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RESEARCH ARTICLE

STUDY OF PM_{10} BOUND HEAVY METALS IN AMBIENT AIR OF DEWAS INDUSTRIAL AREA, MADHYA PRADESH, INDIA

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ABSTRACT

Heavy metals in ambient air mostly bound with the particulate matter can cause harm to health if its concentration increases. The study of PM_{10} bound heavy metals i.e. Chromium (Cr), Manganese (Mn), Copper (Cu), Zinc (Zn), Cobalt (Co), Cadmium (Cd), Iron (Fe), Lead (Pb), Nickel (Ni) and Arsenic (As) in ambient air atmosphere of Dewas industrial area, Madhya Pradesh, India has been done. Among of all heavy metals mainly three metals i.e. Pb, Ni and As were reported as pollutants in National Ambient Air Quality Standards 2009. Lead (Pb) was found within standard limit (0.5 µg/m^3) at all monitoring locations except A1 (1.054 µg/m^3) and A2 (1.64 µg/m^3) locations, Nickel (Ni) was found exceeded standard limit (20 µg/m^3) at all monitoring locations except A9 (11.48 ng/m^3) and Arsenic (As) was found within standard limit (6 µg/m^3) as per National Ambient Air Quality Standards of India (2009) at all monitoring locations around Dewas industrial area. Based on the study, Dewas Industrial area found polluted w.r.t. heavy metals viz., Ni and Pb in ambient air.

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INTRODUCTION

Particulate matter pollution is a serious environmental issue mainly due to the presence of toxic substances and trace metals in the atmosphere (Shah, 2006). Heavy metals associated with respirable particles have also been shown to increase lung or cardiopulmonary injuries caused by particulate air pollutant exposure (Espinosa, 2001; Cancio, 2008; Leili, 2008). Natural emissions (crustal minerals, forest fires and oceans), traffic and industrial emissions (combustion of fossil fuel and industrial metallurgical processes) are the principal sources of heavy metals in the ambient air (Park, 2008; Stone, 2011; Xue *et al*., 2011). Due to the increase in various developmental activities in different sectors like industrial, transportation and other related fields, the rising problem of air pollution is increasing day by day (Cheung *et al*., 2011). Naturally derived trace metals are usually found in coarse particles (Fang *et al*., 2000). Heavy metals enter into the environment mainly via three routes: deposition of atmospheric particulates; disposal of metal enriched sewage sludge and sewage effluents; and by-products from metal mining processes (Shrivastav, 2001).

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Metals in air are most often bound to dust particles that have a different aerodynamic diameter. In suspended particles, the ability to bind heavy metals increases with their decreasing size (Wichmann, 2000). Heavy metals bound on dust particles in the air are affected by the processes occurring in the atmosphere only to a very low extent (Sýkorová, 2017). The impact of heavy metals on environment and human health is dependent on mobility of each metal and its occurrence in various components of the environment (Nouri, 2009). Atmospheric deposition of heavy metals in the vicinity of metallurgical plants can influence the vegetation growing and can be responsible for damage of physiological functions of living organisms through food chains (Mohanraj, 2004). Potentially toxic metals, e.g. nickel, lead and cadmium are accumulated in the urban environment mainly in the particles of aerodynamic diameter < 1 µm (Cabada, 2004). Approximately 70-90% of heavy metals are distributed in the particles of size smaller than PM_{10}. Several metals, such as Pb, Cd, Cr and Co are considered hazardous contaminants that can accumulate in the human body, with a relatively long half-life (Onder, 2006). Main anthropogenic sources of heavy metals are various industrial sources such as present and former mining activities, foundries and smelters, and diffuse sources such as combustion, traffic, piping etc. major activities emitting heavy metals in the air are organic and inorganic petro-chemical processing, steel and metal foundries, motor

vehicles, fertilizers, other industrial activities such as glass, cement, asbestos manufacture, textile mills and steam generation power plants. Other sources include wind transport from road dust, incineration of municipal refuse and sewage sludge. The burning of wood in fireplaces, campfires, leaf burning, and rubbish incineration also may contribute heavy metals to the air (Kori, 2019). Air emissions from industrial activities may even affect residential areas at remote distances from industrial sectors. The objective of this study was to analyse PM_{10} bound heavy metals in ambient air of Dewas industrial area.

METHODOLOGY

Study Area: Dewas District in Ujjain Revenue Division, is situated on the Malwa plateau in the West-central part of Madhya Pradesh, India and lies between 20°17´ and 23°20´ North latitude and 75°54´ and 77°08´ East longitude. The district is bounded by Ujjain district in the north, Indore district in the west, West-Nimar district in the south-west, East Nimar district in the south, Hoshangabad district in the South East, Sehore district in the east and Shajapur district in the North-East.

Monitoring Locations: Dewas industrial area is consist of four industrial area i.e. Industrial Area 1, Industrial Area 2 & 3, Sia Industrial Area, Ujjain Road Industrial Area. Total nine locations in different industrial area in Dewas were selected for ambient air monitoring is depicted in table no 1 and figure no 1.

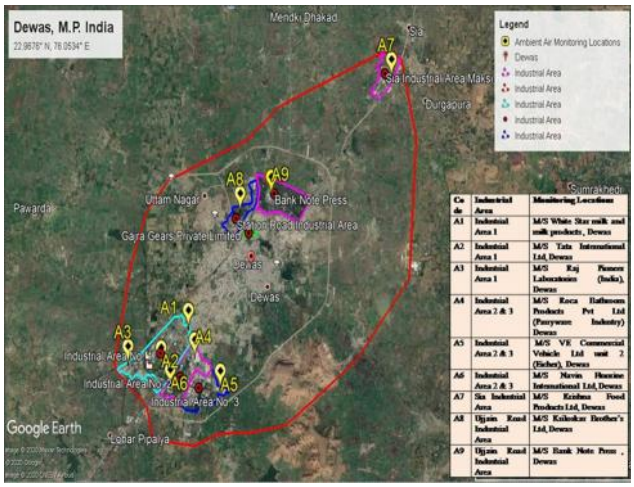

Figure 1. Monitoring Locations in Dewas industrial area

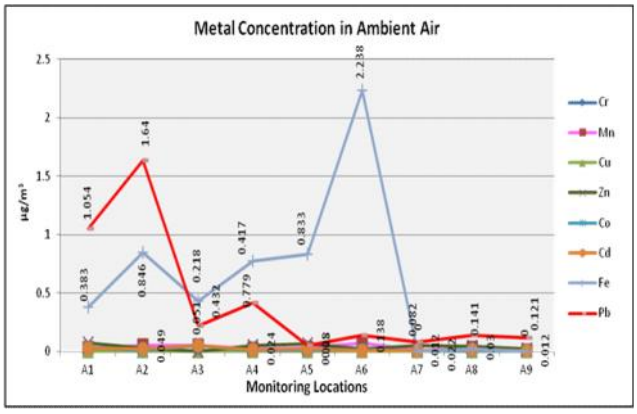

Figure 2. Metal concentrations in Ambient Air

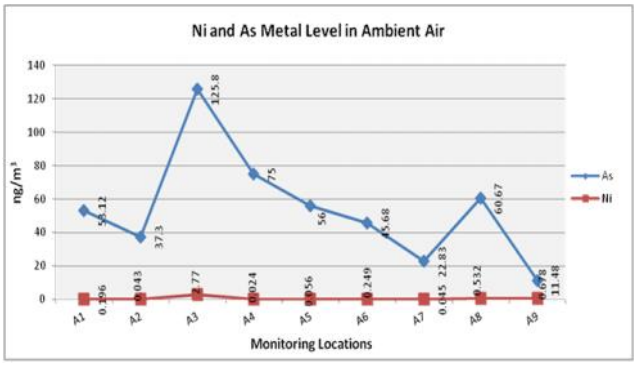

Figure 3. Ni and As Metal Concentration in Ambient Air

Monitoring: Ambient air was drawn through a size-selective inlet of the dust sampler Envirotech APM-460 and according to guideline followed by Central Pollution Control Board (20).

Analysis: For analysis, the collected sample on glass fibre filters extracted by hot plate procedure extraction**.** Cut a 1" x 8" strip or half the filter from the 8" x 10" exposed filter using a stainless steel pizza cutter. Place the filter in a beaker using vinyl gloves or plastic forceps. Cover the filter with the extraction solution (3% HNO_3 & 8% HCl). Place beaker on the hotplate, contained in a fume hood, and reflux gently while covered with a watch glass for 30 min. Do not allow sample to dry. Remove the beakers from the hot-plate and allow to cool. Rinse the beaker walls and wash with distilled water. Add approximately 10 ml reagent water to the remaining filter material in the beaker and allow to stand for at least 30 min. Transfer the extraction fluid in the beaker to a 100 ml volumetric flask or other graduated vessel. Rinse the beaker and any remaining solid material with distilled water and add the rinses to the flask. Dilute to the mark with distilled water (Type I) water and shake. The final extraction solution concentration is 3 % HNO_3/8% HCl. The filtered sample is now ready for analysis (32).

Analysis of digested samples by AAS: Analysis of acid digested samples was carried out with the help of AAS. Digested samples were aspirated into the flame, using nebulizer and concentration of element (µg/ml) in the sample was obtained. Concentration of heavy metals in the atmosphere of selected sites were determined using the following relation

$C = (Ms – Mb) \times Vs \times Fa / (V \times Ft)$

Where,

C = Concentration of metal in µg /m^3, Ms = Metal concentration in µg/ml, Mb = Blank concentration in µg/ml, Vs = Total volume of extraction in ml, Fa = Total area of exposed filter in cm^2, V = Volume of air sampled in m^3, Ft = Area of filter taken for digestion in cm^2.

RESULT AND DISCUSSION

The observed concentration of annual average of PM_{10} bound heavy metals µg/m^3 and ng/m^3 in ambient air is depicted in table 2 and table 3 respectively. In figure 2, observed concentration of PM_{10} bound heavy metals i.e. Cr, Mn, Cu, Zn, Co, Cd, Fe, Pb in µg/m^3 is showing that all heavy metal found in micro level.

Table 1. Monitoring Locations

S.N	Code	Industrial Area	Monitoring Locations	Latitude & Longitude
1.	A1	Industrial Area 1	M/S White Star milk and milk products , Dewas	22.5754 & 76.2453
2.	A2	Industrial Area 1	M/S Tata International Ltd, Dewas	23.1064 & 77.52432
3.	A3	Industrial Area 1	M/S Raj Pioneer Laboratories (India), Dewas	23.07689 & 77.55652
4.	A4	Industrial Area 2 & 3	M/S Roca Bathroom Products Pvt Ltd (Parryware Industry) Dewas	23.11448 & 77.51583
5.	A5	Industrial Area 2 & 3	M/S VE Commercial Vehicle Ltd unit 2 (Eicher), Dewas	23.10886 & 77.51757
6.	A6	Industrial Area 2 & 3	M/S Navin Fluorine International Ltd, Dewas	23.09844 & 77.52922
7.	A7	Sia Industrial Area	M/S Krishna Food Products Ltd, Dewas	23.08073 & 77.53493
8.	A8	Ujjain Road Industrial Area	M/S Kriloskar Brother's Ltd, Dewas	23.07719 & 77.54176
9.	A9	Ujjain Road Industrial Area	M/S Bank Note Press , Dewas	23.07449 & 77.53204

Table 2 Metal concentration level in ambient air

S.N	Analytes	NAAQS	Unit	A1	A2	A3	A4	A5	A6	A7	A8	A9
1	Cr	-	µg/m^3	ND	ND	0.007	0.005	ND	ND	ND	ND	ND
2	Mn	-	µg/m^3	0.033	0.049	0.051	0.024	0.028	0.071	0.012	0.03	0.012
3	Cu	-	µg/m^3	ND	ND	ND	ND	ND	ND	ND	ND	ND
4	Zn	-	µg/m^3	0.076	0.03	ND	0.053	0.067	0.026	0.05	0.047	0.024
5	Co	-	µg/m^3	0.035	0.006	0.051	0.006	0.009	0.018	0.01	0.002	0.01
6	Cd	-	µg/m^3	0.027	0.021	0.049	0.016	0.02	0.011	0.01	0.015	0.009
7	Fe	-	µg/m^3	0.383	0.846	0.432	0.779	0.833	2.238	ND	0.022	ND
8	Pb	0.5	µg/m^3	1.054	1.64	0.218	0.417	0.05	0.138	0.082	0.141	0.121

Table 3. Ni and As metal level in ambient air

S.N	Analytes	NAAQS	Unit	A1	A2	A3	A4	A5	A6	A7	A8	A9
1	Ni	20	ng/m^3	53.12	37.3	125.8	75	56	45.68	22.83	60.67	11.48
2	As	6.0	ng/m^3	0.196	0.043	2.77	0.024	0.056	0.249	0.045	0.532	0.678

Pb was found within standard limit (0.5 µg/m^3) as per National Ambient Air Quality Standards 2009 at all monitoring locations except A1 (1.054 µg/m^3) and A2 (1.64 µg/m^3) locations of Dewas industrial area. In figure 3, observed concentration of PM_{10} bound heavy Ni was found, exceeded at all monitoring location except A9 (11.48 µg/m^3) as comparison of standard limit (20 µg/m^3) as per National Ambient Air Quality Standards 2009. As was found within standard limit (6 µg/m^3) as per National Ambient Air Quality Standards 2009 at all monitoring locations of Dewas industrial Area.

Conclusion

The observed concentration of PM_{10} bound heavy metals i.e. Cr, Mn, Cu, Zn, Co, Cd, Fe, Pb, Ni and As in ambient air has been done. Among of all heavy metals mainly three metals i.e. Pb, Ni and As were reported as pollutants in National Ambient Air Quality Standards of India (2009). Pb was found within standard limit (0.5 µg/m^3) at all monitoring locations except A1 (1.054 µg/m^3) and A2 (1.64 µg/m^3) locations, Ni was found exceeded standard limit (20 µg/m^3) at all monitoring locations except A9 (11.48 µg/m^3) and As was found within standard limit (6 µg/m^3) as per National Ambient Air Quality Standards of India (2009) at all monitoring locations around Dewas industrial area.

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