

AN EXPERIMENTAL ANALYSIS ON HEAVY METALS IN SOIL BY USING ATOMIC ABSORPTION SPECTROMETER

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ABSTRACT

In an earth ecosystem the soil is the most important component. Soils can be infected by the accumulation of heavy metals and metalloids through the emissions of industrial waste, elimination of high quality metal waste, application of soil fertilizers, sludge purification, residues, petrochemical spills and atmospheric storage. For the present study, three soil samples were examined for heavy metal (chromium, lead, cadmium, manganese) analysis of soil samples. Soil samples were collected from three different places of JSW steel limited Pottaneri, Mecheri, Salem District. Each sample having twenty meter distance. Soil samples were analysed by AAS which detect the concentration of heavy metals in given soil samples. Atomic absorption spectrometry (AAS) is a technique which is helpful to measuring the quantities of trace elements present in soil samples. The results of the study revealed that Chromium present in the soil sample are within the permissible limit as per WHO(1996). Cd, Mn and Pb are present in lower than that of Cr in all three samples and also lesser than the permissible limit. Therefore, the soils studied were not harmful, so there is no serious implication for health hazard. However, the concentration of such a heavy metal in these sampling sites were below the world health organization permissible limit the soil sample taken from sampling site of industry.

Keywords: Atomic absorption spectrometry(AAS), Soil Samples, Heavy Metals (Lead, cadmium, manganese, chromium)

Introduction

Anthropogenic sources of heavy metals such as industrial wastes, automobile emissions, mining activity and application of chemical fertilizers, have led to their accumulation in soils. Heavy metals levels in soil are increasing also due to disposal of domestic sewage sludge on agricultural areas. Lead and cadmium level in soil tend to be higher in cities, near road ways and around industrial sources. This study may serve as an important tool for policy makers to make decisions concerning the environment and to secure the well being of the community or promoting health care services by minimize the level of heavy metals.

Atomic Absorption Spectroscopy technique was introduced for analytical purpose by Walsh, Alkemade and Milatz in 1956. Atomic absorption spectroscopy is a very common technique for detecting metals and metalloids in samples. It is very reliable and simple to use. It also measures the concentration of metals in the sample.

1. Methodology

1.1. Study area

The soil samples were collected around three different places of JSW steel limited pottaneri mecheri, salem. Expansion from 1 to 1.3 MTPA Integrated steel plant at Mecheri, Mettur, Mettur-Taluk, Salem District, Tamil nadu. The soil samples were kept in polythene bags and labeled to avoid a mix up of the different soil samples. They finally were brought to the laboratory.



Fig:1 Soil Samples

1.2. Soil Sample Collection

Soil samples were collected from three different places of JSW steel limited pottaneri mecheri, salem and the soil samples were collected separately by a random selection from surface with a small core sampler. The soil samples collected from different places were kept in clean polyethylene bags and labeled. Then it was brought to the laboratory and kept in the air dried place prior to analysis for heavy metals.

1.3. Soil Sample Preparation

Unwanted materials such as stones, leaves and debris were removed from the soil samples by hand picking and dried on an air dried oven. The samples were mixed, gently homogenized and sieved through 2-mm-mesh sieve. The samples were first air dried, then placed in electric oven at a temperature of 40 °C approximately for 30 minutes. The resulting fine powder will be kept at room temperature for digestion.



Fig:2 Sieve process of soil samples



Fig: 3 Oven Drying

2. Experimental Procedure

2.1 Instruments and Reagents

Atomic Absorption Spectrometer, Aquaregia (35% of HCL, 65% of high purity HNO₃, in 3:1 ratio)

2.2 Preparation Aquaregia

Aqua regia is a corrosive acid mixture made by combining nitric acid and hydrochloric acid. The usual ratio of acids is 3 parts of hydrochloric acid to 1 part of nitric acid.



Fig:4 Con HCL 35%



Fig:5 Con HNO₃ 65%



Fig:6 Addition of nitric acid to HCL

Add the nitric acid to the hydrochloric acid. Do not add hydrochloric to nitric! The resulting solution will be a fuming red or yellow liquid. Aqua regia is used to dissolve gold, platinum, and palladium. The weighed samples were transferred to a 250 ml beaker and were digested with aqua regia acid solution. The soil samples were heated with 15ml of aqua regia (35% HCL and 65% high purity HNO₃, in 3:1 ratio). The resulting solution was cooled, then filtered through whatman filter paper.



Fig:7 Heating of mixed sample



Fig:8 Diluting the filtered sample



Fig:9 For ASS analysis

The samples were cooled, and into a 50ml dilute to 50 ml volumetric flask and diluted to mark volume using de-ionized water. Then the sample solution was analyzed for concentration of Cd, Mn, Cr and Pb using an atomic absorption spectrometer.

2.3 Preparation of Calibration Standards

2.3.1 Chemicals used

1. Lead nitrate (Pb(NO₃)₂)
2. Potassium dichromate (K₂Cr₂O₇)
3. Manganese sulphate (MnSO₄)
4. Cadmium chloride (CdCl₂ · 2½H₂O)



Fig:10 Chemicals

2.3.1.1 Preparation of Standards Solutions

The standard solution for lead,chromium,cadmium,manganese are prepared by using intermediate stock solution.

3. Analysis of Soil Samples

Prepare the stock solutions (eg. 4ppm 6ppm 8ppm etc). Switch on the atomic absorption spectrometer and computer. Open the software [Wfx 130] .Screen open,select operation – edit analytical method – continue. Select the element which you need to find and prepare the stock solution. Now switch on the compressor below .Turn on the air pipe on side of AAS [gas inlet] .Switch on the cylinder by tool.



Fig:11 Wfx 130 Software



Fig:12 Check for flame



Fig:13 Sample Solution

4. Experimental Results

Sample No.	Lead(Pb) concentration range ppm	Chromium(Cr) concentration range ppm	Cadmium (Cd)concentration range ppm $\times 10^{-4}$	Manganese (Mn)concentration range ppm
Sample 1	0.00438	0.00401	4.33	0.247
Sample 2	0.00168	0.00591	3.17	0.221
Sample 3	0.00129	0.00592	3.04	0.272

Table:1 Heavy metals concentration in soil samples

S.No.	Element	Permissible limit (ppm)
1	Lead	600
2	Cadmium	100
3	Chromium	50
4	Manganese	20

Table:2 Permissible limits of heavy metals in soils as per WHO

In this study result shows the variation in the soil samples of the industrial area. The results of the study revealed that Chromium present in the soil sample are within the permissible limit as per WHO(1996). Cd, Mn and Pb are present in lower than that of Cr in all three samples and also lesser than the permissible limit. This is due to the fact that the study area is contaminated by the industrial effluents from the nearby industries and vehicular emissions. In general, the results also show that the level of contamination of the soils by the heavy metals is not high at present and the soil is not polluted by toxic heavy metals (Cd and Pb).

5. Conclusion

The concentrations of heavy metals in soil samples from industrial area at different places have been determined. The results of the study revealed that Chromium present in the soil sample are within the permissible limit of WHO. Cd, Mn and Pb are present in lower than that of Cr in all three samples Mn, Cr, Cd, and Pb are all far below the maximum tolerable levels set by WHO. In general, the results also show that the level of contamination of the soils by the heavy metals is not high at present and the soil is not polluted by toxic heavy metals (Cd and Pb). Therefore, the soils studied were not harmful, so there is no serious implication for health hazard. However, the concentration of such a heavy metal in these sampling sites were below the world health organization permissible limit the soil sample taken from sampling site of industry. . Even if the result is below the limit, certain precautionary measures must be conducted in order to prevent possible ingestion of soil containing heavy metals. Finally, we recommend further study on this area by increasing the sample size to make it more representative, and these results may serve as a base line data for determination of mineral contents and physicochemical properties of the soil in the study area.

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