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# A Study on Air Pollution: Effects and Control Measures

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**ABSTRACT:** Detrimental effect of air pollution is well known to our health. The air we breathe can contain a variety of pollutants emanated into the atmosphere outdoors (also called ambient air) as well as into the air indoors. Air pollution can comprise a mixture of solid droplets, liquid droplets, liquid precipitations and gases from a variety of sources such as industry, motor vehicles, heating applications and tobacco smoke. Air pollution can also be created by natural (I think this would be industrial, man-made and natural) events such as bush fires and can contain windblown dust, pollen and mould spores. The composition of air pollution can vary greatly, depending on the season, the weather, types and numbers of sources. Exposure to particulate matter for a long time can lead humans to respiratory and cardiovascular diseases such as asthma, bronchitis, lung cancer and heart attacks.

**KEYWORDS:** Air pollutants, pollutants emitted, effects of air pollution, harmful effects.

## I. INTRODUCTION

**Air pollution** is the introduction of harmful including particulates and biological molecules into Earth's atmosphere. It may cause diseases, allergies or death in humans; it may also cause harm to other living organisms such as animals and food crops and may damage the natural or built environment. Air Pollution in India is quite a serious issue with the major sources being fuelwood and biomass burning, fuel adulteration, vehicle emission and traffic congestion. The deadly power of air pollution is no new finding. Numerous studies have concluded that both outdoor and indoor pollution can cause a variety of serious diseases, including ischemic heart disease, chronic pulmonary obstructive disease, increased risk of stroke and even lung cancer. One study published in 2015 in Nature, for instance, estimated that a type of pollution known as "fine particulate matter" tiny toxic particles that can be released by a variety of sources, including the burning of fossil fuels or organic matter is responsible for about 3 million deaths worldwide each year. (Nature 2015) The Global burden of disease study for 2010, published in 2013, had found that outdoor air pollution was the fifth-largest killer in India and around 620,000 early deaths occurred from air pollution related diseases in 2010. According to WHO (World Health Organization) study, 13 of the 20 most-polluted cities in the world are in India; however the accuracy and methodology of the WHO study was questioned by the Government of India led by Manmohan Singh.

## II. AIR POLLUTION IN INDIA

In certain parts of the world, particularly India and China, air pollution is an ever-growing public health concern. This may be especially true for India, which reportedly surpassed China earlier this year in the overall amount of fine particulate matter pollution its citizens are exposed to. That report, which was published in February by Greenpeace, found that fine particulate matter levels in New Delhi came to about 128 micrograms per cubic meter, in comparison to Beijing's 81 and Washington D.C.'s 12. A few broad studies have attempted to produce estimates for the globe as a whole, including regional estimates for India or South Asia these included two independent 2015 studies and a 2014 World Health Organization report, all of which suggested that pollution-related premature deaths were above 0.5 or 0.6 million annually. The study relied on computer simulations of outdoor air pollution levels throughout the nation

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including both fine particulate matter and ozone, which is also known to cause respiratory disease using data from national inventories on pollutant emissions. The researchers then used a model relying on previous research on the human health response to pollution exposure to estimate the number of associated premature deaths. All the simulations were based on 2011 data. Their results suggested that about 570,000 premature deaths in India were caused by exposure to fine particulate matter in 2011, and an additional 12,000 were caused by exposure to ozone. The most severely affected part of the country was the Indo-Gangetic region, which includes the northern strip of the country. The rate at which urban air pollution has grown across India is alarming. A vast majority of cities are caught in the toxic web as air quality fails to meet health-based standards.

### III. NEW DELHI AIR POLLUTION

**New Delhi** has an air pollution problem. It is the 11<sup>th</sup> worst polluted city in the world, with an annual average PM<sub>2.5</sub> measurement of 122. Average air-quality index reading for Delhi in October 2015 was considered “poor” according to the Central Pollution Control Board’s air quality index bulletin. PM 2.5, tiny particles suspended in the air that can lodge into lungs and cause diseases, jumped to dangerous levels in the Delhi on 1<sup>st</sup> November, 2016 according to data measured by the board’s air-quality stations in the city. The burning of solid waste and crops, vehicular emissions and dust from construction sites are major contributors to the city’s smog. Firecrackers and fireworks set off during the Diwali celebrations had also added to the city’s pollution levels. Perhaps for the first time, the three municipal corporations of Delhi closed schools under their jurisdiction, numbering around 1,700, due to the high level of air pollution. It had been observed that open burning of solid waste in and around Delhi, vehicular emissions in Delhi, dust by the roadside and around construction sites in Delhi and stubble burning residue in neighboring states of Delhi are major contributors to pollution in Delhi. Doctors have cautioned that the particle matter can cause respiratory diseases, if one is subjected to prolonged exposure to unsafe levels. The pollution monitoring agency has advised people to avoid outdoor physical activity when air quality is rated “severe”. People with heart or lung diseases, outdoor adults and children have been advised to remain indoors and keep activity levels low.

### IV. AIR POLLUTANTS

**Air Pollutants** are the substance which pollute the air. Some of the common air pollutants are dust, soot, ash, carbon monoxide and excess of Carbon Dioxide, Sulphur Dioxide, oxides of nitrogen, hydrocarbons, chlorofluorocarbons (CFC), lead compounds, asbestos dust, cement dust, pollens and radioactive rays. The air pollutants are classified as primary or secondary based on their characteristics while they are emitted and physical/chemical changes they undergo while in the atmosphere. The pollutants emitted (explain primary and secondary air pollutants) into the atmospheric directly from the identifiable sources that remain scattered in the atmosphere in the same chemical form as the time of emission from source are known as the primary pollutants. The pollutants which undergo chemical changes in the atmosphere as a result of reactions among two or more pollutants are called secondary pollutants. The pollutants like Sulphur dioxide, nitrogen dioxide and particulates are recognized as primary pollutants while several other air pollutants are categorized as secondary pollutants.

#### TYPES OF AIR POLLUTANTS:

1. **Sulphur Dioxide (SO<sub>2</sub>): Critical Pollutant:** Sulphur Dioxide is generated from the natural resources such as bacterial decomposition of Sulphur’s in the soil from the oxidation of hydrogen sulphide produced by the decay of organic matter, from volcanoes, etc. The anthropogenic sources of Sulphur Dioxide emission arise mainly from combustion of fuels because of trace amount of inorganic and organic Sulphur contained in the fossil fuels and ores. It has been estimated that about one third of the Sulphur dioxide emission in the atmosphere arises from the activities of man chiefly the combustion of fossil fuels. Significant quantities of Sulphur dioxide are emitted by oil refineries, automobiles, thermal power plants, acid plants, smelters, incinerators, etc. From 1960 to 1980, Sulphur

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Dioxide emissions were considered the most critical pollutant by its Nagpur based National Environmental Engineering Research Institute (NEERI).

- 2. Nitrogen Oxides (NO<sub>2</sub>): Killer Gas:** Generally recognized as sum of nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>), it is a reddish brown corrosive gas. The automobile exhaust is one of the largest sources of NO<sub>2</sub> emission in the ambient air, as these are formed during combustion as a result of oxidation of atmospheric nitrogen and organic nitrogen. The significant concentration of nitrogen oxides in gaseous emissions occurs from the industrial emissions where nitric acid is produced or is used in chemical reactions. The residence time of NO<sub>2</sub> in the atmosphere is about a few days and is scavenged from the atmosphere through formation of nitric acid, nitrites or nitrates and through their dry dissociation.
- 3. Particulate Matter (P.M):** The particulate matter refers to the solid or liquid particles in its form of dust fumes mist or smoke and originated either by dispersion of particles from breakdown of solid bulk material or condensation originated, built up from molecular dimension after heating or cooling. The particles have several physicochemical properties such as size, mass, volume, settling velocity, chemical aerodynamics and optical properties. These properties of the particles play a vital role in atmospheric processes. The size, density and shape of the particles are of prime importance because these factors not only influence their cleansing rate from the environment, but also their effects.
- 4. Carbon Monoxide (CO<sub>2</sub>):** Incomplete combustion of carbon results in the production of carbon monoxide (CO). The anthropogenic sources of CO are motor vehicles, coal combustion, fuel oil combustion, industrial processes, and solid waste disposal and refuse burning. In motor vehicles air-to-fuel ratio has a direct impact on carbon monoxide emissions. At lower air-to-fuel ratio, carbon monoxide emissions are increased due to incomplete combustion in low presence of oxygen. In urban areas, carbon monoxide concentration follows a diurnal pattern, which depends on traffic volume and speed. Generally CO concentrations reach to a maximum in the early morning hours due to peak of CO concentration is usually observed corresponding to the late afternoon traffic period, and decrease to low levels during the night.
- 5. Photochemical Oxidants:** These are mainly the result of secondary reactions in the atmosphere and are not directly attributed to nature. Ozone is the main photochemical oxidant and its formation is normally attributed to nitrogen dioxide photolytic cycle. Ozone is formed through dissociation of nitrogen oxides (NO<sub>2</sub>) by sunlight to yield the oxygen atoms, which then react with molecular oxygen to produce ozone molecule. The presence of reactive hydrocarbon allows ozone to accumulate at higher than steady levels.

### V. SOURCES OF AIR POLLUTION:

**Sources of Air Pollution:** The pollution of air can be caused by natural processes or by human activities. The sources of air pollution are classified into two groups:

- 1. Natural Sources of Air Pollution:** They are dust storms, forest fires, ash from smoking volcanoes, decay of organic matters and pollen grains floating in air.
- 2. Man-made Sources of Air Pollution:** They are population explosion, deforestation, urbanization and industrialization, whose effects can be explained as follows:
  1. Burning of fuels like wood, cow dung cakes, coal and kerosene in homes pollute the air.
  2. Exhaust gases emitted by motor vehicles which pollute the air are the major source of air pollution in big cities.
  3. Industries pollute air by releasing various types of pollutants such as Sulphur Dioxide, oxides of carbon, nitrogen oxide, chlorine, asbestos dust and cement dust.

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4. Thermal power plants pollute air by emitting Sulphur dioxide and fly-ash.
5. Nuclear power plants pollute air by releasing radioactive rays.
6. Use of fertilizers and pesticides in agriculture pollute the air.
7. Mining activities releases particulate matter into the air and pollutes it.
8. Indiscriminate cutting of trees and clearing of forests increases the amount of carbon dioxide in the atmosphere and thereby pollutes it.
9. Use of chlorofluorocarbons in refrigeration, fire extinguishers and aerosol sprayers pollutes air by depleting the ozone layer.
10. Smoking pollutes air by emitting carbon monoxide and nicotine.

### VI. HARMFUL EFFECTS OF AIR POLLUTION:

- 1) Air pollution affects respiratory system causing breathing difficulties and diseases such as bronchitis, asthma, lung cancer, tuberculosis and pneumonia.
- 2) Air Pollution affects the central nervous system causing carbon monoxide poisoning. CO has more affinity for hemoglobin than oxygen and thus forms a stable compound carboxy hemoglobin (COHb), which is poisonous and causes suffocation and death.
- 3) Air pollution causes depletion of ozone layer due to which ultraviolet radiations can reach the earth and cause skin cancer, damage to eyes and immune system.
- 4) It causes acid rain which damages crop plants, trees, buildings, monuments, statues and metal structures and also makes the soil acidic.
- 5) It causes greenhouse effect or global warming which leads to excessive heating of earth's atmosphere, further leading to weather variability and rise in sea level. The increased temperature may cause melting of ice caps and glaciers, resulting in floods.

### VII. PREVENTION AND CONTROL OF AIR POLLUTION:

Different techniques are used for controlling air pollution caused by 'gaseous pollutants' and 'particulate pollutants'.

**Methods of controlling gaseous pollutants:** The air pollution caused by gaseous pollutants like hydrocarbons, Sulphur dioxide, ammonia, carbon monoxide, etc. can be controlled by using three different methods-Combustion, Absorption and Adsorption.

1. **Combustion:** This technique is applied when the pollutants are organic gases or vapors. The organic air pollutants are subjected to 'flame combustion or catalytic combustion' when they are converted to less harmful product carbon dioxide and a harmless product water.
2. **Absorption:** In this method, the polluted air containing gaseous pollutants is passed through a scrubber containing a suitable liquid absorbent. The liquid absorbs the harmful gaseous pollutants present in air.
3. **Adsorption:** In this method, the polluted air is passed through porous solid adsorbents kept in suitable containers. The gaseous pollutants are adsorbed at the surface of the porous solid and clean passes through.

**Methods of controlling air pollution at an industrial scale:** The air pollution caused by particulate matter like dust, soot, ash, etc. can be controlled by using fabric filters, wet scrubbers, electrostatic preceptors and certain mechanical devices.

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1. **Mechanical Devices:** It works on basis of following:

1. **Gravity:** In this process, the particulate settle down by the action of gravitational force and get removed.
  2. **Sudden change in the direction of air flow:** It brings about separation of particles due to greater momentum.
  3. **Effect of gravity and sudden change in direction of air flow is used in well-known devices known as cyclone separator (commonly oil refineries to separate oils and gases.)**
2. **Fabric Filters:** Fabric Filters (also called baghouses and bagfilters) are air pollution control devices that remove particulate matter from a gas stream by passing the dirty air through a layer of cloth. The particulate matter deposits on the cloth surface and the clean air passes through. (Nowadays synthetic fibers are used or preferred over natural fibers due to better resistance to chemical attack and is highly efficient at operating at high temperatures)
3. **Wet Scrubbers:** Wet Scrubbers are effective air pollution control devices for removing particles or gases from industrial exhaust streams. A wet scrubber operates by introducing the dirty gas stream with a scrubbing liquid—typically water. Particulate or gases are collected in the scrubbing liquid.

### Some other methods of controlling Air Pollution:

1. Tall chimneys should be installed in factories.
2. Better designed equipment and smokeless fuels should be used in homes and industries.
3. Renewable and non-polluting sources of energy like solar energy, wind energy, etc. should be used.
4. Automobiles should be properly maintained and adhere to emission control standards.
5. More trees should be planted along roadside and houses.

### PHOTOCATALYST CEMENT:

**Photocatalyst Cement** is one of the most recent discoveries and still more advancements are made and experiments are being conducted and air quality after instillation of this new kind of cement is recorded showing promising. There have some projects which have been successfully completed and have received appreciation to one of the projects like Pilot project: Leien in Antwerp (2004-2005).

### ANALYSIS OF PHOTOCATALYTIC CEMENT

The name says it all Photo: phenomenon induced by (sun) light (UV-spectrum) & Catalyst: a compound which initiates a chemical reaction, without being used during this reaction mostly in the form of micro-particles of titanium dioxide ( $\text{TiO}_2$ ) in the crystal form anatase.  $\text{TiO}_2$  combination with cement leads to the alkalinity of the concrete. Thus, a synergetic effect is created in the presence of the cement matrix, which helps to effectively trap the reactant gases ( $\text{NO}$  and  $\text{NO}_2$ ) together with the nitrate salt formed. Subsequently, the deposited nitrate can be washed away by rain or washing with water. In addition, these nitrates pose no real threat towards pollution of body waters because the resulting concentrations in the waste water are very low, even below the current limit values for surface and ground water, even this problem can be dealt with if the government installs a filtration system before the waste water is formed.

### Uses of photocatalytic cement specially in India:

India has a rising pollution problem and there is an increase in recorded amounts of deaths due to air pollution this cement has shown to decrease the amount of  $\text{NO}_2$  and  $\text{NO}$  considered to be one of the main pollutants which will prove to be beneficial for the people and the environment of our growing country. Especially in places Delhi and Mumbai which are heavily polluted and are facing tremendous rise in temperature, using this technology would reduce the deaths caused due to air pollution and prevent or slow down the rise in temperature.

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**Note:** -One of the major disadvantages is that this cement reacts in a different manner if the level of humidity or level of air pollution is lowered and it was also found out that  $TiO_2$  would catalyze a reaction with ammonia which actually increases  $NO_2$  levels in the atmosphere.

## VIII. CONCLUSION

The World Health Organization defines Air Pollution as “the presence of materials in the air in such concentration which are harmful to man and his environment”. In fact air pollution is the occurrence or addition of foreign particles, gases and other pollutants into the air which have an adverse effect on human beings, animals, vegetation, buildings, etc. The controversies around air pollution show no signs of abating. Points of concentrated air pollution are getting more attention and becoming political battlegrounds. Since there so many problems and diseases caused by air pollution it is the duty of each one of us to try to contribute even in a small way to reduce air pollution. Air pollution in recent years has reached a point where neither can we completely control it nor can we reverse its effects which might take years research without guarantee of success thus we should participate in the active efforts made by our government and environmental health organizations hoping to reduce the rate of increase of air pollution.

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