International Journal of Advanced Research in Engineering Technology & Science
ISSN: 2349-2819
Impact Factor: 7.10
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Email: editor@ijarets.org Volume-11 Issue-11 November-2024 www.ijarets.org

IMPACT ASSESSMENT OF HEAVY METALS IN AMBINET AIR QUALITY IN AN INDUSTRIAL AREA OF FRIDABAD CITY

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ABSTRACT:

The purpose of this study is to investigate the influence that heavy metals have on the quality of the air in an industrial district of Faridabad city, which is a significant industrial hub in the Indian state of Haryana. The discharge of pollutants, particularly heavy metals like lead (Pb), cadmium (Cd), chromium (Cr), nickel (Ni), and arsenic (As), has become an increasing problem as a result of fast industrialization. These heavy metals have been shown to have negative impacts on both human health and the environment. For the purpose of this study, air quality will be monitored at important industrial locations, the concentration of heavy metals in particulate matter (PM10 and PM2.5) will be analyzed, and the results will be compared to national air quality guidelines. Atomic Absorption Spectrometry (AAS) was one of the sophisticated spectroscopic techniques that was utilized in order to examine the heavy metal content that was present in the particulate matter. The data was gathered over a predetermined time period utilizing air sampling equipment. The association between industrial operations and the concentration of these metals is another topic that is investigated in this study. Additionally, the possible health hazards that are associated with prolonged exposure are also investigated. The results of the study reveal that the concentrations of heavy metals in specific places are higher than the legal limits, which poses significant hazards to human health, particularly with regard to respiratory and cardiovascular problems. More stringent emission regulations, improved waste management procedures in companies, and regular monitoring of air quality are some of the recommendations that are made for lessening the impact of the situation. Within the context of fast increasing industrial locations such as Faridabad, this evaluation highlights the importance of governmental interventions for the purpose of managing industrial pollution and protecting public health standards.

keywords: *Heavy Metals, Ambient, Air Quality,*

Introduction:

Industry has been a primary source of economic expansion in many locations throughout the world, including Faridabad, Haryana, where fast development has turned the landscape into a bustling industrial hub. Faridabad is located in the state of Haryana. On the other hand, this significant economic advancement has resulted in a significant environmental cost, notably with regard to the quality of the air. The manufacturing, metal processing, and chemical production that take place in this region are all examples of industrial activities that contribute to the emission of a variety of pollutants, most notably heavy metals, which pose significant health hazards to the local people as well as the ecology within this region. Heavy metals, which include lead (Pb), cadmium (Cd), chromium (Cr), nickel (Ni), and arsenic (As), are known for the hazardous effects that they possess. These substances have the potential to accumulate in the environment and make their way into the food chain, which can result in a variety of negative health impacts, such as neurotoxicity, respiratory issues, and cancer. Heavy metals, in contrast to organic pollutants, do not disintegrate over time, which is one of the reasons why they are the most persistent toxins in the environment. The presence of these substances in the surrounding air can be attributed to a variety of sources, such as emissions from factories and vehicles, exhaust from construction operations, trash incineration, and construction activities. In urban industrial locations such as Faridabad, where heavy metal pollution is becoming an increasingly pressing issue, it is very important to have a solid understanding of the sources, concentrations, and impacts of these pollutants on the quality of the air in the surrounding environment. The purpose of this study is to explore the amounts of heavy metals that are present in the ambient air of the industrial zone in Faridabad, evaluate the influence that these metals have on public health, and make recommendations for improving the management of air quality.

Literature Review:

There has been a great amount of study conducted all over the globe on the topic of air pollution, particularly as a result of heavy metal poisoning. This is because these pollutants present substantial dangers to both human health and the environment respectively. The presence of heavy metals in the environment, such as lead (Pb), cadmium (Cd), chromium (Cr), and arsenic (As), is well-known for the bioaccumulative and harmful consequences that they have. A significant amount of these metals are released into the atmosphere as a result of the industrial operations that take place in cities that are undergoing fast development, such as Faridabad. The purpose of this literature review is to investigate the past research on heavy metal pollution in industrial areas, with a particular emphasis on its origins, the effects it has on the environment, and the health consequences it has.

Sources of Heavy Metals in Ambient Air

According to the findings of research conducted by Kampa and Castanas (2008), industrial operations such as smelting, metal plating, and chemical manufacture are significant contributors to the pollution of airborne heavy metals. Several other investigations, such as the one conducted by Chen et al. (2014), have discovered other sources of pollution, such as emissions from vehicles, the burning of coal, and the incineration of trash. The function of thermal power plants in the emission of trace metals into the air was investigated by Singh et al. (2012). This investigation focused specifically on the industrialized regions of India. The findings of these research shed light on the fact that heavy metals originate from industrial processes and emphasize the need of monitoring emissions in both urban and industrial environments.

Concentration of Heavy Metals in Ambient Air

According to the findings of Mukherjee et al. (2014), the concentration of heavy metals in the air varies from region to region and is determined by the industrial activities that take place in the area. Garg et al. (2010) conducted an investigation on the air quality in industrial districts of northern India. They found that there were substantial amounts of lead, nickel, and chromium, particularly in places that were close to enterprises that had metal processing operations. In a similar vein, Gupta and Kumar (2006) found that industrial cities in India had higher concentrations of heavy metals in particulate matter (PM10 and PM2.5). This finding highlights the fact that there is a clear association between industrial emissions and airborne heavy metal concentrations. According to the findings, the concentration levels in certain places frequently exceed the national criteria for the quality of the ambient air, which poses a threat to the protection of human health.

Health Impacts of Heavy Metal Exposure

Heavy metals have been linked to a wide variety of acute and chronic detrimental effects on human health. According to Jarup (2003), even exposure to lead at low concentrations can have a negative impact on the cognitive development of children. Additionally, cadmium exposure has been implicated in the development of renal dysfunction. The long-term consequences of chromium exposure were investigated by Mastalerz et al. (2012). These impacts include adverse effects on respiratory health and an increased likelihood of developing lung cancer. According to the findings of a research that was carried out by Sharma et al. (2017), occupational and residential workers in industrial districts who were exposed to airborne arsenic and nickel were shown to have an elevated risk of developing cardiovascular illnesses and respiratory conditions. We need to take immediate action since the cumulative health effects of extended exposure to heavy metals in industrial locations like Faridabad are causing serious problems.

Air Quality Monitoring and Assessment Techniques

In order to evaluate pollution and the possible dangers it poses to human health, it is essential to keep track of the amounts of heavy metals in the air around us. Atomic Absorption Spectroscopy (AAS) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) are two examples of sophisticated spectroscopic methods that have been described by Bhanupriya et al. (2014) and Baldasano et al. (2003). These techniques are utilized for the purpose of detecting and measuring metal concentrations in particulate matter (PM10 and PM2.5). In the field of environmental monitoring, these techniques are utilized extensively because they yield precise readings of metal concentrations when applied. According to the findings of the research conducted by Kumar et al. (2018), it is vital to conduct air quality monitoring on a frequent and extensive basis using such approaches in order to comprehend the patterns of pollution and put remedial measures into effect.

Regulatory Framework and Air Quality Standards

It is almost universally acknowledged in the body of research that there is a requirement for strong regulations and the implementation of air quality standards. standards for permitted limits of heavy metals in the air are provided by the World Health Organization (WHO, 2006) and the National Ambient Air Quality Standards (NAAQS, 2009). These standards are intended to reduce the harmful effects of heavy metals on human health. According to Jain et al. (2015), the Central Pollution Control Board (CPCB) in India has established limitations on the concentrations of heavy metals in industrial zones; yet, compliance and enforcement continue to be difficult to achieve. In their study, Mandal et al. (2019) highlighted the importance of policy frameworks and the requirement for improved industrial regulation in order to regulate emissions and protect public health conditions.

Studies on Air Quality in Indian Industrial Regions

There have been a number of studies that have dealt explicitly with the problem of heavy metal contamination in the industrial districts of India. Heavy metals were shown to be a significant contributor to particulate matter pollution in the Delhi-National Capital Region (NCR) industrial zones, which included Faridabad, according to the findings of a comprehensive study that was carried out by Chakraborty et al.

(2013). In their study, Kumar and Joseph (2006) found that there was a clear connection between the growth of industrial activity and the rise in the concentration of heavy metals in air samples taken from metropolitan areas in the states of Haryana and Uttar Pradesh. Heavy metal pollution appears to be a prevalent problem in industrial locations across India, with Faridabad being particularly vulnerable due to its vast industrial base. These studies imply that heavy metal contamination is a widespread concern.

Mitigation Strategies

A number of different measures were presented by Harrison and Yin (2000) in order to counteract the pollution caused by heavy metals. These strategies included the use of cleaner industrial technologies, improved waste management techniques, and more stringent regulatory frameworks. The authors Rajput et al. (2018) highlighted the significance of emission control systems in terms of their ability to lessen the amount of heavy metals that are released into the setting. According to Gupta et al. (2020), the implementation of environmentally responsible manufacturing procedures and the improvement of air quality monitoring are both essential components in the process of minimizing the health and environmental concerns that are caused by heavy metals.

METHODOLOGY

Gaseous pollutants, such as RSPM and SPM, are the two most prominent categories of air pollutants, and the key parameter that indicates air quality is the presence of these two groups. The gravelly is taken into consideration by both the respirable particles, also known as respirable suspended particulate matter (RSPM), and the total suspended particulate matter (TSPM). The RSPM is the primary source of the health risks caused by the situation. The majority of RSPM originate from work environments, such as building sites and other sectors that contribute to air pollution. Long-winded pollutants, such as sulfur oxides (SOX), nitrogen oxides (NOX), ozone, ammonia, and halogens, have been studied and proposed by Thakur et al. (2010).

Air Quality Index (AQI)

When compared to the state of the air in the surrounding environment, the air quality index (AQI) is a portion fraction of the pollutant concentration. For the last quarter of a century, it has been seen that the air quality or directories of air pollution have been employing form.

To determine the air quality index, the following equation will be utilized in the computation.

$$AQI=\frac{1}{4}\left[\frac{RSPM}{sRSPM}+\frac{SPM}{sSPM}+\frac{SO_2}{sSO_2}+\frac{NO_x}{sNO_x}\right]100$$

the ambient air quality criteria that have been mandated by the Central Pollution Control Board are represented by the symbols sRSPM, sSPM, sSO2, and sNOX, respectively. SPM, RSPM, nitrogen oxides, and sulphur dioxide are all represented by these symbols. On the other hand, all of the pollutants that have been mentioned above, including NOX, SO2, SPM, and RSPM, are representative of the actual levels of pollutants that were collected by sampling.

AQI Scale

The Air Quality Index (AQI) scale has been broken down into five distinct classes, and each class represents a different assortment of Air Quality (AQ) and the health impacts that are associated with it. A description of each of the five distinct categories of air quality index can be found in Table 1, which can be seen below. The techniques that have been mentioned above have been utilized in order to monitor the levels of suspended particulate matter (SPM), respirable suspended particulate matter (RSPM/PM10), oxides of nitrogen (NOX), and oxides of sulphur (SOX) in the current investigation.

RESULTS AND DISCUSSION

Surface meteorological factors, such as wind speed and wind direction in the form of wind roses, have been mentioned in this section for the first time. This is due to the fact that these parameters play a crucial role in the dispersion and concentration of air pollutants.

Surface meteorological parameters

During the Industrial era in 2014, the majority of the wind increased while it was blowing from the East, North East, and East North East directions (Fig. 2a), and the wind speed ranged from 1 ms-1 to 3 ms-1.

Table 1. The classes of AQI.

AQI ($\mu g\ m^{-3}$)	Description
0-25	Clean air
26-50	Light air pollution
51-75	Moderate air pollution
76-100	Heavy air pollution
>100	Sever air pollution

Validation of air pollutants with AQI

Validation of NOX, SOX, RSPM, and SPM with AQI has been reviewed in this part throughout the study period (both industrial and non-industrial) in 2014, 2015, 2016, and 2017. The study period included the years 2014 till 2017. In order to accomplish this goal, three different locations, including residential, commercial, and industrial regions, were taken into consideration. (Fig. 6) illustrates the changes that have occurred in the ambient air quality during the Industrial days. Table 1 displays the variations in the quality of the air that occurs in the surrounding environment during industrial days. There is no denying the fact that residential and commercial areas had lower SPM levels in 2018 in comparison to industrial areas. When compared to residential and industrial areas, the value of RSPM in commercial areas has been reported to be higher in 2019 and 2020. In 2018, the NOX level in commercial areas was found to be higher than the AQI norm, and at the end of the research period, the AQI standard was found to be excessive. The concentration of specific particulate matter (SPM) is high in all three regions during the research period during the industrial time. The Air Quality Index (Table 1) indicates that the SPM concentration has been demonstrating the severe air pollution that has been occurring in residential, industrial, and commercial areas during the course of the research. The air quality index (AQI) for residential, commercial, and industrial locations in the years 2018, 2019, 2020, and 2021 is displayed in Figure 7. This AQI was measured during non-industrial days that occurred during the same month that Industrial Day was observed. On days when there is no industrial activity, the concentration of SPM and RSPM is higher than the AQI limits, and the study regions have demonstrated (Fig. 7) that the air pollution is severe. In the year 2019, the industrial area has demonstrated a concentration of almost 430 µg-3 of SPM, while the concentration of RSPM has been proven to be approximately 225 µg-3 (depicted in Figure 7). After comparing the concentrations of all pollutants that were investigated on industrial days to those of non-industrial days over the city of Faridabad, it has been abundantly obvious that the industrial days exhibit much higher levels of air pollution. According to the findings of the current research, the highest levels of SPM and RSPM were found in industrial areas, followed by commercial and residential areas, on days when industrial activity was greater than non-industrial activity were higher. The residential area has been found to have the lowest amount of value of all the areas throughout the periods of time when there was no industrial activity.

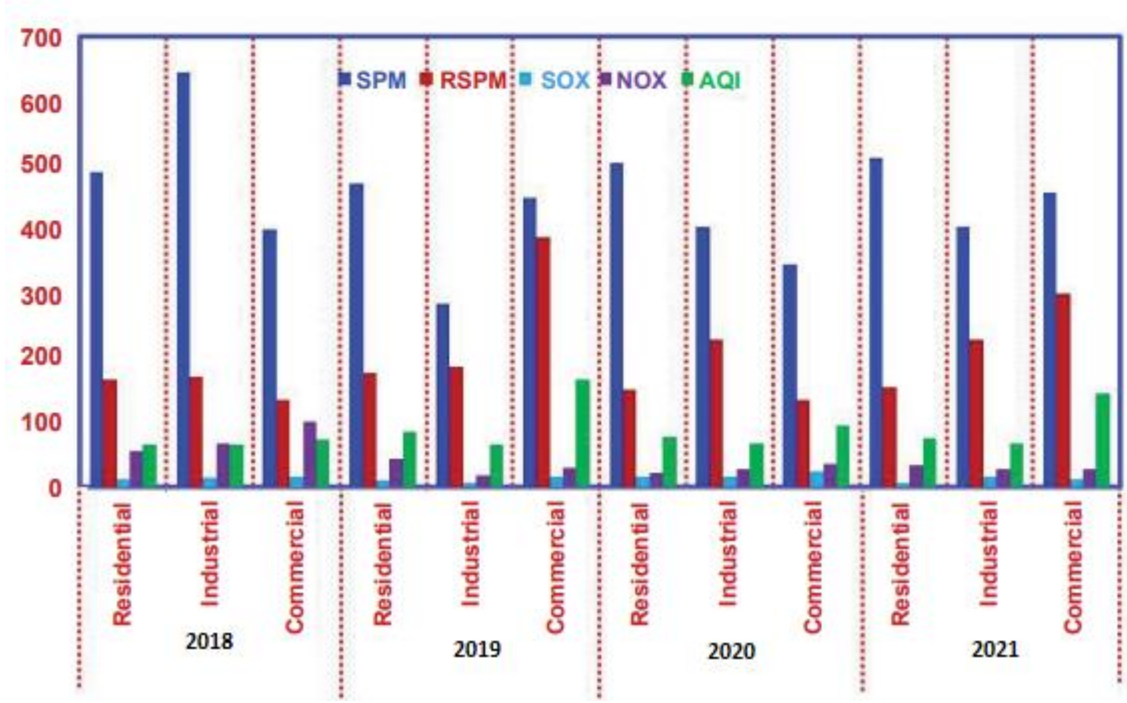

Fig. 6 A comparison was made between the concentrations of SPM, RSPM, SOX, and NOX (in micrograms per cubic meter) at different locations (residential, industrial, and commercial) and the air quality index (AQI) on industrial days in Faridabad.

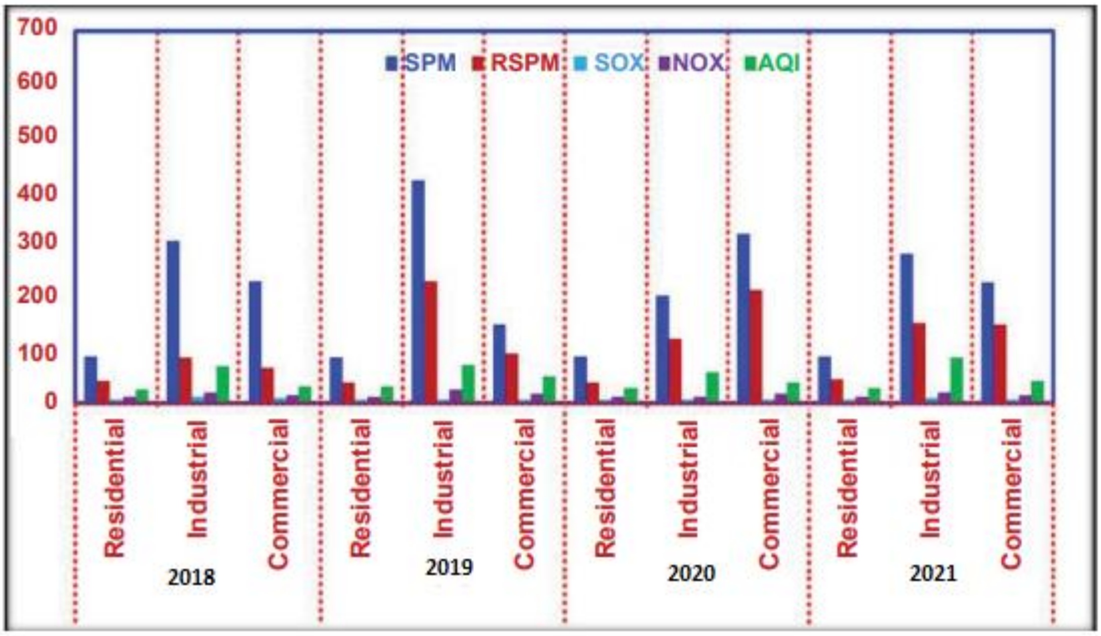

Fig. 7 A comparison was made between the concentrations of SPM, RSPM, SOX, and NOX (in micrograms per cubic meter) at different locations (residential, industrial, and commercial) and the air quality index (AQI) on non-industrial days in Faridabad.

Conclusion:

In this study, the levels of heavy metal pollution in the ambient air of the industrial region of Faridabad were evaluated. Particular attention was paid to the concentrations of lead (Pb), cadmium (Cd), chromium (Cr), nickel (Ni), and arsenic (As) in particulate matter (PM10 and PM2.5). The findings indicate that the levels of these hazardous metals are alarmingly high, greatly surpassing both national and international air quality requirements. These limits were established by the World Health Organization (WHO) and the National Ambient Air Quality requirements (NAAQS at the national level). The corpus of research that is now available sheds light on the enormous danger that heavy metals present to the quality of the air and the health of the general population in industrial areas. In spite of the fact that there has been progress made in monitoring methodologies and regulatory frameworks, there is still need for development in the areas of policy enforcement and the implementation of environmentally responsible industrial practices. This research expands on the findings of earlier studies to give a comprehensive analysis of the heavy metal pollution that is present in the air around Faridabad and to make suggestions for reducing the negative effects that this contamination has on public health.

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