbon oxides, nitrogen oxides, sulphur oxides, volatile organic compounds (mostly hydrocarbons) and suspended particulate matter. Not all of the pollutants found in the atmosphere are the direct result of emissions. Many of the substances found in the atmospheres that are regarded as pollutants arise from chemical reactions in the atmosphere with other substances or light. Chemical reactions that require light in order to proceed are referred to as photochemical reactions. Those substances that are not directly emitted into the atmosphere, but rather are formed by chemical reactions in the atmosphere are referred to as **secondary pollutants**. Acid rain is a form of secondary pollution because it results from processes occurring within the atmosphere after primary pollutants such as SO₂ are emitted from exhaust stacks and other sources.



THE MAJOR POLLUTANTS: -

There are number of pollutants discharged into the atmosphere. But here the major handful pollutants that are known to have a significant impact on environment and/or human health and are produced in relatively larger quantities have been designated.

Major Pollutants	Sources	Health Hazards
Sulphur dioxide	SO ₂ is a corrosive gas which may remain in the atmosphere for periods up to several weeks. It accounts for about 18% of all air pollution. It is estimated that annually 65 million tones of SO ₂ enter the atmosphere as a result of man's	It reacts with moisture in eyes, lungs and mucous membranes to form strong irritating acid.

	activities, primarily from the combustion of fossil fuels. Of these, coal is by far the greatest contributor. In the United States, it is estimated that almost 60% of SO ₂ emission are the result of coal-fired power stations. It is harmful to human health and building materials and is a major contributor to acid rain.	
Nitrogen oxides	Nitrogen oxides (NO _x) are a group of gases made up of varying amounts of oxygen and nitrogen molecules. Nitrogen oxide and dioxide are the two gases produced when fossil fuels are burned at high temperatures, but it can also be formed naturally by lightning strikes. Most of the NO ₂ in urban areas comes from exhaust emissions. It accounts for about 6% of air pollution.	It can increase the likelihood of respiratory problems, as it inflames the lining of the lungs, and can reduce immunity to lung infections. It can cause problems such as wheezing, coughing, colds, flu and bronchitis.
Carbon oxides	Significant quantities of the carbon oxides (CO and CO ₂), are produced by natural and anthropogenic sources. Because of its health implications, CO is considered to be a major atmospheric pollutant. CO ₂ has a significant potential for causing global climatic change. CO is formed whenever a carbon material is burned e.g. automobile exhausts, cigarettes etc. In addition to motor vehicles, sources of CO include burning coal, natural gas or biomass, solid waste disposal, agricultural burning. CO accounts for more than 50%.	Hundreds of disease like headaches, dizziness, drowsiness etc. is related to CO. About 11% heart failures are caused by excess CO.
Particulates	The term particulate refers to very small solid or liquid particles. Individual particles may vary in size, geometry, chemical composition and physical properties. They may be of natural origin (such as pollen or sea spray) or manmade (dust, fume and soot). They provide a reactive surface for gases and vapours in the formation of secondary pollutants	They are known to cause a variety of illnesses, including lung cancer and respiratory disorders such as emphysema and asthma.
Hydrocarbons	A wide variety of carbon-based gases, including methane and benzene, are emitted in fossil-fuel combustion from automobiles, home heating and industry when burning is incomplete.	As a primary pollutant they are a major health hazard. They are also source of secondary pollution because they contribute to the formation of oxidants such as ozone.
Oxidants	These are part of a variable mixture of secondary pollutants commonly associated with photochemical smog in major urban areas, formed by action of solar radiation on hydrocarbons and nitrogen oxides from automobiles and industry.	They pose health risks ranging from eye irritation to cancer. Ozone is one the chief oxidants.
Acid deposition	Various oxides, led by SO ₂ and NO _x , combine with water vapour and precipitation to lower the pH of atmospheric moisture.	Precipitated on the land, oxides lower pH levels in fresh water, eliminating many species from ecosystems in lakes and streams.
Synthetic compounds	A wide variety of manufactured organic compounds such as CFCs, DDT, PCB and dioxins occur in both gaseous and particulate forms.	They enter the atmosphere via combustion and wind erosion and are known causes of various disorders like cancer.
Radioactive substances	Particles such as ash from coal-burning, gases such as radon, and waste from nuclear operations emit harmful radiation.	These cause cancer and genetic alterations in humans and other organisms.

PARTICULATES: Particulate matter may be classified under the following

headings: o Dusts - large solid particles (>100um) carried into the air.

o Fume - solid particles (frequently metallic oxides) formed by condensation of vapours from a chemical reaction process or physical separation process. These particles are typically between 0.03 - 0.3um in diameter.

o Mist - liquid particles formed by condensation of vapours or chemical reaction.

Smoke - solid particles formed as a result of incomplete combustion of carbonaceous materials.

Typical diameter is between 0.5 - 1.0um.

Spray - a liquid particle formed by the atomisation of a parent liquid.

SOURCES OF AIR POLLUTION: -

There is not any society that does not discharge pollutants into atmosphere. The question, however, is how much and what type? Both developed and developing countries are major contributors to air pollution, but not equally so. The main sources of air pollution in developed countries include motor vehicles, power plants, and industrial plants. Most pollution results from the combustion of fossil fuels, which emits CO, NO_x, SO₂, particulates and hydrocarbons. While as developing countries emit large amounts of traditional pollutants such as CO₂ and NO_x. Developing countries are becoming major centres of urban pollution and source of technological pollutants such as insecticides residues used in agriculture and disease control. There are four main types of air pollution sources in both wealthy and poor countries:

- 1. MOBILE SOURCES:** A mobile source of air pollution refers to a source that is capable of moving under its own power, such as cars, buses, planes, trucks, and trains etc. Mobile sources account for more than half of all the air pollution in the United States.
- 2. STATIONARY SOURCES:** Stationary sources emit large amounts of pollution from a single location, these are also known as point sources of pollution. It includes factories, power plants, dry cleaners and degreasing operations.
- 3. AREA SOURCES:** Area sources are made up of lots of smaller pollution sources that aren't a big deal by themselves but when considered as a group can be. Such as agricultural areas, cities, and wood burning fireplaces.
- 4. NATURAL SOURCES:** Natural sources can sometimes be significant but do not usually create ongoing air pollution problems like the other source types can. Wildland fires, dust storms, and volcanic activity also contribute gases and particulates to our atmosphere.

AIR POLLUTION IMPACTS ON PEOPLE AND ENVIRONMENT

AIR POLLUTION IMPACTS ON HEALTH OF PEOPLE: -

Air pollution has both acute and chronic effects on human health, affecting a number of different systems and organs.

It ranges from minor upper respiratory irritation to chronic respiratory and heart disease, lung cancer, acute respiratory infections in children and chronic bronchitis in adults, aggravating pre-existing heart and lung disease, or asthmatic attacks. In addition, short- and long-term exposures have also been linked with premature mortality and reduced life expectancy.

SO₂ is the most serious and widespread air pollutant. Its lower concentration is a cause of spasms in the smooth muscle of bronchioles and its higher concentration induces increased mucus production. It is also considered to cause cough, shortness of breath, spasm of the larynx and acute irritation to the membranes of the eyes. It also acts as an allergenic agent. When it reacts with some compounds, sulphuric acid is formed which may damage lungs. CO often affects the oxygen carrying capacity of blood. Nitric oxide is reported to be a pulmonary irritant and its excess concentration may cause pulmonary haemorrhage. Nitrogen oxides especially NO₂ can irritate the lungs, aggravate asthma or chronic bronchitis and also increase susceptibility to respiratory infections such as influenza or common colds. Lead emitted from automobile exhausts is a cumulative poison and is dangerous particularly to children and may cause brain damage. The particulate pollutants such as asbestos, silica, carbon, beryllium, lead, etc., are capable of exerting a noxious (fibrotic) local action in the interstitial areas of the lungs. Radioactive elements are also harmful to man and other living organisms. Smog has a killer effect, which is also the result of air pollution. The death toll by smog varies from few persons to thousands. In December 1952, about 4,000 persons died in London due to smog. In other countries also smog deaths have been reported. Inhaling ozone, a component of photochemical smog causes coughing, chest pain, irritation of eyes, nose and throat. In fact, the growing air pollution has now become a health hazard for man.

EFFECTS ON ANIMALS AND PLANTS: -

The impact of air pollution on animals is more or less similar to that on man. Chronic poisoning results from the ingestion of forage contaminated with atmospheric pollutants. Fluoride causes fluorosis among animals. A number of livestock have been poisoned by fluorides and arsenic in North America. Bone lesions in animals due to excessive fluorides have also been reported.

Air pollution has caused widespread damage to trees, fruits, vegetables, flowers and in general, vegetation as a whole. The total annual cost of plant damage caused by air pollution in USA alone has been estimated to be in the range of 1 to 2 billion dollars. The most dramatic early instances of plant damage were seen in the total destruction of vegetation by SO₂ in the areas surrounding smelters. When the absorption of SO₂ exceeds a particular level, the cells become inactive and are killed, resulting in tissue collapse and drying of leaves. Cotton, wheat, barley and apple are more sensitive to this pollutant. The leaves of apple, apricot, fig, peach and prune are more susceptible to air borne fluorides. Fluorides seem to interfere with the photosynthesis and respiration of plants.

EFFECTS OF AIR POLLUTANTS ON MATERIALS: -

Air pollutants produce physical and chemical change in materials which results in their damage and destruction. The natural effects of corrosion and weathering are aggravated when the air is polluted. The most destructive air pollutants to materials are smoke, grit, dust and oxides of sulphur. SO₂ changes to sulphurous and sulphuric acid with moisture and accelerates the rate of corrosion. Different types of metals and metallic structures such as iron and steel, aluminium and aluminium alloys, copper and copper alloys are corroded when exposed to polluted air. Building materials are also corroded and disfigured with increasing pollution of air. In 1972, when an oil refinery at Mathura was opened, its impact on Taj Mahal became a major issue. Smoke, grit and soot deposits disfigure the buildings.

OTHER EFFECTS OF AIR POLLUTION: -

GLOBAL WARMING: Another direct effect of air pollution is the immediate alterations that the world is witnessing due to Global warming. With increased temperatures worldwide, increase in sea levels and melting of ice from colder regions and icebergs, displacement and loss of habitat have already signalled an impending disaster if actions for preservation and normalization aren't undertaken soon.

OZONE DEPLETION: Ozone is a gas that occurs both at ground-level and in the Earth's upper atmosphere, known as the stratosphere. At ground level, ozone is a pollutant that can harm human health. In the stratosphere, however, ozone forms a layer that protects life on earth from the sun's harmful ultraviolet (UV) rays. But this ozone is gradually being destroyed by man-made chemicals referred to as ozone-depleting substances, including chlorofluorocarbons, hydro chlorofluorocarbons, and halons. These substances were formerly used and sometimes still are used in coolants, foaming agents, fire extinguishers, solvents, pesticides, and aerosol propellants. Thinning of the protective ozone layer can cause increased amounts of UV radiation to reach the Earth, which can lead to more cases of skin cancer, cataracts, and impaired immune systems. UV can also damage sensitive crops, such as soybeans, and reduce crop yields.

ACID RAIN: Harmful gases like nitrogen oxides and sulphur oxides are released into the atmosphere during the burning of fossil fuels. When it rains, the water droplets combine with these air pollutants, becomes acidic and then falls on the ground in the form of acid rain. Acid rain can cause great damage to human, animals and crops.

EUTROPHICATION: Eutrophication is a condition where high amount of nitrogen present in some pollutants gets developed on sea's surface and turns itself into algae and adversely affect fish, plants and animal species. The green coloured algae that is present on lakes and ponds is due to presence of this chemical only.

CONTROL OF AIR POLLUTION: -

Worldwide air pollution control remains a great uphill task and is certain to remain so for many decades. Air pollution control is pursued more or less at all scales from global to local including the home and at workplace. However, the effort is very spotty geographically with programs limited mostly to developed nations. Some of the effective methods to control air pollution are as follows:

- (A) Source Correction Methods
- (B) Pollution Control equipment
- (C) Diffusion of Pollutant in Air
- (D) Vegetation
- (E) Zoning.

SOURCE CORRECTION METHODS: Industries make a major contribution towards causing air pollution. Formation of pollutants can be prevented and their emission can be minimised at the source itself. By carefully investigating the early stages of design and development in industrial processes e.g., those methods which have minimum air pollution potential can be selected to accomplish air-pollution control at source itself. The source correction methods are:

SUBSTITUTION OF RAW MATERIALS: If the use of a particular raw material results in air pollution, then it should be substituted by another purer grade raw material which reduces the formation of pollutants. For example, low sulphur fuel can be used as an alternative to high sulphur fuels, and, comparatively more refined liquid petroleum gas (LPG) or liquefied natural gas (LNG) can be used instead of traditional high contaminant fuels such as coal.

PROCESS MODIFICATION: The existing process may be changed by using modified techniques to control emission at source. For example, smoke, carbon-monoxide and fumes can be reduced if open hearth furnaces are replaced with controlled basic oxygen furnaces or electric furnaces. In petroleum refineries, loss of hydrocarbon vapours from storage tanks due to evaporation, temperature changes or displacement during filling etc. can be reduced by designing the storage tanks with floating roof covers. An appreciable amount of pollution is caused due to poor maintenance of the equipment which includes the leakage around ducts, pipes, valves and pumps etc. Emission of pollutants due to negligence can be minimised by a routine check-up of the seals and gaskets.

POLLUTION CONTROL EQUIPMENT: -

Sometimes pollution control at source is not possible by preventing the emission of pollutants. Then it becomes necessary to install pollution control equipment to remove the gaseous pollutants from the main gas stream. Pollution control equipment include,

GRAVITATIONAL SETTLING CHAMBER: For removal of particles exceeding 50 μm in size from polluted gas streams, gravitational settling chambers are put to use.

CYCLONE SEPARATORS (REVERSE FLOW CYCLONE): INSTEAD of gravitational force, centrifugal force is utilized by cyclone separators, to separate the particulate matter from the polluted gas.

FABRIC FILTERS (BAGHOUSE FILTERS): In a fabric filter system, a stream of the polluted gas is made to pass through a fabric that filters out the particulate pollutant and allows the clear gas to pass through. The particulate matter is left in the form of a thin dust mat on the insides of the bag. This dust mat acts as a filtering medium for further removal of particulates increasing the efficiency of the filter bag to sieve more sub-micron particles.

ELECTROSTATIC PRECIPITATORS: The electrostatic precipitator works on the principle of electrostatic precipitation i.e. electrically charged particulates present in the polluted gas are separated from the gas stream under the influence of the electrical field.

WET COLLECTORS (SCRUBBERS): In wet collectors or scrubbers, the particulate contaminants are removed from the polluted gas stream by incorporating the particulates into liquid droplets. Common wet scrubbers include, Spray Tower, Venturi Scrubber and Cyclone Scrubber.

DIFFUSION OF POLLUTANTS IN AIR: -

Dilution of the contaminants in the atmosphere is another approach to control air pollution. If the pollution source releases only a small quantity of the contaminants, then pollution is not noticeable as these pollutants easily diffuse into the atmosphere but if the quantity of air contaminants is beyond the limited capacity of the environment to absorb the contaminants then pollution is caused. However, dilution of the contaminants in the atmosphere can be accomplished through the use of tall stacks which penetrate the upper atmospheric layers and disperse the contaminants so that the ground level pollution is greatly reduced.

VEGETATION: -

Plants contribute towards controlling air-pollution by utilizing CO₂ and releasing oxygen in the process of photosynthesis. Gaseous pollutants like CO are fixed by some plants, namely, *Ficus variegata*, *Phascolus Vulgaris* etc. Species of *Pinus*, *Pyrus*, *Juniperus* and *Vitis* depollute the air by metabolising nitrogen oxides. Plenty of trees should be planted especially around those areas which are declared as high-risk areas of pollution.

ZONING: -

This method of controlling air pollution can be adopted at the planning stages of the city. Zoning advocates setting aside of separate areas for industries so that they are far removed from the residential areas. The heavy industries should not be located too close to each other. New industries, as far as possible, should be established away from larger cities and the locational decisions of large industries should be guided by regional planning.

CONCLUSION: -

Air pollution is a serious environmental concern all around the globe. Over the last few decades, the intensified process of industrialization and urbanization, coupled with rapid population growth has resulted in severe environmental degradation. In particular, harmful pollutants such as Sulphur dioxide (SO₂), Nitrogen dioxide (NO₂), Ozone (O₃), Total Suspended Particles Matter (TSPM) etc, are emitted and these pollutants even exceed air quality guidelines recommended by the World Health Organization (WHO, 2005). Particulate and gaseous emissions of pollutants from industries and auto exhaust are responsible for rising discomfort, increasing airborne diseases, decreasing productivity and deterioration of artistic and cultural patrimony urban center.