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A Review Paper on Air Pollution Engineering

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ABSTRACT: ***Air pollution is an environmental and societal issue that has a wide range of negative consequences for human health and quality of life, ecosystem health, and climate change. Air pollutants are produced from a variety of natural and human sources, and they may travel great distances. Some air pollutants are highly persistent in the atmosphere and may build up in the environment and food chain, posing a threat to humans, animals, and natural biodiversity. Clearly, air pollution is a complicated issue that presents a number of difficulties in terms of management and pollution reduction. An effective response to the issues of air pollution requires a thorough understanding of the causes of pollution, as well as knowledge of current and future trends in air quality, as well as the effects on people and ecosystems. This chapter examines the complexity of air pollution and provides an overview of various technological procedures and equipment for air pollution management, as well as the fundamental principles that govern their operation. Only a combined effort of different scientific and technical disciplines, such as chemistry, physics, biology, medicine, chemical engineering, and social sciences, can address the issues of air pollution and other ecosystem protection. The majority of the engineering contribution is focused on the creation, design, and operation of equipment to reduce hazardous emissions into the environment.***

KEYWORDS: ***Air pollution, Pollutants, Air Pollution Sources, Particulate Matter, Air Poll.***

1. INTRODUCTION

1.1 The air pollution protection system's complexity:

The world is economic, industrial, and demographic expansion have had a major effect on air quality in cities and rural areas. Today, air pollution poses a significant environmental threat, particularly in regions where hazardous air pollutants are present in high quantities. Power plants, industrial sources, traffic and transportation vehicles, as well as other industrial and human activities, all contribute significantly to air pollution. Natural catastrophes (e.g. volcanic eruptions, forest fires), sea-salt emissions, natural processes, and biological processes, in addition to human activity, may produce air pollution. According to some estimates, the world's active volcanoes number about 1,500, with 50 erupting each year, and 2012 was designated as The Year in Volcanic Activity. However, it is widely acknowledged that fabricated or anthropogenic activities are the primary contributors to rising emissions into the atmosphere[1]–[3].

The National Oceanic and Atmospheric Administration (NOAA) of the United States declared 2015 to be the hottest year since records started in 1880, with the 16 warmest years occurring between 1998 and 2015. China (with a 29 percent share in the global total), the United States (14 percent), and the European Union (EU28) (10 percent), India (7 percent), the Russian Federation (5 percent), and Japan (3.5 percent) were the five largest emitting countries (including the European Union) in 2015, accounting for two-thirds of total global emissions. According to climate model predictions, global surface temperatures are expected to increase by 0.3 to 1.7 °C in the twenty-first century for the lowest emissions scenario and 2.6 to 4.8 °C for the highest emissions scenario. Increased warmth melts ice caps and glaciers and influences the seas, leading in habitat alterations for many plant and animal species, particularly in the Arctic[4]. The development of food crops and other plants is affected by extreme weather, such as excessive rainfall in certain regions, droughts and heat waves in others. Climate change, which has been seen and scientifically proven in recent decades because of global warming, is highly dependent on particular issues linked to air pollution. Human activities are without a

doubt the primary source of the climate change that the Earth has been experiencing since the Industrial Revolution in the mid-eighteenth century. The Industrial Revolution is widely acknowledged as the start of a significant rise in the usage of fossil fuels. The quantity of people, their quality of life, and their energy consumption are all linked to fuel combustion. According to UN estimates, there are more over 7 billion people on the planet today. The growth in global population between 1900 and 2000 was three times larger than the preceding history of humankind, rising from 1.5 to 6.1 billion in only 100 years. CO2 is the most significant representative of the greenhouse gases (GHGs) responsible for the warming impact. Coal is still the most important source of energy for power generation and the largest contributor to carbon dioxide (CO2) emissions[5]–[7].

Air pollution is undoubtedly a complex problem that has many challenges in terms of management and pollution reduction. A comprehensive understanding of the sources of pollution, as well as present and future changes in air quality, as well as the impacts on people and ecosystems, is required for an effective response to air pollution problems. This chapter looks at the complexities of air pollution and gives an overview of the different technical processes and equipment used to control air pollution, as well as the basic principles that govern their functioning. Air pollution and other ecosystem preservation problems can only be addressed by a collaborative effort of many scientific and technological disciplines, such as chemistry, physics, biology, medicine, chemical engineering, and social sciences. The bulk of the engineering contribution is devoted to the development, design, and operation of equipment that reduces harmful emissions into the atmosphere[8].

Air pollution in large cities and industrialized regions is an issue that developed nations confront in particular, and they often attempt to address it by relocating their industrial facilities to less developed countries. This seems to be a poor example of temporary issue solution and moving the problem to another place. Currently, certain governments and special interest groups in the more industrialized regions of the globe refuse to take action to decrease global environmental pollution, owing to substantial economic effects of specific sectors or portions of the economy. Development in emerging and transitional nations, on the other hand, is typically built on "dirty" industries and unsustainable technology. Because air pollutants may be carried across vast distances from their source, the result is pollution on a global scale. The length of time an air pollutant, such as ozone or greenhouse gases, will remain in the atmosphere is governed by its reactivity and natural clearance rate (dry or wet deposition, natural reservoirs or sinks). Some air contaminants may last anywhere from a few hours to thousands of years in the environment. As a result, safeguarding human health and the environment from the effects of air pollution and climate change has become one of the century's most pressing issues. The interrelationship between air quality, climate change, and current and emerging energy choices further complicates these issues[9], [10].

Despite significant progress in the last half-century because of numerous efforts to reduce air pollution and greatly improve air quality, many people continue to live in counties that fail to meet current air quality standards for air pollutants regulated by environmental agencies such as the European Environment Agency (EEA) and many national environmental agencies around the world. As a result, ongoing improvements and knowledge of emissions, atmospheric processes, exposure, and consequences are still necessary to ensure that air quality continues to improve. It is technically challenging and costly to reduce essential pollution emissions into the atmosphere. Although there are some natural air self-cleaning processes, their effectiveness is inadequate to satisfy regulatory standards[11].

Air quality management is unquestionably one of the most demanding and complicated tasks, requiring a high level of organization across all aspects of human civilization as well as the successful execution of an institutional air protection system for the whole community. The entire air protection plan is based on environmental protection principles, international political principles, and environmental laws, rules, judgments, and directives based on the most up-to-date scientific information and best practices from across the globe. Policy or political commitment at the international, regional, national, and local levels, law, resources (human and financial), and available equipment or technological devices are the most significant elements affecting air pollution control systems. An effective air quality management system is based on environmental policy, which includes, among other things, continuous improvement of the installation through effective management, adoption and implementation of adequate legislation and regulations to limit emissions of air pollutants from all types of sources and recommended emission limit values, monitoring and measurement of emissions to air, and so on. Regulations are critical, but they are only effective if they are implemented. Many nations have issued many acts and regulations to preserve the air and environment since 1972, yet the efficacy of these laws is still debatable. Local restrictions kinds of air pollutants are insufficient to address regional and global environmental issues linked to atmospheric pollution. In certain instances, global action and the use of several methods are the only options. The European Union's (EU) environmental policy has a lengthy history and is consistent with other international instruments and agreements. A succession of issues and scandals concerning waste treatment in the 1970s and 1980s provided the push for the development of a unified environmental policy and suitable solutions.

Since then, many policy plans have been established, with The Lisbon Strategy (2001) and The Europe 2020 Strategy being the most well known (2010). The Lisbon Strategy set a strategic objective for the EU with the purpose of transforming the EU into a competitive knowledge-based economy with a focus on environmental preservation and long-term sustainability. In a United Nations study from 1987, the term "sustainable development" was defined as "development that satisfies current demands without jeopardizing future generations' capacity to satisfy their own needs." Although the Lisbon Strategy was not completely effective, according to some, one of the most significant objectives of this strategy was to contemplate an economy with minimal CO2 emissions. The European Commission launched the Europe 2020 Strategy in 2010. The well-known objectives of this new viable development strategy, the so-called 20-20-20, include reducing greenhouse gas emissions by 20% below 1990 levels by 2020, increasing the share of renewable energy sources to 20% in terms of actual final consumption, and increasing energy efficiency by 20%. This approach is built on cutting-edge low-carbon technology. Despite the fact that scientists and politicians do not always agree on the optimal course of action and collaboration at the global, European, national, and local levels, the majority of them believe that certain adjustments are required to reduce global climate change caused by air pollution. Implementation of legal limitations for ambient concentrations of air pollutants, as well as emission mitigation measures for national and particular sources or sectors are part of current European policy. These policies have resulted in significant reductions in emissions of some air pollutants (such as SO2, CO, NOx, lead, and some particulates) and noticeable improvements in air quality over the last three decades, but existing technical processes, particularly those for reducing greenhouse gas emissions and persistent organic compounds, still have a lot of room for improvement.

1.2 Basic categories and definitions:

The Earth's atmosphere is made up of a combination of gases that cannot be seen yet exists all around us. This layer of gases encircling our globe maintains the Earth’s gravity. The

atmosphere is a complex system that is continuously undergoing physical and chemical interactions, but the dynamic of these processes may be disrupted by the presence of undesired and dangerous substances.

Air pollution may be described in a variety of ways. The discharge or emission of various chemicals, particles, biological materials, or other hazardous elements into the Earth's atmosphere, both from natural and human causes, is referred to as air pollution. In general, an emission is the discharge of pollutants into the atmosphere, which may include gaseous, vaporous, and solid chemicals, as well as heat, noise, and radiation. All stationary sources, such as smokestacks, vents, surface areas of residential, commercial, or industrial buildings, as well as many mobile sources, are very significant in the context of air pollution. Air pollution, in general, refers to any kind of air pollution, regardless of the environment, which may be inside or outside. As a result, both interior and outdoor air pollution are included in the broad categorization of air pollution. Figure 1 shows the sources of air pollution are classified.

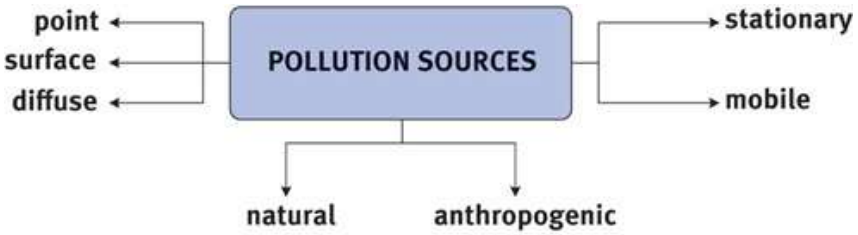

Figure 1: The above figure shows the sources of air pollution are classified.

Pollutants may collect and reach quantities higher than those found outdoors if a facility is not adequately ventilated. The so-called Sick Building Syndrome has gained public attention because of this issue (SBS). Tobacco smoke, as well as carbon monoxide, nitrogen monoxide, and sulphur dioxide, which may be released by furnaces and stoves, are major sources of indoor pollution. When cleaning or renovating a home, hazardous substances such as volatile organic compounds (VOCs) produced by household cleansers, paint, and varnishes are released into the air. When bacteria die, however, they emit endotoxins into the air, which may have negative health consequences. The literature has further information about indoor air pollution. Indoor air pollution and poor urban air quality are often cited as two of the world's most serious pollution issues. According to World Health Organization (WHO) statistics, more than 3 million people die each year because of air pollution, accounting for approximately 3% of all fatalities. Surprisingly, indoor air pollution is linked to a higher death rate. Because indoor air contains much more contaminants than outside air, indoor air pollution is a highly hazardous issue. According to some estimates, the amount of pollutants within buildings may be two–five times, and occasionally even 100 times, higher than those outside. Air pollution from mobile sources and transportation has become increasingly dominant in recent years, due to the high level of motorization in economically developing countries, in addition to various industrial emission sources and other sources connected with various human activities, mostly related to heat and electricity production. According to some estimations, mobile sources of air pollution are increasing at a quicker rate than industrial sources. According to Copper and Alley motor vehicles, contribute for 10–60% of overall air pollution emissions.

Natural (biogenic) and fabricated (anthropogenic) air pollution sources may be distinguished based on the origin of emissions or precursors. Volcanic activity (which produces sulphur, chlorine, ash, and particulates), anaerobic microbial degradation in soil (which produces oxides of nitrogen), atmospheric electrical discharges (source of ozone), methane emitted by animal digestion, forest fires (which produce smoke and carbon monoxide), and evaporation of

droplets are all natural sources of air pollutant emissions (such as radon in concrete and building materials). Some air pollutants, such as CO2, CH4, and N2O, may be found in large quantities in nature, but there are also natural processes for removing them from the atmosphere (or sinks).

The majority of air pollutants come from manufactured sources or anthropogenic activities, such as:

- stationary sources (all activities involving the combustion of fossil fuels in the production of heat, electricity, or other forms of energy, such as production processes and power plants, households and waste incinerators, furnaces and other types of fuel-burning heating devices, traditional biomass combustion, etc) (motor vehicles, marine vessels, aircraft).
- Another approach to categorize air pollution emission sources based on their location and kind of emission is to use the terms point, line, surface (or area), and volume. Point sources of emission (such as chimneys, stacks, vents, and other functional apertures) are examples of independent single sources that release pollutants on a regular basis.

The emission from such a source will always be extremely big due to the tiny exit area. Diffuse or fugitive sources include line sources such as car emissions from highways, surface or area sources (e.g. volatile emissions from lagoons, forest fires), and volume sources (e.g. diffuse air pollutant emissions from oil refineries). Fugitive emissions, as contrast to emissions from point sources, are emissions that cannot be collected and flow through a stack, vent, or other similar aperture. This distinction also influences the technological equipment used to reduce such emissions.

What is a contaminant in the air? Any solid, liquid, or gaseous substance existing in the air at a quantity that may harm humans or other living creatures, natural biodiversity, construction, building, and other kinds of common materials, and the whole environment is considered an air pollutant. The atmosphere includes a variety of air pollutants that are produced or released by various natural and human sources.

Geogenic and anthropogenic sources produce radioactive contaminants in the air. The existence of radionuclides, which come from either radioactive materials in the Earth's crust or the interaction of cosmic radiation with atmospheric gases, causes Geogenic radioactivity. Nuclear reactors, the atomic energy sector (mine and processing of reactor fuel), nuclear weapon explosions, and facilities that reprocess spent reactor fuel are all sources of anthropogenic radioactive emissions. Coal contains tiny amounts of uranium and thorium, which may be released into the atmosphere by coal-fired power stations and other sources.

Waste heat and light pollution are other types of atmospheric pollution, although they are not discussed in depth in this chapter. Briefly, waste heat is produced in flue gases or vapour streams because of the fuel combustion process or a chemical reaction. Waste heat recovery systems, such as recuperators, regenerators, heat wheels, heat pipe exchangers, heat pumps, and similar technological devices, may recover some of the waste heat and reduce heat/energy losses. The waste heat recovery method is mostly determined by the temperature of waste heat gases and the economics involved. Light pollution (also known as photo pollution) is a by-product of modern civilisation. This phrase refers to a variety of issues that are all caused by the wasteful or excessive usage of artificial light. Over-illumination, glare, and light clutter are all examples of light pollution. Light pollution or excessive light exposure has been linked to a variety of negative health consequences, including headaches, worker tiredness, medically defined stress, and an increase in anxiety, according to medical studies.

2. DISCUSSION

The author has discussed about the Air pollution engineering, Air pollution in big cities and industrialized areas is a problem that developed countries face in particular, and they often try to solve it by moving their manufacturing plants to less developed countries. This seems to be a bad example of a temporary issue solution and problem relocation. Because of the significant economic impacts of particular sectors or parts of the economy, some governments and special interest groups in the world's more industrialized areas are now refusing to take action to reduce global environmental pollution. On the other hand, development in developing and transitional economies is often based on "dirty" sectors and unsustainable technologies. Because air contaminants may travel great distances from their source, pollution on a global scale occurs. The reactivity and natural clearance rate of an air pollutant, such as ozone or greenhouse gases, determine how long it will stay in the atmosphere (dry or wet deposition, natural reservoirs or sinks). Some air pollutants may be found in the environment for anything from a few hours to thousands of years.

3. CONCLUSION

The author has concluded about the air pollution engineering, Air pollution is an environmental and societal issue that has a wide range of negative consequences for human health and quality of life, ecosystem health, and climate change. Air pollutants are produced from a variety of natural and human sources, and they may travel great distances. Some air pollutants are highly persistent in the atmosphere and may build up in the environment and food chain, posing a threat to humans, animals, and natural biodiversity. Clearly, air pollution is a complicated issue that presents a number of difficulties in terms of management and pollution reduction. An effective response to the issues of air pollution requires a thorough understanding of the causes of pollution, as well as knowledge of current and future trends in air quality, as well as the effects on people and ecosystems. This chapter examines the complexity of air pollution and provides an overview of various technological procedures and equipment for air pollution management, as well as the fundamental principles that govern their operation. Only a combined effort of different scientific and technical disciplines, such as chemistry, physics, biology, medicine, chemical engineering, and social sciences, can address the issues of air pollution and other ecosystem protection.

REFERENCES

[1] J. Rembiesa, T. Ruzgas, J. Engblom, and A. Holefors, “The impact of pollution on skin and proper efficacy testing for anti-pollution claims,” *Cosmetics*. 2018, doi: 10.3390/cosmetics5010004.

[2] P. Villarrubia-Gómez, S. E. Cornell, and J. Fabres, “Marine plastic pollution as a planetary boundary threat – The drifting piece in the sustainability puzzle,” *Mar. Policy*, 2018, doi: 10.1016/j.marpol.2017.11.035.

[3] K. Aunan, M. H. Hansen, and S. Wang, “Introduction: Air Pollution in China,” *China Quarterly*. 2018, doi: 10.1017/S0305741017001369.

[4] D. Ierodiakonou *et al.*, “Ambient air pollution,” *J. Allergy Clin. Immunol.*, 2016, doi: 10.1016/j.jaci.2015.05.028.

[5] T. M. Karlsson, L. Arneborg, G. Broström, B. C. Almroth, L. Gipperth, and M. Hassellöv, “The unaccountability case of plastic pellet pollution,” *Mar. Pollut. Bull.*, 2018, doi: 10.1016/j.marpolbul.2018.01.041.

[6] T. Bourdrel, M. A. Bind, Y. Béjot, O. Morel, and J. F. Argacha, “Cardiovascular effects of air pollution,” *Archives of Cardiovascular Diseases*. 2017, doi: 10.1016/j.acvd.2017.05.003.

[7] X. Zhang, X. Chen, and X. Zhang, “The impact of exposure to air pollution on cognitive performance,” *Proc. Natl. Acad. Sci. U. S. A.*, 2018, doi: 10.1073/pnas.1809474115.

[8] L. Bai, J. Wang, X. Ma, and H. Lu, “Air pollution forecasts: An overview,” *International Journal of Environmental Research and Public Health*. 2018, doi: 10.3390/ijerph15040780.

[9] Y. Chae and Y. J. An, "Current research trends on plastic pollution and ecological impacts on the soil ecosystem: A review," *Environmental Pollution*. 2018, doi: 10.1016/j.envpol.2018.05.008.

[10] K. K. Lee, M. R. Miller, and A. S. V. Shah, "Air pollution and stroke," *Journal of Stroke*. 2018, doi: 10.5853/jos.2017.02894.

[11] K. Maduna and V. Tomašić, "Air pollution engineering," *Phys. Sci. Rev.*, 2017, doi: 10.1515/psr-2016-0122.