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A Review on Studies and Research on Gold Recovery from Industrial Solid Waste

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ABSTRACT

Solid waste treatment is becoming more important in industrial waste treatment. The electronic circuits and components contain various hazardous as well as precious materials. The use of heavy metals in the various components of mobiles, computers, remote, chips and other components calls for effective solid waste management. The electronic waste includes used components and electronic goods. These electronic materials and goods contain various valuable metals like gold, silver, platinum etc. These wastes are normally treated unscientifically. These methods are inefficient and at times hazardous. There is need to explore methods which are systematic and efficient. The current review summarizes research and studies for recovery of gold from waste.

Key words: leaching, solvent, recovery, pre-treatment, recycle.

INTRODUCTION

India is rapidly growing economy. The growth of Indian information technology sector has attracted investment worldwide. Other sectors such and chemical, pharmaceutical, petroleum and fertilizer are also growing rapidly. It is necessary to get measure of pollution problem arising from industrialization and explore effective methods for their treatment. The waste treatment problem can be divided into four parts namely liquid waste, solid waste, air pollution and noise pollution. The liquid effluent treatment is widely investigated area research. The pollutants are treated by new and modified technologies for more effective treatment by large number of investigators. Removal of heavy metals is major area of investigation for electronic, mining, catalyst and packaging industries. Various investigators have studied methods for removal and recovery of metals like zinc, cadmium, mercury, chromium, lead etc. from effluent. [1-5] The regeneration and recovery of these metals is also widely investigated area of research. [6-10] Methods like adsorption, electrostatic separation, and biological treatments can be used for heavy metals. [11-15] Gold is most precious metal and it has high recovery value. Electronic and mobile boards and components contain gold in considerable amount. The present review summarizes research and studies on gold recovery from industrial solid waste.

RESEARCH AND STUDIES ON GOLD RECOVERY FROM INDUSTRIAL SOLID WASTE

Ficeriova et. al. carried out an investigation on recovery of precious metals like gold from circuit boards. [16] They proposed ammonium thiosulphate leaching process. They treated printed circuit boards (PCBs) for eliminating the semiconductors, condensers, and resistances. The leaching of as received waste by thiosulphate could accomplish about 16 percent gold recovery. After carrying out pre-treatment, it was possible to recover 98 percent gold. Kamberovic et. al. used hydrometallurgical process for extraction of metals from electronic waste. [17] According to them, highly polluting recycling technology which causes a variety of environmental problems needs to be modernized. They leached pre-treated PCBs with nitric acid. They determined pouring density, percentage of magnetic fraction, particle size distribution,

metal content and leachability by using optical microscopy, atomic absorption spectrometry (AAS), X-ray fluorescent spectrometry (XRF) and volumetric analysis. According to them, size reduction process should include cutting instead of hammer shredding for obtaining suitable shape. Chauhan and Upadhyay reviewed recovery of heavy metals from E waste. [18] They discussed the treatment methods for E waste such as mechanical separation, thermal treatment, incineration, smelting, sintering, hydrometallurgical treatment, electrochemical treatment and their limitations. They concluded that a single method will not be capable of treating the pollution load but the combination of the methods in step is required to recycle, recover and reduction of pollution load. Leaching of gold from the waste mobile phone printed circuit boards (PCBs) was carried out by Tripathi et.al. [19] They used sodium thiosulphate for the recovery. In their investigation, they studied the factors affecting the gold leaching such as ammonium thiosulphate concentration, copper sulfate concentration, pH and pulp density. The presence of copper sulphate helped the leaching. They were able to recover 56.7 percent gold by using 0.1M ammonium thiosulphate. The optimum pH was 10.5, which they attributed to stability of ammonium thiosulphate. Chehade et. al. carried out an investigation on recovery of many valuable metals including gold. [20] According to their estimate the printed circuit board contains about 0.15 percent of gold. Their aim was to design a commercial process to extract these four metals from PCBs of computers and mobile phones. In their studies, they also discussed the relevant market analysis and research that led to the selection of these metals and PCB sources. The treatment of PCBs was divided into three steps. Primary separation, recovery and waste treatment. From 125 kg PCBs waste they were able to recover 0.044 kg of gold. Silvana et. al. carried out studies on recycling of precious metals from E-scrap. [21] Their work was focused on the silver and gold in high purities with Aqua regia as a leaching agent. They concluded that gold recovery from PCBs was very profitable. Hongal et. al. carried out research on extraction of gold from E-waste using a multi-sensor based method using microcontroller. [22] They made an attempt to automize the aqua regia solution process for gold recovery. According to them atomized process using aqua regia can provide a sort of industrial solution as E-waste which is a global problem. Montero et. al. used leaching column technique for recovery of gold, silver, copper and niobium from printed circuit boards. [23] They crushed PCBs in hammer mills and then leached with sodium cyanide. They achieved 46.6 percent gold recovery in their investigation. Chatterjee and Kumar reviewed electronic waste treatment and recovery. [24] They proposed an outsourcing model where equal participation of the formal and non-formal sector is involved. According to them the non hygienic and unscientific practices for gold recovery from waste must be discouraged. Ficeriova et. al. investigated leaching of gold and silver from crushed Au-Ag Wastes. [25] The thiourea process was used for gold recovery. They observed that this process provides viable alternative to cyanide process. They were able to recover 97 percent gold using thiourea method. Potgieter et. al. carried out an investigation on recovery of precious metals from jewellers wastes. [26] They studied the factors like the effects of temperature, stirring rate, leaching agent concentration and solid: liquid ratio on recovery. They used aqua regia method for gold recovery. Gold was leached and then precipitated using sulphate of iron. Bacterial leaching was used for recovery of metals from electronic waste by Willner and Fornalczyk. [27] The bacteria's normally used for gold are Chromobacterium violaceum, Pseudomonas fluorescens, Pseudomonas Plecoglossicida. They carried out bioleaching experiments at 30°C. The particle size of the bioleaching material and the ratio of solid phase to liquid phase

influenced the dynamics of metal dissolution.

CONCLUSION

The use of heavy metals in the various components of mobiles, computers, remote, chips and other components calls for effective solid waste management. These electronic materials and goods contain various valuable metals like gold, silver, platinum etc. These wastes are normally treated unscientifically. It was possible to recover 98 percent gold from printed circuit boards (PCBs) by ammonium thiosulphate leaching process. Hydrometallurgical process for extraction of metals from electronic waste is also effective. Reviews on mechanical separation, thermal treatment, incineration, smelting, sintering, hydrometallurgical treatment, electrochemical treatment are also reported. Aqua regia is commonly used as a leaching agent for gold recovery. Bioleaching was also carried out successfully by investigators. The selection of treatment method depends on concentration of gold in waste, size of waste, composition and treatability of waste.

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