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STUDY OF HEAVY METAL CONTAMINATION IN SOIL SURROUNDING PIRANA LANDFILL SITE BY ATOMIC ABSORPTION SPECTROMETER

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Abstract: Accumulation of Heavy Metals in the soil leads to contamination of soil; which is one of the prevailing issues. Heavy metals released in the environment are majorly infiltrated into soils and most metals do not undergo chemical degradation, thus their concentrations in soils persevere for a long period. The presence of Heavy metals not only create adverse effects on ecosystem but also affects the engineering properties of soil. Hence there lies the importance of determining Heavy Metal Concentration in Soil. In the present study Concentration of Lead, Copper and Zinc were determined in soil samples collected surrounding the Pirana Landfill site. The soil samples were collected from the 8 co-ordinates and analysed with the help of AAS. Some Soil Samples showed considerably high amount of heavy metals while for some soil samples, the concentration of heavy metals was appeared to be within permissible limits.

Keywords: Atomic Absorption Spectroscopy, Pirana, heavy metal, Soil Contamination, AAS.

I. INTRODUCTION

Some metals are naturally occurring in soil but some geologic and anthropogenic activities create an increase in the concentration of these metals. Heavy metal can accumulate through the release of toxic materials from hastily expanding industrial areas, wastewater irrigation, Disposal of metal wastes, deposition of atmosphere and many more. Furthermore, most of the metals refuse to undergo chemical or microbial degradation and so the concentration of metals increases with time.

Soil polluted with Heavy metals impose a great risk on the entire ecosystem in various ways: direct contact or ingestion with contaminated soil, Food chain (soil-plant-animal-human). Also, groundwater under contaminated soils shows a significant amount of pollution as the water reaching through groundwater seeps through the soil. If this water is used as potable water unknowingly then it can lead to hazardous effects on human health. Contaminated soil also affects plant growth and thus affect agriculture productivity. The risk involved in consuming food grown on this land is high.

Conversely, heavy metals may modify soil biological properties as well as engineering properties. Presence of Heavy metals weakens the soil bearing capacity and thus it leads to uneconomical ground improvement techniques. Hence, the remediation of soil polluted by heavy metals cannot be overemphasized.

Most common metals that contaminate soils are Lead (Pb), Arsenic (As), Zinc (Zn), Copper (Cu), Nickel (Ni), Cadmium (Cd), Chromium (Cr). From which concentration of lead, zinc and copper were determined on the surrounding area of Pirana Landfill site.

II. STUDY AREA

Figure 1 Location map of coordinates at Pirana Landfill Site

Solid waste of entire Ahmedabad city is being dumped at Pirana Landfill site since 1982. The massive Landfill site covers 84 hectares of land. Pirana falls on the latitude of 22.980368 and longitude of 72.56212.

A Times of India article regarding dumpsite revealed that the Pirana Landfill site receives approximately 4000 tons of waste every day and most of it is dumped in the landfill untreated. Furthermore, the toxic chemical waste and by-products generated by many industries/factories in the proximity of the landfill site were also dumped haphazardly.
One of the reasons behind heavy metal-contaminated soil is unmanaged toxic waste. Pirana-mountain of garbage having a height of 200m not only affects the aesthetics but also has many hazardous effects on surrounding soil as well as on groundwater. For the assessment of the surrounding land near Pirana dumpsite total of 8 co-ordinates were taken. Google earth image of these points surrounding Pirana Landfill site is shown in figure 1.

III. SAMPLE COLLECTION

Disturbed Soil Samples were taken manually, at the depth of approximately 0.5meter. Soil texture was observed to be different at various locations as some points contained fine-grained soil while some points contained coarser particles.
A) Co-ordinate 1:
This sample's latitude is 22.983811 and longitude is 72.567376. The sample had a blackish and foul smell. As this point was located into Pirana landfill itself, a high amount of solid waste including non-biodegradable materials (such as plastic) were found. Also, the sample was found moist.

B) Co-ordinate 2:
This sample's latitude is 22.981291 and longitude is 72.569987. This point was located in a residential area and houses were constructed on the land. A densely packed soil sample was observed to have medium to fine particles and had a brown colour.

C) Co-ordinate 3:
This sample's latitude is 22.979305 and longitude is 72.569933. The point was not feasible.

D) Co-ordinate 4:
This sample's latitude is 22.977917and longitude is 72.569054. This point was very near to the boundary of Pirana and so the soil wasn't densely packed. Soil surface was free from landfill waste but it contained waste at a shallow depth of 0.3meter. The soil sample was observed black in colour and has a foul smell at a depth of 0.5meter.

E) Co-ordinate 5:
This sample's latitude is 22.976968 and longitude is 72.565029. The sample contained a large amount of solid waste as it was a part of Pirana Landfill site. Soil was not packed densely which suggests the waste was not properly compacted. The Sample was found black in colour and was having a foul smell. Also, Soil sample was observed very moist.

F) Co-ordinate 6:
This sample's latitude is 22.979256 and longitude is 72.562516. These co-ordinates were located slightly far than the Landfill site. It was unfertile land with majorly pebbles and gravels at the depth of 0.5 meter. The soil was detected dry and brownish in colour.

G) Co-ordinate 7:
This sample's latitude is 22.981408 and longitude is 72.562495. The co-ordinates were falling into a farm and so the soil sample was sticky containing a high amount of moisture. Crops were harvested on this land and so the land was observed as a fertile.

H) Co-ordinate This sample's latitude is 22.983321 and longitude is 72.564017. The point was located in an unknown land where the soil was detected dry and brownish in colour.

IV. SAMPLE ANALYSIS

Sample Analysis of collected soil samples was carried out with the help of ATOMIC ABSORPTION SPECTROSCOPY (AAS) instrument. The concentrations of Lead (Pb), Zinc (Zn) and Copper (Cu) was analysed as described in **(Lead IS 12074) (Copper IS 11123) (Zinc IS 9958)** for each soil sample.

Atomic Absorption Spectroscopy which is also known as Atomic Emission Spectroscopy (AES) is Spectro analytical procedure for the determination of chemical elements. This method was founded by Alan Walsh.

The AAS uses absorption of light of wavelengths by atoms. The classification of Atoms is done on the basis of energy (high/low). The state having low energies is known as the ground state and the state having high energies are termed as the excited state. The difference between energies in both the states is fixed by the element and wavelength of light which is measured by the hollow cathode lamp (HCL).

Figure 3 Atomic Absorption Spectrometer

Figure 2 Soil Samples after acid digestion

Sample Preparation for AAS:

For the preparation of sample one gram of soil sample was taken. To perform the test sample is to be digested, so to digest the sample 60ml of Nitric acid and 40ml of water was mixed together. Then soil sample was added in a prepared mixture of 100ml of the digested sample. After that prepared sample was placed in an oven for 120°c to 130°c for nearly 2 hours. After 2 hours sample was taken out of the oven and cooled for 30 minutes and kept into individual flasks. Another sample was prepared by taking 1ml of the prepared sample and 9ml of nitric acid into the same resulting in 10ml of sample. In a similar manner total 7 number of samples were prepared according to 8 coordinates taken for the test. A solution of the metals that are to be tested (zinc, lead, copper) were taken into test tubes in different concentration (2.5, 5, 7.5, 10). Different concentration of metal solution was prepared by adding required amount of metal and remaining of nitric acid so as to make 10ml of solution such as 2.5ml of zinc solution and 7.5ml nitric acid, 5ml zinc solution and 5ml nitric acid, 7.5ml zinc solution and 2.5ml nitric acid, 10ml zinc solution. Similarly the procedure was repeated by taking copper and lead instead of zinc.

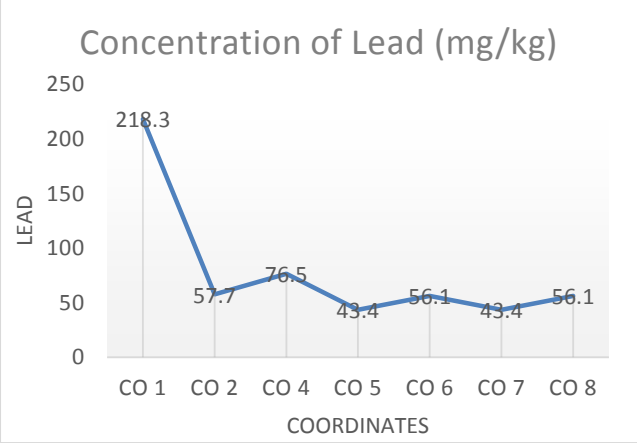
AAS testing Procedure (software):

Proper hollow cathode lamp was chosen for the analysis of a particular metal which is to be tested. The lamp was allowed to warm up for 15 minutes minimum before proceeding further. Then, the instrument was aligned. From the desktop window following the procedure: Method >Analysis>Method>Calibration>Standard concentration. Information was added according to the test needed to be performed. Then the method was saved and named accordingly. Lastly, samples were analysed by clicking on Sample Analysis and results were obtained. The same process was repeated for other metals.

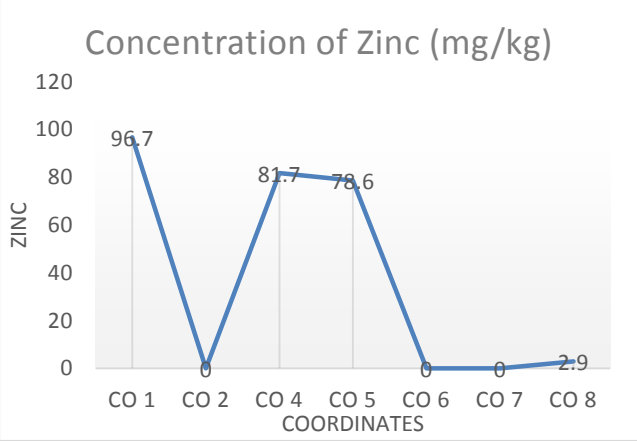
V. RESULT AND DISCUSSION

Below table summarizes the results obtained by performing AAS:

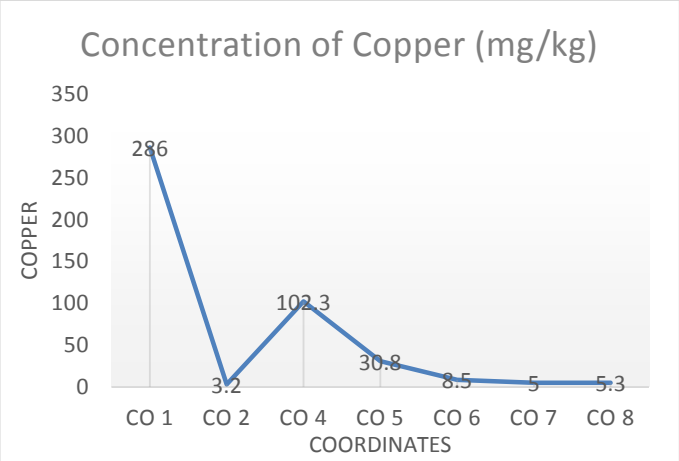
S No.	Sample	Lead		Copper		Zinc	
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
1.	**Co-ordinate 1**	2.183	218.3	2.860	286	0.967	96.7
2.	**Co-ordinate 2**	0.577	57.7	0.032	3.2	-	-
3.	**Co-ordinate 4**	0.765	76.5	1.023	102.3	0.817	81.7
4.	**Co-ordinate 5**	0.433	43.4	0.308	30.8	0.786	78.6
5.	**Co-ordinate 6**	0.561	56.1	0.085	8.5	-	-
6.	**Co-ordinate 7**	0.434	43.4	0.005	5	-	-
7.	**Co-ordinate 8**	0.561	56.1	0.053	5.3	0.029	2.9



Graph 1 Lead Concentration of co ordinates



Graph 2 Zinc Concentration of co ordinates



Graph 3 Copper Concentration of co ordinates

Graph 1 suggests that the concentration of lead at Co-ordinate 1 is highest as the Co-ordinate 1 was falling inside Pirana Landfill site, while at other Co-ordinates the amount of lead was below the permissible limit. Graph 2 indicates that the amount of Zinc is above permissible limit at Co-ordinate 1 while at other Co-ordinates it is low and within the permissible limit. Graph 3 shows the Copper concentration, it indicates that the concentration of Copper is highest and above the permissible limit at Co-ordinate 1, while at all the other Co-ordinates it is within the permissible limit.

Hence it can be concluded that the amount of soil contamination due to Heavy metals is more inside Pirana Landfill Site and it can percolate to deeper soil strata and cause pollution to groundwater. A higher concentration of heavy metals in soil deteriorates properties of soil and therefore difficulties maybe faced in future construction. This pollution can further affect agriculture as well as the ecosystem.

The study suggests that metals are concentrated more or less at every co-ordinate which in future may increase. This increase in concentration may lead to land and environment pollution which may spread in surrounding areas and cause hazardous effects to human health.

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