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CHARACTERIZATION OF ORGANIC AND ELEMENTAL CARBON IN $PM_{2.5}$ & PM_{10} AEROSOLS AT TROMBAY, MUMBAI.

S.K. Sahu, R.C. Bhangare, S. Sharma, G.G. Pandit and V.D. Puranik

Environmental Assessment Division
Bhabha Atomic Research Centre
Trombay, Mumbai-400094
e-mail sksahu@barc.gov.in

Introduction

Carbonaceous aerosol which consists of particulate organic carbon (OC) and elemental carbon (EC) is one of the major components of atmospheric aerosol *(Rogge et. al., 1993)*. EC is directly emitted mainly from the incomplete combustion whereas particulate OC comes from both the primary emission such as coal combustion, traffic exhaust and biomass burning (*Cachier et al., 1995; Duan et al., 2004*), and also the secondary origin formed through atmospheric chemical conversion processes from the organic precursors *(Kim et.al., 2000; Chow et.al., 1996)*. Carbonaceous aerosols play a key role in formation of cloud condensation nuclei (CCN) and global climate change *(Hitzenberger et. al., 1999).* OC usually includes mutagenic and /or carcinogenic compounds which are detrimental to human health. Presence of total carbon (TC) determines the aerosol properties. Therefore, it is important to measure carbonaceous species in particulate matters in order to understand anthropogenic air pollutant levels.The identification of Primary and secondary OC is difficult to accomplish. However, the OC/TC or OC/EC ratio can be used to identify the presence of secondary organic aerosol *(Hildman et.al., 1991; Chow et. al.,1996).* The comparison of EC and OC in the particulate matter may help to distinguish between the combustion of biomass and fossil fuels. Despite their importance, information concerning the spatial and temporal variability of EC and OC in India is still limited. In the current study the mass concentration of EC, OC and total carbon (TC = EC + OC) were measured in the aerosols (PM_{10} and $PM_{2.5}$) samples collected at Trombay, Mumbai.

Sampling and Analysis

A cyclone based two stage high volume particulate sampler was used to collect PM_{10} samples. $PM_{2.5}$ samples were collected using an impactor based Fine particulate Sampler. All the samples were collected for 24 hours. The samples were collected at a height of 8 meters from the ground level. Pre-weighed filter papers were used to collect the samples. Analysis of particulate bound carbon was performed using Total Organic Carbon Analyzer (TOC Vcsh, Shimadzu) equipped with a Solid Sample Module (SSM-5000A, Shimadzu) . The method is based on High Temeperature Catalytic Combustion (HTCC) under pure oxygen stream resulting in the oxidation of carbon to form carbon dioxide (CO_2) and its subsequent detection and quantification using Non-Dispersive Infra Red (NDIR) detector. For measurement of OC the filter was heated up to 620 ^{0}C and for TC up to 900 ^{0}C. The EC was calculated by subtracting OC from TC.

Results & Discussion

The aerosols display seasonal variation with the highest concentration during the winter and the lowest values during the monsoon seasons (Figure 1.). The PM_{10} concentrations were found to be ranged from 24.94 to 82.05 µg/m^3 whereas $PM_{2.5}$ varied in the range of 11.31 to 74.49 µg/m^3. The carbonaceous species are one of the major components of fine particles in Mumbai. OC contributed about 72.93% of TC in PM_{10} whereas in $PM_{2.5}$ it was up to 70.14%.

Aerosols found in diesel engine exhaust and fuel oil and coal combustion products tend to have high OC to EC ratio (exceeding 1) while emission from gasoline, biomass combustion products and road dust tend to have a low ratio (<1). The concentration of OC is found to be much higher than EC. High carbon contents measured indicates the importance of fossil fuel and biomass contributions to fine particulate air pollution. OC/EC becomes very large towards low EC concentration, when non combustion OC concentrations are significant. OC/EC <2 suggests direct emission. The monthly variations in OC and EC concentrations in $PM_{2.5}$ and PM_{10} are shown in (Table 1). For $PM_{2.5}$ the OC/EC ratio ranged from 1.31 to 3.15 with the mean ratio of 2.3. Minimum OC/EC ratio (1.31) was observed in the month of July which is the peak monsoon period in Mumbai. The highest OC/EC (3.15) was observed in the month of December. For PM_{10} OC/EC ratio ranged from a minimum of 1.64 in July to the maximum of 4.88 in December with the mean ratio of 3.20. The high OC/EC ratio in PM_{10} further confirms the greater contribution from non combustion sources and the presence of secondary organic aerosols.

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Figure 1 Monthly Average Concentration of PM_{10} and $PM_{2.5}$

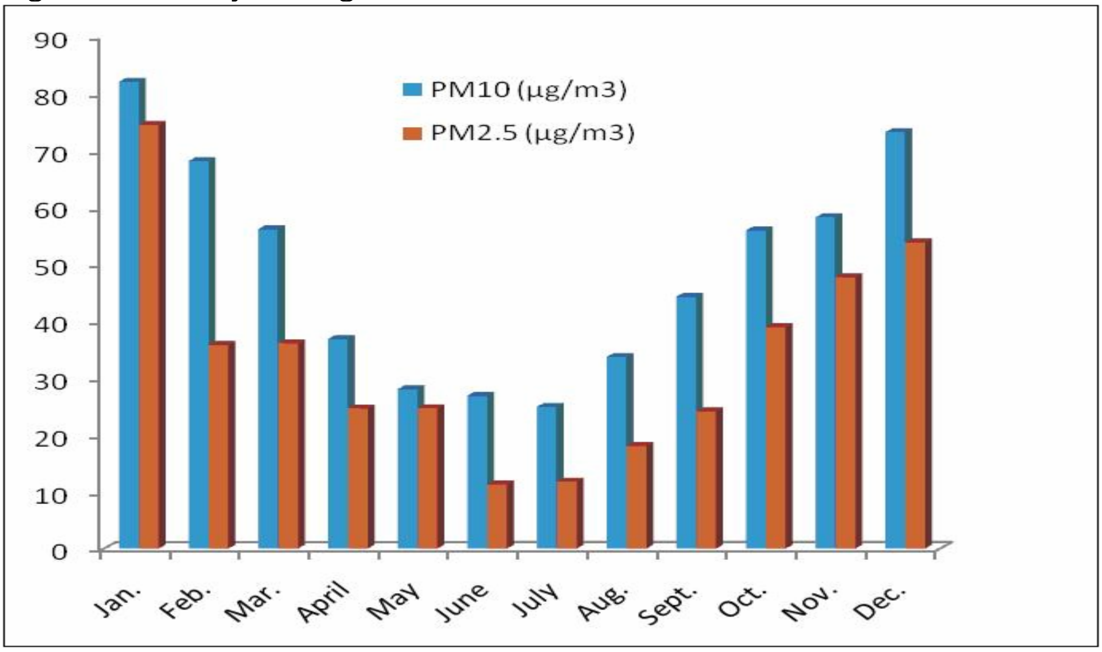

Table1 Monthly Average Carbon Concentrations in PM_{10} and $PM_{2.5}$

		TC ($\mu g/m^3$)	OC ($\mu g/m^3$)	EC ($\mu g/m^3$)	OC/EC	% TC in Aerosols	%OC in TC	%EC in TC
January	PM10	64.30	50.28	14.02	3.59	78.36	78.20	21.79
	PM2.5	43.76	31.14	12.62	2.47	58.74	71.16	28.84
February	PM10	29.57	23.19	6.38	3.64	43.39	78.43	21.56
	PM2.5	25.21	16.85	8.35	2.02	70.36	66.83	33.12
March	PM10	26.99	17.14	9.84	1.74	48.03	63.52	36.48
	PM2.5	24.13	15.94	8.19	1.95	66.81	66.05	33.94
April	PM10	25.68	17.85	7.83	2.28	69.69	69.50	30.49
	PM2.5	18.35	11.60	6.75	1.72	74.42	63.22	36.78
May	PM10	24.05	16.59	7.46	2.22	85.78	68.97	31.02
	PM2.5	19.92	14.73	5.19	2.84	80.75	73.96	26.03
June	PM10	21.48	15.93	5.55	2.87	79.91	74.15	25.84
	PM2.5	6.76	4.78	1.98	2.41	59.74	70.71	29.29
July	PM10	19.86	11.74	7.12	1.64	79.61	84.29	15.70
	PM2.5	8.20	4.65	3.54	1.31	69.44	56.78	43.21
August	PM10	22.91	17.38	5.53	3.14	67.97	75.85	24.14
	PM2.5	15.00	9.78	5.21	1.88	83.04	65.24	34.75
September	PM10	27.32	18.98	10.34	1.83	61.67	62.14	37.85
	PM2.5	17.94	12.94	5.00	2.59	74.23	72.12	27.87
October	PM10	32.24	25.95	6.30	4.12	57.63	80.47	19.52
	PM2.5	32.20	23.52	8.68	2.71	82.67	73.04	26.95
November	PM10	40.27	32.76	7.51	4.36	69.12	81.34	18.65
	PM2.5	34.79	25.53	9.26	2.76	72.87	73.38	26.61
December	PM10	47.85	40.14	8.21	4.88	65.37	77.61	22.39
	PM2.5	41.75	33.25	8.50	3.91	77.51	79.64	20.35
Average	PM10	31.88	23.99	7.88	3.20	67.21	74.54	25.45
	PM2.5	24.00	17.06	6.94	2.38	72.55	69.34	30.65