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Air Pollution and Air Quality Index of Kodinar Gujrat, India

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Abstract

This paper present the air pollution (PM_{10} , RPM, SO_2 and NOx) emitted from a cement industry. The data collected were compared with Indian Standard prescribed by CPCB. Sampling of air quality was done at various distances from the cement industry at six sampling points. It was observed that SPM was higher than the permissible limit at all the sampling points except Pransli the control site but RPM were higher at Ronaj, Muldwarka and Vadnagar than the permissible limit. Air quality index was also calculated and this study indicates that the air quality of Kodinar is unhealthy at various sampling site. People with asthma or other respiratory diseases, the elderly, and children are the groups most at risk.

Keywords: Air pollution, cement industry, PM₁₀, RPM, SO₂, NOx and API.

Introduction

Air pollution is the processes which the substance is not present in normal atmospheric composition reach the atmosphere, or is present but in much lower concentrations. Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment or built environment, into the atmosphere¹.

Air pollutants can be physical, chemical, mechanical or acoustic²⁻⁴. Pollutants produced by different sources, are transported and transformed having different effects on ecosystems^{5,6}.

Indian Cement industry, which is 88 year old, comprises 128 large cements plants beside some 365 mini plants, with total installed capacity of about 152.09 million tones and a production of 125.56 million tons (2004-2005), comprising ordinary Portland cement, blended cements and others^{7, 8}. Every industry has both positive and negative impact on environment associated with it positive, in terms of socio-economic environment and negative in terms of associated emissions⁹⁻¹¹.

Study area: The Study area was Kodinar in the Shaurashtra region of Gujrat state forms a part of a bay in the Arabian Sea. It is located approximately 30 km. from famous temple Somnath (Veraval) on the Veraval–Una National Highway No. NH-8E. The area has co-ordinates with latitude, N 20° 54' 45" and longitude 70° 30' 41". In this area there are total 04 cement plant units namely Ambuja Cement, Gajambuja -1, Gajambuja-2 and Siddhi Cement Ltd with capacity 2–2.5 MTPA. It is the most important industrial place.

Objectives: The objective of present study were -i. To study the meteorological condition of study area. ii. To study ambient air quality in the vicinity. iii. To calculate the API for the area.

Material and Methods

The study was conducted in summer, winter, and post monsoon season 2011-12 which include the meteorological condition and ambient air quality of the area. The ambient air quality was measured at six locations keeping in view the prevalent wind direction of the area table-1.

Ambient air quality study includes the following parameters. i. Particulate Matter (PM_{10}), ii. Respirable Particulate Matter (RPM<10micron), iii. Gaseous pollutants Viz. SO₂, and NOx. Measurement of PM_{10} , RPM and gaseous sampling was done with the help of 'Envirotech APM-460' instrument. Sampling was done 24 hours/8 hourly durations. All the sampling and analysis were done as per CPCB guideline.

Results and Discussion

Particulate Matter (PM₁₀): PM₁₀ was measured at all six selected stations with the help of Respirable Dust Sampler. The minimum ground level concentration (GLC) of PM₁₀ was found at Pransli 73.8µg/m³ in post monsoon season as it is a control site situated 15 km away from the industry while at Muldwarka the PM₁₀ concentration was found highest in 184.50µg/m³ in post monsoon season also table-2. At this site maximum loading unloading activity takes place for transportation. The PM₁₀ values were observed higher than the permissible limit (100µg/m³) at all the sampling station except Pransli station the control site. In this study particularly PM₁₀ was in agreement with the monitoring results obtained around different cement plants of the country¹²⁻¹⁴. Average PM₁₀ at different stations are given in figure-1.



Figure-1 Map- Location map of study area Kodinar

Table-1

Locations of air quality monitoring stations with reference to cement plant										
S. No.	Name of station Direction from cement plant Map distance in km.									
1.	Pransli	NW	15.0							
2.	Moradia	NW	1.5							
3.	Fachariya	NE	2.0							
4.	Ronaj	SE	4.5							
5.	Muldwarka	SSW	9.1							
6.	Vadnagar	ENE	0.5							

Table-2
Concentration of PM ₁₀ and RPM at various stations in 2011-12

		Ground level concentration, 24 hourly µg/m ³									
S. No.	Stations]	PM_{10}		RPM					
		Winter	Post Monsoon	Summer	Mean ± SD	Winter	Post Monsoon	Summer	Mean ± SD		
1	Pransli	75.3	73.8	80.1	76.4±3.29	41.6	43.5	47.5	44.2±3.01		
2	Moradiya	141.0	146.0	139.6	142.2±3.36	44.0	40.6	60.6	48.4±10.70		
3	Facharia	154.3	146.9	161.9	154.4±7.5	50.4	49.0	50.9	50.1±0.98		
4	Ronaj	163.3	155.6	161.0	159.9±3.95	63.2	62.4	61.0	62.2±1.13		
5	Muldwarka	181.9	184.5	183.3	183.2±1.30	74.1	74.3	78.3	75.6±2.37		
6	Vadnagar	173.1	175.9	173.3	174.1±1.56	67.1	69.8	61.9	66.3±4.01		

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Respirable Particulate Matter (RPM) >2.5 micron: RPM was measured at all six selected station with the help of Respirable Dust Sampler. The results obtained are given in table-2. The ground level concentration (GLC) of RPM was found at minimum at Marodiya 40.6 μ g/m³ in post monsoon but higher value was observed at Muldwarka 78.3 μ g/m³ in summer season than the permissible limit 60 μ g/m³. Second most polluted site in term of RPM was Vadnagar ranging from 61.90-69.80 μ g/m³. The third most polluted site was observed Ronaj with range of 61.0-63.2 μ g/m³. Average RPM at different stations are given in figure-3.

SO₂: SO₂ concentration was measured at all the six selected sampling station in summer, winter and post monsoon season and the values are given in table-3. The values of SO₂ at all the sampling stations were found within the permissible limits $80\mu g/m^3$. The minimum SO₂ concentration was observed at control site Pransli $5.75\mu g/m^3$ on post monsoon and maximum $17.00\mu g/m^3$ at Vadnagar on summer. It may be because this station is nearest (0.5km) from industry and wind direction is also in same direction^{6, 15}. Average SO₂ at different stations are given in figure-4.



Figure-2 Average concentration of PM10 at various stations (2011-12)



Figure-3 Average concentration of RPM at various stations (2011-12)

NO_x: The ground level concentration (GLC's) of NOx was estimated at six sampling station in summer, winter and post monsoon season. The minimum NOx was observed at Pransli station the control site $7.13 \mu g/m^3$ in winter table-3 and highest value was found $15.50 \mu g/m^3$ in winter at Vadnagar. The values

observed for all the stations were within the permissible limit $(80\mu g/m^3)$ (Sirajuddin and Ravichandran 2010, Chauhan and Joshi 2010). Average NO_x at different stations are given in figure-5.

Table-3									
Concentration of S	O ₂ a	nd NO	x at	various	sta	tions	in	2011-	12
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S.		Ground level concentration, 24 hourly µg/m ²									
No.		SO ₂				NOx					
	Stations	Winter Post			Mean ± SD	Winter	Post		Mean ± SD		
			Monsoon	Summer			Monsoon	Summer			
1	Pransli	7.13	5.75	7.75	6.88±1.02	7.13	8.13	8.33	7.87±0.64		
2	Moradiya	9.63	10.13	9.25	9.67±0.44	9.25	10.00	9.63	9.63±0.37		
3	Facharia	9.75	10.13	9.88	9.92±0.19	8.75	9.75	9.00	9.17±0.52		
4	Ronaj	7.38	8.00	8.25	7.88±0.45	9.75	9.75	10.50	10.00±0.43		
5	Muldwarka	9.13	8.75	8.88	8.92±0.19	9.13	9.13	8.55	8.94±0.33		
6	Vadnagar	16.75	16.88	17.00	16.88±0.12	15.50	15.25	14.63	15.13±0.45		



Figure-4 Average concentration of SO₂ at various stations (2011-12)



Figure-5 Average concentration of NOx at various stations (2011-12)

Air Pollution Index: Air quality index values are divided into ranges, and each range is assigned a descriptor and a color code. Standardized public health advisories are associated with each API range. According to EPA, 2009 there are six levels of health concern table-4 and what they mean are: i. "Good" API is 0 - 50. Air quality is considered satisfactory, and air pollution poses little or no risk. ii. "Moderate" API is 51 - 100. Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. For example, people who are unusually sensitive to ozone may experience respiratory symptoms. iii. "Unhealthy for Sensitive Groups" API is 101 - 150. Although general public is not likely to be affected at this API range, people with lung disease, older adults and children are at a greater risk from exposure to ozone, whereas persons with heart and lung disease, older adults and children are at greater risk from the presence of particles in the air. iv. "Unhealthy" API is 151 - 200. Everyone may begin to experience some adverse health effects, and members of the sensitive groups may experience more serious effects. v. "Very Unhealthy" API is 201 - 300. This would trigger a health alert signifying that everyone may experience more serious health effects. vi. "Hazardous" API greater than 300. This would trigger a health warning of emergency conditions. The entire population is more likely to be affected.

Conclusion

The minimum ground level concentration (GLC) of PM_{10} was found at Pransli 73.8µg/m³ in post monsoon season as it is a control site situated 15 km away from the industry while at Muldwarka the PM_{10} concentration was found highest in 184.50µg/m³ in post monsoon season. This site has maximum loading unloading activity for transportation. The PM_{10} values were observed higher than the permissible limit (100µg/m³) at all the sampling station except Pransli station the control site. In this study PM_{10} are in agreement with the monitoring results obtained around different cement plants of the country. RPM was found at minimum at Marodiya 40.6 μ g/m³ in post monsoon but higher value was observed at Muldwarka 78.3 μ g/m³ in summer season which was more than the permissible limit (60 μ g/m³). SO₂ and NOx values were found within the permissible limits at all the stations in all the season. Air pollution index was also calculated for PM₁₀, RPM, SO₂ and NOx which also indicates that API index for PM₁₀ shows the air quality at different station was in moderate to unhealthy zone for sensitive groups. API for RPM shows that air quality is unhealthy for sensitive group table-5 and API for SO₂ and NOx shows good quality (green zone) in their respective term.

Our finding indicates that gaseous air pollutants were well below the permissible standards for ambient air quality. The PM_{10} and RPM were high because lots of dust generates during processing and transportation. People with asthma or other respiratory diseases, the elderly, and children are the groups most at risk. Water sprinklers tree planting are the mitigation measure that industry have to implement in order to minimize fugitive dust in the area.

Table-4
Air Pollution Index, health concern and respective colour

Air Pollution Index	Levels of Health	Colors
(API) Values	Concern	
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for	Orange
	Sensitive Groups	
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Source: EPA, August, 2009

Table-5
Air Pollution Index for PM ₁₀ and RPM at various stations on 2011-12

		PM ₁₀		RPM			
health concern	Winter Post monsoon		Summer	Winter	Post monsoon	Summer	
Pransli	61	60	63	111	114	121	
Level of health concern	Yellow	Yellow	Yellow	Orange	Orange	Orange	
Moradiya	94	96	93	115	109	142	
Level of health concern	Yellow	Yellow	Yellow	Orange	Orange	Orange	
Facharia	100	96	104	125	123	126	
Level of health concern	Yellow	Yellow	Orange	Orange	Orange	Orange	
Ronaj	105	101	104	146	145	143	
Level of health concern	Orange	Orange	Orange	Orange	Orange	Orange	
Muldwarka	114	115	115	156	156	158	
Level of health concern	Orange	Orange	Orange	Red	Red	Red	
Vadnagar	110	111	110	152	153	144	
Level of health concern	Orange	Orange	Orange	Red	Red	Orange	

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