



**A DISSERTATION REPORT  
ON  
AMBIENT AIR QUALITY ANALYSIS IN VICINITY OF  
NATIONAL FERTILIZER LIMITED, PANIPAT**

**SUBMITTED IN PARTIAL FULFILLMENT FOR THE DEGREE OF**

**MASTER OF SCIENCE  
IN  
ENVIRONMENTAL SCIENCE**



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**May, 2016**



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### **CERTIFICATE**

This is to certify that the work reported in the dissertation entitled, "**Comparative study of air quality parameters around an industrial area**" is an original piece of work, carried out by Mr. AMIT SHARMA in partial fulfillment of the requirements for the degree of Master of Science in Environmental Science under my guidance and supervision.

The matter embodied in this report has not been submitted for award of any other degree. No part of this original report can be reproduced in any form or incorporated into any information retrieval system, without the written permission of the supervisor and the institute.

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## ACKNOWLEDGEMENT

It gives me immense pleasure to acknowledge the gratitude and help of those persons, who directly and indirectly helped me in completion of the dissertation.

It is very gratifying to acknowledge the supervision made by, **Prof. Smita Chaudhry Director** institute of environment studies, Kurukshetra university without whose guidance and connotation encouragement, the work would not have been impossible. I want to convey my sincere thanks to her for supervising my work her inspiring guidance, motivation, valuable suggestions during preparation of this dissertation.

Words are not enough to express my sincere gratitude and sincere thanks to **Mrs. Dipti Grover**, Research scholar, IES, KUK, who guided me throughout the research work and gave her precious time over a long period. Her vast experience and talent was essential for the completion of this work.

I would also like to thank other faculty members for their co-operation and personal help extended to me in hours of need. I would like to thank **Ms. Pooja Arora and Ms. Bhawna**, Asst. Prof. IES, KUK for their kind help during the working on spectrophotometer. My special thanks to laboratory assistants Mr. Manoj, Mahaveer ji and Mr. Shobit for their help during this work, and thanks lot my friends Mr. Parshant, Mr. Rahul Sharma and Mr. Rahul Arya, who help to me in different ways and at last but not least special thanks to Mr. Satpal, who provide vehicle for carrying our instruments .

Date-

**Amit Sharma**

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## Chapter -1

### 1.1: Introduction

For decades, it has been well known that air pollution causes adverse health effects on humans. Air pollutants are added in the atmosphere from variety of sources that change the composition of atmosphere and affect the biotic environment. The concentration of pollutants vary spatially and temporarily causing the air pollution pattern to change with different locations and time due to changes in meteorological and topographical condition (Shandilya *et al.*, 2012).

The epidemiological studies of effects of air pollution have demonstrated that the PM exposure and gaseous pollutants are associated with the occurrence of acute respiratory infections, lung cancer and chronic respiratory and cardiovascular diseases. Rapid industrialization and urbanization are the major causes of day to day increase in environmental pollution. Concern about air pollution in urban regions is receiving increasing importance world-wide, especially pollution by gaseous and particulate trace metals. Gaseous air pollutants like oxides of nitrogen (NO<sub>x</sub>), oxides of sulphur (SO<sub>x</sub>), tropospheric ozone (O<sub>3</sub>) etc. pose serious risk to human health and environment due to their detrimental effects (Dey *et al.*, 2014).

Normal air contains about 78% nitrogen, 21% oxygen, 0.93%, argon 0.038% carbon dioxide, and several other trace gases. Changes in the gaseous composition of earth's atmosphere have become a prime concern for today's world due to human activities. Even though air pollution is usually a great problem in cities, pollutants contaminate air everywhere. Pollutants discharged beyond the limits of the buffering capacity of an ecosystem prevent it from maintaining its normal structure and function (Mishra *et al.*, 2012).

Air pollution has long been recognized as a potentially lethal form of pollution. Entry of pollutants into the atmosphere occurs in the form of gases or particles. Continuous mixing, transformation and trans-boundary transportation of air pollutants make air quality of a locality unpredictable. The growth of population, industry and number of vehicles and improper implementation of stringent emission standards make the problem of air pollution still worse (Kaushik *et al.*, 2006).

In India air pollution is increasing unhindered in present times. Almost all major Indian cities have suspended particulate matter above prescribed limits. All type of combustions release gases and particulates matter into the air. These include sulphur and nitrogen oxides, carbon monoxide and soot particles, suspended particles as well as smaller quantities or toxic metals, organic molecules and radioactive isotope (Hosamane *et al.*, 2007).

Dangerous pollutants includes TSP (Total Suspended Particulates), and PM<sub>10</sub>, PM<sub>2.5</sub>, coarse particles, fine particles, ultrafine particles, BS (Black Smoke) and BC black carbon. Particulates that range in size from 0.1-45µm are designated as dust or total suspended particulates. Particulates larger than that range tends to settles as dust and remain suspended except during high winds.

Most of such particulate matter is emitted by establishments which use coal as fuel. These air pollutants are also known as aerosols (CPCB, 2015).

**Table I: Major air pollutants and their effect on public health**

Outdoor Air Pollutant	Major Health Concern	Pollutant Source(s)
Suspended particulate matter (SPM, PM <sub>10</sub> , PM <sub>2.5</sub> )	Disrupts lung's gas exchange function and causes respiratory illness	Mixture of solid and liquid organic plus inorganic materials including sulfate, nitrates, ammonia, sodium chloride, carbon, mineral dust and water
Ozone (O <sub>3</sub> )	Increases respiratory infections (colds, pneumonia), breathing difficulties and asthma	Part of photochemical smog produced by the interaction of sunlight and air pollutants
Nitrogen dioxide (NO <sub>2</sub> )	Long-term intake is toxic, reduces lung function and causes bronchitis in asthmatic children	Part of PM <sub>2.5</sub> and O <sub>3</sub> , found in nitrate aerosols, produced by burning fuels, electricity generation plus vehicle engines
Sulphur dioxide (SO <sub>2</sub> )	10 minute exposure decreases pulmonary function. Causes eye irritation and respiratory inflammation (coughing, infections, mucus secretion, asthma attacks, bronchitis)	Burning fossil fuels and industrial processes
Carbon dioxide (CO <sub>2</sub> )	Lowers oxygen levels, reduces respiratory and brain functions, causes vision defects	Burning coal, oil and natural gases
Carbon monoxide (CO)	Lowers blood oxygen levels, slows reflexes, increases confusion and sleepiness	Cigarettes plus burning petrol, diesel, and wood
Lead (Pb)	Damages nervous system in children	Petrol, diesel, lead batteries, paints, and colouring agents

(Hosamane *et al.*, 2013)

In order to arrest the deterioration in air quality, Govt. of India has enacted Air (Prevention and Control of Pollution) Act in 1981. The responsibility has been further emphasized under Environment (Protection) Act, 1986. It is necessary to assess the present and anticipated air pollution through continuous air quality survey/monitoring programs. Therefore, Central Pollution Control Board had started National Ambient Air Quality Monitoring (NAAQM) Network during 1984 - 85 at national Level (CPCB, 2003).

Sources of dust pollution include agriculture related activities, power plants, cement factories, etc. and also due to increased reliance on road transport. Roads have become a common source of dusts as driving of heavy vehicles over unpaved roads loose the soil structure and soil packing density. It reduces the soil cohesion and mechanical stability resulting in accelerated wind erosion and emission of dust particles into the air (WMO, 2005).

## 1.2: Sources of Air Pollution

**Natural sources:** Natural sources of air pollution include volcanic activity, dust, sea-salt, forest fires, lightening, soil outgassing etc.

**Anthropogenic sources:** These sources include stationary point sources (e.g. emission from industries), mobile sources (e.g. vehicular emission, marine vessels, airplanes etc.), waste disposal landfills, open burning etc.

### 1.3: Classification of air pollutants

Air pollutants can be categorized by various means:

#### On the basis of source of origin

1. **Natural air pollutants:** Natural air pollutants are emitted from natural sources such as volcanic activity, dust, sea-salt, forest fires, lightening, soil outgassing etc.
2. **Anthropogenic air pollutants:** These pollutants include the emissions from stationary point sources (e.g. emission from industries), mobile sources (e.g. vehicular emission, marine vessels, airplanes etc.), waste disposal landfills, controlled burning etc.

#### On the basis of method of origin

1. **Primary air pollutants:** Those pollutants which are emitted directly from any emission source in the atmosphere are termed as Primary air pollutants. E.g. Sulphur dioxide (SO<sub>2</sub>), Carbon monoxide (CO), Lead (Pb), Ammonia (NH<sub>3</sub>) etc.
2. **Secondary air pollutants:** Secondary pollutants are formed by the reactions between primary air pollutants and normal atmospheric constituents. In some of the cases, these pollutants are formed by utilizing the solar energy. E.g. Ozone, Peroxyacetylnitrate (PAN), Smog etc (CPCB, 2015)

Increase in technological, industrial and agricultural advancement, coupled with increases in population growth, has triggered the deterioration of environmental quality throughout the world. Rapidly growing cities, more traffic on roads, growing energy consumption and waste production, and lack of strict implementation of environmental regulation are increasing the discharge of pollutants into air, water, and soil. Urban ambient air pollution is the result of emissions from a multiplicity of sources, mainly stationary, industrial and domestic fossil fuel combustion, and petrol and diesel vehicle emissions. Fossil fuels, the primary source of energy consumption, are the greatest source of ambient air pollution, producing nitrogen oxides, sulfur oxides, dust, soot, smoke, and other suspended particulate matter. These pollutants can lead to serious public health problems, including asthma, irritation of the lungs, bronchitis, pneumonia, decreased resistance to respiratory infections, and premature death. The burning of fossil fuels is also the major source of carbon dioxide emissions, a primary contributor to global warming. Motor vehicles emit PM, nitric oxide and NO<sub>2</sub> (together referred to as NO<sub>x</sub>), carbon monoxide, organic compounds, and lead. The chemical composition of the atmosphere is being altered/changed by the addition of gases, particulates and volatiles substances, which may be toxic to living beings. The levels of air pollutants are rapidly increasing in urban and rural areas in many megacities (urban population

greater than 10 million) of the developing world. The air pollutants so generated are detrimental to human health. In addition, they cause negative impacts directly or indirectly, if at elevated concentrations, on vegetation, animal life, buildings and monuments, weather and climate, and on the aesthetic quality of the environment (Hosamane *at el.*, 2013).

#### **1.4: Objectives of the study**

1. To analyze the SPM level in ambient air is vicinity of National Fertilizer Limited, Panipat city, Haryana.
2. To analyze the SO<sub>2</sub> level in ambient air is vicinity of National Fertilizer Limited, Panipat city, Haryana.
3. To analyze the NO<sub>2</sub> level in ambient air is vicinity of National Fertilizer Limited, Panipat city, Haryana.

#### **1.5: Justification of the study**

Need to study since the air quality of Panipat is degraded due to no. of industries, factories, NFL, thermal power plant and traffic load.



## Chapter-2

### Review of Literature

#### 2.1: Global scenario

Urban air pollution (UAP) is a major concern throughout the world in both, developed and developing countries. Swelling urban population and increased volume of motorized traffic in cities have resulted in severe air pollution affecting the surrounding environment and human health. The World Health Organization (WHO) has estimated that in developing countries, increasing UAP has resulted in more than 2 million deaths per annum along with various cases of respiratory illnesses (Cities Alliance, 2007; WHO, 2014).

Thoracic particulate matter is the major cause of human mortality and morbidity from air pollution; studies in the United States (US) have indicated that there are 20,000–100,000 deaths due to particulate pollution per year (US EPA, 1996). Megacities of India are no exception to the global pattern of deteriorating urban air quality. Indian cities are among the most polluted in the world, with concentrations of a number of air pollutants being well above recommended World Health Organization (WHO) levels (Kandlikar, 2000).

In dry, unpolluted atmospheric conditions, it is estimated that the average SO<sub>2</sub> concentration ranges from 0.03 to 0.3 μg/cu-m (0.01 to 0.1 parts per billion or ppb). In remote areas, SO<sub>2</sub> concentrations range 0.13 to 0.31 μg/cu-m (0.05 to 0.12 ppb). In urban and industrialized areas, SO<sub>2</sub> concentrations range from 2.6 to 2600 μg/cu-m (1 to 1000 ppb). A survey by the World Health Organization (WHO) of urban areas showed annual mean SO<sub>2</sub> concentrations ranging from 20 to 60 μg/cu-m (7 to 21 ppb) and daily means rarely exceeding 125 μg/cu-m (44 ppb) (WHO, 2000). IARC (1992) presents data for ambient air concentrations of SO<sub>2</sub> in different parts of the world (WBK *et al.*, 2003).

A study of air pollution in the city Taipei reveals that sulphur dioxide and nitrogen oxides are the major contributors for air pollution and are found in abundance in the urbanized city. The emissions of sulphur oxides (SO<sub>x</sub>) total 2,658 tonnes per year. Combustion emission accounts for approximately 62 per cent, mostly fuel combustion (44 per cent for commercial activities and 12 per cent for industries). Non-fuel combustion emissions account for some 3 per cent, and road transportation emissions 37 per cent (23 per cent from petroleum vehicles 8 per cent from diesels and 6 per cent from motorcycles). The NO<sub>x</sub> emissions total 22,023 tonnes per year. Road transportation accounts for 81 per cent (diesels 44 per cent; petroleum cars 34 per cent and motorcycles 3 per cent). As for non-road transportation emissions, aircraft account for some 10 per cent. Combustion emissions accounts for some 9 per cent, of which fuel combustion accounts for a major share (approximately 6 per cent) (Wang, 2003).

The rapid growth of China's economy has led to severe air pollution characterized by acid rain, severe pollution in cities, and regional air pollution. High concentrations are found for various pollutants such as sulfur dioxides (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), and fine particulates. Great efforts have thus been undertaken for the control of air pollution in the country. This paper discusses the development and application of appropriate technologies for reducing the major pollutants produced by coal and vehicles, and investigates air quality modeling as an important support for policy-making (Jiming *et al.*, 2007).

Median daily PM<sub>2.5</sub> concentrations varied across states, with the highest population-attributable risks seen in Mississippi, Kentucky, and Tennessee and the lowest in Utah, Wyoming, and North Dakota (Gurtu *et al.*, 2013). Reducing PM<sub>2.5</sub> concentrations to 5·8 µg/m<sup>3</sup> in each state would require a mean reduction in PM<sub>2.5</sub> of 3·9 µg/m<sup>3</sup> across the USA (Kjellstrom *et al.*, 2002).

Measurements of PM<sub>10</sub> and black smoke in the ambient air have been made by (Hock *et al.*, 1997) at 28 sites in 10 countries of Europe. The difference of particle concentration across the Europe appeared to be considerably larger than the difference between rural and urban location within countries. A study conducted in 421 houses in northern-central Italy showed a positive correlation between indoor PM<sub>2.5</sub> exposure and the presence of bronchitis and asthmatic symptoms, especially during the winter season (Simoni *et al.*, 2002).

Increases in particulate matter concentration was associated with heart failure, hospitalization or death (PM<sub>2.5</sub> 2·12% per 10 µg/m<sup>3</sup>, 95% CI 1·42–2·82; PM<sub>10</sub> 1·63% per 10 µg/m<sup>3</sup>, 95% CI 1·20–2·07). Strongest associations were seen on the day of exposure, with more persistent effects for PM<sub>2.5</sub>. In the USA, it was estimated that a mean reduction in PM<sub>2.5</sub> of 3·9 µg/m<sup>3</sup> would prevent 7978 heart failure hospitalizations and save a third of a billion US dollars a year (Shah *et al.*, 2013).

## 2.1: India scenario

In the assessment of Ambient air quality in Northern India using Air Quality Index method. The present study dealt with the assessment of ambient air quality in both commercial and residential areas like Aminabad, Indian Institute of Toxicology Research (IITR) Campus, Aliganj and Indranagar at Lucknow city of Northern India. The air quality was assessed based on measurement of our air pollutants like Suspended Particulate Matter (PM<sub>10</sub>), Respirable Suspended Particulate Matter (PM<sub>2.5</sub>), Oxides of Nitrogen (NO<sub>x</sub>), and Sulphur Dioxides (SO<sub>x</sub>) and also eight heavy metals associated with PM<sub>10</sub> and PM<sub>2.5</sub>. The results suggested that the commercial area like Aminabad has the average value 284 µg/m<sup>3</sup> for PM<sub>10</sub> and residential area like Aliganj has the average value 182.3 µg/m<sup>3</sup> for PM<sub>2.5</sub>, which represented high pollution level among the four locations. In both commercial and residential area, the average concentration of PM<sub>10</sub> and PM<sub>2.5</sub> were obtained above National Ambient Air Quality Standards (NAAQS) and SO<sub>x</sub>, NO<sub>x</sub> were obtained under the prescribed limits of Central Pollution Control Board (CPCB), New Delhi. The calculated values of air quality index revealed that the commercial area was found to have higher

AQI (122.95) than residential area (97.8). The average contribution of four (PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>x</sub>, NO<sub>x</sub>) pollutant were obtained 31.7% in Aminabad, 25% in Aliganj, 22% in IIT Rand 21.3% in Indranagar. The order of metals associated with PM<sub>10</sub> and PM<sub>2.5</sub> were Fe > Zn > Pb > Cr > Cu > Mn > Co > Ni and Fe > Cr > Zn > Co > Pb > Ni > Mn > Cu respectively. The sources of heavy metals in this area are vehicular emission, industrial operation, combustion of waste, and construction activity of street dust particles etc. (Chaudhary *et al.*, 2013)

In the assessment of ambient air quality status in urban residential areas of Jhansi city and rural residential areas of adjoining villages of Jhansi city, the concentration of the SPM recorded in the study areas ranged between 248.23 to 376.79 µg/m<sup>3</sup>. Rural residential area has lower values of SPM (250.06 µg/m<sup>3</sup>) compared to the Urban residential area, that has mean SPM value of 373.48 µg/m<sup>3</sup>. In urban residential area, pollution sources like diesel powered electric, generator, sugarcane juice stall, telephone tower etc. are more than the rural residential area. The average values of SPM recorded in Shivaji Nagar and Veerangana Nagar was 376.79 and 370.17 µg/m<sup>3</sup>, respectively. Similarly, the average values of SPM recorded in Kochha Bhavar and Lakara was 251.90 and 248.23 µg/m<sup>3</sup>, respectively. All these values exceeded the National Ambient Air Quality Standards (NAAQS) prescribed (200 µg/m<sup>3</sup>) for residential and rural residential by the Central Pollution Control Board (CPCB, 1994), New Delhi (Yadav *et al.*, 2012)

Considering the mounting evidences of the effects of air pollution on health, it was undertaken to assess the ambient air quality status in the fast growing urban centres of Haryana state, India. The samples were collected for total suspended particulate matter (TSPM), respirable suspended particulate matter (PM<sub>10</sub>), sulfur dioxide (SO<sub>2</sub>), and for oxides of nitrogen (NO<sub>2</sub>) during different seasons from 8 districts of Haryana during January, 1999 to September, 2000. The four types of sampling sites with different anthropogenic activities i.e. residential, sensitive, commercial and industrial were identified in each city. The ambient air concentration of TSPM and PM<sub>10</sub> observed was well above the prescribed standards at almost all the sites. The average ambient air concentrations of SO<sub>2</sub> and NO<sub>2</sub> were found below the permissible limits at all the centres. Comparatively higher concentration of SO<sub>2</sub> was observed during winter seasons, which seems to be related with the enhanced combustion of fuel for space heating and comparatively stable atmospheric conditions. The high levels of TSPM and SO<sub>2</sub> especially in winter are of major health concern because of their synergistic action. The data from Hisar city reveals a significant increase in the total number of hospital visits/admissions of the patients with acute respiratory diseases during winter season when the level of air pollutants was high (Kaushik *et al.*, 2000)

Across in Delhi and its surrounding in July-December 2003, 113 sites were selected for air pollution monitoring By Kumar (2009). From the analysis of these data three important findings emerge. First, air pollution levels in Delhi and its surroundings were significantly higher than that recommended by the World Health Organization (WHO). Second, industries and trucks were identified as the major contributors of both fine and coarse particles. Third, air quality regulations in the city adversely affected the air quality of the areas surrounding Delhi (Kumar, 2009).

The concentration of SO<sub>x</sub>, and NO<sub>x</sub> were monitored from February 2013 to May 2013 over Gopalpur village in Durgapur situated at 23°29'52.67" N and 87°23'46.08"E. The data obtained from the field work were compared with the secondary data obtained from Durgapur Station of Central Pollution Control Board (CPCB). Their relationships with different meteorological parameters were identified. The concentration of SO<sub>x</sub> over the site is found to lie between 14.219µg/m<sup>3</sup> to 390.041µg/m<sup>3</sup>, with a mean value of 104.601±103.860 µg/m<sup>3</sup> and 45 % of the total data exceeded the NAAQS for the concentration of SO<sub>x</sub> in the ambient air. The recorded concentration of NO<sub>x</sub> lies between 32.50 µg/m<sup>3</sup>- 112.79 µg/m<sup>3</sup>, with a mean value of 66.99±21.63 µg/m<sup>3</sup> and 20% of the monitored data is found to exceed the NAAQS for NO<sub>x</sub> in the atmosphere. Record of eight hour (08:00:00 – 16:00:00 h. Industrial emission (Sponge Iron industries, Steel industries etc.), vehicular exhausts, open biomass burning, mining etc. were identified as the probable sources of the pollutants in the ambient atmosphere of Gopalpur (Dey *et al.*, 2014)

During the summer of 2009, concentrations of oxides of nitrogen (NO<sub>x</sub>), oxides of sulphur (SO<sub>x</sub>), suspended particulate matter (SPM) and carbon monoxide (CO) were collected over successive periods of about 8 hour at eight sites. High volume air sampler was used to measure the concentration of oxides of nitrogen (NO<sub>x</sub>), oxides of sulphur (SO<sub>x</sub>), suspended particulate matter (SPM) and CO monitor was used to measure the concentration of carbon monoxide (CO). The results reported pertain to an eight hour successive continuous air sampling exercise carried out at each of the eight select locations in Puducherry, a southern semi urban settlement in India. Criteria pollutants SPM, CO, SO<sub>2</sub> and NO<sub>2</sub> measured are found to have either crossed or on the average of crossing the limits, necessitating the immediate installation of a continuous monitoring and control mechanism. While transport related emissions are the major sources of air contamination, increasing civil construction activities also contribute to particulates. The exponential rise in volume of vehicles, disadvantageous traffic flow pattern, differing driving cycle pattern and human interceptions deserve due attention. The concentrations of SO<sub>x</sub> were below the prescribed limits. The SPM values were exceeded the National Ambient Air Quality Standard (NAAQS) at all the eight locations. The NO<sub>x</sub> values were exceeded the National Ambient Air Quality Standard (NAAQS) at all the eight locations. The CO values were exceeded the National Ambient Air Quality Standard (NAAQS) at seven locations (Balashanmuga *et al.*, 2009)

The average percentage of disease observed higher in commercial. Ambient air quality in the commercial zone is affected adversely due to emission and accumulation of SPM, RSPM, SO<sub>2</sub> and NO<sub>x</sub> as, compare to residential zone. Zone due to high concentrations of air pollutant and lower in residential zone to low concentrations of air pollutants. The total number of study population suffering from eye diseases, 44% observed in commercial zone and 13.5 % in residential zone. commercial zone ( cough 45.20%, Sneezing 26.75%, Nose block 21.20%, Wheezing 19.55%, Dry cough 13.75%, Bronchitis 7.67%, Asthma 3.95% ) as to compare residential zone ( cough 13.5%, Sneezing 14.0%, Nose block 13.0%, Wheezing 12.0%, Dry cough 6.80%, Bronchitis 4.3%, Asthma 0.88% ) during winter 2010 (Kaushik *et al.*, 2013)

Acc. to Meena (2012) data of the ambient air quality status of residential area of Himalayan region viz. Garhwal (NewTehri) and Kumaon (Muktheshwar) in state of Utrakhhand India. At four different locations with respect to, SO<sub>2</sub>, NO<sub>2</sub>, PM-10, benzo (a) pyrene, benzene, toluene, lead and nickel. During winter, the benzo (a) pyrene was found slightly higher (1.15 ng/m<sup>3</sup>) than the National Ambient Air quality Standard limit (1.0ng/m<sup>3</sup>). This may be due to Vehicle movement in the site selected at Muktheshwar. Rest of the other places benzo (a) pyrene levels were observed below 1 ng/m<sup>3</sup>. There are no industries in or along the roads in sampling area hence any source of atmospheric air pollution is not expected during the study period. Pollutants concentration (SO<sub>2</sub>, NO<sub>2</sub>, and PM<sub>10</sub>) was used to calculate the air quality index which ranges from 7.91 to 14.93 thus categorizing the sites under the clean air and reported healthy (Meena *et al.*, 2012)

In the assessment of in residential zone, the average concentration of SPM and RSPM, were found to be 197.7 (196.7-198.7) and 79.98 (65.1-94.8) µg/m<sup>-3</sup> respectively whereas, in commercial zone, the average concentration of SPM and RSPM, were found to be 605.0 (558.7-652.0) and 377.4 (319.0-435.0) µg/m<sup>-3</sup> respectively. Gaseous pollutants (SO<sub>2</sub> and NO<sub>x</sub>) were found to be 13.5 (10.2-16.8), 19.75 (15.5-24.0) µg/m<sup>-3</sup> in residential zone whereas, 22.1 (21.2-23.0) and 31.2 (30.0-32.5) µg/m<sup>-3</sup> respectively found in commercial zones, which is found below the permissible limits at all sites of Panipat city. The 24 hr. mean concentration of SPM and RSPM, at all the locations in commercial zone were found higher than the respective prescribed National Ambient Air Quality Standards (NAAQS). On the other hand the Air Quality Index (AQI) based on the calculation of 24 hr. average concentration of SPM, RSPM, SO<sub>2</sub> and NO<sub>x</sub> at different locations showed to polluted (V) category at all the commercial zone, whereas, the residential zone showed fairly clean (III) for residential sector 24, HUDDA and clean (II) category in residential sector 7, HUDA . Higher index values indicate higher health risks and maximum value was found in the commercial area. Urban air pollution due to vehicular emission is a matter of concern because of exposure of large number of people to it. Vehicular emission is responsible for higher level of air pollutants like SPM, RSPM, SO<sub>2</sub>, and NO<sub>x</sub> (Kaushik *et al.*, 2013).

## Chapter-3

### Material and methods

#### 3.1: Study area

Panipat is an ancient and historic city of Haryana State, India. According to the mythology, Panipat was one of the five cities (Prasthas) founded by the Pandava brothers during the period of the Mahabharata; the historic name of Panipat was Panduprastha. Three battles fought at the city were pivotal in Indian History. (HSPCB, 2010).

Panipat is well known city for textiles and carpets. It is the biggest centre for quality blankets and carpets in India and famous for handloom weaving. Heavy industries with national importance viz. National Fertilizers Limited, Refinery of the Indian Oil Corporation Limited, Power Plant of Haryana Power Generation Corporation Limited, Urea Manufacturing Facility of, Sugar Mill and Distillery of Panipat Co-operative Sugar Mills are located in Panipat (HSPCB, 2010). Panipat is situated in the eastern part of Haryana, India (Latitude 29°39'0N, Longitude 76°09'60E) having area of 1268 square kilometers. As per 2011 census, it had population of 9,67,468. The climate here is typical of Haryana plain i.e. very hot in summer (average 45<sup>0</sup>C temp) and very cold in winter (average 10<sup>0</sup>C temp). Panipat is well known for its industrial destination in the state. With increasing population, the trading aspects became brighter and city went on becoming the second highest revenue generator of Haryana immediately after Faridabad.

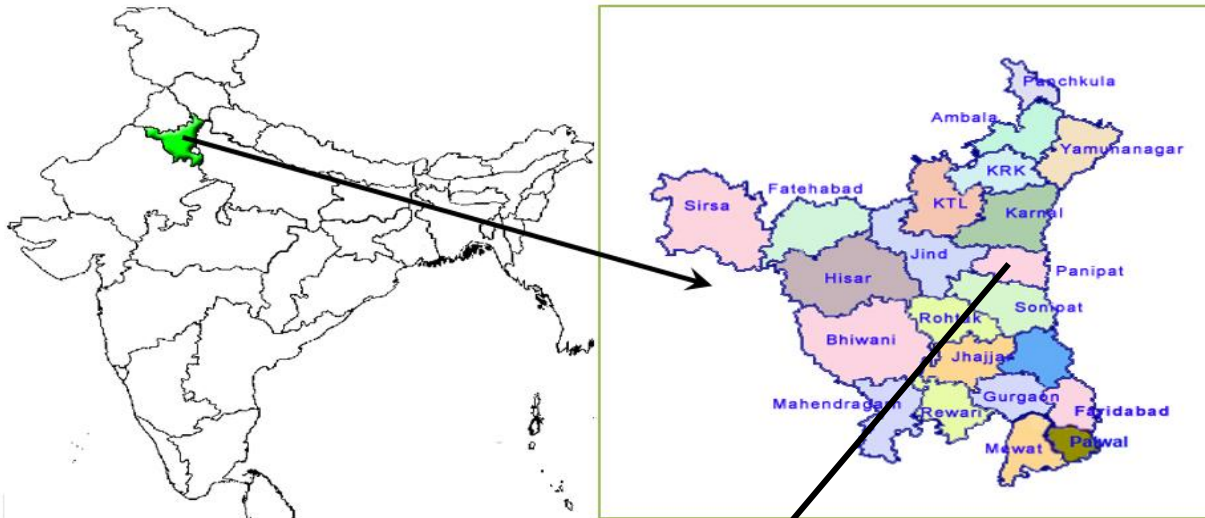


Fig.-3.1. India map showing Haryana



Fig.-3.2. Haryana map showing National fertilizer limited, Panipat

To assess the ambient air quality status of the industrial area, four sites were selected nearby the National fertilizer limited, located in the Vikas Nagar (Site-I), Meharana (Site-II) village, Siwah (Site-iii) and Diwana (Site-iv) respectively. Vikas Nagar is about 500 m away from the NFL having population of about 4500 people approximate, whereas Meharana village is at a distance of about 600 m from the NFL in other direction whereas Siwah village is at a distance of about 4944m and last Diwana village is at a distance of about 6440 m away from the National fertilizer limited Panipat. Vikas nagar and Meharana village are polluted site and Siwah or Diwana are less polluted places.

### 3.2: Instrument used:



**Fig.3.3. Envirotech APM 550 Fine Particulate Sampler**

The air quality monitoring was carried out by using A Envirotech model APM 550 Fine Particulate Sampler for the monitoring of ambient air pollutant. Envirotech model APM 550 Fine Particulate Sampler was developed in 1999 to check the status of PM 2.5 in the community. The sampler shown in fig 3.3. Works on EPA requirements

Which is instrument used to collect them air borne particulate component present in the atmosphere. A variety of options available for the sampler provides broad versatility and allows the user to develop information about the quantity and size of air borne particulate matter and, information about the chemical properties for the particulate matter using subsequent chemical analytical technique. This collects suspended particulates on PM 2.5 paper fixed on the wein's impactor inside the sampler. The flow rate was maintained to  $1\text{m}^3/\text{min}$ . Large quantities of particles ranging from 0.1 to  $1.0\text{gm}$  are collected over a typical 24-hour sampling period. These facilities gravimetric and chemical analyses are the advantage of Fine Particulate sampler over other air sampling methods. Sampler is set at height of 3 meters to 10 meters from the ground at



the designated sampling site. SO<sub>2</sub> & NO<sub>2</sub> are measured after the collected air is passed through absorbent solution. The absorbent is then analyzed by spectrophotometer method at 560 nm and 540 nm.

### **Monitoring and Analysis of Pollutants:**

Ambient air quality was monitored for major air pollutants viz. Suspended Particulate Matter (SPM), Sulphur dioxide (SO<sub>2</sub>) and Nitrogen dioxide (NO<sub>2</sub>) for this purpose standard methods prescribed by Central Pollution Control Board of India were adopted. The study was carried out during the months of 23march to 27march, 2016. The monitoring of pollutants were carried out for 8 hours, data were analyzed during the observation period and the values were taken for the calculation of the gaseous pollutants.

### **3.1: Sampling and analysis of sulphur dioxide in ambient air (Improved West and Gaeke method)**

#### **Principle of the method**

Sulphur dioxide from air is absorbed in a solution potassium tetrachloromercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with pararosaniline and formaldehyde to form the intensely coloured pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer.

#### **Apparatus/ Instrumen used:-**

- Fine particulate Sampler APM 550
- Absorber: midget impinger was used as an absorber.
- Spectrophotometer: capable of measuring absorbance at 560 nm

**Reagents/ / Chemicals for SO<sub>2</sub> measurement:-**

**Preparation of absorbing solution: 0.04M potassium tetrachloromercurate (TCM):**

Dissolve 10.86 g, mercuric chloride, 0.066 g EDTA, and 6.0 g potassium chloride or sodium chloride 4.68 gm in water and bring to the mark in a 1 litre volumetric flask. *Caution: highly poisonous if spilled on skin, flush off with water immediately.* The pH of this reagent should be approximately 4.0 but, it has been shown that there is no appreciable difference in collection efficiency over the range of pH 5 to pH 3. (CPCB, 2011).

**Sulphamic Acid (0.6%):-** Dissolve 0.6 g sulphamic acid in 100 ml distilled water. Prepare fresh daily.

Dissolve 0.6 gm of sulphamic acid was dissolved in 100 ml distilled water.

**Pararosaniline stock solution:-**

Dissolve 0.50gm of specially purified pararosaniline in 100 ml distilled water and keep for 2 days (48 hours).

**Pararosaniline working solution:-**

Take 10 ml of stock PRA in 250 ml volumetric flask. 15 ml concentrated HCL was added to it and volume was made with distilled water.

**For Preparation of Calibration Curve**

**Stock Iodine solution (0.1 N):-**

Place 12.7 gm iodine, 40 gm potassium iodide in 250 ml beaker and make a paste by adding 25 ml distilled water dilute to 1.0 litre with distilled water.

**Iodine working solution :- (0.01N)**

50 ml stock solution was added to 500 ml distilled water

**Starch indicator:-**

Take 0.4 gm of soluble starch and 0.002 gm mercuric iodide and 200ml boiled distilled water.

**Stock sodium thiosulfate solution (0.1N):-** Dissolve 25 gm sodium thiosulfate penta hydrate ( $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ ) in 1 litre of freshly boiled water and add 0.1 g sodium carbonate as preservative. The solution is allowed to stand for 24 hours before standardization.

**Standardization of stock solution:**

1.5 gm potassium iodide solution dried at  $180^\circ\text{C}$  and dilute it to 500 ml distilled water in a conical flask. Out of which pipette out 50 ml of potassium iodate. Add to it 2.0 gm potassium iodide and 10 ml (1:10) HCL and Stopper the flask for 5 minutes and titrate it with sodium thiosulfate till a pale yellow colors appear. Add 5.0 ml starch and titrate till the blue colors just disappear. The normality of stock solution was calculated.

$$\text{Normality of Thiosulphate solution} = \frac{M \times 2.80}{V}$$

Where:-

V=Volume in ml of thiosulphate used, and  
M=Mass in gm of potassium iodate.

**Stock sodium sulphite solution:-**

Dissolve 0.4 gm sodium sulphite or 0.3 gm sodium metabiosulphite in 500 ml boiled & cooled distilled water. For standardization, 50 ml of the 0.01N iodine solution was measured in to each of two 500 ml iodine flasks A &B, 25 ml distilled water was added to flask A (blank) and 25 ml sulphite solution was measured in to flask B (sample) by pipette. The flask were stoppered and allowed to react for 5 minutes. The working sulphite TCM solution was prepared as the same time iodine solution was added to the flasks. Solution in each flask was titrated against standardized 0.01 N thiosulfate, to pale yellow. 5 ml starch solution was then added and the titration was continued until the disappearance of blue color.

**Working sulfite – solution:-**

2 ml of the standard solution was added was measured in to a 100 ml volumetric flask by pipette and the volume was raised up to mark with 0.04M TCM. The concentration of sulfur dioxide in the working solution was calculated in microgram of sulfur dioxide per milliliter.

**Formaldehyde:-**

Dilute 5 ml of 40% formaldehyde solution to one litre with distilled water. This solution should be prepared fresh.

**Procedure:-**

20 ml absorbing reagent (TCM) was taken in impinger Initial time totalizer reading was noted and Rota meter flow was set at 1.0 LPM of air, Final time totalizer and rotameter reading were noted after the sampling time was over.



Fig.3.4. Impinger tubes box



Fig.3.5. Impinger tubes connected with Air flow meter

**Analysis:-**

Replace any water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber. Mix thoroughly, pipette out 10 ml of the collected sample into a 25 ml volumetric flask. Add 1 ml 0.6% sulphamic acid and allow reacting for 10 minutes to destroy the nitrite resulting from oxides of nitrogen. Add 2 ml of 0.2% formaldehyde solution and 2 ml pararosaniline solution and make up to 25 ml with distilled water. Prepare a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 30 min color development interval and before 60 minutes, measure and record the absorbance of samples and reagent blank at 560 nm. Use distilled water; not the reagent blank, as the optical reference

### Preparation of calibration curve:-

The actual concentration of the sulphite solution is determined by adding excess iodine and back titrating with standard sodium thiosulfate solution. To back-titrate, measure, by pipette, 50 ml of the 0.01 N iodine solution into each of two 500 ml iodine flasks A and B. To flask a (blank) add 25 ml distilled water and into flask B (sample) measure 25 ml sulphite solution by pipette. Stopper the flasks and allow to react for 5 minutes. Prepare the working sulphite-TCM solution at the same time iodine solution is added to the flasks. By means of a burette containing standardized 0.01 N thiosulfate, titrate each flask in turn to a pale yellow. Then add 5 ml starch solution and continue the titration until the blue color disappears.

### Preparation of Standards

Measure 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml, 2.5 ml, 3.0 ml, 3.5 ml and 4.0 ml of working sulphite TCM solution in 25 ml volumetric flask. Add sufficient TCM solution to each flask to bring the volume to approximately 10 ml. Then add the remaining reagents as described in the procedure for analysis. A reagent blank with 10 ml absorbing solution is also prepared. Read the absorbance of each standard and reagent blank.

### Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

### Calculation

The concentration of SO<sub>2</sub> in ambient air was calculated by the formula:-

$$(\text{SO}_2 \text{ } \mu\text{g/m}^3) = \frac{(A_s - A_b) \times \text{CF} \times V_s}{V_a \times V_t}$$

Where:-

SO<sub>2</sub> = Concentration of Sulphur dioxide,  $\mu\text{g/m}^3$

A<sub>s</sub> = Absorbance of sample

A<sub>b</sub> = Absorbance of reagent blank

C<sub>f</sub> = Calibration factor

$V_a$  = Volume of air sampled, m<sup>3</sup>

$V_s$  = Volume of sample, ml

$V_t$  = Volume of aliquot taken for analysis, ml

### **3.4: Sampling and analysis of Nitrogen dioxide in ambient air (Modified Jacob and Hochheiser Method)**

There are many methods for measurement of NO<sub>2</sub>, but Sodium arsenate modification of Jacobs-Hochheiser, (1958) method which is recommended as the manual method for the determination of NO<sub>2</sub> was followed.

#### **Principle:-**

Ambient nitrogen dioxide (NO<sub>2</sub>) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO<sub>2</sub>) produced during sampling is determined colorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm.

#### **Reagents for NO<sub>2</sub> measurement**

**Absorbing solution:** (Dissolve 4.0 g of sodium hydroxide in distilled water, add 1.0 g of sodium Arsenite, and dilute to 1,000 ml with distilled water)

#### **For Analysis**

**N-(1-naphthyl)-Ethylenediamine Di hydrochloride (NEDA)** - A solution: 0.5 gm NEDA was dissolved in 500 ml distilled water.

**Sulfanilamide solution:** 20g Sulfanilamide was dissolved in 700 ml distilled water, 50ml of 85% Phosphoric acid was added and diluted to 1000ml solution with distilled water.

**Hydrogen peroxide solution:** 0.2 ml of 30% Hydrogen peroxide was diluted to 250 ml with distilled water.

**Stock Nitrite solution:** - Dissolve 1.5 gm NaNO<sub>2</sub> in 1 liter of distilled water. This solution contains 1000µg/ml. weight may be taken by after calculation from the following formula:

$$G = 1.5 \times 100/A$$

Where:-

G = Gram of NaNO<sub>2</sub>.

A = Assay percent

1.5 = Gravimetric conversion factor.

#### **Working Nitrite solution:-**

Dilute 10 ml of Stock nitrite solution to 1 liter. Again dilute 25 ml of diluted solution to 250 ml with the absorbing media. This contains 1.0µg/NO<sub>2</sub>/ml.

#### **Procedure:-**

Place 20 ml of absorbing solution in an impinger and sample for four hour at the flow rate of 0.2 to 1 L/min. After sampling measure the volume of sample and transfer to a sample storage bottle.

#### **Analysis:-**

Replace any water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber, mix thoroughly. Pipette out 10 ml of the collected sample into a 50 ml volumetric flask. Pipette in 1 ml of hydrogen peroxide solution, 10 ml of sulphanilamide solution, and 1.4 ml of NEDA solution, with thorough mixing after the addition of each reagent and make up to 50 ml with distilled water. Prepare a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 10 min colour development interval, measure and record the absorbance of samples and reagent blank at 540 nm. Use distilled water; not the reagent blank, as the optical reference Samples with an absorbance greater than 1.0 must be re-analyzed after diluting an aliquot of the collected samples with an equal quantity of unexposed absorbing reagent. A randomly selected 5-10% of the samples should be re-analyzed as apart of an internal quality assurance program.

**Preparation of calibration curve:-**

With the help of pipette known amount of final working Sodium nitrite solution i.e. 1ml=1ml=1 µg NO<sub>2</sub> such as 0.0, 1.0, 2.0, 3.0, 5.0, and 10.0 ml was taken in series of 50 ml volumetric flask. Added 1 ml of H<sub>2</sub>O<sub>2</sub>, 10ml of Sulfanilamide, 1.4 ml of NEDA to each volumetric flask. Made up the final volume with distilled water. A blank was also prepared as above. Allowed to stand for 20 minutes for colors development. Measured the absorbance with spectrophotometer at 540 nm against blank as 0.000.

**Standard Curve:**

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

**Calculation:-**

The concentration of NO<sub>2</sub> in air was calculated using the formula:

$$(\text{NO}_2 \mu\text{g}/\text{m}^3) = \frac{(A_s - A_b) \times \text{CF} \times V_s}{V_a \times V_t \times 0.82}$$

**Where:-**

NO<sub>2</sub> = Concentration of Sulphur dioxide, µg/m<sup>3</sup>

A<sub>s</sub> = Absorbance of sample

A<sub>b</sub> = Absorbance of reagent blank

C<sub>f</sub> = Calibration factor

V<sub>a</sub> = Volume of air sampled, m<sup>3</sup>

V<sub>s</sub> = Volume of sample, ml

V<sub>t</sub> = Volume of aliquot taken for analysis, ml

0.82 = Sampling efficiency



### **3.5: Determination of PM<sub>2.5</sub> Respirable Suspended Particulate Matter in Ambient Air by Gravimetric Method.**

#### **Definition**

PM<sub>2.5</sub> refers to fine particles that are 2.5 micrometers ( $\mu\text{m}$ ) or smaller in diameter. Ambient air is defined as any unconfined part of the Earth's atmosphere, that the surrounding outdoor air in which humans and other organisms live and breathe.

Several methods are used for measuring the SPM in ambient air. But most commonly used device is Fine Particulate sampler, which consists essentially of a blower and a filter, which is operated at 3 to 10 meter to collect 24-hr sampling. The sample is weighted to determine concentration and may be analyzed chemically. The Fine Particulate sampler is considered a reliable instrument for measuring the mass concentration of TSPM (2.5) in ambient air.

#### **Procedure for measurement of RSPM in Ambient Air:-**

- Filter papers were visually inspected using a light table and a serial number was assigned of each of these filter papers.
- The filter paper were equilibrated in environment condition for 24 hours before weighing or kept in oven for at 90 °C -100 °C for 3 hours.
- Filter paper placed with the rough side on the filter cassette inside the PM<sub>2.5</sub> impactor.
- Sampling sites need to be 3 – 10 metre high from ground level.
- It was ensured that Fine Particulate Sampler should not be parallel to the ground and not placed under a tree, near a wall or other obstruction that would prevent free air flow.
- Time Totalize was reset to the desired sampling time.
- The flow rate was measured after a warm up time of 5 minutes.
- The calibration graph was referred to adjust the speed of blower motor to obtain the required flow rate.
- The reduced final flow rate was also obtained from the calibration graph.
- Sampling time was noted with the help of time totalize.

- Amount of particulates collected was determined by measuring the change in weight of the filter paper.

The instrument provides instantaneous flow rate and the period of operation (on- time) for calculation of air volume passed through the filter.



Fig.3.6 PM<sub>2.5</sub> filter paper before sampling



Fig 3.7 PM<sub>2.5</sub> filter paper after sampling

### Measurement of Respirable Suspended Particulate Matter (RSPM)

The equation to calculate the mass of fine particulate matter collected on a Teflon filter is as below

$$M_{2.5} = (M_f - M_i) \text{ mg} \times 10^3 \mu\text{g}$$

**Where,**

**M<sub>2.5</sub>** = total mass of fine particulate collected during sampling period ( $\mu\text{g}$ )

**M<sub>f</sub>** = final mass of the conditioned filter after sample collection (mg)

**M<sub>i</sub>** = initial mass of the conditioned filter before sample collection (mg)

**10<sup>3</sup>** = unit conversion factor for milligrams (mg) to micrograms ( $\mu\text{g}$ )

- Field records of PM<sub>2.5</sub> samplers are required to provide measurements of the total volume of ambient air passing through the sampler (V) in cubic meters at the actual temperatures and pressures measured during sampling. Use the following formula if V is not available directly from the sampler:

$$V = Q_{avg} \times t \times 10^{-3} \text{ m}^3$$

**Where,**

**V** = total sample value (m<sup>3</sup>)

**Q<sub>avg</sub>** = average flow rate over the entire duration of the sampling period (L/min)

**t** = duration of sampling period (min)

**10<sup>3</sup>** = unit conversion factor for liters (L) into cubic meters (m<sup>3</sup>)

**PM<sub>2.5</sub>** =  $M_{2.5} / V$

**Where,**

**PM<sub>2.5</sub>** = mass concentration of PM<sub>2.5</sub> particulates (μg/m<sup>3</sup>)

**PM<sub>2.5</sub>** = total mass of fine particulate collected during sampling period (μg)

**V** = total volume of air sampled (m<sup>3</sup>)

### Precautions

1. The samples must be transported in ice trays so that no loss of samples occur.
2. In case of SPM sampling and analysis, pre and post conditioning of filter paper must be done.
3. Distilled water should be used as the optical reference, instead of reagent blank. It is important because of the color sensitivity of the reagent blank to the temperature change which may be induced in the color compartment of the spectrophotometer.
4. In case of SO<sub>2</sub>, the absorbance of the sample at 560 nm should be determined after 30 minutes of test sample prepared
5. Don't allow the colored solution to stand in the absorbance cell. Clean cell with alcohol and clean pipe cleaner after use.

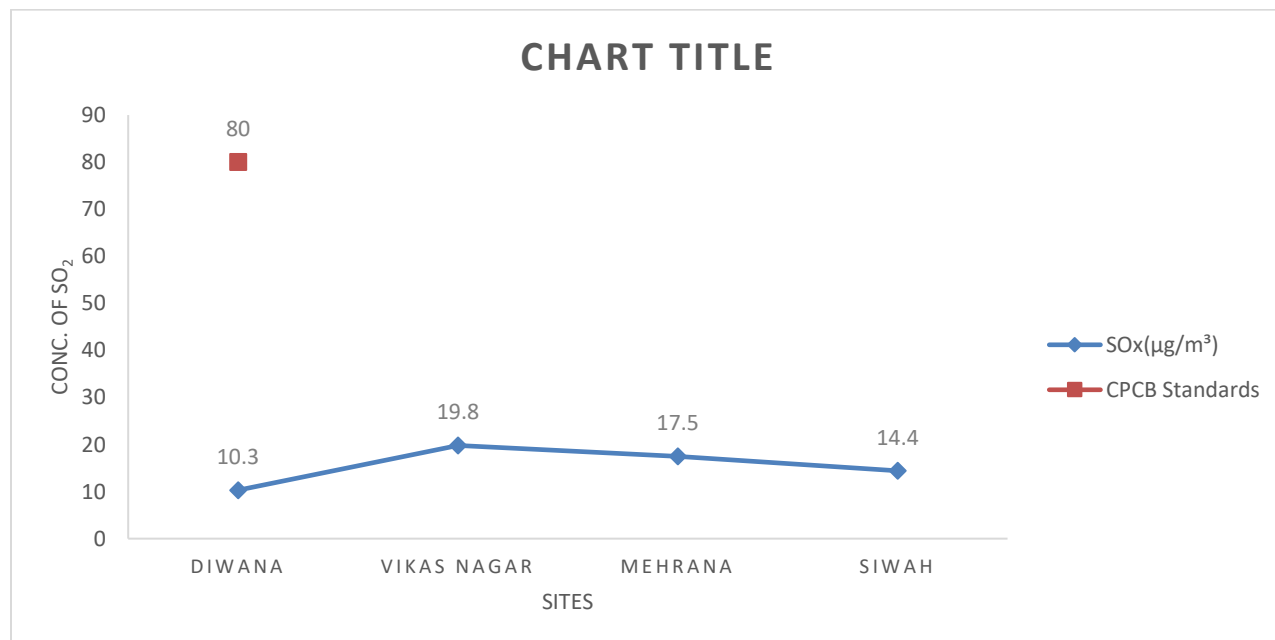
## Chapter - 4

### RESULTS AND DISCUSSION

The study for major pollutants i.e SO<sub>2</sub>, NO<sub>2</sub> & PM<sub>2.5</sub> was conducted at 4 different sites nearby NATIONAL FERTILIZER LIMITED Panipat city, Haryana and the results were compared with National Ambient Air Quality Standards (NAAQS) specified by CPCB (Annexure-) and other study papers.

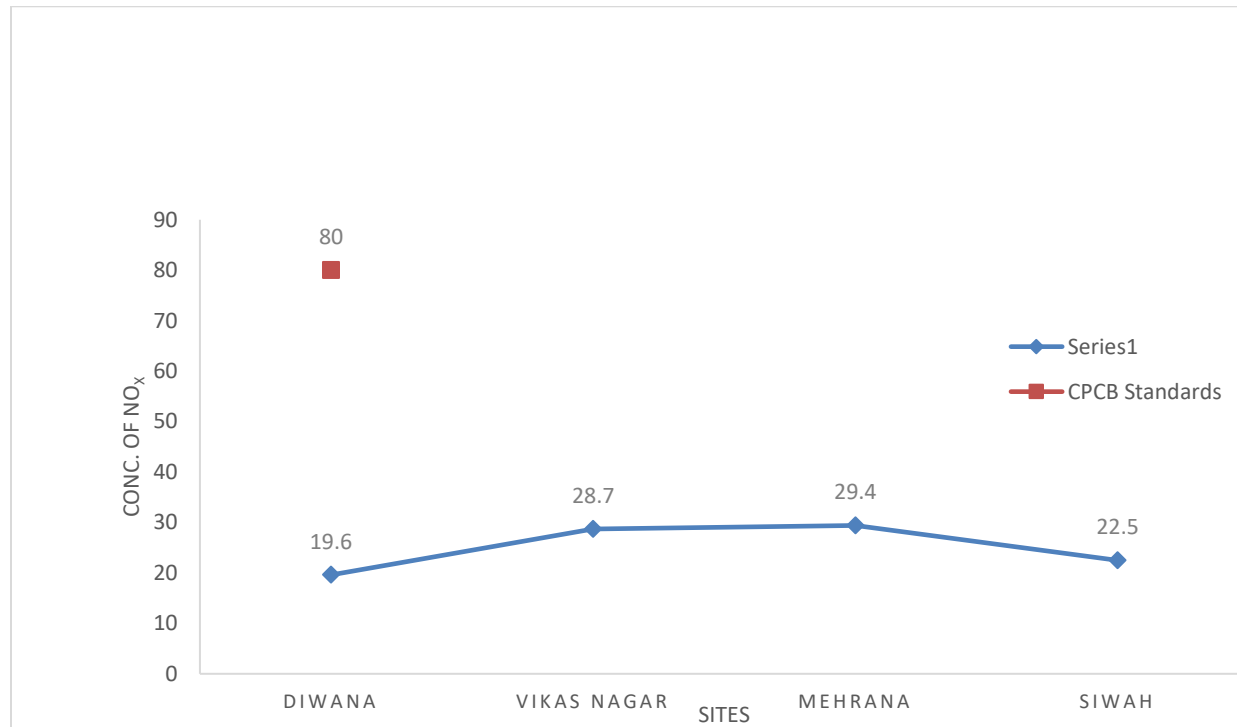
#### 4.1. Concentration of SO<sub>2</sub>

The concentrations of SO<sub>2</sub> was well within permissible limits (80µg/m<sup>3</sup>) prescribed by CPCB at all both the sampling sites. The concentration of NO<sub>2</sub> was higher at Vikas Nagar (19.8µg/m<sup>3</sup>) and Mehrana (17.5 µg/m<sup>3</sup>) as compared to the Siwah and Diwana (14.4µg/m<sup>3</sup>), (10.3 µg /m<sup>3</sup>) as shown in Fig 4.1. The main reason of higher concentration at Vikas Nagar and Mehrana is due to closer to NFL than Siwah and Diwana . The higher levels of SO<sub>2</sub> around Vikas Nagar and Mehrana may be due to the large number Industries and factories and National highway, near of NFL or around the sampling site. Large number of houses in the Vikas Naagar and village Mehrana (Panipat) near to NFL burn coal for the fertilizers , and for textile, handlooms industries purpose that contributes the large amount of SO<sub>2</sub> and also the SPM in the ambient air. Therefore many of the people around the NFL are suffering from the the respiratory diseases.



**Fig., 4.1 Concentration of SO<sub>2</sub> at selected sampling sites:****4.2 Concentration of NO<sub>2</sub>**

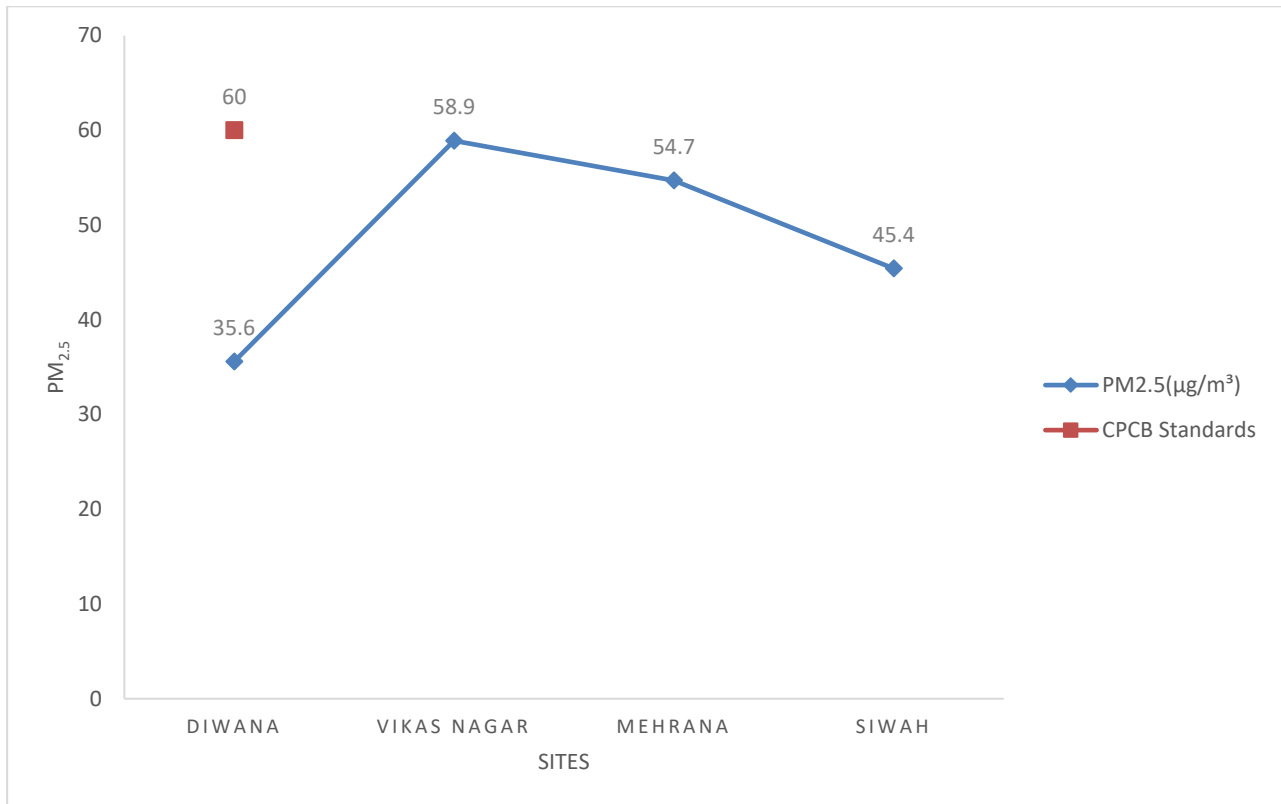
Vehicular emission is the major contributor of NO<sub>2</sub> in the atmosphere. The concentration of NO<sub>2</sub> was higher at Vikas Nagar and Mehrana (28.7 μg/m<sup>3</sup>), (29.4 μg/m<sup>3</sup>) as compared to the Siwah and Diwana (22.5 μg/m<sup>3</sup>), (19.6 μg/m<sup>3</sup>). The main reason of higher concentration at Vikas Nagar and Mehrana is due to closer to Siwah and Diwana. The concentration of NO<sub>2</sub> was within the prescribed limit of CPCB at all the sampling site. It may be contributed to the green belt along the road sides of Panipat City. The concentration of NO<sub>2</sub> at the selected sites is given in the fig. 4.2.

**Fig., 4.2 Concentration of NO<sub>x</sub> at selected sampling sites:**

**4.3. Concentration of Particulate Matter (PM<sub>2.5</sub>):** Exposure to RSPM is also an equally serious risk to health. SPM includes all air borne particles in the size range of 0.5μ to 100μ. The concentration of PM<sub>2.5</sub> was comparatively higher than of SO<sub>2</sub> and NO<sub>2</sub>. However the increased amount of PM<sub>2.5</sub> found in areas of all sites of NFL due to the ash components released from the industrial plant near to NFL.

The PM<sub>2.5</sub> levels were determined in all the 4 NFL sites and the concentration of PM<sub>2.5</sub> was high in Vikas Nagar (58.9µg/m<sup>3</sup>) and Mehrana (54.7µg/m<sup>3</sup>) than Siwah (45.4µg/m<sup>3</sup>) and Diwana (35.6µg/m<sup>3</sup>). The concentrations of PM<sub>2.5</sub> in Vikas Nagar, Mehrana, Siwah and Diwana were below the permissible limits range specified by CPCB in NAAQ.

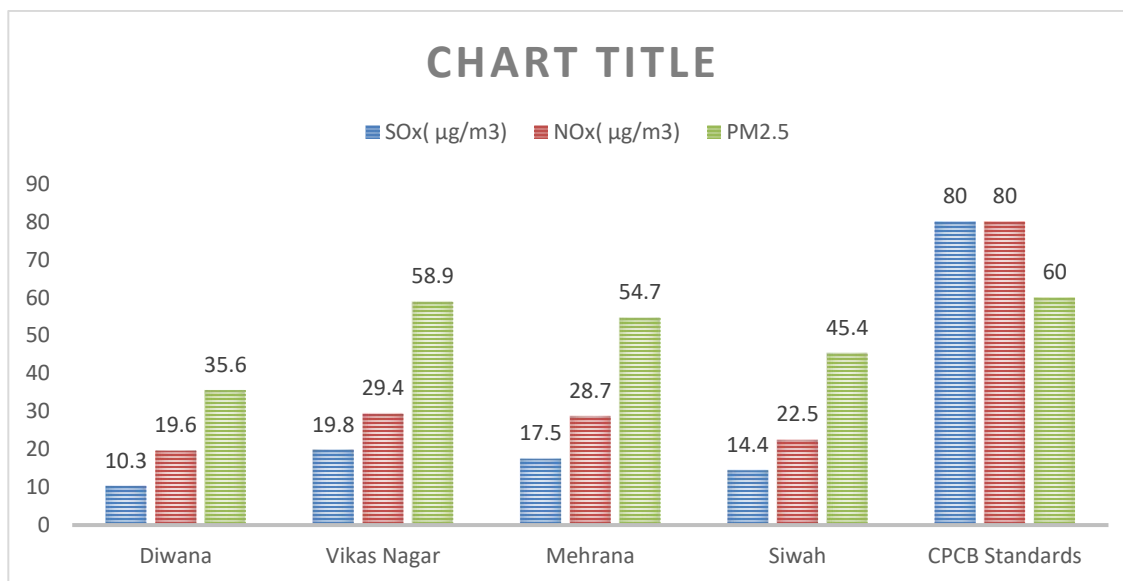
The higher levels PM<sub>2.5</sub> of around all site of NFL may be due to the JP CEMENT Industry, factories and the large number of heavy vehicle running on state highway approx. 500 -1000 m from both Sampling Sites. Other main cause of heavy ash particles in these location is due to open dumping large remaining coal ash after burning in NFL, which is hurled in about 3 square kilometer area, it is mixed with water but after evaporation of water from ash, this ash cause large amount of air pollution.



**Fig., 4.3 Concentration of PM<sub>2.5</sub> at selected sampling sites:**

**Table: 4.3 Concentration of SO<sub>2</sub>, NO<sub>2</sub> and PM<sub>2.5</sub> in all Selected Industrial Sites:**

Sites	SO <sub>x</sub> ( μg/m <sup>3</sup> )	NO <sub>x</sub> ( μg/m <sup>3</sup> )	PM <sub>2.5</sub> (μg/m <sup>3</sup> )
Diwana	10.3	19.6	35.6
Vikas Nagar	19.8	29.4	58.9
Mehrana	17.5	28.7	54.7
Siwah	14.4	22.5	45.4
CPCB Standards	80	80	60

**Fig. 4.3 Concentration of SO<sub>2</sub>, NO<sub>2</sub> and PM<sub>2.5</sub> in all Selected Industrial Sites:**

The above Tabulated data shows that the concentrations of SO<sub>2</sub>, NO<sub>2</sub> and PM<sub>2.5</sub> are in the permissible limits prescribed by CPCB according to NAAQ Standards.

Whereas the data of SPM shows that the concentrations of all site of NFL are below the Permissible limits.

## Chapter 5:

### Conclusion

The present study indicates the status of pollutants in ambient air of Panipat city in Haryana state. According our study the areas (Vikas Nagar & Mehrana) near NFL have more concentration of SO<sub>x</sub>, NO<sub>x</sub> and PM<sub>2.5</sub> in the ambient air compared to distant villages Siwah and Diwana, which are much below the standard given by CPCB. It is due to the combustion of coal in NFL, high number of industries/ factories and high traffic load in Panipat city. The concentration of SO<sub>x</sub>, NO<sub>x</sub> and PM<sub>2.5</sub> are found to be in the range of 10.3-19.8 (µg/m<sup>3</sup>), 19.6-29.4 (µg/m<sup>3</sup>) and 35.6-58.9 (µg/m<sup>3</sup>) respectively.

### Recommendation

To reduce the air pollution stress tolerant plants should be planted around the industries and factories and both side the roads which absorb the heavy particulate matter from the air. Strict laws and rule must be followed against the Polluters. Auditing agencies must be active in monitoring of these pollutants' emission.

Development of greenbelt around industries areas would be beneficial in control of these pollutants.



**Annexure-1**

[ भाग III—खण्ड 4 ]

भारत का राजपत्र : असाधारण

3

**NATIONAL AMBIENT AIR QUALITY STANDARDS  
CENTRAL POLLUTION CONTROL BOARD  
NOTIFICATION**

New Delhi, the 18th November, 2009

No. B-29016/20/90/PCI-L—In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No.14 of 1981), and in supersession of the Notification No(s). S.O. 384(E), dated 11<sup>th</sup> April, 1994 and S.O. 935(E), dated 14<sup>th</sup> October, 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect, namely:-

**NATIONAL AMBIENT AIR QUALITY STANDARDS**

S. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Government)	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1	Sulphur Dioxide (SO <sub>2</sub> ), µg/m <sup>3</sup>	Annual* 24 hours**	50 80	20 80	- Improved West and Gaeke -Ultraviolet fluorescence
2	Nitrogen Dioxide (NO <sub>2</sub> ), µg/m <sup>3</sup>	Annual* 24 hours**	40 80	30 80	- Modified Jacob & Hochheiser (Na-Arsenite) - Chemiluminescence
3	Particulate Matter (size less than 10µm) or PM <sub>10</sub> µg/m <sup>3</sup>	Annual* 24 hours**	60 100	60 100	- Gravimetric - TOEM - Beta attenuation
4	Particulate Matter (size less than 2.5µm) or PM <sub>2.5</sub> µg/m <sup>3</sup>	Annual* 24 hours**	40 60	40 60	- Gravimetric - TOEM - Beta attenuation
5	Ozone (O <sub>3</sub> ) µg/m <sup>3</sup>	8 hours** 1 hour**	100 180	100 180	- UV photometric - Chemiluminescence - Chemical Method
6	Lead (Pb) µg/m <sup>3</sup>	Annual* 24 hours**	0.50 1.0	0.50 1.0	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
7	Carbon Monoxide (CO) mg/m <sup>3</sup>	8 hours** 1 hour**	02 04	02 04	- Non Dispersive Infra Red (NDIR) spectroscopy
8	Ammonia (NH <sub>3</sub> ) µg/m <sup>3</sup>	Annual* 24 hours**	100 400	100 400	-Chemiluminescence -Indophenol blue method

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