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A Study of Chemical Turbulence in Ambient Air Quality in Satna (M.P.)

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Abstract

At present time the problem of environmental degradation is of very much importance. These environmental problems are becoming threats to the existence of living beings. The chemical composition of the atmosphere is being altered by the addition of gases, particulate matter and volatile substances, which may be toxic to living beings. Satna, is known as the cement city on India, due to abundance of lime stone and dolomite in the region. City has 7 cement factories. Major problem in the city is Air Pollution due to atmospheric wastes of cement factories. Two critical gaseous pollutants and particulate pollutants are in abundance in Satna. Satna is an industrial area, and a little change in the concentration of pollutants in ambient air can make a strong effect on the existing living stock causing many adverse effects on health and skin. In present study the quality of Air in the study area is estimated from the air quality index.

Key-Words: Air quality, Gaseus pollutant, Particulate pollutants

Introduction

The natural resources have been explored by the dawn of civilization however the acceleration of exploitation has been increasing at high rate and in non judicious manner during past few decades especially with the advent of industrial revolution. Industrialization has provided humanity with materials and social benefits. It has also brought in wake up many unwanted substance and social problems. One of these problems is the degradation of the environment. These environmental problems are becoming threats to the existence of living beings. The chemical composition of the atmosphere is being altered by the addition of gases, particulate matter and volatile substances, which may be toxic to living beings.

Satna, is known as the cement city on India, due to abundance of lime stone and dolomite in the region. City has 7 cement factories. The city is amongst the few most promising cities of Madhya Pradesh because of several new industries planned by same of the reputed industrial houses in the country. Major problem in the city is Air Pollution due to atmospheric wastes of cement factories. Two critical gaseous pollutants and particulate pollutants are in abundance in Satna. Satna is an industrial area, and a little change in the concentration of pollutants in ambient air can make a strong effect on the existing living stock causing many adverse effects on health and skin.

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The quality of Air in the study area is estimated from the air quality index. The air quality index was calculated from the observed TSP, PM_{10}, NOx and SO_2 values using the formula.

AQI = 1/4 (I_{TSP} / S_{TSP} + I_{PM10} / S_{PM10} + I_{SO2} / S_{SO2} + I_{NOX} / S_{NOX}) X 100

Methodology

According to (CPCB) the methods prescribed for the pollutant gases and particulate pollutants are very sensitive and the percentage of error in results in very low.

Concentration of NO2 in Air sample

Modified Jacob and Hochheiser method had been applied for determination of NO_2 concentration in Air sample.

$$\mu_g NO_2/Cu_m = \frac{\mu_g NO_2 \times Vs}{Va \times 0.82}$$

Where,

$\mu_g NO_2 = NO_2$ concentration in air sample

Va/NO_2 = Volume of air sample

Cu_m 0.82 = Sampling efficiency

D = Dilution factor

(D = 1, no dilution)

(D = 2, for 1:1 dilution)

Vs = Volume of sampling solution the NO_2 concentration is calculated

$$PPm\ NO_2 = (\mu_g NO_2/Cu_m) \times 5.32 \times 10^{-4}$$

Determination of SPM total suspended particulate matter in Air sample

For determination of TSP high volume method had been used.

$$SPM = \frac{(w_f - w_i) \times 10^6}{v}$$

Where,

SPM = Mass concentration of suspended particles in $\frac{\mu_g}{Cu_m}$

w_i = Initial weight of filter in g

w_f = Final weight of filter in g

Determination of respirable suspended particulate matter (PM_{10})

For determination of (PM_{10}) cyclonic Flow technique had been applied.

(PM_{10} = Particulate matter less than 10µm diameter in air sample)

$$PM_{10} = \frac{(w_p + w_f) - (w_i - w_j)}{v}$$

Where,

w_p = Weight of material that was collected on the pan including the weighing paper in gm.

w_j = Initial wt. of weighing paper in gm.

w_f = Wt. of exposed filter in gm.

w_i = Total wt. of filter in gm.

Determination of Sulphur dioxide in air

For determination of SO2 in air sample modified west and crake method had been used. The amount of sulphur dioxide per ml. in the standard solution is calculated as follows.

$$C = \frac{(V_1 - V_2) \times N \times K}{V}$$

Where,

C = Concentration of SO2 in μ_g/ml

V_1 = Volume of thiosulphate for blank soln.

V_2 = Volume of thiosuphate for sample

N = Normality of thiosulphate solution

K = 32,000 (millie equivalent wt. SO_2/μ_g

V = Volume of standard sulphite solution

The concentration of SO_2 in μ_g/Cu_m in the sample is calculated as follows

$$C(SO_{2\mu}/Cu_m) = \frac{(A - A_0 \times 10^3 \times B)}{V}$$

Where,

A = Sample absorbance

A_0 = Reagent blank absorbance

10^3 = Conversion litres to cubic meters

B = Calibration factor

μ_g = Absorbance

V = Volume of air sample in litres

Monitoring Sites

The main concern of the project is to measure the concentration of sulphur dioxide NOx, TSP and PM, taking greadings at different station with the help of respirable dust sampler.

The two gaseous pollutants and the particulate pollutants are in abundance in Satna. Since Satna is an industrial and mineral such place.

A little change in concentration of pollutants in ambient air can make a strong effect on existing living stock causing many adverse effects on health and skin. We decided to choose the sampling stations covering hole Satna city.

Chosen monitoring stations are -

1. Near Prism cement Satna
2. Near J.P. Birla Babupur plant Satna
3. Near Birla Carporation Satna
4. Dhawari Satna (Residential area)
5. Light machinery Satna
6. Semariya Chowk Satna (Dense traffic area)
7. Pannilal Chowk Satna
8. Civil line Chowk Satna

The sampling was done at the roof tops of the respective sites, so it was well above the prescribed height i.e. 1.5 m and was free from any obstruction to flow of air.

Observation

The determination and calculation of pollutants in air samples of different monitoring stations was done. The observed data is tabulated as follows:

Table1: Pollutant results

SN	Name & Sampling Station	SPM (μ_g/m^3)			RSPM (μ_g/m^3)			SO_2 (μ_g/m^3)			NOx (μ_g/m^3)		
		W	S	R	W	S	R	W	S	R	W	S	R
1	Near Prism cement Satna	316.4	317.1	313.8	193.0	206.7	199.1	94.5	87.3	85.5	89.2	85.3	78.0
2	Near J.P. Birla Babupur plant Satna	281.1	295.1	284.5	182.8	185.1	177.8	82.4	79.3	78.0	78.4	72.6	68.0
3	Near Birla Carporation	302.2	325.2	300.4	198.2	204.4	180.4	99.1	89.6	87.2	92.5	86.1	81.0

	Satna												
4	Dhawari Satna (Residential area)	115.4	112.8	112.3	93.8	90.3	85.2	37.6	31.1	27.4	24.2	18.3	22.0
5	Hight machinery Satna	198.4	169.7	150.5	141.1	121.8	113.3	70.5	64.6	59.6	59.5	54.4	48.3
6	Semariya Chowk Satna (Dense traffic area)	194.3	207.0	191.1	130.5	144.3	122.2	31.6	27.6	28.5	26.3	22.4	20.6
7	Pannilal Chowk Satna	82.8	84.5	88.7	71.1	78.2	68.7	29.2	26.4	24.1	22.2	18.3	17.6
8	Civil line Chowk Satna	90.6	93.8	90.8	75.6	83.6	71.2	26.6	24.5	22.1	22.3	18.5	17.3

Results and Discussion

The table reveals the prevalence of high concentration of coarser particulate matter (RSPM) in the ambient air in commercial areas ranging from 182.4 - 198.2 μ_g/m^3 during the winters, followed by rainy reason (177.9 - 199.1 μ_g/m^3) and summer (185.1 - 206.7 μ_g/m^3)

The main environmental issue associated with cement plants is the emission of pollutants. (SPM, SO2 and NOx) in the atmosphere these air pollutants have long been associated with prevalence of various diseases in human beings.

Results revealed higher concentration of SPM in the ambient air the monitoring sites, than permissible limit of 200 μ_g/m^3 prescribed by central pollution control board New Delhi.

Contrarily in the ambient air SO_2 and NOx concentrations have been estimated below the permissible limit of 80 μ_g/m^3 described by CPCB New Delhi.

The human population of all selected sites were surveyed for prevalence of various diseases such as respiratory diseases, Cardic - vascular disease and skin disease.

Result indicated, maximum peoples of all selected sites are suffering with respiratory and cardio vascular diseases than other problems. In Satna region the levels of air pollutants (SO2, NOx, SPM, RSPm) the values of all these pollutants are observed to be little higher than national ambient air quality standards except Pannilal Chowk and Civil line Chowk.

This increase in AQI at some sites is probably due to the emissions of cement plants and vehicular emunissions due to increased transportations and traffics.

In Satna the air quality is giving holistic view of air pollution levels.

From the results obtained in present study, it is evident that for the time being the ambient air in Satna city needs attention for the policy makers to formulate some ways to counteract the increase in air pollution at specific sites.

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