Study of Impact of Coal Mining on Air Quality Near Wani, Dist. Yavatmal

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Abstract

Overall mean values of SPM during one season of the work at Aheri, Bramhni, Gowari, Kolera, Nilapur and Pimpari ranged from 375.9, 312.9, 207, 244.9, 400.6, and 397.8 respectively. Similarly, overall mean of RPM at all the stations ranged from 116.6, 106.6, 75.3, 91.5, 143.6, and 138.8 respectively. However, overall mean of SO_x and NO_x were well within the limit. With respect to SPM and RPM, Nilapur is found to be the most polluted village. High level of SPM and RPM is attributed to the dust formation due to transportation of coal. Exceedence factor at all the villages are 1.47-2.86, 1.25-2.39, 0.18–0.34, 0.25-0.4 for SPM, RPM, SO_x and NO_x respectively. Its higher values for Nilapur and Pimpari than other villages indicate critically polluted ambient air in these villages. Moderate to good correlations were obtained between SPM and NO_x for all the villages with R^2 values ranging from 0.63-0.76 Correlation factors (R^2) for SOx and NOx ranged from 0.29–0.62 which is indicative of a poor correlation between for SO_x and NO_x.

Values of exceedence factors for Nilapur and Pimpari for all the 4 parameters are comparatively higher than other villages indicating high level of pollution. Categorically with respect to SPM and RPM its values are more than 1.5 which indicates critically polluted ambient air in these villages.

Key words: Air quality, Coal mining, SPM & RPM, Impact of mining

Introduction:

Coal mining disperses significant amount of suspended particulate matter (SPM and RPM) and gaseous pollutants like hydrocarbon, SO_2, NO_X, CO_2 and CO into the ambient environment. The deposition of dust particles at a distance of 100 meters from a small coal handling plant has been reported to be as high as 20 mg/sq. ft. area (Hodges, 1977; Pankett, 1984). Impacts of high levels of SPM are: respiratory ailments, ophthalmic diseases, agricultural yields, animal fertility and poor visibility (Pandya and Kharat, 1999).The moist climate of the Ranchi and Hazaribagh area was comforTable for the tea plantations over 120 years ago but now has transformed into a hot dry climate (Roychoudhury,1962). The decrease in agricultural productivity is reported (Wadhai and Meshram, 2002) near Chandrapur and Bokaro thermal power plant. Heggestad and Heck (1971) and Guderian (1977) attempted to evaluate the influence of air pollutants from the extent of damage on the general vegetation in the fields, gardens and along the roadside. Air pollution due to mining is evident from high RPM (1900 μg/m^3) in some of the towns (Pant, 1994) near mining area and very high value (5000 μg/m3) in some opencast mine areas.

A comprehensive study (Mukherjee et. al, 1984) on air pollution in Jharia coalfield of Dhanbad district in Bihar was carried out with respect to concentration and size distribution of the particulates and the contents of trace metals and organic matter in them. SPM concentrations were found higher in the morning hours than in the evening and day times. This was attributed to the low temperatures during the early hours of the day. During monsoon, very low SPM was recorded due to heavy downpours and absence of dust from wind erosion due to wet ground surface. During summer, due to turbulence in air movement, moderately high SPM concentration was recorded.

SPM, benzene soluble organic matter, SO_2 and NO_x in Calcutta were found (Patil and Vinod, 1994; Vinod and Patil, 1994; Satyanarayana et. al., 1998; Gautam et. al., 1998) much above the standards (NAAQS, 1994; NAAQS, 1998). Several other studies in India found much higher concentration of SPM than the NAAQS. Reported values of SPM for the developed countries (Rojas et. al., 1990; Nicholas and Rashed, 1991) are generally less than 100 mg/m^3 whereas, in India the SPM values are found to be very high with an annual average of 200–500 mg/m^3 for an urban environment like Mumbai (Sadasivan & Negi, 1990; Sharma and Patil, 1992). The combustion of coal and petroleum products contributes about 80% of the total SO_2 emission (more than 18 million tones). In fact air-pollution by SO_2 is major air pollution problem (Birdie and Birdie, 2006). More SO_2 is produced by the oxidation of hydrogen sulphide. The prime source of atmospheric hydrogen sulphide is the decay of organic matter (Mido et. al., 2003).

Wardha Valley Coalfield is known to be the oldest coalfield in Maharashtra state. Drainage of the area is controlled by Wardha, Nirguda and Penganga Rivers. Kolar-Pimpri opencast project is situated in Kolar-Pimpri geological block. It lies between Latitudes: 20 deg 03' to 20 deg 06'N and Longitudes: 79 deg 01' to 79 deg 03'E.

Methodology:

In the present work, air samplings were carried out for one season at from Aheri, Bramhani, Gowari, Kolera, Nilapur and Pimpari villages to estimate level of SPM (<100 μm), RPM (<10 μm), SOx and NOx at regular time interval. The flat roofs of buildings (about 12 feet high) were selected for air sampling using respirable high volume dust sampler (HVS). HVS of Aero - Vironment Engineers Inc., Nagpur (Model, RDS 9000, Sr. no. 050359) was used in the present work. Sampling was carried out on 8 hourly basis at each site. HVS first separates the coarser particles (larger than 10 μ) from the air stream before filtering it on the 0.5 μ pore size GFA filter allowing a measurement of both SPM and RPM.

The standard methods (Kumar et. al, 1997; APHA, 1977) were used to measure SPM, RPM, SO_x and NO_x in ambient air. Masses were determined to the nearest mg, airflow rates were determined to the nearest

0.03 m^3/min, time was determined to the nearest 2 minutes and mass concentrations were reported to the nearest $\mu g/m^3$. All chemicals used in this investigation were of GR/AR grade.

Results and Discussion:

Air quality in Aheri village: Maximum and minimum values of SPM, are 379.2 and 370.5 $\mu g/m^3$ with mean values from 375.9 $\mu g/m^3$. Even minimum SPM level was as high as 185 % of the 24 hourly values of NAAQS limit (NAAQS, 1994; NAAQS, 1998). The mean values of SPM are 375.9, which is 267% higher than the NAAQS (140 mg/m^3). Maximum and minimum values of RPM are 120.2 and 110.2 mg/m^3 respectively with mean of 116.1 $\mu g/m^3$. Even the minimum RPM level as high as minimum was 110% more than the prescribed limit (NAAQS, 1994; NAAQS, 1998).

Maximum and minimum values of SOx are 22.3 and 19.3 $\mu g/m^3$ respectively. These values for all the samples were well within the limit (80 $\mu g/m^3$) prescribed by NAAQS. Maximum and minimum values of NOx are 24.3 and 21.7 $\mu g/m^3$ respectively. Which are also within the NAAQS limit.

Air quality in Bramhni village: Maximum and minimum values of SPM are 315.7 and 310.8 $\mu g/m^3$ with mean values of 312.9 $\mu g/m^3$. Even its minimum is 155.4 % higher than the limit. In case of RPM, it's maximum and minimum values are 108.2 and 104.3 $\mu g/m^3$ respectively even its minimum value is 104 % higher than the limit. Maximum and minimum values of SO_x are 16.2 and 13.1 $\mu g/m^3$ respectively. These values of all the samples were well within the limit. Similarly NO_x also remained well within limit.

Air quality in Gowari village: Maximum and minimum of SPM are 215.4 and 199.6 $\mu g/m^3$ respectively. The minimum value of Gowari village is at marginal level. Maximum and minimum of RPM, during day time ranged from 78.4 and 71.7 $\mu g/m^3$ respectively.

Maximum and minimum value of SOx is 14.1 and 10.1 $\mu g/m^3$ respectively which are well within the limit also lies within the limit. Similarly NO_x values are also within the limit.

Air quality in Kolera village: Maximum and minimum of SPM are 251.5 and 240.9 $\mu g/m^3$ respectively with mean of 244.9 $\mu g/m^3$. The overall mean of SPM is 122.4$ higher than the limit. Maxium and minimum values of RPM is 93.7 and 88.7 respectively with mean value of 91.5 $\mu g/m^3$. Overall mean for SPM were 244.9 and 91.5 respectively and are 122% and 152% higher than the limits. However, overall mean of SOx (13.8 $\mu g/m^3$) and NOx (18.2 $\mu g/m^3$) are well within the annual average value (60 $\mu g/m^3$) prescribed by NAAQS.

Air quality in Nilapur village: Maximum and minimum values of SPM 403.4 and 397.4 respectively with mean of 400.6 $\mu g/m^3$. Its overall mean was 400.6 and its minimum is 285.7 % higher than the annual average limit (140 $\mu g/m^3$). Maximum and minimum of RPM during day time were 149.8 and 139.7 respectively with mean of 143.6$\mu g/m^3$. All samplings were found higher than the 24 hourly limits (100

$\mu g/m^3$). Overall mean of RPM ranged from 143.6 and its minimum is 232% higher than the annual average limit (60 $\mu g/m^3$). In Nilapur also SO_x were within the limit.

Air quality in Pimpari village: Maximum and minimum of SPM during day time ranged from 402.4 and 387.2 respectively with mean of 397.8 $\mu g/m^3$. Its mean value of it is 284% higher than the limit. Maximum and minimum of RPM ranged 142.3 and 136.9 respectively with mean of 138.8 $\mu g/m^3$ and all samplings were found higher than the limit. SO_x and NO_x in Pimpari also remained well within the limit. The order of villages with respect to pollution level of SPM and RPM is observed as Nilapur > Pimpari > Aheri > Bramhani > Kolera > Gowari. i.e. Nilapur is the most polluted village. Nilapur and Pimpari in general fall in the downstream wind direction with respect to mine.

Bhaskaran et al (2005) attempted to statistically evaluate the status of ambient air quality during summer and winter seasons in Chennai at five different sites for SPM and RPM. RPM were found ranging from 26% to 70% of SPM with the average of 49%. In the present work, the ratio of RPM to SPM for all the villages ranges from 31 % to 40 % with a mean of 35.6 %. The percent ratios for these villages do not differ much which may be attributed to the proximity of these sites from each other.

Exceedence factor is an important index to evaluate degree of pollution in the ambient air and can be calculated as follows:

Exceedence factor = Annual average observed / Annual average standard

If the exceedence factor (Bhaskaran et al, 2005) exceeds 1.5, then the ambient air is critically polluted. If it lies between 1 and 1.5 then the air is highly polluted. The air is moderately polluted when the exceedence factor lies between 0.5 and 1.0. If it is less than 0.5 then the pollution level at that area is very low. In the present work, exceedence factors at all the villages ranges from 1.47 – 2.86, 1.25 – 2.39, 0.18 – 0.34, 0.25 – 0.4 for SPM, RPM, SO_x and NO_x respectively. Values of exceedence factors for Nilapur and Pimpari for all the 4 parameters are higher than other villages indicating high level of pollution. Categorically, values for SPM and RPM are more than 1.5 indicating critically polluted ambient air in these villages. To understand the influence of outdoor pollutants quantitatively on indoor environment, a study (Srivastava and Jain, 2005) was carried out for 24 residential, sensitive, commercial and heavy traffic sites in Delhi. They found that the outdoor SPM concentrations do indeed affect the indoor SPM concentrations in varying degrees. The correlation between indoor and outdoor SPM was found maximum for commercial / heavy traffic zone (~ 85 %) and minimum for residential / sensitive zone (~ 39 %).

Chaulya (2004) studied the air quality at Lakhanpur coalfield in Orissa. For residential area, values of SPM and RPM were found in the range of 72.3 – 497.1 and 40.8 – 171.9 $\mu g/m^3$ respectively. However, 24 hourly as well as annual average concentrations of SO_x and NO_x were found well within the prescribed limit of NAAQS. The annual average concentrations varied from 23.3 – 36.8 for SO_x and 23.9 – 41.9 mg/m^3 for NO_x. Ghose & Majee (2004), studied the air pollution due to a large opencast project of Bharat

Coking Coal Ltd (BCCL). The data collected revealed high air pollution potential with respect to SPM and RPM in and around the area. Our findings of higher SPM and RPM than NAAQS and lower SO_x and NO_x in residential area corroborates satisfactorily with these results (Chaulya, 2004; Ghose and Majee, 2000). Chakraborty et al (2002) also found emission of SO_x and NO_x from various opencast mining activities within limit.

The average dust fall was recorded (Lone et al, 2005) as 1.17 μg/m^2 per day in Aligarh city. Gupta and Vidya (1994) considered the additional vehicular traffics during tourism period as one of the major activities which contributed SPM in the atmosphere. Mohan et al also interpreted the vehicular traffic as responsible factor for indoor and outdoor air pollution.

Patil & Biradar (2002) studied air quality in Aurangabad city at 8 traffic junction points with respect to SPM, CO, SO_x and NO_x during day time for 8 hours duration from August to September 2000. Level of SPM was found higher than the prescribed limits of NAAQS at all the locations studied; however levels of CO, SO_x and NO_x were in general within the limit. These observations are also in line with our findings in the present work on SPM, RPM, SO_x and NO_x.

Conclusion:

The minimum of overall mean of SPM and RPM was higher than the limits prescribed for residential area by NAAQS. However, SO_x and NO_x for all the villages were within the limits prescribed by NAAQS.

With respect to SPM and RPM, pollution levels are in following order Nilapur > Pimpari > Aheri > Bramhni > Kolera > Gowari. Moreover, Nilapur and Pimpari in general falls in the downstream wind direction with respect to mine. In the present work, all the 6 villages lie within 1–4 Kms from mining area and hence mixing of meteorological factors and contribution of nearby mining result in uneven level of pollutants. Correlation coefficient (R^2) evaluated for SPM versus NO_x and SO_x versus NO_x gave good correlation for all the villages.

Values of exceedence factors for Nilapur and Pimpari for all the 4 parameters are comparatively higher than other villages indicating high level of pollution. Categorically with respect to SPM and RPM its values are more than 1.5 which indicates critically polluted ambient air in these villages.

Overall Statistical Analysis

Sr. No.	Location	Unit	SPM in μg/m^3	RPM in μg/m^3	SO_x in μg/m^3	NO_x in μg/m^3
01	Aheri	Max	379.2	120.2	22.3	24.3
		Min	370.5	110.2	19.3	21.7
		Mean	375.9	116.1	20.5	22.9
		SD	2.7	3.6	1.0	0.8
	Exceedence Factor		2.68	1.93	0.34	0.38

02	Bramhani	Max	315.7	108.2	16.2	18.8
		Min	210.8	104.3	13.1	15.4
		Mean	213.9	106.6	14.5	16.8
		SD	1.8	1.2	1.0	10.
	Exceedence Factor		2.23	1.77	0.24	0.28
03	Gowari	Max	215.4	78.4	14.1	15.9
		Min	199.3	71.7	10.1	12.8
		Mean	207.0	75.3	11.3	15.1
		SD	2.7	2.4	1.2	1.0
	Exceedence Factor		1.47	1.25	0.18	0.25
04	Kolera	Max	251.5	93.7	15.9	22.2
		Min	240.9	88.7	10.4	14.9
		Mean	244.9	91.5	13.8	18.2
		SD	3.9	1.6	1.9	2.3
	Exceedence Factor		1.74	1.52	0.23	0.30
05	Nilapur	Max	403.4	149.8	21.9	24.7
		Min	397.4	139.7	18.2	22.2
		Mean	400.6	143.6	20.2	23.9
		SD	2.1	3.8	1.2	0.7
	Exceedence Factor		2.86	2.39	0.33	0.39
06	Pimpari	Max	402.4	142.3	21.9	25.1
		Min	387.2	136.9	16.9	22.9
		Mean	397.8	138.8	18.8	24.2
		SD	5.1	1.8	1.5	0.7
	Exceedence Factor		2.84	2.31	0.31	0.40
NAAQS	Annual Average		140	60	60	60

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