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TRENDS IN THE ATMOSPHERIC PARTICULATE MATTER COLLECTED DURING 2003-2005 AT TROMBAY, MUMBAI

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INTRODUCTION

Air quality has been a complex issue in most of the urban areas due to a variety of source contribution. Controlling air pollution to reduce risk of poor health, to protect the natural environment and to contribute to the quality of life is a key component of sustainable development. The anthropogenic air pollution emissions could be attributed to industries, mobile sources, construction, garbage burning etc. Of many pollutants, particulate matter in recent past has been considered one of the most potent pollutants with regard to its human health. PM with aerodynamic diameter less than 10 μm (PM 10), especially the finer particle fraction PM2.5 (particulate matter with aerodynamic diameter less than 2.5 μm), have been shown to be associated with increases in mortality (e.g. Dockery and Pope, 1994), asthma (e.g. Anderson et al., 1992) and visibility degradation (e.g. Milne et al., 1982). This paper presents the trends of the particulate matter in two size fractions collected during 2003 to 2005 at a sampling site in Mumbai.

STUDY AREA

The sampling site is situated at Trombay in Mumbai where the Gent's air sampler located about 15km from the Mumbai main center, 19^0 2' North latitude and 75^0 53' East longitude, bordered by the Bombay Harbour Bay on the East, Mumbai-Pune National Highway on the North-East at about 5km. Refineries, a Fertilizer complex and a thermal power plant operating on gas/oil is situated at a few kilometers to the West. Few chemical and Paint Industries are located in this region. The sampling was carried out on the terrace of building, which is about 15m height from the ground level. The sampling location is separated from the industrial area by 275 m high hill. The other side of the sampling point is surrounded by sea.

SAMPLING AND ANALYSIS

The Nucleopore polycarbonate filters used for collecting particulate matter were desiccated for 24 h before sampling at constant temperature. The filters are then weighed and inserted into stacked filter units. The stacked filter unit (SFU) is then inserted into sampling head with size selective inlet and exposed to ambient air drawn through the stacked filters of two different sizes by the pump. On an average the particulate samples are collected for 24 h. However, the collection time is reduced, particularly during winter season, when the flow is reduced below 14 lpm due to high loading on the filter. The particulate deposited filters are then numbered and the filters are weighted after desiccation for 24 h. The ambient particulate matter concentrations are then calculated from the weight of particulate matter collected on the filter and the total volume of air sampled.

Analysis

Reflectance measurements are carried out on the filter samples collected for estimation of Black Carbon (BC) using Smoke Stain Reflectometer supplied by International Atomic

Energy Agency (IAEA). The elemental analysis of some of the air filter samples collected is carried out by Insturmental Neutron Activation Analysis (INAA) and Energy Dispersive X-Ray Fluoroscence (EDXRF). Si, S, Ca, Pb, Ti and Ni are analyzed by EDXRF and Na, K, Cr, Fe, Zn, Co, Sb and Sc are analyzed by INAA. These techniques are commonly used for multielemental simultaneous analysis of elements in ppb levels. The details of the analytical techniques are discussed elsewhere.

RESULTS AND DISCUSSION

The particulate data collected during 2003-2005 are analyzed for the trends in particulate matter as well as for its sources contributing to the particulate matter. Figures 1 to 2 shows the box whisker plots for monthly fine and coarse fractions measured at Trombay for the period 2003-2005. The three year average of PM2.5 and PM2.5-10 values at Trombay site are 39.6 $\mu g/m^3$ and 56.11 $\mu g/m^3$ respectively. From figs. 1 & 2 the fine and coarse particulate matter show a clear seasonal variation at the site. This is possible as in Mumbai during monsoon season very high precipitation occurs from June to September every year. The particulate matter levels in both fractions are on the higher side during winter season. The RSPM ($PM_{<10\mu m}$) is ranging from 34.59 $\mu g/m^3$ to 190 $\mu g/m^3$. The annual average value (96 $\mu g/m^3$) is within the limits of 120 $\mu g/m^3$ specified by Central Pollution Control Board (CPCB) for industrial area (CPCB, 2007). Where as the 24h value exceeded the standard of 150 $\mu g/m^3$ occasionally during the study period. The ratio of $PM_{2.5\mu m}$ to $PM_{<10\mu m}$ is about 0.4 which indicates the significant contribution from fine particulate matter. Overall no significant variation in the annual trend is observed during the study period from 2003 to 2005.

Reflectance values of fine and coarse filters are measured using smoke stain reflectometer for estimation of BC values. The methodology of estimation is discussed elsewhere (Mahadevan et al., 2000). The average BC values in the coarse and fine particulate matter at Trombay are 3.02 and 6.29 $\mu g/m^3$ respectively. The black carbon contributes around 10 to 20 % with an average value of 16 % of the fine mass is due to vehicular emission near the site.

Table 1 presents the average concentration of elements analyzed at Trombay site in fine and coarse fractions. The elemental concentrations reported in table are results of analysis some of the samples collected during the study period. Results showed the elements from crustal origin (Si, Ca, A, Sc) and sea salt (Na, K) contributed significantly to the particulate matter concentration. To confirm the anthropogenic origin of elements, enrichment facto analysis with respect to crustal source is performed considering Fe as reference element. The elements such as Zn and Pb have shown high enrichment both in coarse and fine particulate matter where as S, Ni have shown medium enrichment (Yuanxun et.al., 2006). The Pb values observed during the study shows the decreasing trend compared to earlier values (Mahadevan, 1986) which is due the use of unleaded petrol. The preliminary factor analysis of the sample data indicates soil, sea salt and industrial sources in coarse fraction and vehicular, industrial, biomass and soil in fine fractions.

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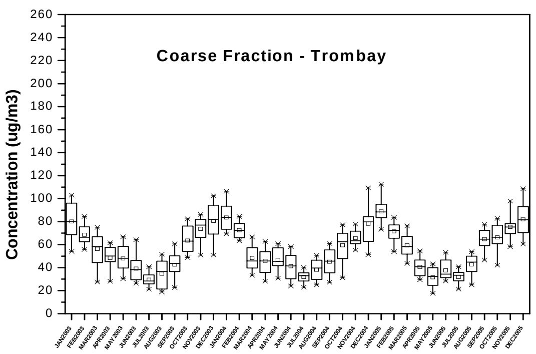

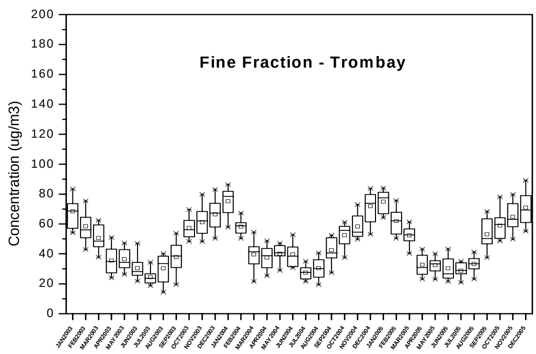

Figs.1 & 2: Seasonal Variations of Coarse and Fine Fractions at Trombay

Table 1: Average Elemental Concentrations at Trombay Site

Element	Unit	Trombay	
		Fine Fraction	**Coarse Fraction**
PM	$\mu g/m^3$	39.6±14.7	56.11±20.3
BC	$\mu g/m^3$	6.29±2.84	3.02±1.89
Na	ng/m^3	797.1±779	1185.5±873.6
Si	ng/m^3	2465.4±1877.5	5893.7±2466.7
S	ng/m^3	355.0±194.4	1464.9±498.5
K	ng/m^3	1090.3±921.5	965.4±710.6
Ca	ng/m^3	339.0±238.3	3510.4±2173.2
Cr	ng/m^3	14.48±12.4	28.0±25.2
Fe	ng/m^3	854±246.6	2468±1068.4
Zn	ng/m^3	105.6±124.1	864.7±568.4
Pb	ng/m^3	102.6±50.8	248.8±138.2
Co	ng/m^3	1.77±1.6	2.73±2.65
Sb	ng/m^3	1.86±1.8	3.73±3.69
Ti	ng/m^3	89.6±24.8	382.4±197.6
Sc	ng/m^3	0.17±0.21	0.67±0.48
Ni	ng/m^3	9.78±4.75	15.72±8.79