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EVALUATION OF HEAVY METAL CONCENTRATION IN E-WASTE USING ATOMIC ABSORPTION SPECTROSCOPY

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ABSTRACT

Developing countries like India generate the E-waste mostly due to industrialization and also imported from various countries which cause serious impact on both the human health and environment. The new finding of this research is the presence of toxic metal in the portable water and land soil. This study would help in the detection of heavy metal ions in contaminated water and soil and estimate the concentration level of heavy metals like Cadmium, Chromium, Nickel, Zinc with the help of Atomic Absorption Spectroscopy. The introduction part covers up how the e-waste disturbs all living being and environment in different aspect which have been studied by the various people. The objective of this paper is to minimize the e-waste, creating awareness to the dealers while recycling. In materials and methods section, the collection of samples is mentioned and working process has been explained. As a result, concentration of heavy metals was found in the taken samples and concluding the presence of heavy metals in municipal waste is 37% and e-waste is 65%. Considering the threat seriously we discussed to have ways to recycle e-waste generated in different methods.

Keywords: Atomic Absorption Spectroscopy, E-Waste, Heavy Metals, Cadmium, Chromium, Nickel, Zinc.

I. INTRODUCTION

E-waste is biologically non-degradable and also causes hazardous effects on humans and livestock. E-waste comprises of 40% and 60% of lead and heavy metals like Cadmium, Chromium, Zinc, Nickel respectively which may also cause acidification of soil and water. Discharging these E-waste in soil affects the agricultural and pollutes the ground water, and discharging them in water will cause DNA damage, lung cancer, disorders in heart, spleen, liver, also cause chronic damage to brain. These devices minimize the human work load and make effective results. Though the advancement of these devices is increased, the waste components impact the environment badly. These devices pollute the soil by dumping the e-waste which also pollutes ground water, affects the atmosphere by incineration etc. E-waste, the most dangerous one, affects the human health, livestock in their daily habits. They also make the agricultural land into an idle one which cannot be used for any purpose. These issues are most happened by the heavy metals presence in large amount. Some components in the E-waste are recycled for their future inventions. Like the quote “Prevention is better than cure” all the waste components are properly dismantled and some of the effective components are reused after their harmless recycling procedures. The amount of the heavy metal like Cadmium, Chromium, Zinc and Nickel in both the polluted soil and water sample which collected from Vellalore, Coimbatore. Due of limited infrastructure and access, most poor nations lack systems that span all processes from disposal to ultimate processing. It aims to integrate technically and logistically the best method for physically dismantling electrical garbage in underdeveloped nations, End-processing at its 'best' in worldwide state-of-the-art end-processing facilities to address hazardous and complicated fractions. Market volume, unofficial competitors, national e-waste regulations, formal take-back schemes, funding, and industrial player trust all seem to be factors to take into account. E-waste recycling has become a contentious topic across the world. Analyses of the environmental, economic, and social ramifications of e-waste recycling in under develop have been taken. To mitigate the growing environmental disturbance caused by incorrect e-waste disposal, more realistic alternatives are advocated that take into consideration local economic and social situations as well as the concepts of Extended Producer Responsibility. E-waste recycling may be able to provide at least a portion of the worldwide demand for metals, particularly in areas where resources are scarce. Nearly 80% of all e-waste created in affluent nations is anticipated to be shipped overseas. The rapid growth of e-waste in undeveloped countries than in prosperous countries indicates the development of a wide and low-cost informal processing sector, which is efficient in its own right but necessarily toxic. A large amount of e-waste is illegally exported to underdeveloped nations because it is too expensive to treat responsibly. Heavy metals and dioxins are polluted by e-waste processing in underdeveloped nations. Well-intentioned trash rules in poor countries are difficult to enforce. Several rare minerals are not recoverable through e-waste processing in their raw form. The objective of this paper is to test the soil and water quality in a specific location that has been impacted by e-waste components, to analyze the environmental impact of e-waste goods, to investigate the various forms of e-waste recycling processes, to raise awareness among the dealers about the need of proper recycling. The quantity of e-waste being treated in a hazardous manner will continue to increase. Electronic waste contains a variety of harmful elements that require particular management. To govern their disposal, developed nations have treaties, directives, and legislation, the majority of which are based on extended producer responsibility. Heavy metals in the soil and ground water are extremely hazardous to human and cattle health. The quantity of heavy metals in the project is stated explicitly (Zinc, Nickel, Chromium and Cadmium) presented in the e-waste polluted samples taken. The apparatus (AAS) Atomic Absorption Spectrometer calculates the amount of heavy metals present in ground water. AAS is a widely used method for identifying metals and metalloids in samples. Electronic waste (e-waste), that will either be produced domestically or illegally imported as "used" electronics, is a real concern in emerging regions. The ways to recycle e-waste generated is clearly explained in the following section e-waste recycling approaches, that shows how the e-waste materials are recycled in different means like using pyrolysis method, hydrometallurgical method, mechanical recycling, electrostatic separation method etc.

II. METHODOLOGY

Study Area and Sampling Procedure

The polluted soil and water samples are collected from 1st and 2nd sampling site is Vellalore, Coimbatore Figure.1 which is a municipal solid waste dump yard. sampling location 2 is an e-waste dump yard near SREC, Coimbatore. Three soil samples have been taken from a distance of one metre and a depth of two metres. Figure.2. Three water samples are collected from bore well Figure.3.

Figure 1: Sampling location 1 is Vellalore, Coimbatore.

Figure 2: E-waste in soil.

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Figure 3: E-waste in water.

Working principle

Heavy metals are elements with a high atomic weight and a density greater than 5 times that of water that occur naturally. They are widely distributed in the environment due to their various industrial, household, agricultural, pharmaceutical, and technical applications, expressing concern about their possible impact on human health and the surroundings. Schematic diagram of atomic absorption spectroscopy Figure.4. Start the AAS Atomic Absorption Spectroscopy Figure.5 then connect with the computer that the signals could be displayed and do the zero calibration. Make sure to get a linear calibration curve. Once we attain the calibration curve start sampling standard solutions prepared. 1 ml, 2ml and 3ml known concentration solutions are prepared from the stock solutions. Finally, the instrument is fed the contaminated sample, and The element's absorbance in the solution is measured.

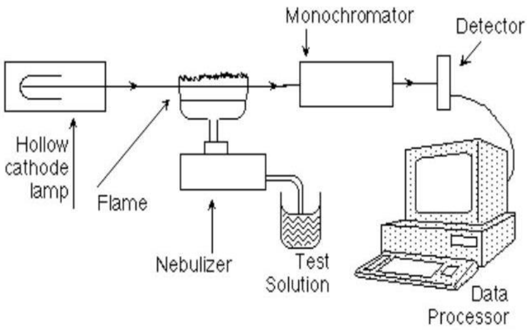

Figure 4: Schematic diagram of atomic absorption spectroscopy.

Figure 5: AAS Atomic Absorption Spectroscopy.

The absorbance of each unknown and known solution is then measured, and a concentration vs. absorbance calibration curve is produced. The unknown element concentration is then computed. Atomic absorption spectroscopy is based on the idea that free atoms (gas) produced in an atomizer may absorb radiation at a particular frequency. The absorption of ground state atoms in the gaseous state is evaluated using Atomic absorption spectroscopy. The atoms absorb ultraviolet or visible light and transfer to higher electronic energy levels as a result. Concentration measurements are usually determined from a working curve after the calibrating the instrument with standard of known concentration. The technique of atomic absorption is widely

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used to identify metals and metalloids in environmental materials. Note: Because the heavy metals are intimately engaged in the molecules present, utilise the water sample as is. Nevertheless, for a soil sample, combine 1 g of material with 100 mL distilled water.

E-waste recycling approaches

Method of pyrolysis

Pyrolysis is a chemical recycling process that is widely used to recycle synthetic polymers, notably polymers combined with glass fibres. Gases, oils, and chars are produced when such polymers are pyrolyzed. These materials can also be employed as chemical feedstock or as fuels. In the presence of oxygen, The printed circuit boards are heated to the extent where the solder used to connect the electrical components to the circuit board melts. A blackish metal material is left behind after pyrolysis. When this blackish metal material is leached, it yields a considerable amount of copper. Also recoverable are minor amounts of iron, calcium, nickel, zinc, and aluminium.

Method of Hydrometallurgy

This technique is mostly employed in the profitable recycling of metallic fractions. In this procedure, metals are dissolved in corrosive solutions such as strong acids and alkalis. After that, the appropriate metals are electro-refined. This method is said to be more adaptable and energy efficient, making it more cost effective. Aqua regia, nitric acid, sulphuric acid, and cyanide solutions are all common lea chants. In the case of non-metallic substrates, metals leak out of the substrate and into the resultant solution. Electrochemical processing can be used to recover metals from metallic surfaces. As an outcome, pure metal recovered can be sold without further processing, but non-metallic substrates must be thermally treated before being reused or disposed of in landfills. The caustic and toxic nature of the liquid utilised is a key downside of this procedure. This technique also produces a large amount of fully dissolved solids.

Recycling via Mechanical Means

It is a method of physical recycling. The dismantled samples are initially chopped into specified sizes based on the milling requirements in this process. Following that, the fragments are milled, resulting in finely crushed PCB powder. Eddy current separators are used to separate the metals based on their eddy current properties. Finally, density separation is performed on the crushed materials. Stratification can be detected in the liquid column depending on density and particle size.

Method of Electrostatic Separation

Electric force acting on charged or polarised substances is utilised in electrostatic separation technology to separate granular substances. Metals and polymers from industrial waste have been recycled using these technologies. Cu, Al, Pb, Sn, and iron, as well as a small quantity of noble metals and plastic, may be recycled using electrostatic separation methods from trashed printed circuit boards.

III. RESULTS AND DISCUSSION

From the testing, we came to know the characteristics of samples Table.1 like pH, Electrical conductivity, Chloride content, Turbidity, Dissolved Oxygen, COD, BOD for the different type of sample such au portable water, municipal solid waste in soil and water samples and also soil and water samples with E-waste. Polluted difference between municipal waste with e-waste of soil sample's observed value in AAS is 0.081(Cd),0.002(Cr), 0.009(Zn) and -0.001(Ni) µg / lit and for e-waste soil sample is 0.16(Cd), 0.002(Cr), 0.020(Zn) and 0(Ni) and tabulated in table.2. Likewise, the polluted difference between municipal waste with e-waste of water sample's is 0.03(Cd), 0.002(Cr), 0.12(Zn) and 0(Ni) and for e-waste waste sample is 0.06(Cd), 0.0048(Cr), 0.020(Zn), and 0.004(Ni)are tabulated in table.3. Evaluation report from AAS of heavy metals cadmium, chromium, zinc, nickel in samples collected.

Table 1: Physical and chemical parameters

CHARACTERISTICS	PORTABLE WATER	SOIL SAMPLE		WATER SAMPLE	
		MUNICIPAL WASTE	E-WASTE	MUNICIPLE WASTE	E-WASTE
pH	6.8	6.11	5.57	6.2	5.8
Electrical conductivity (Ω m)	Nil	0.079	0.049	0.019	0.234
Chloride content (g/ l)	0.2	0.4	0.5	0.4	0.9
Turbidity (ntu)	100	161	148	105	112
dissolved oxygen (mg / l)	0.05	5.52	4.89	6.3	5.9

Table 2: Pollutant percentage in water sample

NAME OF HEAVY METAL	CONCENTRATION OF HEAVY METALS IN WATER SAMPLE (MUNICIPAL WASTE + E –WASTE)	CONCENTRATION OF HEAVY METALS IN WATER SAMPLE (E –WASTE)
CADMIUM (Cd)	0.081 > 0.05 µg / lit	0.16 > 0.05 µg / lit
CHROMIUM (Cr)	0.002 < 0.005 µg / lit	0.002 < 0.005 µg / lit
ZINC (Zn)	0.009 > 0.003 µg / lit	0.020 > 0.003 µg / lit
NICKEL (Ni)	-0.001 < 0.001 µg / lit	0 < 0.001 µg / lit

Table 3: Pollutant percentage in soil sample

NAME OF HEAVY METAL	CONCENTRATION OF HEAVY METALS IN SOIL SAMPLE (MUNICIPAL WASTE + E –WASTE)	CONCENTRATION OF HEAVY METALS IN SOIL SAMPLE (E – WASTE)
CADMIUM (Cd)	0.03 > 0.05 µg / lit	0.06 > 0.05 µg / lit
CHROMIUM (Cr)	0.002 < 0.005 µg / lit	0.0048 < 0.005 µg / lit
ZINC (Zn)	0.012 > 0.003 µg / lit	0.020 > 0.003 µg / lit
NICKEL (Ni)	0 < 0.001 µg / lit	0.0004 < 0.001 µg / lit

IV. CONCLUSION

According to the Dangerous Waste Act of 1989, the presence of a large number of particular compounds in waste materials confirms the hazardous nature of e-waste. The Central Pollution Control Board, or CPCB, has enacted legislation that punishes individuals responsible for inappropriate e-waste disposal and management. The limitation of the component usage which affects the soil and water is studied to avoid the environmental pollution. In today's world, the electronic trash recycling company may be found in all parts of developed countries. We can avoid health concerns, reduce greenhouse gas emissions, and generate jobs through properly discarding or repurposing gadgets. Sorting, dismantling, and recovery of precious elements are all part of the recycling process, which is accomplished through refurbishment and reuse. Refurbishing the whole electronic or one its components and recycling to recover the metals, precious metals, and various non-metals that contained within electronics. Some of them exhibit hazardous characteristics as well and they must be properly disposed. The best techniques to dispose e-waste are to melt circuit boards, burn cable insulation to recover copper wire, and use open-pit acid hangers to separate hard assets. Electrolysis, osmosis, electrolytic recovery, condensation, filtration, centrifugation, and other unique procedures are used to reclaim waste materials in place of methods like incineration and landfills.

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