

Review on Air Pollutants and Its Effect on Human Health

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ABSTRACT

Pollutants constitute of the harmful contaminants to the environment through various media such as gases, liquids, waste and noise, making the surrounding unhealthy for living. Because of these contaminants, the ecosystem is damaged on various levels breaking the coordination and eventually disturbing the balance of the environment. The elements which pollute the environment are known as pollutants. They therefore cause some basic main types of pollution like air pollution based on this study and all these harmful effects on human life. Air pollutant is the second most feared because there are direct exits of gaseous pollutants through chimneys into the atmosphere and its mechanism of toxicity can induce some health disorders like asthma, coughing etc. No one other than humans are responsible for air pollution and it is us who can control it too. Various pollutants are Sulfur dioxide, NO₂, CO etc. the sources of this pollutant are combustion, which makes them one of the widely found air pollutants in the environment, others are Volatile Organic Compounds (VOCs).

Keywords: VOCs, Pollutant, Ozone and Contaminants

INTRODUCTION

Pollutants are the contaminants that get introduced into the natural environment, beyond permitted limits, and cause deleterious effects to the inhabitants in a visible way. A pollutant is a substance or energy introduced into the environment that has undesired effects, or adversely affects the usefulness of a resource [1]. A pollutant may cause long- or short-term damage by changing the growth rate of plant or animal species, or by interfering with human amenities, comfort, health, or property values. Pollutants are the elements, molecules and particles involved in pollution - life can be harmed when exposed to these materials, and the effects of them on humans and plants are well known. Pollutants can be introduced into the environment in many ways, both naturally and by humans [2]. What pollutants do once they are emitted into the atmosphere, soil or water supply is dependent on the type of pollutant. Pollutants can affect cardiovascular health by hardening the arteries and increase the risk of heart attack and

strokes, and there is even emerging evidence that air pollution may be linked to mental health conditions and degenerative brain diseases such as Alzheimer's disease, Parkinson's disease and schizophrenia [3].

Characteristic of pollutants

1. Primary pollutants

Primary pollutants cause pollution by their direct release into the environment [4]. The substance released may already be present in some quantities, but it is considered a primary pollutant if the additional release brings the total quantity of the substance to pollution levels. For example, carbon dioxide is already naturally present in the atmosphere, but it becomes toxic when additional releases cause it to rise above its natural concentrations [5]. The rise in levels of carbon dioxide is one contributing factor to the greenhouse effect. These are substances that are released into the atmosphere directly from the polluting source, and are mostly derived from the combustion of fossil

fuels. The substance released may already be present in some quantities, but it is considered a primary pollutant if the additional release brings the total quantity of the substance to pollution levels [6]. For example, carbon dioxide is already naturally present in the atmosphere, but it becomes toxic when additional releases cause it to rise above its natural concentrations. The rise in levels of carbon dioxide is one contributing factor to the greenhouse effect. Petrol engines that ignite the fuel in an oxygen-restricted environment produce varying quantities of carbon monoxide, nitrogen oxides and hydrocarbons such as benzene and polycyclic aromatic compounds [7]. All of these pollutants are reduced by the use of a catalytic converter. In contrast, diesel engines burn fuel with an excess of oxygen, producing little carbon monoxide but more nitrogen oxides and particulate matter.

2. Secondary pollutants

This is when two or more primary pollutants react in the atmosphere and cause additional atmospheric pollution. These are formed in the atmosphere from chemical changes to primary pollutants. Nitric oxide (NO) produced from vehicle engines is quickly converted to nitrogen dioxide, and in doing so may react with ozone, reducing the atmospheric concentration of the latter [8]. Alternatively, when exposed to sunlight in the lower atmosphere both NO and NO₂ react with oxygen to produce ozone (O₃) [8].

Therefore, they are various types of pollutants in the environment affecting humans in the society, one of such is air pollutants

AIR POLLUTANTS

Air pollutants are solid particles, gases, and liquid droplets in the air that can adversely affect ecosystems and the health of humans [9]. Air pollutants potency varies as per diffusion rate, transportation distance, reaction properties, chemical composition, and their effects on human/animal health. However, Air pollutants bear similarities

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I. Gaseous pollutants

These substances are gases at normal temperature and pressure as well as vapors evaporated from substances that are liquid or solid. Fossil fuel combustion produces gaseous pollutants, causing variation in atmospheric composition [10]. Nitrogen Oxide (NO) reacts actively with ozone (O₃) or radicals in atmosphere forming nitrogen dioxide (NO₂). In lower atmospheric layers, sun light acts as catalyst in reactions between NO₂ and VOC (Volatile Organic compounds) to produce Ozone.

II. Persistent organic pollutants

Persistent organic pollutants (POPs) is a group of organic compounds (pesticides, dioxins, furans, and PCBs). POPs bioaccumulate in food chain affecting environment and human health [11]. Bioaccumulation is the result of the fact that POPs are resistant to natural/environmental degradation (biological, chemical and photolytic processes). Dioxins, chemical-based compounds (polychlorinated dibenzofurans, polychlorinated dibenzo-dioxins etc.), whereas chemicals like polychlorinated biphenyls (PCB) depict dioxin like toxicity. Partial combustion especially of materials consisting chlorine produces dioxins. Insolubility property of dioxins inhibits groundwater pollution. Air dust or pesticide deposit dioxins on plants which is their entry point in food chain by stably bounding with lipids. Dioxins half life in body is approximately 7-11 years. Their high toxicity lead to reproductive problems, immune system damage, hormone interference and cancer. While short term exposure (high levels) in humans lead to skin lesions (chloracne), patched dark skin and liver function alteration. The sensitive group to dioxin consists of developing fetus, Newborns (developing organ system), people with specific diet (high fish consumers), occupational (pulp and paper industry, incineration plants etc.) [12].

III. Heavy metals

Heavy metals comprise of lead, mercury, cadmium, nickel silver, chromium,

manganese and vanadium. These metals occur natural in earth's crust which neither can be degraded nor destroyed. Most common sources of heavy metals are lead acid batteries, fertilizers, paints, mining and industrial waste, vehicle emissions. Heavy metals are transported by air and can enter water sources as well as human food supply [13]. They enter human tissue via, diet, inhalation or manual handling. Heavy metals are essential for normal metabolic reactions and maintenance. They are essential elements of many enzymes and play key role in oxidation reduction reactions. Even lower level of exposure can result in multiple organ damage. The bio-accumulating tendency of heavy metals render them dangerous. The increase of concentration of a certain chemical over time in biological organism as compared to natural environment concentration is termed as bio-accumulation [14]. This is due to the fact that compounds are taken and stored faster in an organism than they metabolize. Heavy metals affect nuclei, lysosome, cell membrane, mitochondrial and also enzymes responsible for detoxification, metabolism and maintenance. Their interaction with DNA and nuclei protein can cause carcinogenesis/apoptosis, cell cycle modulation etc.

IV. Particulate matter

Particulate matter is generic term to classify air pollutants comprising of suspended particles in air, varying in composition and size, resulting from various anthropogenic activities. Industrial facilities, Power plants, vehicles, incinerators, dust and fires are the major source of particulate matter [15]. The particle size ranges between 2.5 μm (PM_{2.5}) and 10 μm (PM₁₀). The part of respiratory system affected by PM depends upon the size of particle. The upper respiratory tract is affected by PM₁₀ while lung alveoli is affected by ultrafine particles (0.1 μm diameter). The size, surface, number and composition of particles play an important role in eliciting health effects. PM can absorb and transfer multitude of pollutants which results in its composition variation.

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However, PM mainly comprises of ions, reactive gases, organic compounds, metals, and particle carbon core. While relating to mortality, respiratory and cardiovascular effects it can be inferred that finer particles are more hazardous to human health than the coarser ones. Particulate matter can cause premature mortality in patients suffering from lung or heart disease, nonfatal heart attacks, aggravate asthma, reduced lung functionality, irritation in airways, coughing difficult breathing etc.

Determinants of Air Pollution Exposure

Most toxicological and epidemiological studies evaluate the link between air pollution and particle mass [5]. Particle Mass based studies do not establish rigid and thorough interrelationship of particle on human health. Particle size, morphology, chemical composition etc. are the other major parameters to be taken into account for elaborate analysis of particles on human health.

Air pollution interacts primarily with human through inhalation and ingestion. Polluted food and water intake are the primary route of pollutants ingestion. Pollutants are absorbed by gastrointestinal and respiratory tract while they get deposited in various tissues through circulation. Pollutant removal to some extent is through excretion.

Pollutants Concentration

These varies with multiple time scale, emission rate, diurnal/seasonal cycles of temperature and solar radiation and weather patterns [12]. These aspects affect the characteristics of population and individual-level exposures. The rate of formation and duration in atmosphere also govern the temporal behavior of the pollutants. Air pollutants concentrations tend to covary viz. carbon monoxide and nitrogen oxides are the result of combustion along with particle constituents and volatile organic compounds hence their concentrations are at maximum during rush hour. While Ozone, other photochemical oxidants, secondary PM_{2.5} and VOCs are at maximum concentration at Noon, especially due to sunshine availability.

Ozone and PM_{2.5} owing to similar atmospheric lifetime build up over several days and spreading over large geographical regions [2]. This leads to exposure to large number of people but with lesser individual variability as they depict similar spatial and temporal patterns.

The suppression horizontal and vertical mixing in lower atmospheric levels over time leads to buildup of multiple pollutants. Stationary or slow moving high-pressure systems results in stable atmosphere, longer duration of sunshine and light winds. These meteorological conditions seasonality and frequency and their effect on pollutants concentration varies as per their geographical conditions. The complex relationship between meteorological condition and emission sources and their effect on pollutants concentration covariation on multiple spatial and temporal scales makes it even more challenging to identify individual pollutants effect on human health for epidemiological studies. Routes of exposure and evidence for actual exposure are vital for assessing biological effects of environmental conditions. Especially where compounds affect number of systems inducing various effects. Composition of respirable PM varies depending upon the distance of the source and the source itself, along with variation in health impacts and physicochemical properties.

The other approach to identify the most harmful pollutants one by one is to focus on the source of the pollutants [16]. The source can determine the characteristics of the pollutants which in turn can be used to identify its impact on human health.

Cellular Mechanisms of Action of Air Pollutants

Air pollution effect on human health is diverse depending dose and time of exposure, varying composition of air pollutants and generally the exposure to pollutant mixtures rather than a single substance makes it more complex mechanism [7]. Air pollutants directly act as prooxidants of proteins/lipids or generate free radicals, inducing oxidative

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Safety Precautions

The American Lung Association encourages everyone to get involved in the fight for cleaner, healthier air [9]. Here are some simple, effective tips for protecting you and your family from the dangers of air pollution:

1. Check daily air pollution forecasts in your area. The color-coded forecasts can let you know when the air is unhealthy in your community. Sources include local radio and TV weather reports, newspapers and online at airnow.gov.
2. Avoid exercising outdoors when pollution levels are high. When the air is bad, walk indoors in a shopping mall or gym or use an exercise machine. Limit the amount of time your child spends playing outdoors if the air quality is unhealthy.
3. Always avoid exercising near high-traffic areas. Even when air quality forecasts are green, the vehicles on busy highways can create high pollution levels up to one-third a mile away.
4. Use less energy in your home. Generating electricity and other sources of energy creates air pollution. By reducing energy use, you can help improve air quality, curb greenhouse gas emissions, encourage energy independence

and save money! Check out the U.S. Environmental Protection Agency's easy tips for conserving energy at home.

5. Encourage your child's school to reduce exposure to school bus emissions. To keep exhaust levels down, schools should not allow school buses to idle outside of their buildings. Many school systems are using the U.S. EPA's Clean School Bus Campaign to clean up these dirty emissions.
6. Walk, bike or carpool. Combine trips. Use buses, subways, light rail systems, commuter trains or other alternatives to driving your car.

CONCLUSION

From smog hanging over cities to smoke inside the home, air pollution poses a major threat to health and climate. The combined effects of ambient (outdoor) and household air pollution cause about 7 million premature deaths every year, largely as a result of increased mortality from stroke, heart disease, chronic obstructive pulmonary disease, lung cancer and acute respiratory infections. More than 80% of people living in urban areas that monitor air pollution are exposed to air quality levels that exceed the WHO guideline level of $10\mu\text{g}/\text{m}_3$, with low- and middle-income countries suffering from the highest exposures. Air pollution can be significantly reduced by expanding access to clean household fuels and technologies, as well as prioritizing: rapid urban transit, walking and cycling networks; energy-efficient buildings and urban design; improved

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7. Don't burn wood or trash. Burning firewood and trash are among the major sources of particle pollution (soot) in many parts of the country.
8. Use hand-powered or electric lawn care equipment rather than gasoline-powered. Old two-stroke engines like lawnmowers and leaf or snow blowers often have no pollution control devices. They can pollute the air even more than cars, though engines sold since 2011 are cleaner.
9. Don't allow anyone to smoke indoors and support measures to make all public places tobacco-free.

waste management; and electricity production from renewable power sources. WHO has convened a Global Platform on Air Pollution and Health with experts across academia and government, to improve methods of global, regional and national monitoring and surveillance of air pollution exposures, ensuring open-access to air quality data. WHO is leading an Urban Health Initiative (UHI), in collaboration with other UN and civil society actors, to catalyze effective urban action on air pollution by linking decision-makers across health, environmental and planning sectors. In terms of the Sustainable Development Goals, WHO is responsible for monitoring health-relevant indicators for: Air pollution-related mortality, access to clean energy in homes, and Air quality in cities.

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