Air quality analysis of Imphal city, India

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Abstract

Nine samples of suspended particulate matters (SPM) in air which is deposited on the road side tree of Imphal city were collected and EDXRF analysis was done to identify the elements present in air. The elements like Mg, Al, Si, S, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Pb, Rb, Sr and Zr were detected. Out of which the toxic elements viz. Cr and Pb are potential threat to our health.

Key words: air quality, elements, environment

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Introduction

The suspended particulate matter in air is of great concern for its health impact to our body. Many cardiac and lungs relating diseases can be caused by them. Moreover, the toxic elements present in aerosols may lead to severe effect. Small solid particles and liquid droplets are in atmosphere collectively termed SPM. The size of the particulate matter is very important which determines its role in the environment. The size of the particulate matter is very important parameter which determines its role in the environment. The size may vary from 0.5-1.0 µm to 500 µm. The residence time of a particle in the atmosphere depends upon the settling rate which, in turn, depends upon the particle size and density, turbulence of air and humidity. SPM may be of natural or artificial (anthropogenic) origin. The natural sources are sea salt, volcano, soil. Artificial sources are combustion of fossil fuel (coal and oil) cement kilns, incinerators and many industrial plants. Aerosols are special SPMs which remain suspended in the atmosphere for an indefinite period. It is a colloidal state of matter where the dispersed phase is a solid/liquid substance and the medium is gas.

The longer residence time of solid aerosols in the atmosphere is due the existence of electrical charge on the surface. This prevents them from coming in contact with one another and condensing. The main constituent aerosols are dust, sea salt, soot and organic compounds. Among the elements that can be found in the aerosols, the predominant ones in the coarser fraction are C, O, N, Fe, K and Ca, whereas the majority of the heavy metal content is present in the fine fraction (Wojas and Almquist, 1997; Espinosa et al., 2001; Marcuzzan et al., 2007). Manipur, a landlocked north east state of India bordering Myanmar is situated at an elevation of about 800 m above sea level. The valley region, about 10% of the total area 22, 356 sq. km is surrounded by remaining hill region. More than 50% of the total population of 27 lakhs resides in the valley region. Imphal, the largest city is the capital of the state. As reported by Sangai Express, the daily news paper, Manipur dated 29-03-2011, it had been mentioned that Air pollution due to dust particle was highest at Imphal city as compared to remaining cities of North East states of India. It may due to the bad road management, various construction works and particulate matter emitted from various brick fields surrounding the city. So, identification of the elements present in air of the city is necessary for our better future. Many techniques viz. PIXE, ICP-AES were reported for the elemental analysis (Cahill, 1996; Castanho and Artaxo, 2001; Madhu Jha et al., 2010).

Materials and Methods

The dust particles deposited on the leaves of road side tree were collected in November from nine (9) different stations of Imphal city, the capital of Manipur. The most traffic congested area was chosen for collection site to see the nature of pollutants. The collection was done from a height 2 to 3 m of the trees to avoid soil
contamination from the ground and they are coded as A1, A2 to A9. The samples were ground in an agate mortar to minimize its particle size so as to enable us its homogeneity. 150 mg of the powder sample was made into pellets of diameter 13 mm by using a tabletop pelletizer at a pressure 130 kg/cm² for 2 min. The elemental analysis of the sample was carried out using a Jordan Valley EX-3600 Energy Dispersive X-ray Fluorescence (EDXRF) spectrometer, which consists of an oil-cooled Rh anode X-ray tube (maximum voltage 50 kV). The measurements were carried out in vacuum using different filters (between the source and sample for optimum detection of elements. The anode voltage of the X-ray tube was kept at 6 kV, 14 kV and 23 kV with no filter, Ti and Fe filter respectively. All measurements were carried out for 200 s. The X-rays were detected using a liquid-nitrogen-cooled 12.5 mm² Si (Li) semiconductor detector (resolution 150 eV at 5.9 keV) which was seen in the monitor fitted with the spectrometer. Further, the aerosol was collected at a height 9 m on the quartz filter with the help of an aethalometer in Manipur University campus. This aerosol loaded filters was used for qualitative analysis of the elements present in it. The Black Carbon concentration can estimate by the aethalometer.

Results and Discussion

Fig.1. EDXRF spectrum of A1 for 14 kV anode voltage of X-ray tube.

The peaks seen in this spectrum are \( K_α \) characteristic X-ray of the elements detected in the energy range 0-10 keV. The overlapping peaks of V and Ti, Cr and V, Mn and Cr signify that V \( K_α \) line mixes with Ti \( K_β \), Cr \( K_α \) line mixes with V \( K_β \), Mn \( K_α \) line mixes with Cr \( K_β \), line respectively. The area under the peak is directly proportional to the concentration of the respective element present in the sample. As evident from the spectrum, peak area of Fe (iron) was found to be highest among the elements present in the sample leading to the conclusion that the SPM deposited on the plant leaves was almost soil origin as iron is abundant in the soil. The spectra of the nine samples had almost the same form. The elements detected in the samples along with their collecting stations are shown in table 1.

### Table 1. Elements detected in the SPM deposited on the plant leaves

<table>
<thead>
<tr>
<th>Stations</th>
<th>Code</th>
<th>Peaks (Elements detected)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khuyathong</td>
<td>A1</td>
<td>Mg, Al, Si, S, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Pb, Rb, Sr, Zr</td>
</tr>
<tr>
<td>North AOC</td>
<td>A2</td>
<td>Mg, Al, Si, S, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Pb, Rb, Sr, Zr</td>
</tr>
<tr>
<td>Kangla</td>
<td>A3</td>
<td>Mg, Al, Si, S, K, Ca, Ti, Cr, Mn, Fe, Ni, Cu, Zn, Pb, Rb, Sr, Zr</td>
</tr>
<tr>
<td>Porompat</td>
<td>A4</td>
<td>Mg, Al, Si, S, K, Ca, Ti, Cr, Mn, Fe, Ni, Cu, Zn, Pb, Rb, Sr, Zr</td>
</tr>
<tr>
<td>Waheng Leikai</td>
<td>A5</td>
<td>Mg, Al, Si, S, K, Ca, Ti, Cr, Mn, Fe, Ni, Cu, Zn, Pb, Rb, Sr, Zr</td>
</tr>
<tr>
<td>RIMS gate</td>
<td>A6</td>
<td>Mg, Al, Si, S, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Pb, Rb, Sr, Zr</td>
</tr>
<tr>
<td>Keisampat</td>
<td>A7</td>
<td>Mg, Al, Si, S, K, Ca, Ti, Cr, Mn, Fe, Ni, Cu, Zn, Pb, Rb, Sr, Zr</td>
</tr>
<tr>
<td>Secretariat</td>
<td>A8</td>
<td>Mg, Al, Si, S, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Pb, Rb, Sr, Zr</td>
</tr>
<tr>
<td>Singjamei</td>
<td>A9</td>
<td>Mg, Al, Si, S, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Pb, Rb, Sr, Zr</td>
</tr>
</tbody>
</table>

The detection of toxic elements viz. chromium (Cr), lead (Pb) in all the samples is important to be noted as they are highly toxic even for a small amount. If the particle size of such toxic elements is PM₂.₅, they will enter to the blood circulation and may lead to health hazard. Another toxic element viz. vanadium (V) is also present in some samples collected from Khuyathong, North AOC, RIMS gate, Secretariat, Singjamei signifying its specific in location. Almost all the above mentioned, elements in table 1 were also detected in the aerosol samples of Mandi-Gobindgarh, Chandigarh, Jaipur (Blouria et al., 2006). The sulphur present in the samples may be in organic or inorganic compound form.
The elements detected from the quartz filter of aethalometer were Si, S, Ca, Ti, Mn, Fe, Cu, Zn and Ni. Here, most of the silicon (Si) detected will be from the quartz (SiO$_2$) filter. The less detection of elements in this case from the elements detected in SPM samples deposited on plant leaves suggest that the size of SPM containing Mg, Al, K, V, Cr, Pb, Rb, Sr, Zr are larger in size or their concentration is very less at higher level from the ground. Lastly, the maximum and minimum black carbon concentration of aerosol in November 1, 2011 observed by aethalometer was found to be 20296 and 759 µg/m$^3$ respectively. It was quite high as compare to aerosol concentration of 700 ng/m$^3$ of black carbon mass over Indian Ocean at a height above 1 km (Veerabhadran Ramanathan et al., 2007).

**Conclusion**

The SPM collected from different stations from Imphal city consists of many elements like Mg, Al, Si, S, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Pb, Rb, Sr, Zr out of which V, Cr and Pb are toxic element. Some of the elements could not be detected at higher level from the ground which may be due their size effect as larger size particulate matter has a better chance of settling on the ground quickly.

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**References**


