ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 2, Issue 1, January 2013

Recovery of Lead Metal from Lead Acid Battery by Hydrometallurgical Method

E.Yoheeswaran[1], Dr.S.Govindaradjane[2], Dr.T.Sundararajan[3]
[1]M.Tech (Environmental Engineering), Department of Civil Engineering,
Pondicherry Engineering College, Pondicherry
[2,3]Associate Professor and Professor, Department of Civil Engineering,
Pondicherry Engineering College, Pondicherry

Abstract*— This work aims at recovering lead metal from used lead acid batteries, by the hydrometallurgical method. The treatment of used batteries for recovering lead is important from the point of view of lead production as well as pollution abatement as otherwise the battery scarp leads to serious disposal problems. As the Pyrometallurgical and other methods suggested in the past decades, are found to be impracticable, the above new method was used. The recovery of lead metals from lead acid batteries by electrochemical method comprising two successive steps of lead leaching and electrode position. It is found that 95% of lead metal was leached by 2M of nitric acid and the electrode position step more than 90% of lead metal can be recovered with low current efficiency from the leaching solution. The method adopted seems promising and has great potential for removal of lead from used lead acid batteries.

Keywords: **Lead Acid Battery, Recovery, Hydrometallurgical Method, and Electrode Position.**

I. INTRODUCTION

The electrical and electronic waste (e-waste), like a municipal solid waste (MSW), is one of the fastest growing advanced types of solid waste streams in the urban environment, worldwide. Globally, e-waste is growing by about 40 million tons (MT) a year. In India e-waste generation is growing at about 15% and is expected to cross 800,000 tons per year in 2012. The composition of e-waste is very diverse and contains over 1000 different substances, which falls under organic and inorganic fractions [1]. Heavy metals form a significant part of inorganic fraction amounting to 20-50%, which may consists of hazardous metallic elements like lead, cadmium, chromium, mercury, arsenic, selenium and precious metal like silver, gold, copper and palladium. Pondicherry, which is one among the four regions constituting the Union Territory (UT) of Pondicherry. The population of Pondicherry municipality is 221,000. The MSW generated is about 175 tons per day and the per capita generation of e-waste is 0.578 kg per annum [4].

A previous study conducted by Pondicherry Engineering College (PEC) has revealed that MSW management. Self is far from satisfactory, leave alone E-waste management. However, in recent times the need for managing MSW and E-waste has been realized by the authorities, but no concrete action plan has been initiated. As part of continuous research on MSW and E-waste management, the Department of Civil Engineering, PEC, has initiated a series of scientific studies. Based on preliminary survey, the importance of recovery of lead from used/discarded lead acid batteries has been taken up for investigation. Lead acid batteries have lead alloy metal, lead sulfate, micro porous paper and plastic. Every year, the industry produces about 2.5 MT of lead throughout the world. Most of this lead is used for batteries. The remainder is used for cable coverings, plumbing, ammunition, and fuel additives. Other uses are: as paint pigments and in PVC plastics, x-ray shielding, crystal glass production, and pesticides. Heavy metal ions can be removed or recovered by several techniques such as: chemical precipitation, ion exchange process, adsorption by biosorbents and electrochemical methods. In electrode position, lead ion in solution can be deposited on the cathode. If the electrolyte is acid, the reduction of hydrogen ions to hydrogen gas also takes place in the reaction [2], [3]. Metals can be recovered by the metallurgical method, which can be carried out in three ways, namely, (i) Pyrometallurgical or fusion reduction method, (ii) Hydrometallurgical or electrolytic method and (iii) Biometallurgical method. Of the above, hydrometallurgical method is widely adopted for extracting a large number of metallic elements. In view of the above, in this study, the above method is adopted to extract lead from lead acid battery and the performance of the method has been assessed and reported.

II. EXPERIMENTAL INVESTIGATION

The waste lead acid batteries were collected from an automobile workshop. The collected batteries were of Exide brand, with the model of the battery as 12MX2.5L-C-4 and size of each battery being 7.7x6.7x10.1 cm. The lead

ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 2, Issue 1, January 2013
content (as indicated by the manufacturer) is 65.8% (by weight) and was taken as a reference for comparison and further assessment in this study. The details of scraped battery details are given in Table 1 and the line diagram of the experimental set up is shown in figure 1. The process of lead metal removal from the batteries consists of two steps, namely, (i) lead metal leaching by solvent and (ii) electrode position, which are briefly described below:

A. Lead Metal Leaching By Solvent

The leaching was carried out in 2 liters of solvent. The solvent was prepared by 2M of nitric acid by maintaining the solid-liquid ratio 1g: 100ml. 20g of the waste was kept immersed in the solvent and the equilibrium reaction was attained in 120 minutes. The measured pH and electrical conductivity at that stage were: 0.89 and 0.054 Siemens.

B.Lead Removal by Electrode position

Two liters of distilled water were added for diluting the solution, without adding any buffer solution. The anode and cathode used are: graphite rod and lead plate. The graphite rod was collected from waste battery and the lead plate size used was: 7.5x7.5x0.3 cm. The anode and cathode were connected by Direct Current (DC) supply, with 1.5 to 3 volt. Due to the high current supply imposed on the electrolyte, the lead plate (cathode) dissolves into the solution.

III. RESULTS AND DISCUSSION

One gram of lead acid battery waste contains 0.658 mille grams (mg) of lead, which was measured by UV spectrophotometer with 510 nano meter wave length. Initial weight of the lead plate (cathode) was 109.18 grams, after electrode position, the weight of the plate was 121.5 grams. Hence the metal recovered was 12.32 gm.

The possible reaction involved is highlighted below:

$PbSO_4 + HNO_3 \rightarrow PbNO_3 + H_2SO_4$

$Pb + HNO_3 \rightarrow PbNO_3 + H_{2\,(g)}$

Effect of pH

No addition of any buffer solution was made, as it would affect the reaction that is undergoing in the reactor, and hence, the effect of variation of pH could not be studied.

Energy consumption

Specific electrical energy consumption is defined as the amount of electrical energy consumed per unit mass of E-waste loaded and it was calculated in terms of kilo watt hour(kWh) for per gram of lead metal recovered (kWh g^{-1} Pb). In this case the maximum power or energy consumption was found to be 0.0025 kilo watts per hour for 12.32 gm of lead metal recovered.

Table 1: Scraped battery details

Plastic	132.24 gm
Paper	40.53 gm
Metal (Cathode & anode)	922 gm
Total wt of battery	**1094.77 gm**

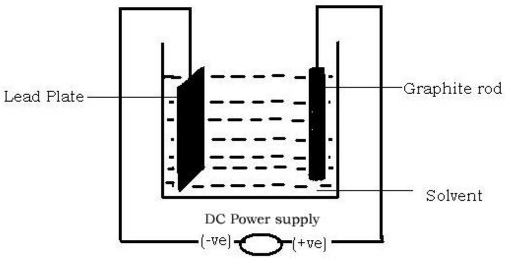

Fig 1: Line diagram of electrode position

IV. CONCLUSION

Based on the above experimental investigations, following are the salient conclusions:

- For the recovery of lead metal from E-waste (lead acid battery), the maximum duration for dissolution process was found to be two hours for dissolution of 20 gm of lead acid battery compounds and the maximum duration of electrolysis for deposition of 12.32 gm of lead metal was 90 minutes.
- The maximum power consumption was 0.0025 kWh for the above quantity of lead metal recovered.
- The maximum lead (Pb) recovery was 92.33% which was achieved in 90 minutes by the above process is at 4 L of dissolved solution.
- On overall assessment the proposed method is very promising for the removal of lead from used lead acid batteries.

ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 2, Issue 1, January 2013

REFERENCES

[1] Viraja Bhat et., al, Development of an integrated model to recover precious metals from electronic scrap – A novel strategy for e-waste management, Procedia social and behavioral 37, 397-406, 2012.

[2] Kejvalee Pruksathorn and Somsak Damronglerd, Lead recovery from waste frit glass residue of electronic plant by chemical-electrochemical methods, 22(6), 873-876, 2005.

[3] Colin G.Fink, Lawrence Greenwspan, Electrolytic recovery of lead from lead sulfate waste, 465-473.

[4] dste.puducherry.gov.in