LEVELS OF TRACE METALS IN RURAL AIRBORNE PARTICULATE MATTER IN KANYAKUMARI DISTRICT

[1]C. JESURAJ, [2]J.PREMA KUMARI
[1]Research Scholar, [2]Assistant Professor,
[1] Dept. of Chemistry,
[1]Scott Christian College, Nagercoil.

Abstract

An investigation was conducted to examine the variation trend of heavy metal concentration and distribution in ambient air based on seasonal fluctuations in Kanyakumari District. The aim of this study is to measure the concentration of heavy metals in the sampling sites which are characterized by different contributions of vehicular traffic intensity, ores refining industry, mountain and paddy field areas in and around of Kanyakumari district. The elements taken: Cd, Cr, Co, Cu, Fe, Pb, Mn, Ni and Zn in particulate matter collected on whatman filters were determined by means of Atomic Absorption Spectrometer (AAS). The obtained concentrations of trace elements were compared to their abundance from high-level and low-level emission sources.

Keywords: *Airborne Particulate Matter (APM), Trace Elements (TEs), Atomic Absorption Spectrometer AAS.*

I.INTRODUCTION

Air constitutes one of the most important components of living system. It is possible to live without water for some time but it is rather impossible to survive without air even for a short period. Air is vital and precious natural resource which is ignored and readily damaged whereby air becomes impure.

Trace metals in atmospheric particulate matters causes serious health hazard since they can be absorbed into human lung tissues during breathing. Anthropogenic emissions increase the levels of trace metals in suspended particulate matters above the natural background levels [1].

Trace metals pollution in the atmosphere is mainly related to the inorganic fraction, which is released from various kinds of vehicles, brickfields, constructions, ores refining factories, navigation, corrosion of metallic parts, soil dusts, etc.,[5]. Therefore, WHO gives guidelines for some trace metals [4] which can be present in air well above natural background levels as the result of anthropogenic process. For mega cities in India and Pakistan, high amount of exceedance of the WHO guideline values for cadmium and lead were reported.

The measurements of metal concentration in total suspended particles (TSP), PM_{10} or PM_2 give some indication of the general levels of pollution, but provide no information on size distribution of the pollutants. From a toxicological point of view, the most important particles are those with a diameter <10 µm, (PM_{10}), so called respirable fraction, which penetrate the human respiratory system deeply [3].

Trace elements from high temperature sources tend to concentrate during combustion in particles of a diameter below 2 µm. Combustion of fossil fuels and emissions from gasoline fueled road vehicles are the principal anthropogenic source of Cu, Ni and Zn in the rural air particulate matter [6].

The Kanyakumari district is recognized as the area with the highest level of air pollution. This is a result of the fact that in a relatively small area of 1684 km^2 with a dense population (over 1.8 crores inhabitants). Indian rare earths (IRE), Cashew nut factories, Tiles and brick factories are the industrial sources in Kanyakumari District. However, recent estimations show great importance of low emissions from household heating and traffic [2]. Individual heating devices are still utilized by 70% of inhabitants of the district. Fig.1 shows the area map representation of Kanyakumari District.

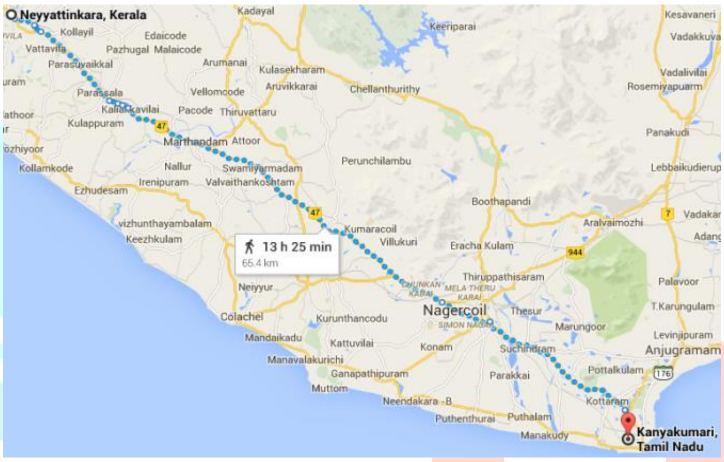

Fig.1 Kanyakumari District Area

Although heavy metals differ in their chemical properties, they are used widely in electronic components, machinery and materials. Consequently, they are emitted to the environment from a variety of anthropogenic sources to supplement natural background geochemical sources. Some of the oldest cases of environmental pollution in the world were caused by heavy metal extraction and use, for example, copper, mercury and lead mining, smelting and utilization.

The amount of most heavy metals deposited to the surface of the Earth from anthropogenic activities is many times greater than depositions from natural background sources. Combustion processes are the most important sources of heavy metals, particularly, power generation, smelting, incineration and the internal combustion engine.

Present research focused on size distribution of trace metals in ambient particulate matter. The comparison of the results obtained for four sites in the district in diverse periods of the year allows appraisal of the input of different pollution sources in the district.

II.MATERIALS AND METHODOLOGY

The samples were taken in diverse periods in the years 2013–2016 non-simultaneously at four measuring points in rural area to analyze the influence of traffic intensity and other sources on ambient air pollution.

The first measurement place taken as Colachel Municipality known to be dense populated area and is characterized by high wind and sea shore with dense buildings, narrow streets and heavy traffic. The high volume air sampler was situated 2m above ground level, 5m from the nearest busy street intersection, with intense car, bus and train traffic.

The second sampling point, taken to measure the metal concentration is at manavalakurichi. This area is exposed to heavy vehicular traffic and factories like cashew nut factory, ore refining factory and the sampler was placed at 4m from the ground level in the buildings nearest to factories.

The third point, Monday Market situated at 10km near to manavalakurichi which is highly immense with dense population and vehicular traffic area. The high volume air sampler was placed 2m above ground level, 5m from local road with car and bus traffic and 3m from small local road.

The Fourth sampling point taken as Kurunthencode an area is specialized for agriculture located with a distance of 7kms from Monday Market. The high volume air sampler was placed 1 m above ground level, 5 m from local street.

Each sampling lasted to minimize the influence of short-term weather condition changes. A high volume air sampler running on electrical energy has been purchased to collect air sample contaminated with automobile exhaust at the above mentioned sampling sites. The extent of absorption of heavy metals in each sample is calculated from the values obtained.

The high volume air sampler is popular and frequently used equipment for the determination of suspended particulate matter (SPM) in air. The principle involved in this method is that the particles are filtered from known volume of an air sample by a suction apparatus, a vacuum pump and the particles are made to deposit on porous filter paper.

The filter plate provides the base for sitting the filter paper of size 200mm x 250mm, through which air samples collected by creating suction in the filter area. This suction is created by vacuum pump with a flow rate of 25lpm. These conditions will permit the sampling of ambient air for a period of 8 hrs.

The suspended particle of size less than 10 microns and greater than 2 microns are retained on the filter. The duration of sampling is measured in an elapsed time meter which is placed in series with the blower. The sampler was placed 2m above the ground level.

For the determination of heavy metals in the samples, exposed filter paper was punched in to 8 circle of 2.5cm diameter. The circle of filter paper was treated with acid digestion process. A blank filter paper was similarly digested and same procedure was carried out. The metals were determined using an Atomic Absorption Spectrometer. The concentration was calculated comparing the absorbance of sample solution with the standard metals solution.

III.RESULTS AND DISCUSSIONS

In all of the four sampling sites, the concentration of air particulate matter in the fine particles region (< 2µg) were higher during the winter period, which indicated higher contribution of the dust sediment sources and gaseous pollutants from the factories.

Table 1: Weight concentration [ppm] of 9 TEs- Winter Season

Area	Cd	Cr	Co	Cu	Fe	Pb	Mn	Ni	Zn
Colachel	0.1102	0.1981	0.0342	0.1279	1.1451	0.1832	0.0298	0.0616	1.8623
Manavalakurichi	0.1121	0.1796	0.0492	0.1045	1.1045	0.1765	0.0256	0.0434	1.1432
Monday Market	0.1498	0.1268	0.0264	0.1165	1.1231	0.1976	0.0342	0.0275	1.5889
Kurunthencode	0.1656	0.1265	0.0397	0.1198	1.1092	0.1738	0.0198	0.0498	1.6221
Average	0.1344	0.1577	0.0373	0.1171	1.1204	0.1827	0.0273	0.0455	1.5541
Min	0.1102	0.1265	0.0264	0.1045	1.1045	0.1738	0.0198	0.0275	1.1432
Max	0.1656	0.1981	0.0492	0.1279	1.1451	0.1976	0.0342	0.0616	1.8623

Table 1 show the values of weight concentration [ppm] of 9 TEs in fly ashes escaping from power plants and originating from other traffic sources (low emissions) compared with their concentration in relevant ambient aerosol fractions for four locations.

Fig 2 shows the graphical representation of the weight concentrations of trace elements from four locations during winter season.

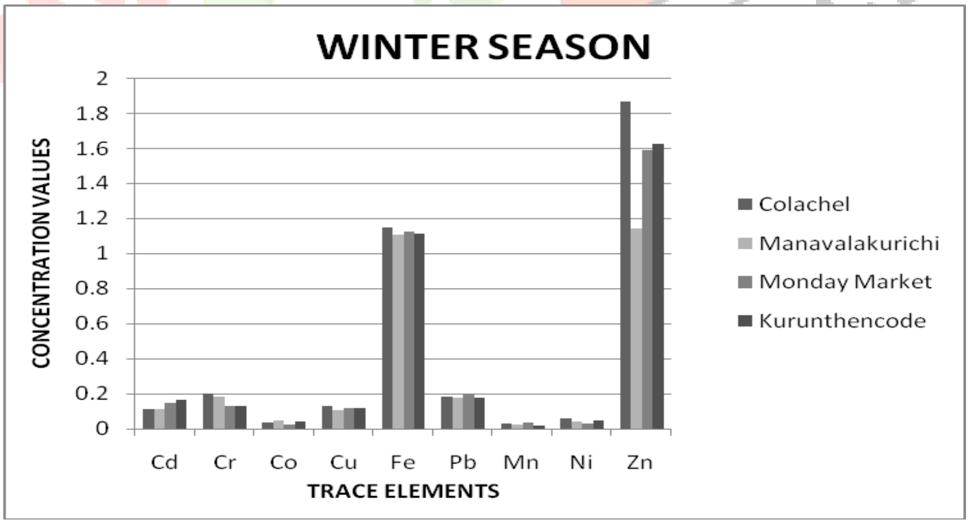

Fig 2: Graphical representation of 9TEs [ppm] - Winter Season

Due to seasonal variation trace metal concentration in the atmospheric aerosol vary significantly. The values of weight concentration [ppm] of 9 TEs in fly ashes during summer season from four locations are summarized in the Table 2.

Table 2: Weight concentration [ppm] of 9 TEs-Summer Season

Area	Cd	Cr	Co	Cu	Fe	Pb	Mn	Ni	Zn
Colachel	0.1001	0.1887	0.0241	0.1087	0.9784	0.1738	0.0176	0.0516	1.7823
Manavalakurichi	0.1012	0.1733	0.0343	0.0945	1.0116	0.1656	0.0145	0.0298	1.0812
Monday Market	0.1158	0.1031	0.0251	0.1034	1.1094	0.1526	0.0245	0.0176	1.4456
Kurunthencode	0.1297	0.1257	0.0368	0.1136	1.1028	0.1586	0.0134	0.0346	1.3574
Average	0.1117	0.1477	0.0301	0.1051	1.0506	0.1627	0.0175	0.0334	1.4166
Max	0.1297	0.1887	0.0368	0.1136	1.1094	0.1738	0.0245	0.0516	1.7823
Min	0.1001	0.1031	0.0241	0.0945	0.9784	0.1526	0.0134	0.0176	1.0812

The graphical representation of the weight concentrations of trace elements from four locations during summer season is shown in Fig 3.

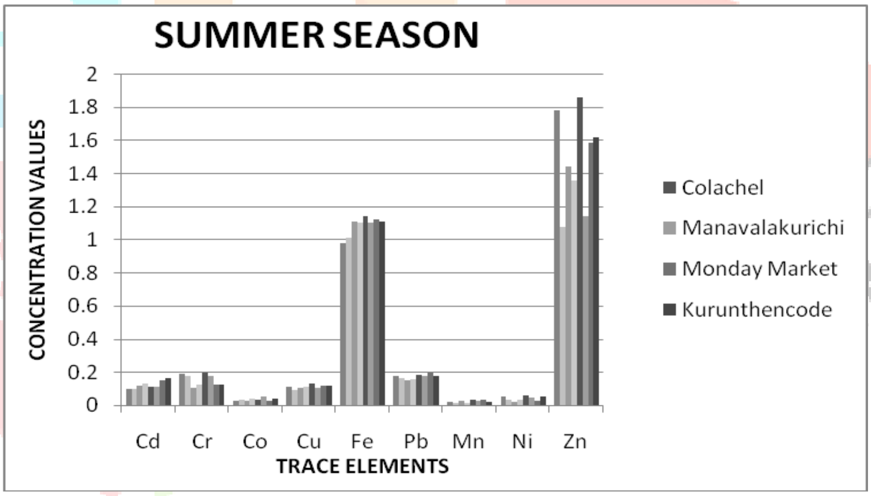

Fig 3: Graphical representation of 9TEs [ppm]-Summer Season

According to the data presented in Table 1 and Table 2, generally three types of weight distribution.

First, there is a group of elements whose weight concentrations are greater than 1ppm during both summer and winter season but the abundant amount of Fe and Zn is present comparatively greater in above locations during winter. These locations are strongly influenced by vehicular traffic and ores refining factories in Kanyakumari District. The airborne particulate matters indicate higher concentration of heavy metals in air due to the lack of air flow during winter season.

Second, there is another group of elements such as Pb, Cd, Cu and Cr whose weight concentrations are marked as below 1ppm at above sites. Since those sites are strongly influenced by constant heavy traffic including passenger cars, buses and heavy duty trucks, the particulate matter indicates lower concentrations due to lower emissions from small factory sources and transport of traffic-related particles in dry, summer weather when compared with winter season.

Third, rest of the group of elements such as Co, Mn and Ni shows the less level of trace elements present in atmosphere while compared to other elements considered during both seasons.

IV.CONCLUSION

High concentrations of trace metals in atmospheric particulate matters are a great threat for the public health in Kanyakumari District. The long-term air sampling period (10–14 days) necessary for fractioned ambient particulate matter collection allows for the weather influenced fluctuations of trace metal concentrations in the rural atmosphere. This is important for a reliable appraisal of the inhabitant's exposure to the inhalation of toxic elements with suspended fine particles. The Kanyakumari district is still contingent upon most important source: vehicular traffic influences mainly the aerosol composition in the centre of the district, predominantly in the fine particulate matter range. According to environmental monitoring and modeling data, the mean 24-hr concentration of PM_{10} resulting from vehicular traffic ranges from 1 µg for most of the district area up to 2 µg in the centre of the district and around main highway junctions.

V.ACKNOWLEDGEMENT

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