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Original Article

A survey of Trace Metals Determination in Hospital Waste Incinerator in Lucknow City, India

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Abstract:
Information on the elemental content of incinerator burning of human organ, animal and medical waste is scanty in India Nineteen trace elements were analyzed in the incinerator ash from four major hospitals, one municipal waste incinerator and two R & D laboratories engaged in animal experiment in Lucknow city. Concentrations of Zinc and Lead were found to be very high in comparison to other metals due to burning of plastic products. The source of Ca, P and K are mainly bone, teeth and other animal organs. A wide variation in trace concentration of several toxic elements have been seen due to variation in initial waste composition, design of the incinerator and operating conditions.
Key words: Trace elements, incinerator ash, hospital waste

Introduction:

A large amount of solid waste is generated in the hospitals during diagnossis and treatment of diseases. The solid waste may contain human organs, bandages, needles, syringes, test tubes, blood tubes, tissue cell culture and other plastic materials. The incinerator is an effective and hygienic method for disposal of hospital waste. In Western Europe more than 600 incinerator plants are in operation.(1) Bottom ash constitutes 20-30% of original waste and is typically composed of aluminosilicate phase and contains significant amount of heavy metals.(2) The presence of significant amount of toxic metals in the incinerator ash may be of serious concern for its disposal. In India, Ministry of Environment has issued guidelines for Bio medical waste management in 1998.

The present study was conducted with an objective to determine the level of trace metals in medical waste incinerator ash in Indian scenario. The ashes were collected from four hospitals, one municipal waste incinerator and two R&D laboratory incinerators. Nineteen trace metals were analyzed.

Materials and Methods:

Ash was collected from incinerators of four hospitals, one municipality and two R & D laboratories. About 5 kg of ash was collected and dried at room temperature. All the visible metals and glass objects were removed; ash samples were then pulverized and passed through 5 mesh sieve. The ash was then made into fine powder using a mechanical grinder. Whole sample was mixed properly using a blender and the blended samples were taken for analysis.

The concentration of Cu, Cr, Cd, Mn, Mg, Ni, Fe, Zn, Pb, Al, Ca, Co, Na, K, P metals were determined by ICP-AES (Perkin Elmer Optima-3000) and Hg, As, Se and Sb were analyzed by Atomic Absorption Spectrophotometer equipped with Hydride Vapor Generator (Analytic Jena Model No.novAA-300 with HS-5).

0.5 gm of ash from each sample was taken for digestion in HNO_3-$HClO_4$ mixture to analyze Cu, Cr, Cd, Mn, Mg, Ni, Fe, Zn, Pb, Al, Ca, Co, Na, K, P metals (4) and 2.0gm of ash from each sample was taken for cold digestion for Hg, As, Se and Sb metals.(5) The limits of detection for each element are given in Table-I; linearity coefficient R^2 was >0.998.

Table-I: Limit of detection for different metals

Metals	**Al**	**As**	**Ca**	**Cd**	**Co**	**Cr**	**Cu**	**Fe**	**Hg**	**K**
Detection Limit (in ppm)	0.09	0.02	1	0.05	0.04	0.05	0.05	0.03	0.01	3.0
Metals	**Mg**	**Mn**	**Ni**	**P**	**Pb**	**S**	**Se**	**Zn**	**Sb**	
Detection Limit (in ppm)	0.05	0.04	0.10	0.50	0.02	0.30	0.5	0.05	0.02	

Results and Discussion:

A general survey of hospital waste properties are shown in Table-II.

Table-II: Waste incinerator sites and types of burning materials

Waste Incinerator Site	**Burning Material**
Hospital-1	Human organ, bandage, syringe, needle, glass, tissue and plastic
Hospital-2	Human organ, bandage, syringe, needle, glass, tissue and plastic
Hospital-3	Human organ, bandage, syringe, needle, glass, tissue and plastic
Hospital-4	Human organ, bandage, syringe, needle, glass, tissue and plastic
Municipal Waste Incinerator	Human organ, bandage, syringe, needle, glass, tissue plastic, and animal carcass
R & D Laboratory-1	Animal carcass
R & D Laboratory-2	Animal carcass

The result of analysis is shown in Table-III.

Table-III: Trace Metal Concentration in Medical Waste Incinerator

Sample	**As**	**Cd**	**Co**	**Cr**	**Cu**	**Hg**	**Mn**	**Mo**	**Ni**	**Se**	**V**	**Zn**	**Pb**	**Al**	**Ca**	**Fe**	**K**	**Mg**	**Na**
Hospital-1	0.25	0.8	0.61	54.6	145	ND	210	14.2	26	0.1	18	320	8.35	2.12	32	0.2	1.95	0.75	1.6
Hospital-2	1.01	1.25	5.5	75	230	ND	525	20.95	580	0.25	22	3610	55	2.1	25	1.35	3.8	1.5	2
Hospital-3	185	9	4.5	88	160	1	310	48.4	110	ND	32	5000	45	5.5	5.5	0.3	4.7	0.5	3.5
Hospital-4	2.1	1.08	1.7	72	156	ND	475	25.05	42	0.25	12	3500	75	2.35	23	1.05	3.6	1.45	2.42
Municipal	1.115	4.45	5.96	140	146	ND	150	35.25	65	0.15	10	7000	375	2.1	9.55	1.25	3.3	0.6	3.8
R & D Lab-1	7	1.13	9	35	870	0.04	180	7.5	70.1	0.15	12	650	9.4	0.5	20.3	0.45	2.75	0.65	1.75
R & D Lab-2	5.05	11.3	0.71	35.2	230	ND	160	4.5	15.45	ND	8	391	ND	0.67	32	1.25	3.1	0.8	3.25

Fate and behavior of toxic waste have been examined in many studies.(6) The concentration of trace elements vary according to the location of incinerator. Zinc concentration is higher in hospital and municipal incinerator samples, probably due to burning of teeth, bones and plastic material.(7) The concentration of Ca, P and K is higher in the animal experimental lab due to burning of animal carcass and preponderance of Ca and P in bones and teeth and K in the kidney and liver. The high concentration of Pb in hospital and municipal waste incinerator samples is due to burning of considerable amount of plastic.

Proper disposal of incinerator ash is therefore important to minimise environmental pollution. Land filling of incinerator residue is the best way of disposal, as the mobility of heavy metals inside landfill is very low. The complete wash out of metal may require thousands of years or more. Recycling may also be a way to reduce the loss of heavy metals to the environment. Hence the proper disposal of incinerator ash would require regular analytical monitoring to ensure that the concentration of trace elements are within permissible limits.

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