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Metal Levels in Airborne Particulate Matter in Industrial Area of Bandar Abbas, Iran

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ABSTRACT

Total Suspended particulate matter (TSP) inurban atmosphere of Bandar Abbas was collected using a high volume sampling technique for a period of one year (2010-2011). The nitric acid–perchloric acid extraction method was used and the metal contents were estimated byatomic absorption spectrophotometer. The highest mean concentration was found for Ni at 34.5 $\mu g/m^3$ followed by Fe (44 $\mu g/m^3$) in hot season and 33 $\mu g/m^3$ and 34 $\mu g/m^3$ in cool season and there were more than WHO and USEPA standards. However, the average Ni level (0.033$\mu g/m^3$) was 6.7 times higher than the proposed WHO standard.On an average basis, the decreasingmetal concentration trend was: Fe>Al>Cd>Pb>Ni. The correlation study revealed very strong correlations ($P<0.01$) between Pb-Ni, Fe-Al and Cd-Pb. Finally, suitable managing solutions to improve existing situation is presented in term for all results.

Keywords: Airborne, metal pollution**,** TSP, Bandar Abbas, Iran

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INTRODUCTION

In the atmosphere, most metals are present in particulate form after release by both natural and man-made activities. The emissions of metals from anthropogenic sources occur via diverse pathways including combustion of fossil fuel, waste incineration, industrial processes, roasting and smelting of ores in non-ferrous metal smelters, melting operations in ferrous foundries, andKiln operations in cement plants [1]. These metals are eventually removed through a deposition on the aquatic and terrestrial ecosystems [1].Atmospheric total suspended particulate matter (TSP) has been linked with a number of environmental and human health effects on regional and global scales [2 , 3]. Since TSP chemical composition is important in understanding the properties of ambient suspended particles, including sources, chemical evolution, optical properties and human health effects, accurate determination of their chemical constituents is critical. The study of the large-scale influence of TSPon the environment needs a deep knowledge of particulate load and of chemical composition and distribution in the atmosphere [4].

The largest emissions of anthropogenic metals occurred in Asia; this is generally explained by the growing consumptionof energy, increasing industrial activities, and the low efficiency of emission control [1]. On a global scale, resuspension of surface dusts acts as the dominant compartment of the natural metal budget; for instance, it is expected to account for >50% of Cr and Mn and >20% of Ni. In contrast, volcanic activity can probably cover around 20% of Hg, As, and Ni emission [5]. The combination of vehicular emissions and the dust resuspension may constitute the most significant man-made sources of metal species [6, 7, 8, and 9].

In this study, the fundamental characteristics of airborne metal pollution were investigated from fifteen different locations of the Almahdi Aluminum factory in Bandar abbas (South of Iran).

MATERIALS AND METHODS

Two sampling locations were selected during the present study; 10 stations inside the factory area and 5 stations outside the complex. The sampling was performed on regular 24 hrs basis, commenced at 08 o Clock in cold and hot season of 2011. Samples were collected on cellulose and glass fiber filters (20.4×25.4 cm) using high-volume samplers(ECHO PM, model GMWL-2000H, Italy) at a stipulated flow rate of 1.7 m^3/min(Method 4096 ASTM: D). For the metal estimation,each filter was extracted by nitric acid(Merck Suprapure 65%) and perchloric acid (MerckSuprapure70%) mixture (10:1, v/v) NIOSH Method-7300 [10]. The extracted solution was filtered with washing by doubly distilled water and refrigerated in pre-cleaned strong polyethylene bottle until analyses [11]. Filter and reagent blanks were also processed following the above procedure for sample treatment. Metals were determined by Atomic Absorption Spectrophotometer (Shimadzu, model Solaar M5, England) following Method IO-3.2 [12].The gained data were analyzed statistically by SPSS software.

RESULTS AND DISCUSSION

The distribution of selected trace metals in samples collected and analysed during the study period are given in Table 1. The average metal concentrations in airborne TSP can be compared with the safe limits proposed by international agencies. The WHO standards for atmospheric Pb, Mn, Cr, Ni and Cd are 0.500, 0.150, 1.10, 0.00038 and 0.005 μg/m^3.Those of USEPA are 1.500, 0.500, 0.100, 0.00024 and 0.006 μg/m^3 [4,13].

Table 1: Comparison the Mean of Metals Concentration with Standards

Metal	Cool Season	Hot Season	SD.
	mean con(µg/m3)	mean con (µg/m3)	mean con(µg/m3)
Fe	0.034	0.044	0.005
Pb	0.1719	0.203	0.5
Cd	0.0014	0.004	0.005
Ni	0.033	0.034	0.005
Al	0.0184	0.073	_

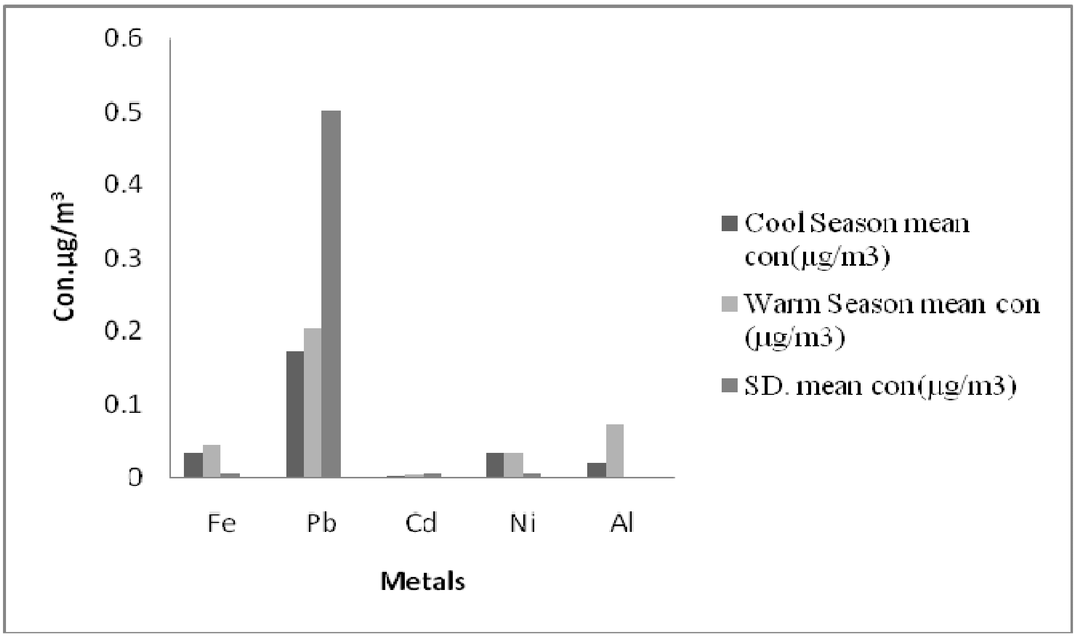
In terms of basic statistical parameters, the highest mean concentration was found for Ni at 34.5 μg/m^3, followed by Fe at 44 μg/m^3 in the hot season; the concentrations were 33 μg/m^3 and 34 μg/m^3, respectively, in the cool season. These levels were higher than the WHO and USEPA standards. The average Ni level (0.033μg/m^3) was 6.7 times higher than the proposed WHO standard. The main reasons for this are oil refinery activity and the use of Matzoth fossil fuels by industries in this region, particularly power plants.

Metal levels in the hot season were higher than those in the cool season. The average metal concentrations in airborne TSP can be compared with the safe limits proposed by international agencies. During the present study, average concentrations of Pb (0.171μg/m^3) and Cd (0.0041 μg/m^3) in the cool season, followed by their concentrations in the hot season (0.203μg/m^3 and 0.004μg/m^3, respectively) were found to be within the WHO and USEPA standard ranges. Based on the results obtained, the level of Pb in air (atmosphere) samples in Bandar Abbas is brought about by oil production and fossil fuels used by the Bandar Abbas power plant factory. Furthermore, because of the vehicle traffic in this area, cadmium (Cd) from vehicles' tires and car oil is increasing the soil and air (atmosphere) pollution in the region. During the present study, average concentrations of Al were 0.184μg/m^3 in the cool season and 0.073μg/m^3 in the hot season. We can not give an opinion about the average aluminium density in the study region because standards and/or international averages are lacking.

Fe is one of the most frequently used elements in industrial activities, and is particularly prevalent in the roll and melting industries. It is the most abundant element in the Earth's crust, and its measure varies in different places. The average concentration of Fe (0.0385μg/m^3) was 7.8 times higher than the proposed WHO and ATSDR standards [4, 13]. The main reason for this is the activity of the zinc and aluminium industries and steel factories in this region. Variations in average levels of Fe, Pb, Cd, Al and Ni exhibited the following pattern during the study period: cool season < hot season, manifesting a negative interaction with the temperature [14, 15]. Furthermore, in general, all metals were found to be negatively correlated with rainfall, signifying their scavenging effect [15, 16, 17, and 18].

Pb and Ni had a strong correlation coefficient with one another. These elements exhibited a positive relationship ($P<0.01$). Furthermore, Fe and Al also had a strong, positive correlation coefficient ($P<0.01$). This was also the case with Cd and Pb ($P<0.01$); an increase in density in one of these elements resulted in an increase in density in the other in air. Overall, the metal correlation data helped to isolate some metal groups that could be used as pointers to common sources of their distribution in TSP [15, 19, and 20].

Figure 1: Comparison of Heavy Metal Concentration Measurements in Air during the Hot and Cool Season (µg/m³)



CONCLUSION

Given the results of this study, recommendations can be made to perform the following actions in order to improve the environmental air quality in the Bandar Abbas Industrial complex:

1- Ensuring that primary materials, including aluminium powder and calcite oil, enter the transmission line through suction tippers. Furthermore, making sure they end up at a land site that is located at a distance of at least 500 m from any beaches. In the developed recommendations, there are two ways for materials to be transported from the land to the factory.

A: Material transmission by truck In this approach, due to the economic value of aluminium powder, almost all of the transmission and discharge activities are performed in the protected area and the material is transported from one portage system to another and/or a silo.
B: Material transmission by truck from the land site to the factory.
2- Setting up wind breakers in places where there are powder-like materials deposited in them.
3- Identifying pollutant sources and controlling their activity.
4- Monitoring of air (atmosphere) and implementation of in ingredient surveillance programs through fixed and mobile stations in the region.
5- Performing studies of Environmental Impact Assessment (EIA) during projects and operations as interceptor tools.
6- Surveillance and scrutiny of air pollutants in the region by satellite and determining pollutants affecting other regions.
7- Restriction of open vehicle traffic carrying mineral materials on highways.
8- Setting up suitable filters to control output gases and chimney contents.

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