iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** VI **Month of publication:** June 2019

DOI: http://doi.org/10.22214/ijraset.2019.6038

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue VI, June 2019- Available at www.ijraset.com

Electronic Waste Metal Extrication by Encrusting Process (EWMEEP)

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Abstract— Nowadays in the changing environment the pollution grows in an increasing rate due to certain physical, chemical & biological aspects, especially by the inorganic wastages let off from the industries, households and garbage dumping. This may cause harm to all living things especially the electronic waste let off from it. Electronic waste connected health risks may result from direct contact with harmful materials such as lead, cadmium, chromium and brominates flame retardants from inhalation of toxic fumes, as well as from accumulation of chemicals in soil, water and food. E-Waste contains other precious metals that are valuable to the society. In order to recycle the precious metals, a system must include crushing and separating units. The introduction of this system will crush and paves the way for further process of recycling the metals within a certain time period. The system crushes all the components connected in PCBs. The metals such as copper (Cu) and silver (Ag) are characterized differently from the PCBs. These systems are integrated with mechanical crusher, chemical substrate to separate the metals from the wastages. The Encrusting method is employed for separation of Electronic waste.

Index Terms— Physical, chemical, biological, electronic, harmful, precious metals, recycling, chemical, extrication and encrusting.

I. INTRODUCTION

Solid waste is generated from industrial, residential and commercial activities in a given area, and may be handled in a variety of ways. As such, landfills are typically classified as sanitary, municipal, construction and demolition or industrial waste sites. Waste can be categorized based on materials such as plastic, paper, glass, metal, organic waste and especially E-wastes. Categorization may also be based on hazard potential including radioactive, flammable, infectious, toxic and non-toxic. Categories may also pertain to the origin of waste such as electronic gadgets from industrial, domestic, commercial, institutional or construction. Regardless of the origin, content or hazard potential, solid waste must be managed systematically to ensure environmental best practices. As solid waste management is a critical aspect of environmental hygiene, it needs to be incorporated into environmental planning. Inorganic waste particularly electronic waste is the waste consisting of materials that are difficult to biodegradable so that destruction takes a very long time. Some of the materials found in E-waste such as plastic, copper, lead and tin. Some inorganic substances as a whole cannot be explained by nature, while others can only be described in a very long time. Electronics are full of valuable materials including copper, tin, iron, aluminum, fossil fuels, titanium, gold, and silver. Many of the materials used in making these electronic devices can be recovered, reused and recycled, including plastics, metals, and glass. But if diligently working on waste from metal can be re-melted for useful items. Inorganic waste cannot be degraded naturally. With creativity, this waste can be recycled for a variety of needs. Collection of Electronic waste can be excreted from different types of gadgets. E-scraps recycling is much better than the sales value of normal E-waste. While mineral resources cannot be updated, if it can even take hundreds or even thousands of years to shape it. One day it will run out of minerals explored. Therefore, it would be wise if we took part in the success of the recycling movement by extracting the precious metals from the electronic scraps. This will definitely reduce the effect of Global warming in future and enhances the technology in a better way from a starting point to an ending point.

II. NEED FOR EXTRICATION SYSTEM

In the modern technology period, the material productivity is going on increasing with equal usages. After a period of using Electronic material, its lifetime will decreases with respect to the quality and becomes a waste. Therefore these electronic wastages are handled by dumping and burning process which is not an eco-friendly solution and it may cause some hazard for the future

generation. Electronic wastages are more toxic than the Inorganic wastages and are non-biodegradable. They may cause pollutions such as water pollution, air pollution, soil pollution, radioactive pollution and visual pollution.

III. LITERATURE SURVEY

A. Novel Approach for Processing Hazardous Electronic Waste

Rapid urbanization, a general improvement in living standards and increased consumption has resulted in the generation of unprecedented amounts of waste in recent years. Among different wastes, electronic wastes (e-waste) volumes are growing three times faster than any other forms of urban waste. E-waste contains over 1000 different substances; some are toxic and hazardous, which cause serious problems to environment and on human health.

Generation of waste residues during recovery of precious metals from e-waste, the presence of hazardous lead, waste plastics, secondary pollution caused by land filling non-metallic residues are some of the problems associated with recycling e-waste. Temperatures above 1350℃ were required to completely remove lead and other metals from e-waste; waste residue that was left behind was predominantly composed of carbon. Further research was carried out on the utilization of lead free non-metallic residue as a carbon source in iron making application. In this Extrication system the heat is not required to separate the precious metals from the electronic wastes.

IV. COMPONENTS USED

A. Mechanical Crusher

The crusher is a mechanical component which is used to shred the larger pieces into the fragments. Crushing devices hold material between two parallel or tangent solid surfaces, and apply sufficient force to bring the surfaces together to generate enough energy within the material being crushed so that its molecules separate from (fracturing), or change alignment in relation to (deformation), each other. Electronic waste material enters the crusher, which allows smaller material to bypass the crusher itself, thus improving efficiency. Primary crushing reduces the large pieces to a size which can be handled by the machinery.

B. Glassware (Beaker)

A beaker is a generally cylindrical container with a flat bottom. Most also have a small spout (or "beak") to aid pouring. Beakers are available in a wide range of sizes, from one millilitre up to several litres. Standard or "low-form" beakers typically have a height about 1.4 times the diameter. These are the most universal character and are used for various purposes from preparing solutions and decanting supernatant fluids to holding waste fluids prior to disposal to performing simple reactions.

In this Project, the rectangular typed beakers are used for containing the PCBs into the chemical solutions. It consists of Acrylic material for non reaction of chemicals with them. There are 3 different sizes of beaker used in this project which is 4 inches, 5 inches and 6 inches respectively

C. Chemical Flow Control Valve

A flow control valve regulates the flow or pressure of a fluid. Control valves normally respond to signals generated by independent devices such as flow meters or temperature gauges.

Flow-control valves include simple orifices to sophisticated closed-loop electro hydraulic valves that automatically adjust to variations in pressure and temperature. The purpose of flow control in a hydraulic system is to regulate speed. In this project manual control valve is used for reaction of chemical with other chemicals.

D. Encrusting Chamber

Encrusting is a process that uses an electric current to reduce dissolved metal cations, so that they form a thin coherent metal coating on an electrode. The term is also used for electrical oxidation of anions on to a solid substrate, as in the formation of silver chloride on silver wire to make silver/silver-chloride electrodes.

Electroplating is primarily used to change the surface properties of an object (such as abrasion and wear resistance, corrosion protection, lubricity, aesthetic qualities), but may also be used to build up thickness on undersized parts or to form objects by electroforming. A power supply supplies a direct current to the anode, oxidizing the metal atoms that it comprises and allowing them to dissolve in the solution. At the cathode, the dissolved metal ions in the electrolyte solution are reduced at the interface between the solution and the cathode, such that they "plate out" onto the cathode.

E. DC Motor

In this project 2 motors are used for opposite rotation of the crusher cylinder. Each motor is connected to the mechanical crusher and are connected opposite to it, so that it can rotate in an opposite direction for wastage crushing. The speed range of the DC Wiper motor is from 45 rpm to 65 rpm.

It produces very less noise during operations and with stand varying load capacity of the motor. Motor Torque Range: 13 to 120 N m, overload protection, Greater life cycle and corrosion resistance.

V. WORKING OF THE PROJECT

In this extraction of metal system, there are four zones for extracting the E-waste and encrusting it into an useful compounds. They are: Mechanical Crushing Zone, Chemical treatment I, Chemical treatment II and Encrusting system.

A. Mechanical Crushing Zone

A Mechanical crushing system is employed to crush the electronic waste into a useful compound. It consists of two rollers rotating on the opposite side and it is connected with the conical projections on the surface of the rollers

B. Chemical treatment I

It consists of reaction of copper metals with the chemical solutions. The diluted nitric acid is promoted to obtain the precipitated form of copper.

Whereas the copper gets extricated and forms the copper nitrate solution and the solution turns into a pale blue color which indicates the dispersion of copper metals into the nitric acid solution.

Chemical Reaction: $\mathbf{Cu(s) + 3N\ HNO_3 \longrightarrow Cu(NO_3)_2}$

C. Chemical treatment II

The Copper Nitrate solution is mixed with the sodium hydroxide which is a basic solution. The copper nitrate is converted into the Copper Hydroxide solution.

To recycle the silver metal, the Silver Chloride is used instead of Sodium Hydroxide.

Chemical Reaction: $\mathbf{Cu\ (NO_3)_2 + 2N\ NaOH \longrightarrow Cu(OH)_2}$

D. Chemical treatment III

The Copper Hydroxide solution formed in the previous chemical treatment is poured into the Dilute sulphuric acid solution. This Copper Hydroxide solution is converted into the Copper Sulphate solution.

This solution is set up for the Encrusting process for recycling the Copper.

Chemical Reaction: $\mathbf{Cu\ (OH)_2 + 4N\ H_2SO_4 \longrightarrow CuSO_4}$

E. Encrusting System

Encrusting involves passing an electric current through a solution called an electrolyte. This is done by dipping two terminals called electrodes into the electrolyte and connecting them into a circuit with a battery or other power supply. Encrusting is known as electro deposition because the process involves depositing a thin layer of metal onto the surface of a work piece, which is referred to as the substrate. An electric current is used to cause the desired reaction.

The chemical solution formed in chemical treatment III is used as an electrolyte here. Then the DC supply is given to the anode and cathode for encrusting the metal ion into a fine coating on the metal surface of the cathode.

Chemical Reaction: $\mathbf{CuSO_4 + electrons \longrightarrow Cu^{2+} + SO4^{2-}}$

VI. EXPERIMENTAL ANALYSIS

A. Atomic Absorption Spectroscopy (AAS)

Atomic Absorption Spectroscopy (AAS) and atomic emission spectroscopy (AES) is a spectro analytical procedure for the quantitative determination of chemical elements using the absorption of optical radiation (light) by free atoms in the gaseous state.

Atomic absorption spectroscopy is based on absorption of light by free metallic ions. In analytical chemistry the technique is used for determining the concentration of a particular element (the analyte) in a sample to be analyzed.

AAS can be used to determine over 70 different elements in solution, or directly in solid samples via electro thermal vaporization and is used in biophysics, archaeology and toxicology research.

The process of atomic absorption spectroscopy (AAS) involves two steps:

1. Atomization of the sample 2. The absorption of radiation from a light source by the free atoms

The standard calibration of copper solutions was shown in the table below

Fig.1.1

Concentration (ppm)	Absorbance
0.5	0.006
1.0	0.010
1.5	0.016
2.0	0.021
2.5	0.025

Standard Calibration Graph for the Copper

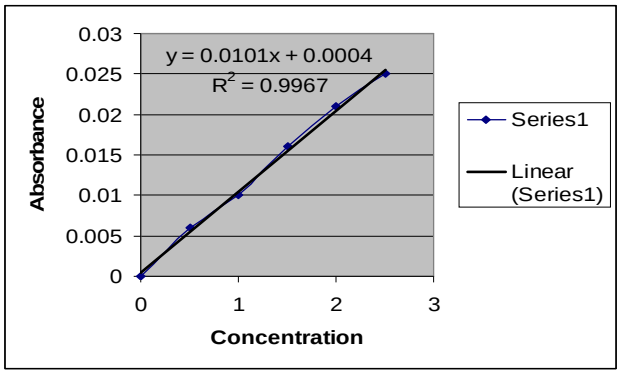

Fig.1.2

VII. DESIGN LAYOUT OF EWMEEP

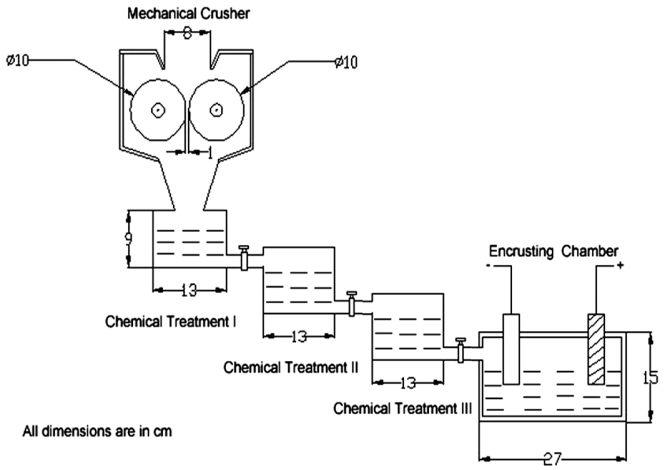

Fig.1.3

VIII. PHOTOGRAPHY OF THE PROJECT

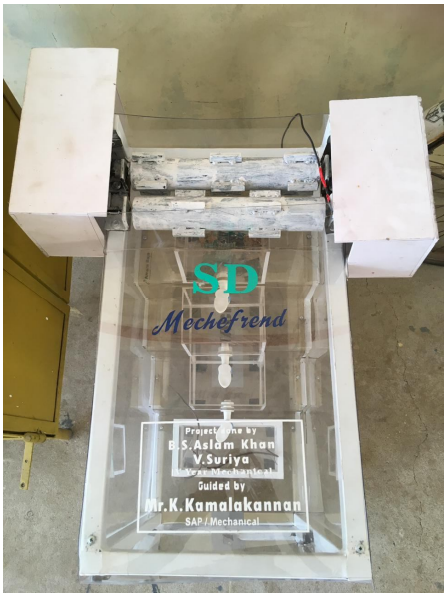

Fig.1.4

IX. OBJECTIVES

A. To control the pollution created by the Electronic wastes.
B. To convert the trace materials from E waste into a useful materials by means of recycling.
C. To reduce the E waste dumping areas
D. To minimize harm occurs by means of the conventional process.

X. ADVANTAGES

A. Extraction of the given Electronic waste materials from waste stream for reuse, recycling or processing which is suitable for use as a raw material for Coating process.
B. It totally reduces the environmental pollutions threatened by Electronic waste.
C. This reduces the wastage area occupied by the E-waste in the dumps and provides clean environment.
D. Precious metals from E-waste can be easily separated by chemical treatment.
E. Easy operation.
F. This system can be handled by a single person.
G. The extraction system is compact in size.
H. It can be used as a portable system for extracting metals from Electronic waste.
I. This system is an Eco-friendly to the environment.
J. Extraction system is transparent and the chemical processes are easily observed.

XI. APPLICATIONS

A. Clean India Project of Central Government.
B. Electronic Industries.
C. Processing Industries.
D. Municipal and Corporation waste management.
E. Electronic Waste Recycling Plants.

XII. CONCLUSION

By implementing this extraction system we can easily convert the precious metals into a useful compounds and it paves way for coating process. Mostly the extracted metals are easily recycled to the useful processing and reduce the source of demand. It also helps to eliminate the harmful effect of Electronic waste into the environment. It reduces the degradation of natural resources. Therefore the system provides a better and clean environment. It can be implemented in industries such as small scale and large scale industries.

XIII. FUTURE SCOPE

The scope for this project is that is simple in construction, design and low price when compared to the other processing methods. Mostly 4/5th of the precious metals are extracted from the electronic waste. This method can be used in static and dynamic conditions with maximum efficiency. Further improvement in the design of machine to extract the other precious metals from the e-waste will have a greater scope in future. By using catalyst in the chemical treatment the accuracy, effectiveness of the machine will be increased with short time period for extraction.

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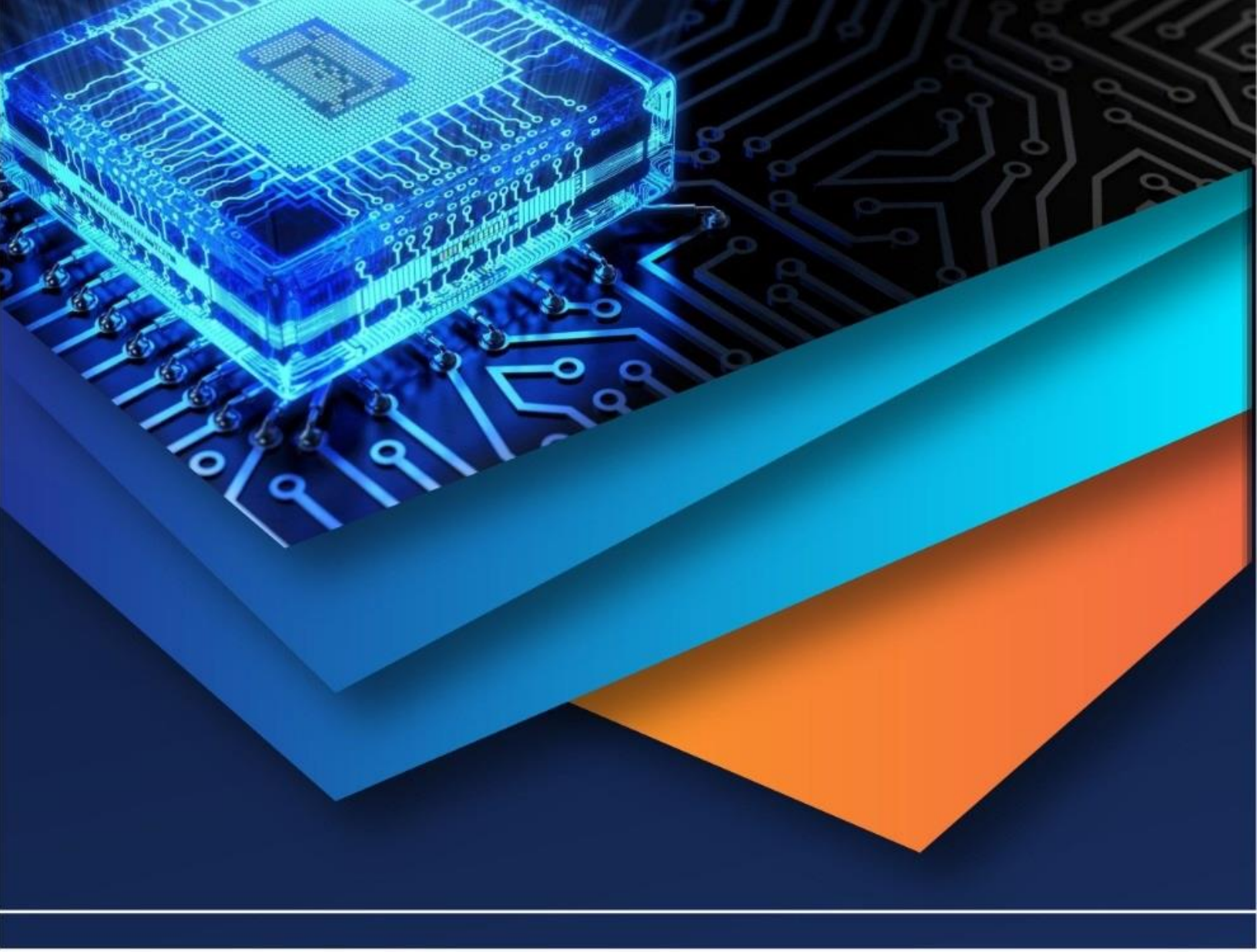

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