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List of Contents

S.No.	Manuscript Detail	Page No.
1	Environmental Impacts of Fuel Chains Involved in Electricity Generating Systems and Ways for its Internalization <i>Vidvan Singh, Abhishek Singh</i>	329-332
2	Assessment of Groundwater Quality in Five Different Districts of Rajasthan: Focus On Important Chemical and Bacteriological Parameters <i>Aginder Singh Yadav, Bhuvana Joshi, Kamal Jyoti Maji</i>	333-342
3	E-Waste: Its Impacts & Clinical Manifestations & Management Strategies for Sustainability Of Future Perspectives <i>Bina Rani, Sakhray Ponnar, Vandana Bunkar, Ashok K. Kokadia, Raaj K Maheshwari</i>	343-347
4	Biogas Technology: An Approach Towards Healthy Environment <i>Er. Kapil K Samar, Dr. Deepak Sharma, Dr. Sudhir Jain, Dr. Diksha Shrivastava</i>	348-352
5	Review on Control of Emissions of Volatile Organic Compounds from Polluted Air <i>Chandorkar Archit P.</i>	353-359
6	Inevitability of Solid Waste Management in Environmental Concern <i>Chandra Prakash Chhangal, Ravi Prakash Maheshwari</i>	360-363
7	Utilization of Piezoelectric Material for Energy Harvesting <i>Divya Gulliyal, Rohi Verma, Utpal Mishra, Pratibha Singh</i>	364-365
8	Role of Education to Control the Environmental Pollutions <i>Praveen Kumar Jain</i>	366-368
9	Toxicity Effect on Eleusine Coracana (Ragi) Under Hydroponic Condition <i>Dr. Suman Krishania</i>	370-372
10	Assessment of Water Quality in Chittorgarh District <i>Dr. Alok Jain</i>	373-375
11	Biogas Technology: An Approach towards Healthy Environment <i>Er. Kapil K Samar, Dr. Deepak Sharma, Dr. Sudhir Jain, Er. Diksha Shrivastava</i>	376-380
12	A Review on Hydrodynamic Cavitation as a Treatment Option for Refractory Organics Removal <i>Goswami Hasya M.</i>	381-384
13	Use of Marble Slurry in Ceramic Art Work – A Review of Solid Waste Management <i>Jayanti Samota, Shyambharadwaj, Kumud Intodia</i>	385-387
14	A Review of an Integrated Anaerobic-Aerobic Systems for the Treatment of Food Processing Wastewater <i>Jgnesh J. Raiyani, Prof. M.J. Pandya</i>	388-393

15	Optimal Identification of Groundwater Pollution Sources <i>Jyoti Chaudher</i>	394-397
16	A Feasible Synthesis and Spectral Characterization of 1, 2, 4-Triazole Fused Schiff Bases <i>Kamul Jar</i>	398-400
17	Aluminium Foam: A New Friend of Environment <i>Kaustabh Khat</i>	401-403
18	Adsorption of Heavy Metals in Soil <i>Kumal Tanwar, Suresh Singh, Ashok Kumar Kalkode</i>	404-408
19	Evaluation and Analysis of the Projected Pathway of Global Warming Targets Matter <i>Kamal Goswami, Pratibha Singh</i>	409-412
20	Treatment Of Distillery Wastewater By Continuous Electrocoagulation Process <i>Pratibha Singh, Nopur Srivastava, Pratibha Singh</i>	413-418
21	World Health Organization (WHO) Recommendations on Water Quality Requirement <i>Prapti Rathod, Pooja Mittal, Veeresh Fashole</i>	419-421
22	Evaluation and Performance Analysis of Car Driven By Solar Energy <i>Pratibha Singh, Saurabh Yadav, Deepika Singh, Divya Gulliyal</i>	422-425
23	A Review of Heavy Metals in Surface Water in India <i>Ravi Kant Parneek, Ramoo Ram, Dr. Varinder Singh</i>	426-429
24	Acid Earth ; Soil Pollution Due to Acid <i>Kinnari Patel, Rakshit Lalani</i>	430-431
25	Occupational Exposure to Metals & Safeguards for Prevention from Metal Exposure in the Environment <i>Rita Mehra, Amit Singh Thakur</i>	432-434
26	Self-Repairing Bio Concrete: A Better Living <i>Rohi Verma, Kirti Srivastava, Avinash Singh, R.S.Jagadeesh</i>	435-438
27	Air Pollution – A Menace to Ahmedabad City <i>Shoaqib Mansuri, Pranav Pandya, Manan Patel, C.B. Mishra</i>	439-441
28	Reduction of Ammoniacal Nitrogen from Pigment Industry Effluent by Air Stripping <i>Shah Mansi N., Prof. Minarva J. Pandya</i>	442-445
29	Global Warming: An Overview on Manoeuvre Made to Reduce Carbon Footprints <i>Shikha Saxena, Anil K Mathur, A.K.Dravedi</i>	446-447
30	Water Quality Analysis of a Water Reservoir at Lansana District Ajmer (Rajasthan) <i>Siroya, A. K., Siroya, Nisha</i>	448-449
31	Effect of the Electromagnetic Field on the Effluent Characteristics <i>Sneha Chowdhari, Rina Patel</i>	450-452

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Adsorption of Heavy Metals in Soil

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Abstract - Soil is a major reservoir for contaminants as it possesses ability to bind various chemicals. Diverse amounts of heavy metals may be found everywhere in soils, water, sediments, plants, even the arctic. Heavy metals may physically or chemically interact with the natural compounds. In other words they may react with particular species, change oxidation state and precipitate. Heavy metals may be bound by particular natural substances, which may increase or decrease mobility. Studying the dissipation of heavy metals is called speciation which may be physical or chemically.

Keywords: Dissipation, leaching

Introduction

The transport mechanism of heavy metals through soil has presented great interest to both environmental & soil scientists because of the possibility of ground water contamination through metal leaching^{1,2}. These metals can be Fe, Cr, Mn, Ni, Zn, Cu, Pb, Cd, Hg, etc. Metal transport is not only dependent on the physicochemical properties of the metals but mostly on the physical and chemical properties of soil. The influence of acid rains on soils and sorption properties of soil complex has been extensively studied by scientists from various disciplines.

The long term use this may contaminate the soil with heavy metals which may pose serious human and animal health. If the heavy metals are drawn into the soil plant - animal continuum then their research has shown beneficial effect of sewage irrigation on soil fertility^{3,4}. However, its removal is not easy and since the curative strategies are expensive and very difficult the preventive strategies need to be fixed in our country. More than 450 cities in India generate more than 17x106m³ of sewage age per day it is being increasingly used for irrigation especially the vegetables four decades on the same land

But it also may contain non-essential heavy metals which when present in large amount could be transferred to animal and human beings through food chain. One major limitation in land application of municipal sewage is the resultant heavy metal accumulation in soils in food chain, posing a potential health hazard for human being. These heavy metal contaminants are not biodegradable into non-toxic products^{5,6}. It contain variable amount of metallic cation and various bacteria and viruses contaminating the soil and plant being grown on them. The nutrient levels of the soil are expected to improve considerable with continuous application of sewage effluent. The agriculturists are much worried about the pollution especially the entry of toxic elements of the heavy metals create serious problem whenever they get accumulate in the environment. Soil micro - organisms are indeed affected by heavy metals as the result of a multiplicity

of interactions that can occur between microbial cells ions and other environmental constituents^{10,11}

Methodology is scientific study of conducting any research in order that a study is reliable and conducted with accuracy. The present study is divided into following section. Location of sample i.e. Jobner area and Kalwar area

Collection of soil sample

On the above basis we collect the soil sample from the field in definite divided areas. Each sample represents an area of approximately 1 hectare. Then we scrap away the surface litter and insert soil auger or sampling tube to a plough depth (about 15cm). Quartering is done by dividing the thoroughly mixed soil into four equal parts and discarding to opposite quarters. Then we are remix the remaining two quarters and again divide it into four parts and reject two of them, repeat this procedure until one half kilogram of soil is left. Put the soil into a clean and numbered cloth bag after air drying in shade.

Material And Method

Principle

DTPA, a chelating agent combines with free metal ions in solution and forms soluble complexes. DTPA offers the most favourable combination of stability constants for the simultaneous complexing of Zn, Cu, Fe and Mn. Since Fe and Zn deficiency is frequently experienced in calcareous soil, the method is designed to avoid excessive dissolution of CaCO₃ with the release of occluded micronutrients which are normally not available to plants when the extractant is added to soil. Additional Ca²⁺ and some mg²⁺ enter the solution. This is largely because the protonated TEA exchange with these ions from the exchange sites and this lead to the increased ionic concentration of Ca²⁺ in the solution, which in turn helps in suppressing the dissolution of CaCO₃. DTPA extractant has the ability to chelate Zn, Cu, Fe and Mn in competition with Ca²⁺ and Mg²⁺.

Instruments

Magnetic Shaker
Atomic absorption spectrophotometer (AAS).

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Figure 1:- Atomic Absorption Spectroscopy

Determination of zinc

Reagents

Dilute HCl - AR grade HCl diluted 5 times with double distilled water

DTPA extractant - Weigh 1.997 g of AR grade diethylenetriaminepentaacetic acid (DTPA) and 1.475 g of $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ (AR grade) in about 25 ml of double distilled water (DDW) by adding 13.5 ml of hydrochloric acid (HCl), followed by other parts of DDW. Transfer the solution in one liter volumetric flask, making 4 to 5 washing, but before making up the volume, adjust pH to 5.2 with Dilute HCl. The weight has 0.0004 DTPA, 0.0004 $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$.

Standard stock solution 'A' (1000 mg Zn l⁻¹), weigh exactly 1.24 g of pure Zn metal (AR grade) and dissolve it in minimum volume of DC HCl (1) and make the volume to one liter.

Standard solution 'B' - Dilute 1 ml of solution A to 100 ml to get solution B containing 10 mg Zn l⁻¹.

Standard working solution - Dilute 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 ml portions of solution B to 50ml to get working standards containing 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 mg Zn l⁻¹. The working standards should be prepared in the solution of the extracting solution after every five days or it cannot be preserved for long.

Procedure

Weigh 10 g of soil sample in 100 ml centrif. flask. Add 20 ml of the DTPA extractant and shake for 2 hrs on a mechanical shaker. Filter through Whatman No. 41 filter paper. Evacuate five five drops. For quick filtration, Whatman No. 1 filter paper can also be used if the filter is coarse. Dig the filter for Zn measurement using AAS. Feed the standard working solution and prepare a standard curve by plotting AAS readings against Zn concentrations.

Calculation

Available (DTPA-extractable) Zn in soil (mg kg⁻¹) = A x 2

Where, A stands for the Zn concentration it always is read from X-axis of standard curve against for sample reading.

Determination of available copper

Available copper can be determined in soil using AAS. For this, the standards can be prepared as given below:

Accurately weigh 1.0 g AR grade copper metal and dissolve it in 50 ml of dilute HNO₃ (AR grade) and finally make the volume to one litre. This solution containing 2000 mg Cu l⁻¹. Prepare solution B containing 200 mg Cu l⁻¹ by diluting appropriate volume of solution A. Finally prepare working standards containing 0.5, 1.0, 1.5, 2.0 and 2.5 mg Cu l⁻¹.

Determination of Iron

Iron in the DTPA extract can also be determined using AAS exactly in the same manner as Zn and Cu are done. However, the working standard solution should be prepared for higher concentrations as the DTPA extract of soil is generally more than 100 mg Fe kg⁻¹. Thus, the standards may be prepared as given below:

Prepare standard stock solution (solution A) by exactly 1.0 g of AR grade Fe metal in about 50 ml of HNO₃ and dilute the contents to one litre with DDW, solution B by diluting 50 ml of solution A to 500 ml with DDW. Finally prepare working standards containing 1.0, 2.0, 3.0, 5.0 and 10.0 mg Fe l⁻¹ by diluting appropriate volumes of solution B with the extractant (DTPA).

Determination of available manganese

DTPA extractable Mn is also determined following the same procedure as adopted for Zn, Cu and Fe. For the standards, standard solutions are followed:

Weigh 1.385 g of AR grade MnO₂ or 1.0 g of pure Mn metal and dissolve it in 50 ml of dilute HNO₃ (AR grade) and dilute the volume to 1 litre with DDW to get solution A containing 1000 mg l⁻¹ iron solution B by diluting 100 ml of solution A to 1000 ml with DDW to get solution B having 100 mg Mn l⁻¹. Finally prepare working solution of 0.5, 1.0, 1.5, 2.0 and 2.5 mg Mn l⁻¹ concentration by diluting 0.5, 1.0, 1.5, 2.0 and 2.5 ml portions of solution B to 100 ml.

Result & Discussion

Standard Graph of Zn- absorbance vs concentration

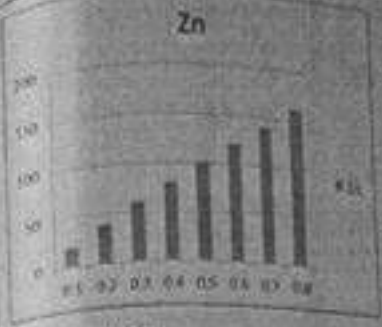


Figure 2:- Standard Graph Zn- absorbance vs concentration

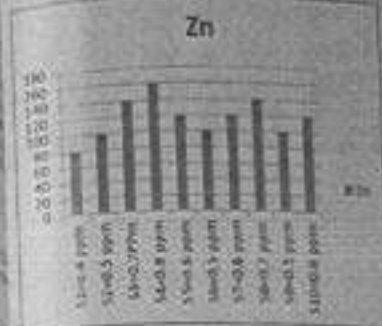


Figure 3:- Standard Graph- Cu Absorbance vs concentration

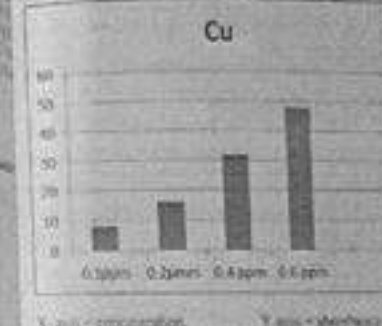


Figure 4:- Standard Graph- Cu Absorbance vs concentration

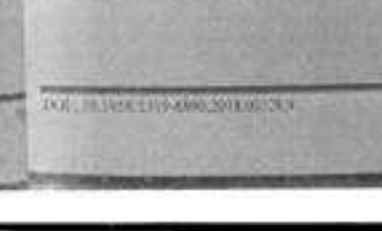


Figure 5:- Standard Graph- Fe Absorbance vs Concentration

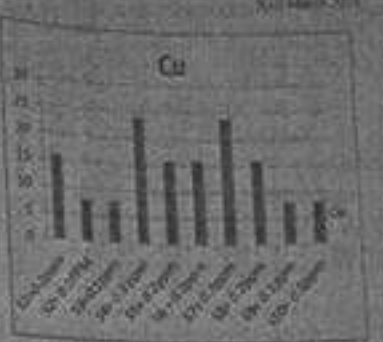


Figure 6:- Standard Graph- Fe Absorbance vs Concentration

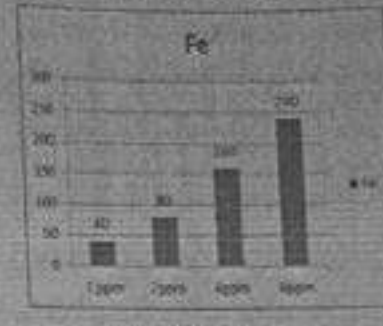


Figure 7:- Standard Graph- Fe Absorbance vs Concentration

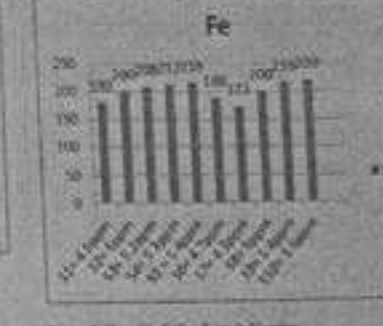
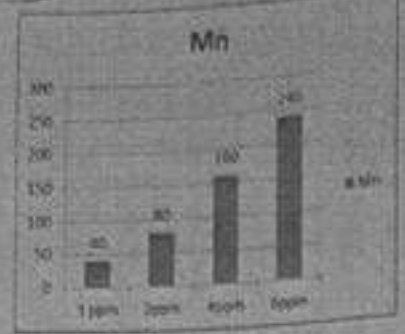
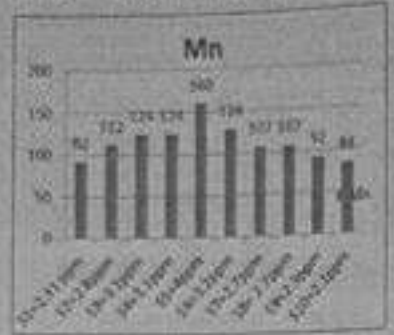


Figure 8:- Standard Graph- Fe Absorbance vs Concentration

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Value concentration, Y-axis - observation
Observation Graph - Mn observation 1-5



Note: 51-510 - Sample number
Soil Sample observation table of heavy metal

Table-1

Sample	pH	EC	Heavy metal concentration in			
			Zn	Ca	Fe	Mn
1	8.8	0.37	0.60	4.22	4.50	1.02
2	8.2	1.80	0.56	3.13	3.18	7.74
3	6.1	0.54	0.70	6.18	3.52	1.52
4	8.4	0.31	0.87	6.30	3.38	1.14
5	7.8	0.40	0.86	6.24	6.44	4.36
6	8.4	0.17	0.24	0.22	4.18	3.02
7	8.3	0.38	0.60	0.54	4.32	2.36
8	8.0	0.36	0.72	0.26	5.68	2.36
9	8.7	0.64	0.55	6.18	5.60	2.36
10	8.3	0.17	0.24	0.14	5.24	2.14

Result for Zinc-

The heavy metal critical limit in soil is 100 mg/kg concentration Zn metal in soil more than 100 mg/kg value of Zn in soil is sufficient and low value is deficient.

The sufficient value of Zn show in sample number 5, 10 and deficient value of Zn show the sample no.

Result for Copper-

Cu heavy metal critical limit in soil is 0.2 mg/kg concentration Cu metal in soil more than 0.2 mg/kg value of Cu in soil is sufficient and low value is deficient.

The sufficient value of Cu show in sample number 5, 8 and deficient value of Cu show the sample no.

Result for Iron-

The heavy metal critical limit in soil is 4.0 mg/kg concentration Fe metal in soil more than 4.0 mg/kg value of Fe in soil is sufficient and low value is deficient.

The sufficient value of Fe show in sample number 6, 8, 9, 10 and deficient value of Fe show the sample no.

Result for manganese-

The heavy metal critical limit in soil is 0.2 mg/kg concentration Mn metal in soil more than 0.2 mg/kg value of Mn in soil is sufficient and low value is deficient.

The value of Mn show in all taken sample is sufficient.

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Government Engineering College, Banswara was established in 2012 under SFS mode and as a part of Ajmer Engineering College Society. Its infrastructure is developed under the Tribal Area Development Department (TADD) and is funded by Government of Rajasthan. At present, it has three branches in B.Tech (Civil Engineering, Electrical Engineering and Mechanical Engineering), each having 60 seats. The good quality of teaching, highly qualified faculty members and dedication of students is the mark return of GEC Banswara. It is situated on backside of Mayur Mill at Lodha village in Banswara, which located at the corner of the Rajasthan and near to the border of Madhya Pradesh and Gujrat. The Banswara is known for its greenery and called as Cherapunji of Rajasthan.

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