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Study of Seasonal concentration of SPM, RSPM, SO_2 and NO_X in the ambient air near J.P. cement plant, Rewa (M.P.)

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Abstract]

This study was undertaken to assess the quality status and seasonal variations of ambient air of pollutants. Results revealed comparatively higher ambient air concentrations of SPM, RSPM, SO_2 and NOx during the winter months to be followed by summer and rainy months. According to air quality surveys the levels of average value of Respirable suspended particulate matter, sulphur dioxide and oxides of nitrogen in sampling site are well within prescribed limits, whereas average concentrations of SPM in the ambient air of the village are above the permissible limits. Results revealed maximum contribution of SPM to the ambient air compare to RSPM, SO_2 and NOx in Sagauni village during 2009-2010.

Key-Words: Ambient air quality, SPM, RSPM, SO_2, NOx, J.P.Cement Plant

Introduction

In recent times there has been significant development activity in terms of industrialization and urbanization in almost all cities, medium and small towns in India. Different industrial activities degrades various environmental components like air, soil, water and vegetation (Dolgner et al.,1983;Sai et al., 1987;Mishra, 1991;Murugasan et al.,2004; Kumar et al., 2008). Air pollution is a problem faced by both developing and developed countries and India is one of them. Rapid industrialization for economic development to meet the specific requirements of the ever-increasing population is proving to be extremely dangerous for human life, ecosystems and cultural assets. Air pollutants do not respect any national boundaries. Air Pollutants means any solid, liquid or gaseous substance present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment.

The Cement Industry presents one of the most energy-intensive sectors within the Indian economy and is therefore of particular interest in the context of both local and global environmental discussions. Increases in productivity through the adoption of more efficient and cleaner technologies in the manufacturing sector will be effective in the merging economic, environmental, and social development objectives. Cement industry is one of the 17most polluting industries listed by the central pollution control board of India.

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It is the major source of particulate matter, SOx, NOx and CO_2 emissions. Significant growth is also observed in the cement industry sector. The main environmental issues associated with cement production are emissions to air and energy use. One of the most critical impacts of cement manufacturing is the dust generated during transport, storage, milling, packing, etc. (NGHI Son Cement Corporation Project, 1996). Atmospheric dust is an important source of air pollution particularly in dry climates. Mineral dust contains high concentrations of many metals known to have toxic effects not only on plants and animals but also on humans (Branquinho, C. et al., 2008; Shukla et al., 1990; Hirano et al., 1995). It has been reported that 1 kg of cement manufactured in Egypt generates about 0.07 kg of dust in the atmosphere (Hindy et al., 1990). Furthermore, it contributes about 5% of the global CO_2, the famous greenhouse gas (Ian and David, 2002). In cement industries, dust is emitted from stock piles, quarrying, and transportation of raw materials, kilns operation, clinker cooling and milling (EIPPC2001).

The cement industry presents one of the most energy intensive sectors within the Indian economy and is therefore of particular interest in the context of both local and global environmental discussions. Cement dust contains heavy metals like nickel, cobalt, lead, chromium, pollutants hazardous to the biotic environment, with adverse impact for vegetation, human and animal health and ecosystems (Baby et al. 2008). Sagauni is a rural area near Rewa, the steel city of Madhya Pradesh. A large number of cement plants are in operation in and around Rewa. The particulate

matters of the dust exhausted from the cement plants are released to the air and it creates considerable environmental pollution. In order to monitor the ambient air quality of Sagauni based on suspended particulates, sulphur dioxide (SO2) and oxides of nitrogen (NOx) a fact-finding survey was conducted for a period of years from 2009 to 2010. The amount of different pollutants is compared with the standard limits recommended by Central Pollution Control Board (CPCB) and air quality parameters are also worked out on that basis.

Material and Methods

Rewa district comes in Madhya Pradesh state in central India. Rewa lies between 24^0 18' and 25^0 12' north latitudes and 81^0 2' and 82^0 18' east longitudes in the north-east of the division of the same. The district is bounded on the north by Uttar Pradesh. For the present study sampling sites was selected in Rewa city. The JAYPEE cement plant, Rewa is located 24^O33' north longitude and 81^o10' east latitude and is situated at Jay Prakash Nagar 20 Km from Rewa city. Jaypee cement plant limited is operating a 2.8 MTPA cement manufacturing plant at Jaypee Nagar. Sagauni is situated in Satna district near J.P. cement plant at a distance 4.5 km towards West-North-West direction. Total area occupied by this village is 332.54 hectare. The annual rainfall of this region is 1241.11 mms and average maximum and minimum temperature are 38.5°C and 7°C respectively. Maximum rainfall occurs during the monsoon months. The mean wind speed in the study area is varied between 0-20 Km/hrs.

Respirable Dust Sampler, Envirotech model APM- 460 BL-441 is employed to monitor the pollutants. The sampling duration was 8 hours period operated at an average flow rate of 1.5 LPM. Monitoring is carried out once in a month at sampling site during (2009-2010). NEERI and CPCB recommended methods are followed to estimate air pollutants concentrations. Amount of Respirable Particulate Matter (RPM) was collected in the glass fabric filter paper whereas suspended particulate Matter (SPM) was collected on dust cup. Samples for determination of SO_2 and NOx were collected by bubbling air samples in the appropriate absorbing media in impingers at flow rate of 1.5 LPM. These samples were analysed for SO_2 and NOx spectrophotometrically.

Results and Discussion

Table-1 represents the average seasonal concentrations of air pollutants in the ambient air of sampling site have been computed from the basic data. Result indicated higher concentrations of air pollutants in winter months as (SPM 375.28μg/m^3,RSPM 82.48μg/m^3,SO_2 23.17μg/m^3 and NOx 48.71μg/m^3) as compared to summer (SPM 293.80μg/m^3, RSPM 70.87μg/m^3, SO_2 18.68μg/m^{3}and NOx 30.14) and rainy (SPM 157.47μg/m^3, RSPM 47.68μg/m^3, SO_2 14.74μg/m^3 and NOx 24.07μg/m^3) months during 2009. There concentrations were computed as (SPM 381.64μg/m^3, RSPM 73.76μg/m^3, SO_2 25.87μg/m^3 and NOx 54.27μg/m^3) in winter followed by (SPM 302.98μg/m^3, RSPM 61.51μg/m^3, SO_2 17.94μg/m^3 and NOx 29.60μg/m^3) in summer and (SPM 208.54μg/m^3, RSPM 53.35μg/m^3, SO_2 15.10μg/m^3 and NOx 19.77μg/m^3) in rainy months of 2010 respectively. This trend of seasonal variation in pollutant concentrations under present investigation supports the finding of other workers (Gupta, 1994, Mathur, 1995, Khare, 2006, Shrivastava, 2011, Khan,2012). In the Ambient air around the Lime Kilns and recorded average values in the range of 500 to 1000 μg/m3 during November and December, due to high pressure conditions and low wind speed resulted in the formation of inversion condition which in turn traps the pollutants in the lower environment and creating high pollution events(Satsangi et al, 2004)

Fig-1 compared the average annual concentrations of air pollutants such as SPM, RSPM, SO_2 and NOx in the ambient air in Sagauni village observed during 2009 and 2010. Almost similar concentrations have been observed for both years. Result determined the average annual concentrations of air pollutants such as (RSPM 67.01μg/m^3,SO_2 18.86μg/m^3 and NOx 34.31μg/m^3 during 2009 and RSPM 62.87μg/m^3, SO_2 19.64μg/m^3 and NOx 34.54μg/m^3 in 2010) in the ambient air of selected site during both the years have been observed lower than the standard value prescribed by CPCB, New Delhi (100μg/m^3 for RSPM and 80μg/m^3 for SO_2 and NOx for residential and rural uses). Whereas results shows higher concentrations of SPM (275.52μg/m^3 in 2009 and 297.72μg/m^3 in 2010) in the ambient air than the standard value of 200μg/m^3, prescribed by CPCB, New Delhi for the residential and rural uses. The results of SPM concentrations under present study are in agreement with the findings of Gupta (1994) and Upadhyay (1998). They have monitored the air quality around the Lime Kilns of Kymore and Maihar region of Madhya Pradesh. Gupta (1994) recorded the average SPM concentration in the Lime Kilns area of Kymore region as 1003.80 μg/m3. Upadhyay (1998) reported the Ambient SPM concentration in the Lime Kiln area of Maihar as 377.69 to 710.41 μg/m3 for 1996-97, respectively. Naik and Purohit (1998) have reported maximum SPM concentration as 742.0 μg/m3 for the ambient air of Rourkela Plant. Agrawal and Khanam (1989) estimated

maximum SPM concentration average (1096.77 µg/m3) during winter season at a distance of five km (SE) from Dala Cement factory at Mirzapur U.P.

Fig-2 shows present concentration of each pollutants to the total pollutants observed in the ambient air of sampling site during 2009 and 2010. Results indicate maximum contribution of SPM (69.63% in 2009 and 71.78% in 2010) to the ambient air. RSPM contributed about (16.93% in 2009 and 15.16% in 2010) to the total pollutants of the ambient air during both the years. There was lesser contribution of gaseous pollutants (NOx and SO_2). Nitrogen oxides had contributed to the total air pollutants in the ambient (8.67% during 2009 and 8.33 during 2010) and other hand, SO_2 contributed about (4.76% in 2009 and 4.74% in 2010) to the total pollutants in the ambient air of sampling site during monitoring period.

Twari et al., (2014) observed maximum contribution of SPM in ambient air than the other air pollutants near JK white cement plant Gotan, Rajasthan. Ravindra (1991) monitored SPM levels in the range of 223.24 to 744.11 µg/m3. Oxides of carbon, nitrogen, and sulfur are mainly produced as a by-product of fuel combustion for power generation (Marland et al., 1989; Ruth, 2000; Battelle Institute, 2002; Ian and David, 2002). In addition; SO_2 is produced from oxidation of volatile sulphur present in the kind of limestone used as raw material (Jeff and Hans, 2004). Environmental contamination due to dust particle coming from Cement Industries has drawn much attention of the environmental scientists today as they create serious pollution problems and serious pose threat to the ecosystem. It has been reported that 1 kg of cement manufactured in Egypt generates about 0.07 kg of dust in the atmosphere (Hindy et al., 1990).

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Table 1: Seasonal variation of air pollutants in the ambient air of sampling site during 2009 and 2010

S.N.	Pollutants ($\mu g/m^3$)	2009			2010		
		S	W	R	S	W	R
1.	SPM	293.80	375.28	157.47	302.98	381.64	208.54
2.	RSPM	70.87	82.48	47.68	61.51	73.76	53.35
3.	SO_2	18.68	23.17	14.74	17.94	25.87	15.10
4.	NOx	30.14	48.71	24.07	29.60	54.27	19.77

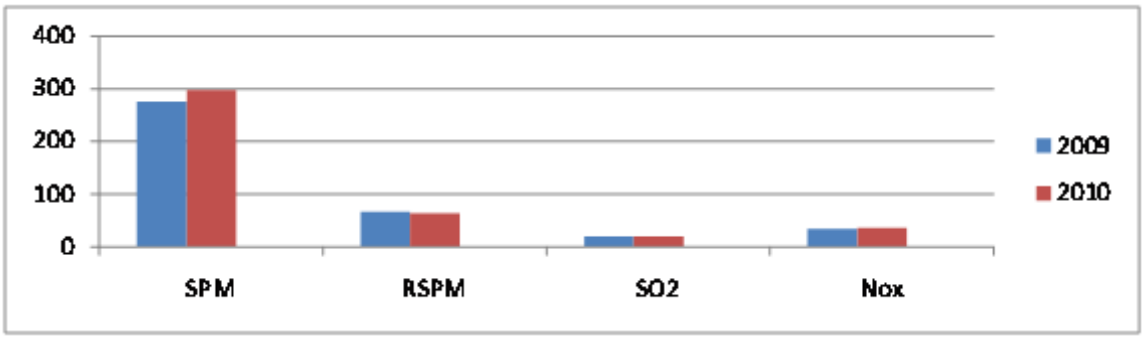

Fig. 1: Annual average concentration of the ambient air of sampling site during 2009 and 2010

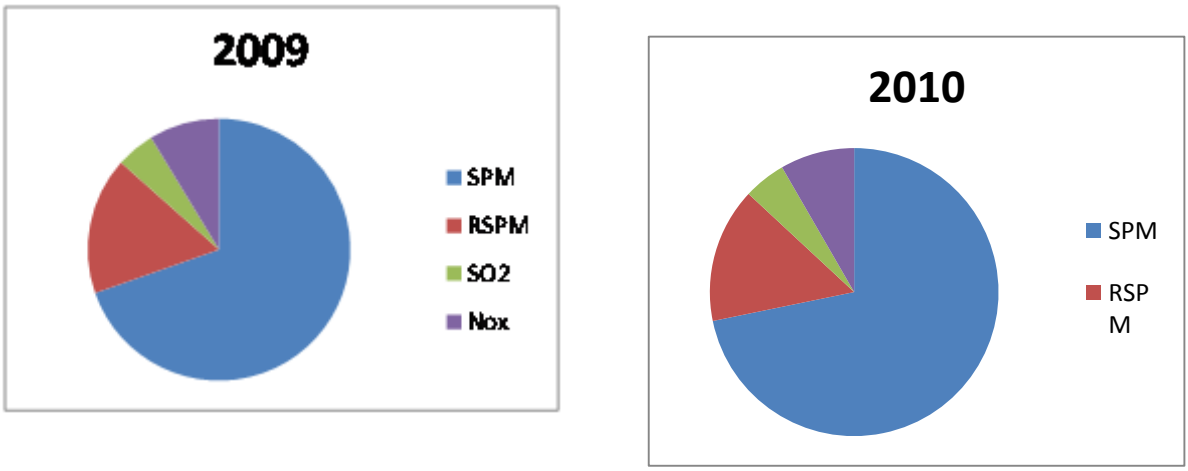

Fig. 2: Percent contribution of each pollutant to the ambient air of Sagauni village around Jaypee cement plant observed during 2009 and 2010

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