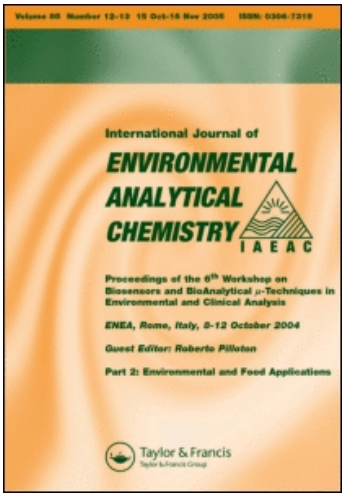

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MICRO POLLUTANT PARTICULATES IN THE AMBIENT AIR OF A CEMENT PLANT

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Suspended particulate matter in the ambient air of an ESP equipped cement plant was determined using a high volume sampler at a number of sites within 10 km radius of the cement plant. The micro pollutants (Co, Ni, Pb, Ag, Bi, Cd, Sb, As, Mn, Li, Rb, Be, Mo) in a number of samples of the suspended particulate matter have been determined by Atomic Absorption Spectrophotometric method.

KEY WORDS: Cement plant, suspended particulate matter samples, multielement determination, atomic absorption spectrophotometry.

INTRODUCTION

In studies conducted earlier, the fallout of settleable dusts from a slagbased cement plant of 1.38 million tonnes annual capacity was found in the range of 34.16 to 978.30 tonnes/km^2/month.[1] The range of fallout of settleable dust for a Pozzolana based cement plant of 0.6 millon tonnes annual capacity was found in the range of 31.08 to 732.18 tonnes/km^2/month.[2] The studies described here have been carried out at a cement plant which works on dry process of manufacture, and is equipped with electrostatic precipitators at sources of major dust emissions. The annual consumption of raw materials at the cement plant, in metric tonnes, are: Lime stone, 760,000; sand, 11,165; iron ore, 9,017; coal 128,500. The raw materials, particularly the iron ore and coal, are found to have traces of heavy metals. Some of these heavy metals are toxic in nature, and have hazards associated with them. The objective of the work is to determine the concentration levels of these toxic metals in the ambient air of a cement plant. The SPM concentration in the ambient air of this plant was determined at a number of sites within 10 km radius and found to be in the range of 77.40–321.76 μg/m^3 on 24 hr basis of measurements.[3]

The micro pollutants that have been studied in the sample of the suspended particulate matter collected from the ambient air of this cement plant are: Co, Ni, Pb, Ag, Bi, Cd, Sb, As, Mn, Li, Rb, Be and Mo. According to the classification of Wood,[4] from this standpoint of environmental pollution, Be, Co, Ni, As, Ag, Cd, Pb, Sb and Bi fall under the category of "very toxic and relative accessible metals".

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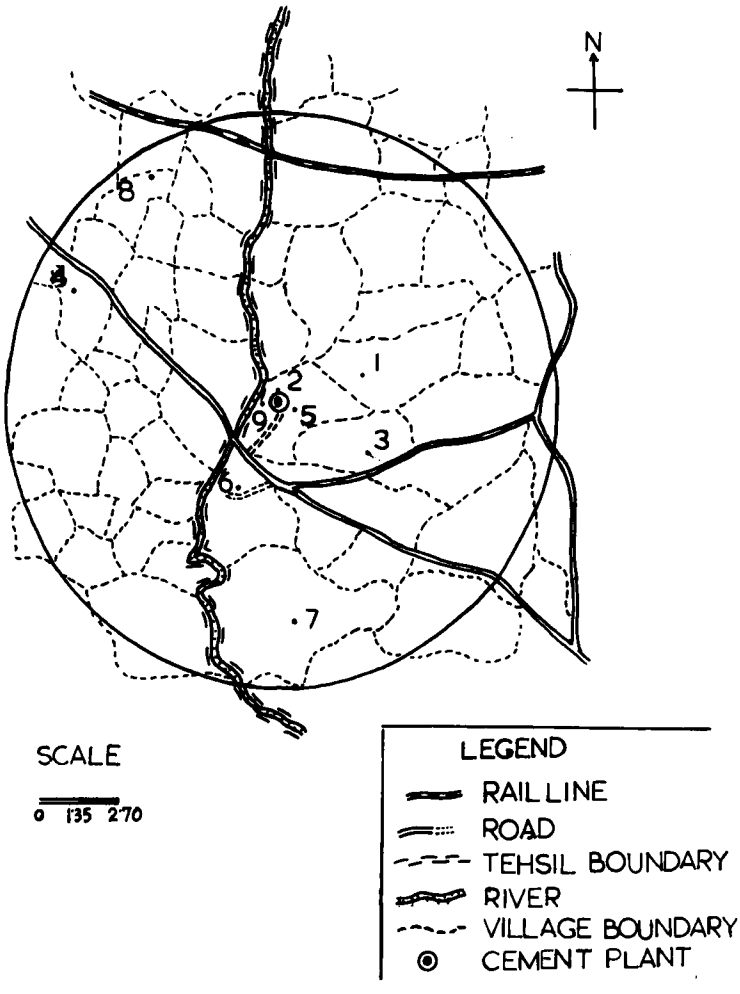

Figure 1 Locations of the sampling sites.

Although Mn, Li, Rb and Mo have been placed under the category of noncritical metals under the same classification, significant toxicological effects of these elements have been reported in recent years.

MATERIALS AND METHOD

Sample collection

Nine sampling sites within a 10 km radius of the cement plant were selected depending on the wind direction, accessibility and topography of the area. The locations of the sampling sites have been shown in Figure 1. A high volume air sampler (Model Envirotech APM-410) was operated at each site for the durations

of 11.30–64.15 hours with flow rates from 0.65 to 1.28 m^3/min. Whatman glass microfilter sheets of retention efficiency of 99.99% for 0.6 μ particles were used with the air sampler to ensure maximum retention of suspended particulate matter. The grain size of suspended particulate matter was determined at distances of 2.5 km and 10 km from the emission source. The grain size in the former case was found to be above 5 μ (60%) and 1–5 μ (40%) and in the latter case the grain size was found to be 1–5 μ (65%) and above 5 μ (35%). The weather conditions were recorded on a daily basis, and the directions were recorded on a half hourly basis during the period of study. The average values of concentrations of SPM have been calculated in $\mu g/m^3$ at each sampling site and shown in Table 1.

Procedure

The microfilter sheet containing the suspended particulate matter of each sampling site was divided into two equal halves. Each half of the filter sheet was treated in a Teflon digestion bomb using 10 ml acid mixture of hydrochloric acid, hydrofluoric acid and nitric acid placing in an oven at 180 °C for 30 minutes as per recommended procedure.[5,6] Thereafter, the solutions were made up to 100 ml volume in a medium of 0.1 M EDTA to suppress the interference of phosphate, carbonate, iodide, chloride and acetate. For the calibration, standard solutions of the metals (1 ml = 1,000 μg of the metal) were prepared in appropriate acid medium.[7] Blank determinations using microfilter sheet of same size and specifications were similarly carried out.

Method

The analysis was performed using an atomic absorption spectrophotometer (Varian Model AA 575) following the recommended conditions of operation for the respective metals.[8]

During the calibration, the standard solutions of the metals were suitably diluted to match the concentration of the sample solutions within the measurement sensitivity. The results obtained have been shown in Table 2.

RESULTS AND DISCUSSION

The analysis data (Table 2) of the elements studied reveal that the average concentrations of the elements in the ambient air in the vicinity of the cement plant within a radius of 10 km, are in the following decreasing order Mn > Rb > Sb > Co > Ni > Li > Pb > Bi > Cd > As > Be = Mo = Ag. The concentration levels of the potentially hazardous elements (Mo, Be, Mn, As, Sb, Cd, Pb and Ni) have been found below the limits prescribed for these elements.[9] Thus an ESP-equipped cement plant as studied here can be taken to pose no environmental hazards with regard to the presence of these elements.

Table 1 Locations of the sampling sites and SPM levels

Sampling site no.[a]	*Direction with respect to cement plant*	*Distance from cement plant (km)*	*Duration of air sampling (hrs)*	*Flow rate (m^3/min)*	*Volume of air sampled (m^3)*	*Wind direction*	*Average weight of SPM (g)*	*Average value of concentration of SPM ($\mu g/m^3$)*
1	E	3.1	21.00	1.275	1,606.50	Mostly WSW, with reversal of direction	0.3384	233
			27.40	0.95	1,561.80			
			22.80	1.175	1,607.40			
			21.37	1.09	1,320.07			
2	N	0.1	21.77	1.05	1,375.50	Mostly SW	0.4786	325
			20.88	1.01	1,265.33			
			29.23	1.05	1,841.49			
3	SE	3.6	11.30	1.10	745.80	Mostly SW	0.1715	230
4	NW	8.4	20.00	0.82	984.00	Variable	0.2302	236
			21.50	0.65	620.95			
			21.00	0.80	1,008.00			
5	SE	0.3	22.76	1.09	1,488.18	Mostly SW	0.4600	309
6	SW	3.5	64.15	0.82	3,156.18	Mostly SW	0.7485	237
7	S	8.0	18.78	0.85	957.95	Mostly NE	0.1922	209
			15.25	0.95	869.25			
			15.16	0.75	682.50			
8	NW	9.0	22.00	1.10	1,450.00	Mostly NE	0.1891	135
			24.00	1.05	1,512.00			
			23.81	0.09	1,286.10			
9	NW	0.7	16.81	1.10	1,109.46	Mostly SW	0.2532	229

[a]Locations shown in Figure 1.

Table 2 Analysis data[a] of micro pollutants

S. nos.	*Pollutants*	*Sampling site nos.*									*Average value*	*Recommended limit in air*
		1	2	3	4	5	6	7	8	9		
1	Co	0.0311	0.0278	0.0414	0.0470	0.0371	0.0189	0.0374	0.0292	0.0274	0.0330	—
2	Ni	0.0285	0.0278	0.0368	0.0302	0.0340	0.0308	0.0436	0.0189	0.0206	0.0301	1,000.0
3	Pb	0.0078	0.0111	0.0138	0.0201	0.0161	0.0071	0.0116	0.0103	0.0114	0.0121	150.0
4	Ag	<0.0003	<0.0003	<0.0002	<0.0003	nil	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	—
5	Bi	<0.0052	<0.0069	<0.0046	<0.0067	<0.0062	<0.0047	<0.0041	<0.0034	<0.0046	<0.0052	—
6	Cd	0.0026	0.0035	0.0018	0.0033	0.0037	0.0024	0.0020	0.0017	0.0023	0.0026	50.0
7	Sb	0.0777	0.1042	0.0736	0.1074	0.0927	0.0806	0.0665	0.0481	0.0681	0.0779	500.0
8	As	<0.0013	<0.0017	<0.0011	<0.0017	<0.0015	<0.0012	<0.0010	<0.0009	<0.0011	<0.0013	2.0
9	Mn	0.1942	0.1564	0.1058	0.3020	0.2781	0.1779	0.1558	0.1203	0.1508	0.1824	5,000.0
10	Li	0.0155	0.0104	0.0161	0.0235	0.0124	0.0095	0.0166	0.0069	0.0121	0.0137	—
11	Rb	0.0777	0.0903	0.0919	0.1342	0.0927	0.0593	0.0914	0.0550	0.0914	0.0871	—
12	Be	<0.0003	<0.0003	<0.0002	<0.0003	<0.0003	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	2.0
13	Mo	<0.0003	<0.0003	<0.0002	<0.0003	<0.0003	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	10,000.0

[a]In $\mu g/m^3$.

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