OCCURRENCE OF PAHs IN AIR SURROUNDING A COAL-FIRED THERMAL POWER PLANT IN SOUTH-WEST COAST OF INDIA

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Introduction

The Atmospheric air dust particle (aerosol), as a component of the hydrological cycle, play a major role in modifying the quality of air. One such anthropogenic constituent that can modify the quality of air is the occurrence of polycyclic aromatic hydrocarbons (PAHs) in the atmosphere. Natural sources of PAHs in air could be from sea salt, aeolian dust, whereas anthropogenic sources could be from fly ash and diesel (eg. thermal power plants), vehicular emission, burning of biomass etc. These particles bearing heavy metals and persistent toxic chemicals like PAHs are emitted in the atmosphere and deteriorates its quality. From the air, the PAHs can enter into the soil, food and water cycle. Their consumption even in low doses can cause serious health issues like lung, skin, bladder cancers, birth defects and increased DNA adduct [1].

The present study is focused on determining the PAHs in air around Udupi Power Corporation Limited (UPCL) a coal based thermal power plant. This study has also monitored seasonal changes of PAH concentrations in the air matrices and investigated its sources.

Study area

Figure 1 shows the study area and sampling locations from where the air samples were collected for PAH measurements. The study area is located between 13^0 N, 13^0 15'N latitudes and 74^0 45', 75^0 E longitudes, covering ~ 300 sq. kms. It is surrounded by Nandikur town on the north, Karkala on the east, Surathkal on the south and the Arabian Sea on the west. The study area is surrounded by National Highway (NH 66), State highway (SH 67 and 1), plenty of agricultural lands.

Air Sampling

Passive air samplers (PAS) were deployed at 12 sites at a radial distance of 2 km, 4 km, 6 km and 8 km from the thermal power plant (Fig. 1). The samplers were placed at about 14 ft, above the ground surface, in roof tops to avoid local influence. Details of the PAS sampler is explained elsewhere [2] briefly, polyurethane foam (PUFs) was positioned in the PAS and was used as a trap for PAHs. The PAS were kept for 90 days in each station. Later, the PUFs were carefully removed from stainless steel bowls and placed in a pre-cleaned aluminum box. The PUFs were stored in these boxes at -20^0 C for further extraction.

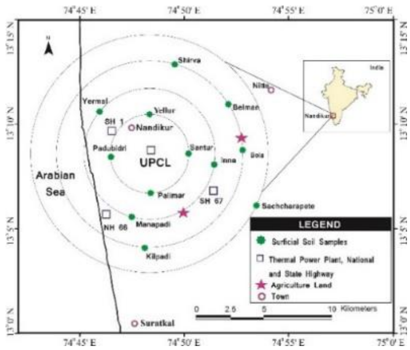

Fig. 1: Locations of (UPCL) and sampling stations. Concentric circles are 2 km apart each.

Extraction and analysis: All air samples were shipped to the International Joint Research Center for Persistent Toxic Sustances (IJRC-PTS) laboratory in Harbin Institute of Technology, Harbin, China for sample processing and 16 PAH analysis. Further extraction and analytical procedures are followed as per methods discussed in Ma et al., 2009 [2].

Quality assurance and quality control: The data has been subjected to strict quality control procedures. 16 PAHs spiked samples were analyzed out of that five samples found replicate. The average recoveries percentage for air ranged from 85.14 to 126.63% respectively. The minimum detection limit (MDLs) has been calculated using standard deviation with six replicate extractions for air ((0.00030 - 0.00177ng/m^3). Spike and blank samples were also injected in between every batch of ten sample.

Results and Discussions

Distance wise distribution of PAHs concentration

Concentration of PAHs in the air during pre-monsoon, early-monsoon and post-monsoon seasons within 2 and 6 km radius of the thermal power plant showed high concentrations compared to monsoon (Fig. 2). On the other hand, a higher concentration of PAHs was observed at a radial distance of 8 km from the thermal power plant during the monsoon season. This could be related with the wind patterns in the study area, when there are strong winds blowing in the monsoon from the southwestern side to the north-northeastern side [3] which results in blowing away of the PAHs in the immediate vicinity of the thermal power plant and getting deposited at the farther end. However, air concentration of PAHs within 4 km radius showed uniform distribution in all seasons. Among 16 PAHs, 3 ringed and 4 ringed PAHs are a significant contributor to the total PAHs concentration such as Phe, Ant, Flu and Pyr.

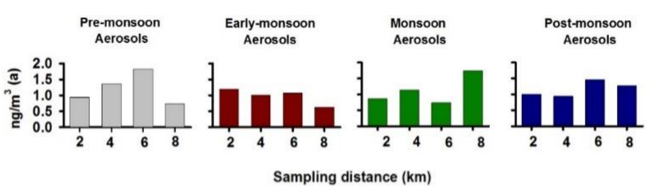

Figure 2. Distance wise distribution pattern of average PAHs in different seasons in (a) aerosol.

Seasonal variations of PAHs compounds based on aromatic rings

PAHs compounds can be differentiated with the help of aromatic rings (Fig 3). The aerosol samples in all seasons are dominated by 3 and 4 ringed PAHs (45% and 51 % respectively) vis-a-vis the 5 ringed (3 %) and 6 ringed (2%) PAHs (Fig. 3a). All samples showed the highest concentration of low molecular weight compounds, compared to high molecular weight compounds in the air. This may be due to the presence of low molecular weight compounds, easily getting evaporated as compared to 5 and 6 rings in the air.

Aerosol samples during the pre-monsoon, monsoon and post-monsoon season showed highest concentrations of 4 ring PAHs (predominantly Flu) compared to the early-monsoon season indicates the impact of petrogenic and pyrogenic sources.

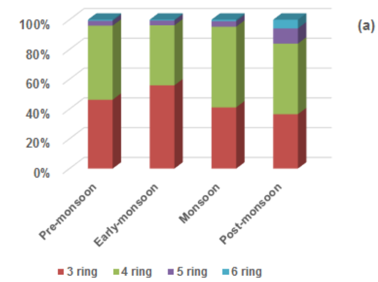

Figure 3. Distribution of PAHs based on aromatic rings in the (a) aerosol.

Thematic Mapping

The aerosol showed a low concentration in all stations compared to fly ash sample from UPCL (2.12 ng/g). It indicates that the PAHs are possibly deposited in the underlying soil (soil acts as a sink) [2] as shown in Figure 4.

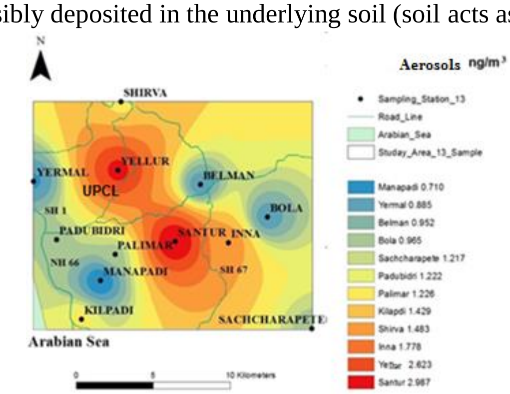

Figure 4. Thematic map representing the average PAHs concentration in the aerosols.

Principal Component Analysis

Figure 5 shows the factor scores with a rotated component matrix. The varimax rotated factor analysis yielded 3 factors in aerosol, factor 1 was highly loaded with B(a)Ant , Chr , B(b)F, B(k)F, B(a)P, B(e)P , DahA, IcdP , BghiP.

It indicated the influence of diesel emission from the thermal power plant, vehicular emission and burning of biomass. Factor 2 was loaded with Acy , Ant , Phe , Flu , Pyr , Chr , B(a)A and factor 3 was loaded with Ace, Flo, reflecting the influence of gasoline-powered vehicles.

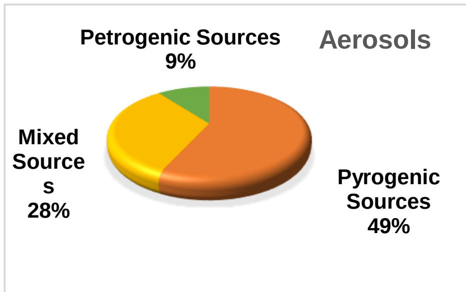

Figure 5: Principal Component analysis of aerosols

Conclusions

Aerosols samples were collected to assess the seasonal variability of PAHs in the air, south-west coast of India. The results of average PAHs concentrations in aerosol, ranges from 0.71-2.98 ng/m^3 in different seasons. The PAH analysis revealed that the aerosol samples are more influenced by the low molecular weight compounds than the high molecular weight compounds.The high concentration of 6 ringed IcdP in aerosol particularly in pre-and post-monsoon seasons, which is carcinogenic, indicates that the air is contaminated.The thematic mapping and principal component analysis revealed that the study area is influenced by the burning of biomass, vehicular emission from (NH 66, SH 67 and 1), fly ash emission and diesel emission from the thermal power plant.

Acknowledgements

Dr TMA Pai Endowment Chair-Earth Sciences, and post-doctoral research grant (to KB) is thanked for logistical support. International Joint Research Center for Persistent Toxic Substances (IJRC-PTS) laboratory in Harbin Institute of Technology, Harbin, China is thanked for providing analytical facilities.

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