**What is the role of chemistry in Air Pollution?**

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**Abstract**

The World Health Organisation (WHO)1 reported that air pollution is among the top three global risk factors for disease. Global warming resulting from the emission of greenhouse gases, especially CO2, has become a major concern in recent years. Almost all countries contribute to the rise of carbon emissions. An increase in CO2 emissions will produce more heat. Survival is becoming very difficult because of fossil fuel burning. Man is causing damage to air, water, and soil. Our atmosphere on a global scale is highly polluted2. One of the greatest problems of this era is air pollution. Since it not only affects the environment but also possesses hazardous effects on human health. The number of pollutants present affects human health and results in many diseases. It creates smog, and acid rain, causes cancer, and respiratory diseases, reduces the ozone layer, and contributes to global warming. And in all the role of particulate matter is significant because these are present in small sizes so, that’s why enters the bloodstream and respiratory system and shows bad impacts on health3. In this chapter, we discuss the causes, impacts of air pollution and its management that result in sustainable development. Sustainable development has become the centre of recent policies and strategies in many countries.

Keywords: Air pollution, environmental pollution, clean air, sustainable development

INTRODUCTION

Air pollution is one of the significant societal challenges for mankind not only in the present time but also a matter of great concern in the upcoming decades. A relevant and recent example that received a great deal of national and international attention is the extremely poor air quality in Delhi, India, particularly during winter times. Several studies have been carried out to understand the interaction between human beings and their physical environment because we know that human actions show greater influence on their surroundings4. Pollutants are dangerous substances of solids, liquids, and gases that are made in high quantities as compared to their normal ranges and show harmful effects on the surroundings. The behaviour of human activities shows adverse influences on the surrounding after drinking the polluted water and through the air or the land in which the cultivation of plants occurs. One of the biggest international health issues is environmental contamination globally. Important factors involved in this problem include legislative, economic, and social. The main problem related to air pollution is anthropogenic activities.5-7

It also influences terrible effects on human health, when the person is exposed for a short time then it causes problems like chronic obstructive pulmonary illness, breath problems, asthma, respiratory illness, cough and hospitalization rates high. While long-duration exposure causes cardiovascular system problems, insufficiency of lungs and asthma. From the study, it was concluded that if a person is exposed to air pollutant for a long duration, the chances of diabetes is more.

It has been estimated that more than six million deaths occur annually due to the combined effect of household and ambient air pollution.8-9 Emission, chemistry, and meteorological conditions are the three prime factors that influence air pollution. This short review aims to explore the role of chemistry in air pollution. Tropospheric ozone (O3), and particulate matter (PM) are the two most important chemical entities that cause poor air quality globally.7-8 Other chemicals that contribute to air pollution include carbon monoxide (CO), nitrogen dioxide (NO2), sulfur dioxide (SO2), and ammonia (NH3) to name but a few. In this review, the chemistry behind the formation of tropospheric ozone (O3) and secondary organic aerosol (SOA), a major constituent of the atmospheric particulate matter (PM) is thoroughly discussed.

Air pollution is a pressing environmental issue that affects the quality of air we breathe. It encompasses a wide range of pollutants, including gases, particles, and volatile organic compounds, which can have detrimental effects on human health and the environment. Chemistry plays a critical role in understanding, analyzing, and addressing air pollution. This document aims to explore the role of chemistry in air pollution and its implications for society.

Chemical Reactions and Air Pollutants:

Chemical reactions are at the core of air pollution. The release of pollutants into the atmosphere from various sources triggers complex chemical reactions that lead to the formation of harmful compounds. For example, the burning of fossil fuels in power plants and vehicles releases carbon dioxide (CO2), a greenhouse gas that contributes to global warming. Additionally, the incomplete combustion of fossil fuels produces nitrogen oxides (NOx) and sulfur dioxide (SO2), which can lead to the formation of acid rain.

Photochemical Smog Formation:

Chemistry also plays a significant role in the formation of photochemical smog, which occurs primarily in urban areas with high levels of air pollution. Photochemical smog is formed when sunlight reacts with nitrogen oxides (NOx) and volatile organic compounds (VOCs) emitted from vehicle exhausts, industrial processes, and other sources. These reactions result in the formation of ground-level ozone (O3) and other harmful secondary pollutants. Ground-level ozone irritates the respiratory system and can cause breathing difficulties, especially for individuals with pre-existing respiratory conditions.

Chemical Monitoring and Analysis:

Chemistry provides the tools and techniques necessary for monitoring and analyzing air pollutants. Scientists use sophisticated instruments to measure the concentration of various pollutants in the atmosphere. These measurements help in understanding the sources, transport, and transformation of pollutants. Chemical analysis is crucial for identifying the types and quantities of pollutants present in the air, allowing policymakers to develop effective strategies for pollution control and mitigation.

Air Quality Management:

Chemistry plays a pivotal role in air quality management. By understanding the chemical processes involved in air pollution, scientists and policymakers can develop strategies to reduce pollutant emissions and improve air quality. This involves implementing stricter emission standards for industries and vehicles, promoting the use of cleaner fuels, and investing in renewable energy sources. Chemistry also contributes to the development of advanced air pollution control technologies, such as catalytic converters, which help reduce harmful emissions from vehicles.

Hence, chemistry plays a crucial role in understanding of air pollution and its impact on human health and the environment. By studying chemical reactions, monitoring pollutants, and developing effective mitigation strategies, we can strive towards cleaner and healthier air. Continued research and collaboration in the field of chemistry are essential to combat the challenges posed by air pollution and ensure a sustainable future for generations to come. Governments around the world should invest in policies and technologies that reduce air pollution and ensure access to clean air. Furthermore, public education and awareness about the dangers of air pollution is essential to create a sustainable future.

**CAUSES OF AIR POLLUTION**

Air pollution is a global issue that poses significant threats to human health and the environment. It is caused by a variety of factors, which can be categorized into both natural and human activities. Understanding the causes of air pollution is crucial in developing effective strategies to mitigate its harmful effects. Most of the climate pollutants are emitted from human activities like a car engine combustion, power stations and industrial machinery. These actions performed daily on large scale causes a major role in air pollution. Some other actions including forest fire and soil erosion have a greater influence on human health. Important major sources of air pollution are petrol stations, printing shops, dry cleaners, domestic actions, incineration of municipality wastes, industrial plants, metallurgical, fertilizer and chemical industry, refineries, power stations and petrochemicals. The mobile sources are vehicles, airways, railways, cars and automobiles. While in natural sources includes physical disasters like soil erosion, forest fire, storms of dust and agricultural burning. Other classifications which done based on pollutants and these are nitric oxide, carbon monoxide, carbon dioxide, hydrocarbons, sulfur dioxide, and nitrogen dioxide. Air pollution has also shown its effects on the soil environment and water. From the study, it was concluded that several radio-active components like uranium and radium accumulate in bones and causes cancer. These radio-active pollutants possess dangerous effects on human health after entering the body. This chapter aims to provide an overview of the primary causes of air pollution.

1. Industrial Emissions:

One of the leading causes of air pollution is the release of harmful pollutants from industrial activities. Industries such as power plants, refineries, and manufacturing facilities emit large amounts of pollutants into the air. These pollutants include sulfur dioxide (SO2), nitrogen oxides (NOx), and particulate matter, which contribute to the formation of smog and respiratory issues.

2. Vehicle Emissions:

The increasing number of vehicles on the road is a major source of air pollution, especially in urban areas. The combustion of fossil fuels in vehicles releases pollutants such as carbon monoxide (CO), nitrogen oxides (NOx), and volatile organic compounds (VOCs). These pollutants not only contribute to poor air quality but also have adverse effects on human health.

3. Deforestation:

Deforestation, primarily due to agricultural expansion and urbanization, is another significant cause of air pollution. Trees play a crucial role in removing pollutants from the air through the process of photosynthesis. When forests are cleared, the capacity to absorb pollutants is reduced, leading to increased levels of air pollution.

4. Burning of Fossil Fuels:

The burning of fossil fuels, such as coal, oil, and natural gas, for energy production is a major contributor to air pollution. Power plants, residential heating, and industrial processes that rely on fossil fuels release large amounts of pollutants into the atmosphere. These pollutants include carbon dioxide (CO2), sulfur dioxide (SO2), nitrogen oxides (NOx), and particulate matter.

5. Agricultural Activities:

Certain agricultural practices contribute to air pollution. The use of fertilizers and pesticides releases nitrogen compounds into the air, which can contribute to the formation of smog and acid rain. Additionally, the burning of agricultural waste, such as crop residues, emits pollutants and contributes to air pollution.

6. Waste Management:

Improper waste management, including open burning of waste and inadequate landfill practices, can release harmful pollutants into the air. The combustion of waste materials generates toxic gases and particulate matter, contributing to air pollution and posing health risks to nearby communities.

7. Natural Sources:

While human activities are the primary contributors to air pollution, natural sources also play a role. Volcanic eruptions, dust storms, and wildfires release large amounts of pollutants into the atmosphere. While these events are natural occurrences, they can significantly impact air quality, especially in the regions directly affected.

In conclusion, air pollution is a complex issue with multiple causes. Industrial emissions, vehicle emissions, deforestation, burning of fossil fuels, agricultural activities, waste management, and natural sources all contribute to the deterioration of air quality. Addressing these causes is crucial in reducing air pollution and safeguarding human health and the environment. By implementing sustainable practices and adopting cleaner technologies, we can work towards a cleaner and healthier future.

CLIMATE CHANGE DUE TO AIR POLLUTION

Climate change refers to long-term shifts in temperature and weather patterns on Earth, resulting in significant and lasting impacts on the environment and human societies. One major contributor to climate change is air pollution. Air pollution refers to the presence of harmful substances in the air, which can have detrimental effects on both the atmosphere and human health.

The release of greenhouse gases, such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), from various human activities, including the burning of fossil fuels, industrial processes, and deforestation, is a significant source of air pollution. These gases trap heat in the atmosphere, leading to the greenhouse effect and subsequent global warming. As a result, the Earth's average temperature is rising, causing changes in weather patterns, sea level rise, and the melting of polar ice caps.

Air pollution also contributes to the formation of smog, a type of air pollution characterized by a mixture of smoke and fog. Smog can have severe consequences for human health, particularly for individuals with respiratory conditions such as asthma or chronic obstructive pulmonary disease (COPD). Prolonged exposure to smog can lead to respiratory problems, cardiovascular diseases, and even premature death.

Furthermore, air pollution affects ecosystems and biodiversity. Acid rain, which is caused by the release of sulfur dioxide (SO2) and nitrogen oxides (NOx) into the atmosphere, can have devastating effects on forests, lakes, and aquatic life. It damages plant life, reduces soil fertility, and alters the pH levels of water bodies, making them uninhabitable for many species.

The consequences of climate change due to air pollution are far-reaching and require urgent action. Governments, industries, and individuals must work together to reduce air pollution and mitigate its effects on the climate. This includes transitioning to cleaner and renewable sources of energy, improving energy efficiency, implementing stricter emission standards, and promoting sustainable practices.

In conclusion, climate change resulting from air pollution is a pressing issue that requires immediate attention. The release of greenhouse gases and the formation of smog have significant impacts on the environment, human health, and biodiversity. It is crucial to take proactive measures to reduce air pollution and combat climate change for the well-being of our planet and future generations.

Climate change is one of the important factors which show their influence on the earth's quality.10-12. The number of pollutants presents include aerosol, tropospheric ozone, methane, and carbon black One of the major problems which arise due to climate change includes air pollution.

According to the world health organization, there are six significant air pollutants present in the atmosphere which include lead, oxides of nitrogen, oxides of sulphur, oxides of carbon, ozone ground level and particle pollution. Effects of these pollutants are seen in air, soil and water. This air pollutant possesses a different impact on human health, climate changes, greenhouse effects and global warming13-14.

**Environment friendly processes to control air pollution**

Air pollution is a significant global issue that poses serious threats to human health and the environment. To combat this problem, it is crucial to adopt environment-friendly processes that can effectively control and reduce air pollution levels. This document explores various sustainable techniques and practices that can be implemented to mitigate air pollution and promote a healthier and cleaner environment.15

1. Transition to Renewable Energy Sources:

One of the primary contributors to air pollution is the burning of fossil fuels for energy production. To curb this problem, transitioning to renewable energy sources such as solar, wind, and hydropower is essential. These energy sources are clean, abundant, and do not release harmful pollutants into the atmosphere, making them an excellent alternative to traditional fossil fuels.

2. Promote Energy Efficiency:

Another effective way to control air pollution is by promoting energy efficiency in all sectors, including residential, commercial, and industrial. Implementing energy-saving measures such as using energy-efficient appliances, improving insulation, and adopting smart technologies can significantly reduce energy consumption and consequently decrease air pollution emissions.

3. Encourage Sustainable Transportation:

The transportation sector is a major contributor to air pollution, primarily due to the burning of fossil fuels in vehicles. Encouraging the use of sustainable transportation options can help minimize emissions and improve air quality. Promoting public transportation, carpooling, cycling, and walking not only reduces air pollution but also helps alleviate traffic congestion and promote a healthier lifestyle.

4. Implement Strict Emission Standards:

Enforcing strict emission standards for industries and vehicles is crucial in controlling air pollution. Governments and regulatory bodies should establish and monitor emission limits, ensuring that industries and vehicles comply with these standards. Regular inspections, emission testing, and penalties for non-compliance are essential to achieve cleaner air.

5. Support Afforestation and Green Spaces:

Trees and green spaces play a vital role in improving air quality. Supporting afforestation initiatives and creating more green spaces in urban areas can help combat air pollution. Trees absorb carbon dioxide and release oxygen, filtering harmful pollutants from the air. Additionally, green spaces act as natural buffers, reducing the impact of pollutants and enhancing overall air quality.

6. Implement Waste Management Strategies:

Improper waste management practices contribute to air pollution through the release of harmful gases and pollutants. Implementing effective waste management strategies such as recycling, composting, and proper disposal of hazardous materials can help minimize air pollution. Additionally, investing in waste-to-energy technologies can convert waste into renewable energy sources, further reducing air pollution.

CONCLUSION

Air pollution can be prevented only if individuals and businesses stop using toxic substances that cause air pollution in the first place. On an individual level, we can reduce our contribution to the pollution problem by using public transportation. Additionally, buying energy-efficient light bulbs and appliances will reduce the pollutants released in the production of electricity, which creates the majority of industrial air pollution. Public awareness is one of the significant methods to stop this air pollution. In this industrial age, air pollution cannot be eliminated, but steps can be taken to reduce it. The government has developed guidelines for air quality and ordinances to restrict emissions to control air pollution. Air pollution poses a severe threat to human health and the environment. However, by adopting environment-friendly processes, we can effectively control and reduce air pollution levels. Transitioning to renewable energy sources, promoting energy efficiency, encouraging sustainable transportation, enforcing strict emission standards, supporting afforestation and green spaces, and implementing waste management strategies are some of the key measures that can be taken to combat air pollution. By implementing these practices, we can create a cleaner and healthier environment for future generations.

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