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Thermal Power Plant: Permeation of Some Toxic Elements in Soil Horizon through Fly-Ash Fallout Over Industrial Zone. (Special Reference to Korba District of Chhattisgarh State)

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The thermal power plant station selected for study here, its production capacity and the coal consumption per day have been studied. The duration of the fly-ash fallout measurements, the number of sampling sites and the area of measurements have also studied. A comparison of the analysis data of the soils collected from the contaminated areas and uncontaminated areas confirms that the soil horizon; around the thermal power plant has received a definite intake of the toxic elements from the dust fallout matter emitted by a thermal power plant. Element-wise, the concentration status (in ppm) in the first 30 cm thickness of the soil in the contaminated areas, and intake of these toxic metals by the soil horizon as shown by the percent increase. The permeability rates of the metals have been discussed in this work. The permeation of some toxic elements (Zn Ni Cu Pb Co Sb and Bi). In soil horizon through thermal power plant fly-ash fallout has been described. Here, the studies have been extended to cover the permeation of some selected metals (Mn, As, Ag, Cr, V, Cd, and Mo) in soil horizon through thermal power plant fly-ash fallout.

Key word: Contaminated, Uncontaminated, Toxic Metals, Permeation,

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I. Introduction

Most of the coal consumed in India is burnt at power plant where the constituents-elements entering the boilers are partitioned between the bottom ash (or slag) stream, and the flue gas stream containing the suspended fly-ash and the vapours of volatile elements or compounds. The grain size of the dust fallout particles was found to be varying depending on the distance was found to be 5-30 micron (60%) and less than 5 micron (40%) whereas at the 4 km distance, the size distribution was 65% for particles smaller than 5 micron and 35% for particles greater than five microns. The discharged particles enter the terrestrial or aquatic environment by wet or dry deposition. Block and Dams reported the presence of a number of toxic metals in coal and coal ash. Klien have reported trace elements flows from a coal fired power plant and have given the rates of atmospheric discharge (g/min.) of toxic metals.

Location selection

The thermal power station selected for the permeability study is located at Korba District (C.G.). The power station has a production capacity of 540 MW with a coal consumption 1500-1700 tones per day. The dust falls studies for the thermal power plant have been carried out during the advantage of a stabilized loading of air with the emitted particles, covering an area of about 64 km^2 around the power plant [20]. The located of the 20 sampling sites were decided on the basis of topographical conditions and accessibility of the areas, and these have been shown in fig.1.

For toxic elements determinations, the samples were collected from the four sampling sites (No.1,2,3,4,5,6).

The four sampling sites are closely located in the four directions around the power plant, which received the highest rates of fallout in their respective directions, during the period of measurements.

Soil sample collection:

Three samples of soil were collected from each of the four sampling sites which are located at a distance of one km in each direction with respect to the emission source, by digging layer thickness of 30 cm, 60 cm and 90 cm. Two samples of soil were collected from contamination-free location situated 20 km away from the emission source which had similar geochemical characteristics by digging a layer 30 cm at each of the locations.

Table 1
Location and Sampling Sites and their fall out rates.

Sample No.	Sampling sites	Direction	Distance from source of emission	Collection Month	Fall out rates $mt/km^2/month$
1	S1	East	0.5 km	Nov.	645
2	S2	West	0.5 km	Dec.	872
3	S3	North	0.5 km	Jan.	578
4	S4	South	0.5 km	Feb.	830
5	S5	North South	0.5 km	March	1000
6	S6	South West	0.5 km	April	950

Table No. 2
Meteorological data of the study area

Parameters	Year 2020-21 Months					
	Oct,	Nov.	Dec.	Jan.	Feb.	March
Highest temperature	38.00	35.00	34.00	33.00	34.00	41.00
Lowest temperature	20.00	12.00	11.50	6.00	9.00	13.00
Rainfall, mm	117.00	14.20	Nil	Nil	30.00	4.00
Minimum wind velocity km/h	--	--	--	--	--	1.83
Maximum wind velocity km/h	--	--	--	--	--	11.10
Wind direction	North-eastern in October and February, North-western in November in March irregular in other months.					

Experimental Procedure:
Reagent: Standard solution of the metals, each having a concentration of 1000 µg of the metal ion per ml of the solution were prepared as per recommended procedure.
Sample Preparation:
The samples of the soil were dried in an oven at 110^0C for three hours. One gram quantity of each sample was treated in a Teflon digestion bomb using 10 ml acid mixture of HF acid, HCl and HNO_3 acid and placing it an oven at 180^0C for 30 minutes. Thereafter the solution was made up to 100 ml volume in a volumetric flask. The solutions for the determination of load were prepared in a medium of 0.1 M EDTA to suppress the interference of Phosphate, Carbonate, Iodide, Fluoride and acetate.
Apparatus:
The elemental analysis was carried out using an atomic absorption spectrophotometer (Varian Model AA 575).

Table No. 3
Operating Condition of A.A.S.

S.No	Methods	Wave length	Fuel	Current (MA)	Support	Flame Condition	Spectral Band Pass (in mm)
1	Cd	228.8	C_2H_2	3.5	Air	Oxidizing	1.0
2	Pb	217	C_2H_2	EDL	Air	Oxidizing	1.0
3	As	193.7		13	Air	Oxidizing	0.7

Outcome:
A comparison of the analysis data of the soils collected from the contaminated areas and uncontaminated areas confirms that the soil horizon around the thermal power plant has received and intake of the toxic elements from the dust fallout matter emitted by a thermal power plant. Element wise the concentration status (in ppm) in the first 30 cm thickness of the soil in the contaminated areas is as follows (The values in the parenthesis are those in the uncontaminated soil):
Cu-22(5.5) **Co-**13.3(3.5) **Ni-**27.5(7.5) **Pb-**18(4.5) **Zn-**40.8(12) **Bi-**1(Nil) **Sb-**7.5(1).
The permeation of the toxic elements in the soil horizon around the thermal power plant as a result of fly-ash fallout is thus confirmed by the above data. Even up-to the depth 90 cm, the concentration of all these elements

in the contaminates soil are much higher than those found in the first 30 cm thickness in the uncontaminated area.

The intake of these toxic elements by the soil horizon, as shown by the percent increase, is in the following order:

Sb > Cu > Pb > Co > Ni > Zn (in case of Bi, a trace presence of about 1 ppm was observed against its complete absence in the uncontaminated soils).

TABLE NO.3
ANALYSIS DATA OF MACRO COMPONENTS AND TOXIC METALS IN SAMPLES OF FLYASH AND SOILS

Micro component %					Toxic metals in ppm			
Fe_2O_3	CaO	MgO	Na_2O	K_2O	Mn	Ni	Pb	Cd
2.95	3.50	2.65	0.69	1.88	250	80	62	0.50
2.68	3.51	2.69	0.58	1.87	240	85	70	0.40
2.69	3.49	2.70	0.60	1.98	250	80	60	0.38
2.85	3.60	2.70	0.65	1.97	260	79	58	0.29
2.69	3.75	2.66	0.88	1.80	240	79	64	0.23
2.79	3.65	2.70	0.00	1.80	260	82	65	-
2.775	3.57	2.68	0.50	1.83	255	80.83	63.15	0.30

II. Results And Discussion:

The higher concentration of the elements in the air and soil samples in the contaminated area, up to the depth of 90 cm, show that the surface deposition of the elements has permeated in the soil. These individual elements show concentration in the top thickness (0-30 cm) are as follows: -

Cu - 68.18%, 47.72%; Co - 66.16%, 41.35%; Ni - 73.82%, 41.09%;
Pb - 65.55%, 36.11%; Zn - 77.94%, 51.47%; Bi - 0%, 0%;
Sb - 30.67%, 0%.

The permeability rates of the elements have been found to be in the following order:

Zn > Ni > Cu > Co > Pb > Sb > Bi.

A comparison of the analysis data (Table 3) of the soils collected from the contaminated areas and uncontaminated areas confirms that the soil horizon around the thermal power plant has received a definite intake of the toxic elements from the dust fallout matter emitted by a thermal power plant.

All toxic metals introduce some toxicity to the soil as a result of their fallout. Viewed from the standpoint of environmental pollution,

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