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METAL EXTRACTION FROM ELECTRONIC WASTE WITH MICROBE ORIENTED TECHNOLOGY

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***Abstract*—** Electronic devices without intention of reuse are called electronic wastage. Electronic waste is a rising crisis associated with both developing countries as well as developed countries. Fascination of people with electrical devices and expeditious development in technology has caused production of enormous quantity of waste caused by electronics. Barely a small portion of e waste is recycled appropriately; a large amount of e-waste is discarded as landfills or burned. Microbial bioengineering method of extraction of metals is based on the capability of microbes to produce lixiviants which removes metals from electronic waste. This method is an innovative motion to remove metals from different kinds of electronic wastage. This method is cost efficient, decreases ecological effects and produces least secondary scrap. Therefore, this paper represents the information on microbe oriented technique for removal of valuable compounds from electronic wastage.

Keywords: - electronic wastage, microbe oriented technology, lixiviants, ecological effects

I. INTRODUCTION

Expeditious development, mechanisation, and population expansion have caused increment in order of electronic and electronic devices. Expeditious development in technology, due to the requirement of public, companies are now producing innovative, improved and advanced electronic and electronic devices at a shocking speed. Lots of electronic goods are manufactured, purchased, utilized and disposed ensuing in the creation of enormous quantity of waste electrical and electrical devices .[1]

The electronic wastage usually contains big and small gadgets like lamps, mobile phones, smart cell phones, televisions, printers, refrigerators, in addition to advance microproccessing gadgets. [2] Because of the rapid development in technology and incredible market expansion the majority of the electronic and electronic devices have a small life period, which causes the rapid build-up of electronic wastage. [3] Generally, electronic devices with no intention of reuse are called electronic waste.

According to the data accessible in this field in 2014, around 42 million tons electronic wastage was created internationally and according to the evaluation electronic wastage is rising at the speed of 4.5 % yearly, which caused 50 million tons of electronic wastage production in 2018. [4] a huge quantity of compound and different electronic wastage produced has unfavourable effect on ecology and also humans, if electronic wastage is not correctly disposed. sadly there is no appropriate method to gather, accumulate, convey, treat, and dispose electronic wastage. therefore, it has developed into a matter of apprehension for the manufacturers, non- government and government institutions and also for the community to guard the surroundings from the dangerous consequence of inappropriately managed electronic wastage. [5]

The main constituent of every electrical and several electronic appliance is circuit cards .they are utilized for smooth, high-speed and suitable performance of big or small electronic gadgets. Electronic devices consist of a number of metals along with a variety of organic contaminant. Therefore, electronic wastage cannot be discarded as landfill or burned. on the other hand, burning and land filling are the widespread means used for electronic wastage disposal, which causes the discharge of poisonous gases in environment and extremely dangerous metals in ground waters and earth .

These contaminants will build up and transfer to plant metabolism, which eventually reach to human beings and animals. [6]Because of this awareness electronic waste disposal has developed into an essential and crucial sector of research all over the planet. The present paper primarily evaluates the microbial treatment of electronic waste with special emphasis on recovery of metals from electronic wastage by utilizing microbial engineering.

Microbial bioengineering method of extraction of metals is based on capability of microbes to produce chemicals which removes metallic compounds from electronic waste. Sulphur or Iron oxidizing microbes produce iron (III) which removes numerous metals in liquid state. Cyanide producing microbes are efficiently utilized in recovery of silver and gold from electronic waste. A number of fungi are used for metal extraction from electronic waste by producing organic compounds. [7] Types of microbes used in the metallic compounds removal method and important process of metal recovery are represented in the paper.

II. METAL EXTRACTION WITH THE HELP OF MICROBES

Lately bio hydrometallurgy is getting a lot of interest from educational as well as sector of research for the removal of metals from electronic waste. Microbes and their compounds are performing an essential function of extraction of metallic compounds in to liquid state from minerals, solids, ores and electronic wastage. Microbes can operate at various conditions and pressure with different circumstances, consequently they can be easy to control and preserve. [8] These days, gold, silver and cobalt are recovered from their ores at their manufacturing level using microbial method.

The growth of molecular biotechnology and the utilization of molecular biotechnology in bio mining sector for the classification of microbes have extended our awareness concerning metallic compounds and microbial metabolism, microbes performing important function in metal extraction. [9] The main microbes used in metal recovery can be roughly classified as iron and cyanide producing microbes, iron oxidizers, and organic compound producers.

III. MAJOR MICROBES AND METAL RECOVERY METHODS [10]

Organisms	**Substrate**	**Lixiviant**	**Element recovered**
Iron oxidising 1. Leptospirillia ferrooxidans 2. Leptospirillia ferriphillum 3.Acidithiobacili ferrooxidans	Iron(II) sulphate	Iron(III) sulphate	Copper, Zinc, Nickel, lead, Cadmium
Sulphur oxidizing 1. Sulphobacilli thermosulphidooxidans 2. Acidithiobacilli thiooxidans 3.Sulpholobus	Sulfur and Sulfur Compounds .	Sulfuric acid oxidized Sulfur Compounds	Copper, Zinc, Nickel, Aluminium
Cyanogenic microbes 1. Chromobacteria violaceum 2. Marsmius oreades 3. Pseudomonas florescence	Glycine	Hydrogen cyanide	gold, silver, lead, Platinum
Organic acids producing microbes 1. Penicillium simplicissimum 2. Aspergillus niger	Carbohydrate	Citric acid, Oxalic acid, Malic acid	Copper, Zinc, Nickel, lead, Aluminium, Cobalt, Lithium

Table 1:– Microbes and Metallic Compounds Recovery Methods

IV. BIOMINING METHOD

Metal removal from electronic wastage is done with one step biomining, two step biomining and spent medium method. Electronic wastage is mainly diverse from sulfide ore. In electronic Wastage, metallic compounds are in their valence state but in the instance of sulfide ore, they are in the state of metal sulfides alongside iron sulfide and sulphur. [11]Metal sulfides, iron sulfide and sulfur are power resource for sulfur and iron oxidizing microbes. Throughout one step method, adding inoculate in the leaching method microbe use it as substrates which continuously produces Iron (III) and H^+ as lixiviants. [12] The lixiviants react with metal sulfides and metal is recovered or extracted. The electronic wastage has no substrates or power sources, therefore it is essential to put in ferrous iron, iron sulfide or sulphur in the leaching process. This helps the microbes to produce necessary lixiviants.

A. ONE STEP BIOMINING METHOD

In One step biomining procedure the inoculate in the logarithmic stage is put in the appropriate leaching solution alongside the electronic wastage and method is performed for production of iron ions and proton, which slowly extracts metallic compounds. The existence of harmful organic substances, elements or produced during the method employ negative impact on microbes. [13] Hence, development and action of inoculum get slow or inhibited. inhibitory impact like this limits the one step biomining method to function at small pulp concentration. According to the accessible information in this field, generally the procedure is done in the range of 1-5% (w/v) electronic wastage. [14] Adding up of small pulp concentration causes less quantity of metal removal from the solution. Additionally, in one step method it is not easy to supply most favourable circumstances at the same time both for the development of the microbe and metallic compound recovery that is accountable for low metallic compound recovery speed in this method.

B. TWO STEP BIOMINING METHOD

In case of two step biomining method, required microbes are developed in a particular medium under the most favourable development circumstances according to initial step of the method. When the highest development of the microbe and lixiviant is accomplished electronic wastage is processed under the second step method. Two-step biomining method decreases inhibition of the microbes because of the toxicity of electronic wastage and it maintains most favourable circumstances both for the development during the initial step method and for metallic compound extraction in the second step method.

Two-step biomining method is extra efficient as it leads to quicker and elevated metallic compound recovery. [15] Furthermore, it is probable to do the method at elevated pulp concentration in comparison to first step biomining method. Throughout the second step bioproduced iron ions are used method where it is re-oxidized and iron ion is generated, which again used as lixiviant for extraction of metallic compounds. [16] In two step method huge amount of lixiviant are present when electronic

wastage is added that right away starts reacting with electronic wastage and metals is extracted as fast as possible.

C. SPENT MEDIUM METHOD

In spent medium method organisms are made to cultivate under favourable circumstances to get highest lixiviants and development. Following development, microbes are separated by centrifugations and are used in spent medium method; electronic wastage is put in the medium. In the scenario of gold recovery, spent medium method is more helpful as it leads to elevated gold recovery in comparision to two-step method. [17] Also, the microbes are separated by this method from the spent medium. They do not utilize the air that was provided for the gold recovery; as a result more air is present for gold mining in comparison to two step method. Cyanide producing microbes create hydrogen cyanide at the end of exponential or starting of stationary state and if the microbes are not separated they transform created hydrogen cyanide in to beta cynoalanine. [18] therefore, existing hydrogen cyanide is reduced, which is accountable for small quantity gold recovery in two-step method in comparision to this method. Inhibitory impact like this might not be happening in the scenario of iron ion or proton creation method. therefore, two step methods is the method of preference for metal recovery from electronic wastage by means of sulphur and iron oxidizing microbes, while utilization of spent medium process is preferred for gold recovery with cyanide producing bacterial method.

D. METALS EXTRACTION FROM LEACHATE

Bioleaching of electronic wastage produce metal loaded liquid medium. In this process metallic compounds are charged with positive charge and cell wall of bacteria is charged with negative charge, therefore nearly all biomasses of bacteria are utilized as biosorbent for the absorption of metallic compounds. Fungal, yeast, plant and bacterial biomass dead or alive are utilized for metal extraction from medium. [19] Numerous reactions and several kinds of biomass are used in metal extraction from metal containing medium.

V.CONCLUSION

Various toxic substances are there in electronic wastage require to be capably treated from the place where they are discarded to reduce their impact on the ecology. Microbial hybrid methods have the potential to decrease the toxicant related with electronic wastage hazards. This paper presents different type of microbes used in extraction of metal from electronic wastage, different biomining process like one step method, two step methods and spent medium method and also the metal extraction from leachate. We can conclude that the effectiveness of biological method would be improved if it is utilized with a mixture of diverse processes like nanoparticles and some non contaminating biodegradable agents. In addition to that there is a requirement to develop more knowledge in this field with more efforts on reusing, recycling and reducing approach.

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