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Ambient air quality of Jamshedpur City: A study with reference to SO_2, NO_2, RSPM and SPM contents

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ABSTRACT

In this study, attempts were made to characterize the air quality of urban- industrial site of Jamshedpur. The city has a problem with the air pollution mostly caused by anthropogenic activities and partly by natural origin activities. For this purpose, daily deposits of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), respirable suspended particulate matter (RSPM) and suspended particulate matters (SPM). In 2008, aerosol fractions were collected during winter sampling periods. The mean mass of SO_2, NO_2, RSPM and SPM are 39.58±8.8µg m^{-3} , 55.22±10.0µg m^{-3}, 184.38±7.5µg m^{-3}, and 247.80±12.2 µg m^{-3} respectively, which is substantially higher than Indian National Ambient Air Quality Standard (NAAQS) and US National Ambient Air Quality Standard (US-NAAQS). This study was conducted as the first step of polluted gaseous assessment in order to point out main air pollution sources and suggest a remedy strategy specific for this region.

Keywords: Urban-industrial, SO_2, NO_2, Daily deposit, winter, Remedy strategy.

INTRODUCTION

Air pollution occurs when the concentration of external substances in atmosphere causes harmful effects to living organism. Substance includes like suspended particulate matter (SPM), SO_2 and NO_2 are considered classical/traditional air pollutants and usually used as indicator pollutants for fuel combustion, industries, urbanization and traffic-related air pollution. In the middle of the twentieth century, SPM levels were very high in some large cities. For instance, during the London episode in 1952, ambient SPM and SO_2 levels reached several thousands of micrograms per cubic meter [1]. NO_2 and SO_2 are common air pollutants produced throughout the combustion of fuels in automotive engines, factories and power plants [2].SO_2 results from the burning of sulfur-containing impurities present in all oil and coal derived fuels. On the other hand, NO_2 is produced by the thermal fixation and oxidation of nitrogen in burning operations that use air as an oxidant.

Air pollution is introduced by any objectionable substance, which enters the atmosphere. Air pollution is a major problem in modern society. Even though air contamination is usually a greater delinquent in cities, pollutants contaminate air everywhere. These substances include various gases and tiny particles or particulates that can harm human health and damage the environment. The most significant sources of air pollution in urban areas, towns and cities of the developing countries are from both stationary (i.e.

industries) and mobile (motor vehicle) exhausts [3].India is one of the fast developing countries of the world, has registered a sharp increase in vehicular pollution, particularly, in the urban area [4].Review of earlier work indicates that pollution studies in chief Cities, particularly New Delhi, the Capital City of India, have been carried out [5,6]. Both industrial and vehicular emissions of CO, hydrocarbons (HC), oxides of nitrogen (NOx), sulphur dioxide (SO_2), Pb and particulates are the main contaminants. Recently, a few studies were accepted out wherein the investigators analyzed the diurnal and seasonal variations of O_3, SO_2, and NOx [7-10].

Increasing industrialization and vehicles in the city, it gives off CO_2, oxides of sulfur (SOx), NOx and lead particles. The SOx occur in ambient air as a specific pollutant particularly in the form of sulfur dioxide (95%) and sulfur trioxide (5%). The nitrogen oxides exist in ambient air in various forms viz., nitrous oxide (N_2O), nitric oxide (NO), nitrogen dioxide (NO_2), nitrogen trioxide (NO_3), nitrogen tetra oxide (N_2O_4) and nitrogen penta oxide (N_2O_5). Only nitric oxide and nitrogen dioxide exists freely in air and are the important primary air pollutants in mining area. Generally, the atmospheric concentration of nitric oxide and nitrogen dioxide are clubbed together and called as oxides of nitrogen The nitric oxide in ambient environment is less stable and rapidly gets converted to nitrogen dioxide. The National Ambient Air Quality (NAAQ) standards prescribed are given in table1.

Table1. National Ambient Air Quality Standards (NAAQS) of CPCB of India

Pollutant	Time Weighted	Concentration in Ambient Air		
		Industrial Area	Residential, Rural and other	Sensitive Area
Sulphur Dioxide (SO_2)	Annual 24 hours	80 µg m^{-3} 120 µg m^{-3}	60 µg m^{-3} 80 µg m^{-3}	15 µg m^{-3} 30 µg m^{-3}
Nitrogen Oxides (NO_2)	Annual 24 hours	80 µg m^{-3} 120 µg m^{-3}	60 µg m^{-3} 80 µg m^{-3}	15 µg m^{-3} 30 µg m^{-3}
Respirable suspended Particulate Matter (RPM)	Annual 24 hours	120 µg m^{-3} 150 µg m^{-3}	60 µg m^{-3} 100 µg m^{-3}	50 µg m^{-3} 75 µg m^{-3}
Suspended Particulate Matter (SPM)	Annual 24 hours	360 µg m^{-3} 500 µg m^{-3}	140 µg m^{-3} 200 µg m^{-3}	70 µg m^{-3} 100 µg m^{-3}

The presented work has been focused on air quality of Jamshedpur, one of the most important City of Jharkhand, India. It is the centre for development, urbanization, industrialization and commercial activity. However, the efforts to enhance the green cover of the city that has cleaning effect on air pollutants in gases are insufficient. Against this background, considering the importance of air- borne polluted gaseous atmosphere, this study has been made.

MATERIALS AND METHODS

Study Area: Jamshedpur (Fig. 1) is situated in the southern end of the state of Jharkhand and is bordered by the states of Orissa and West Bengal. The average elevation of the city is 135 m while the range is from 129 m to 151 m. Total geographical area of Jamshedpur is 149.23 km square. Jamshedpur is Primarily located in a hilly region and is surrounded by the Dalma Hills running from west to east and covered with dense forests. The other smaller hill ranges near the city are Ukam Hill and the Jadugoda-musabani hill range. The city is also a part of the larger Chota Nagpur Plateau region. The region is formed of the sedimentary, metamorphic and igneous rocks belonging to the Dharwarian period. Jamshedpur is a major industrial center of East India. It houses companies like Tata Steel, Tata Motors, Tata Power, Lafarge Cement, Telcon, BOC Gases, Tata Technologies Limited, Praxair, TCE, TCS, Tinplate and many more. It is home to one of the largest industrial zones of India known as Adityapur which houses more than 1,200 small and medium scale industries.

The atmospheric air collection was performed at the terrace, i.e. at an altitude of approximately 20 m from the ground level, of the building.

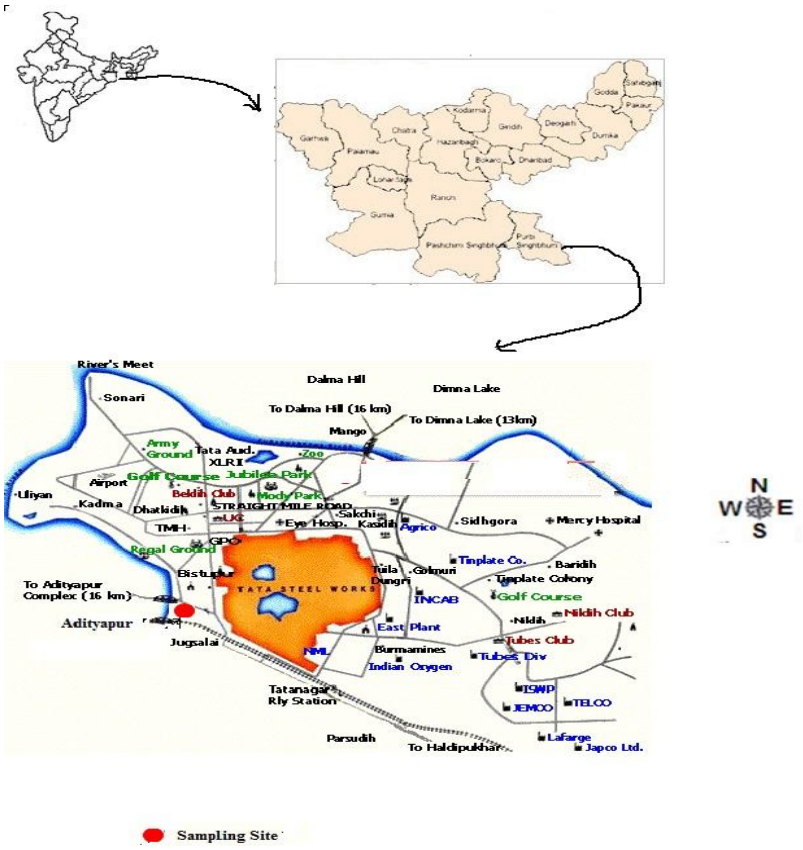

Fig. 1 Location of sampling site in Jamshedpur City, India

Sample Collection and Analysis: The air quality such as SPM, SO_2 and NO_2 were measured. A total number of 25 samples were collected in winter season.

Each site SO_2 was measured by improved West and Gaeke method. Air was absorbed in absorbing solution of sodium tetrachloromercurate at a flow rate of 1.1 to 1.7 m^3 min^{-1}. The sulphur dioxide was estimated by the color produced when prosaniline hydrochloride was added to the solution. The absorbance was read at 560 nm using (Shimadzu UV-1201V) spectrophotometer. Whereas, NO_2 was measured by Jacob and Hochheiser method in which air was absorbed in absorbing solution of sodium hydroxide. The nitrogen dioxide was estimated by color produced when hydrogen peroxide, sulphanilamide and NEDA solution added to the solution. The absorbance was read at 540 nm using the same spectrophotometer.

The SPM sampling was carried out using a High Volume Sampler (HVS-415, Envirotech). SPM was collected on pre-weighed filter papers (GF/A 8"X10") using high volume sampler. The filter papers were dried for 3 hours in an oven at 105°C before and after sampling to remove the moisture to get constant weight. The flow rate of HVS was kept about 0.3 m^3 min^{-1}. The difference in weight of filter paper was used for determining the concentration of SPM. Kriging method weighs the surrounding values to predict values for unknown locality based on its spatial arrangement.

RESULTS AND DISCUSSION

During the study period for each parameter (SO_2, NO_2, RSPM and SPM), a total of 25 samples (duplicates) were collected in January and February, 2008 .The daily temperature and relative humidity (Fig .2) explained. Temperature are recorded between 11.8 to 22°C and whereas relative humidity are varied from 38 to 86.5%.

Mass concentrations of SO_2, NO_2, RSPM and SPM : The results of SO_2, NO_2, RSPM and SPM mass concentrations measurements in 4-hours aerosol deposits on quartz fiber filters collected in the Jan and Feb sampling periods are shown in Fig. 3.

Sulphur dioxide: According to the present study, SO_2 concentrations (Table-1) were below the maximum allowed limit of National Ambient Air Quality Standards (60 µg m^{-3}) for residential areas. During the study period, the four hourly average SO_2 concentrations varied from 27.76 to 49.34 µg m^{-3}, with mean concentration 39.58±8.80 µg m^{-3}. A decreasing trend has been observed in SO_2 levels in residential and industrial areas, which may be due to various measures taken (e.g., reduction of sulfur in diesel etc. and the use of liquefied petroleum gas (LPG) instead of coal as domestic fuel). In addition, conversion of diesel vehicles to compressed natural gas (CNG) may have resulted in the decreasing trend of SO_2 levels.

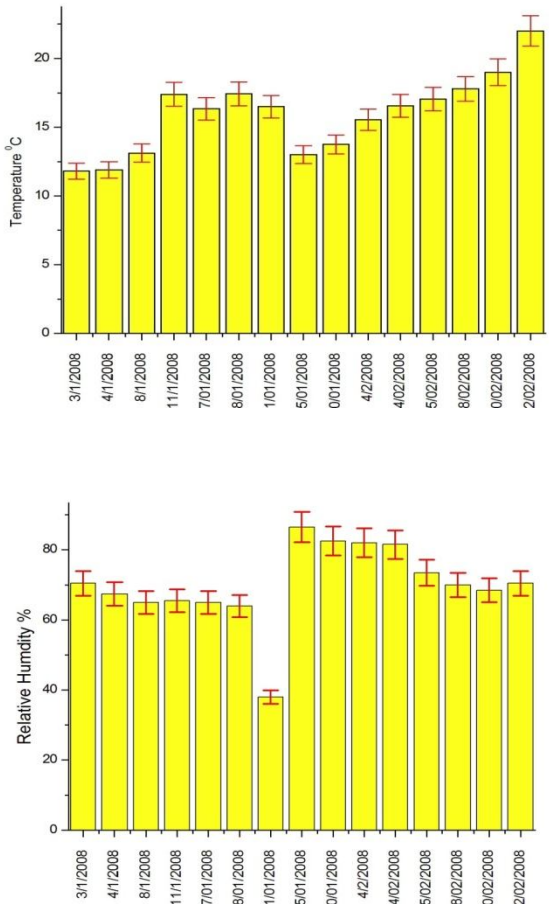

Fig . 2 Temperature and Humidity of the study region during Jan- Feb, 2008.

Nitrogen dioxide: The concentration of NO_2 can vary to a large extent in the ambient air. Natural background concentration of NO_2 in the ambient air can be <1 µg $m^{-3}$to >9 µg m^{-3}. In several Cities, the

annual mean concentration ranged from 20-90 µg $m^{-3}$with hourly maximum concentrations from 75 to 1000 µg m^{-3} (WHO, 1994). In the present study nitrogen dioxide concentrations during four hourly monitoring periods varied between 36.65 µg m^{-3} to 65.45 µg m^{-3}, with mean concentration 55.22±10.0 µg m^{-3}. The NO_2 concentrations (table1) were below the maximum allowed limit of National Ambient Air Quality Standards (60 µg m^{-3}) or residential areas. The decreasing trend in NO_2 levels may be due to various measures taken for vehicular pollution control such as stricter vehicular emission norms, etc.

RSPM and SPM: The concentration of particulate matter in the air is highly variable. In most of the Cities of World, the TSP annual mean concentration were reported to be >100 µg m^{-3}, with the level exceeding 300 µg m^{-3} in several Cities of China and India. There is no evidence of any overall systematic and significant change in the TSP level. The data from the 1990's shows the increasing as well as decreasing trend in a similar number of Cities (WHO, 1999) for eight hourly monitoring periods, the RSPM and SPM concentration varied between 170.24 µg $m^{-3}$to 195.96 µg $m^{-3}$and 221.56 µg $m^{-3}$to 285.56 µg $m^{-3}$with mean concentration 184.38±7.5 µg $m^{-3}$and 247.80±12.27 µg m^{-3}respectively. Vehicular pollution control measures include stringent vehicular emission norms, reduction of sulfur in diesel, stringent standard of particulate matter in diesel vehicles, etc.

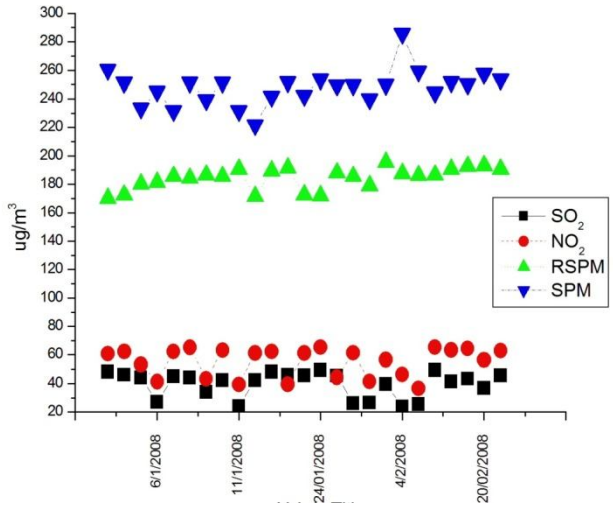

Fig. 3: Daily concentration values of SO_2, NO_2, RSPM and SPM in the Jamshedpur city.

APPLICATIONS

This study is applicable to know the air quality of Jamshedpur city with comparison to NAAQS.

CONCLUSIONS

The present study reports measurement of gaseous SO_2, NO_2, RSPM and SPM at Jamshedpur, an urban industrial site. The sampling was carried out during the winter month (January and February), low temperature and humidity also favored the accumulation of pollutants, resulting in high concentration during these months. An acceptable air quality of any cities depends upon the cumulative approaches of the Government, the Industrial groups, NGOs, Community groups, International organizations, research institutions, public awareness and judiciary. It may be fall back on part of one or more of these factors that ultimately the environment bears the brunt of the exponential urbanization and development. An unhealthy environment is not only violate of peoples basic right to health but also disastrous to the generations to come.

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