Tin Extraction from Slags Used Hydrochloric Acid

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***Abstract* — Slag is a mixture of mineral in tin sand or by product in the smelting process. By using separation process, tin can be separated from other minerals in slag. Extraction process with a solvent is usually used to separate tin from other minerals. Furthermore, solution that still contains many dissolved compounds is adsorbed by activated carbon and desorption back with NaOH solution. This study only focuses on the extraction process to obtain a stannate chloride solution with extraction temperature, solvent concentration, extraction time, and liquid/solid ratio as variables. Hydrochloric acid (HCl) has been used as solvent in this study. The concentration of tin in the extracts of each variable was analyzed to determine the percentage of recovery of tin and the optimum operating conditions in the recovery process of tin from waste slag. Experiment results show that the percentage of recovery increases with the increasing of extraction temperature and solvent concentration The highest recovery is 61.5% which is obtained when the extraction temperature is 80 ºC, concentration of HCl is 10 wt%, with a HCl solution and slag ratio is 7: 1 and extraction time is about 30 minutes.**

Keywords—**Recovery, Smelting Process, Solvent.**

I. Introduction

Since the 19th century, demand of tin increases with the increasing of electronic industry resulting more efforts to produce tin. With the increasing of tin production, waste of this industry that is usually called as slag also increases. However, slag still contain of tin which is about 4-10%. This value is high enough to do recovery process of tin from slag. There are several method to recover tin from slag, such as extraction with solvent.

PT. Indra Eramulti Logam Industri (IMLI) as an example of private industry which produce tin. This company has slag of 10000 metric ton as waste and contain of tin in this slag is about 13.39%. However, it has problem to find which method is more suitable to recover tin from this slag. In the past, recovery process is done by recyle process. Recently, the researchers have found a new method that is chemical method: acid and base methods to purified tin in the slag. Yield in the base method is about 74-83%; however, this method is complex and expensive. In the other hand, yield in the acid method is about 80-85% by using three main processes: leaching, adsorption and desorption.

Extraction of tin has been studied by Elbert, et al (1968) by using HCl as a solvent with concentration range of 5-15%wt. Nixon, et al (1973) have done the extraction of tin from high concentrate of mineral resulting 15.8% Sn in SnO_2 by using H_2SO_4 as a solvent with concentration of 9M. Brian (1985) has studied about slag waste from smelting process of 100 ton feed. He has explained that the main losses in the tin production process are from slag.

This problem can be overcome by using recycle method. However, this method is not efficent and economic.

Barakat (1998) has done recovery process of Zn, Al, Pb dan Sn from waste of PCBs. There are two extraction processes in the recovery process. The first extraction uses H_2SO_4 (3%) at 45^{o}C for 1 h with Pb and Sn are not dissolved in H_2SO_4. In the second extraction process, HCl-HNO_3 5M is used as solvent which can extract Sn up to 99.5%. Katsuhito (1998) has studied about tin recovery process by using leaching process with NaOH as a solvent from sludge which contain of tin in the form of $SnO_2.nH_2O$. Castro, et al (2009) have done extraction of thin by using three kind of solvent: H_2SO_4, HCl dan HNO_3. Based on the composition of slag in PT IMLI, tin contain is about 13.39%. It can be said that this percentage is high enough to do recovery process with high capacity of feed (slag). Thus, it is important to study the extraction process of tin from slag. Extraction of tin from slag of PT IMLI with acid solvent (HCl) has been done and discuss in this study.

II. Method

A. Feed Preparation

To get uniform size of particle, size reduction process has been done by using crusher to obtain particle with size of more than 40 mesh. XRD analysis has been done to observe contain of slag rather than tin. The next step is preparing HCl solution with different concentration.

B. Extraction Process

Extraction process is started by heating HCl solution up to 50 ^{o}C (for variable liquid/solid: 4/1). Then, add 100 g of slag with 40 mesh of size in the extractor tank and stir it. Extraction process is done at 50^{o}C for 15 min. This procedure is repeated for the other variables. Variable in this study are ratio of slag/HCL (L/S) : 4/1, 5/1, and 7/1;

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concentration of HCl is varid, 5 and 10%; temperature (50-80^{o}C) and extraction time from 15 up to 30 min.

III. Result and Analysis

Percentage of tin recovery (% Recovery) defines as ratio of extracted tin to the number of tin in the slag. Effect of ratio HCl/slag and leaching time to percentage of recovery is shown in Figure 1. It can be seen that the trend of % recovery increases with the increasing of extraction/leaching time. Another influencing factor that affect % recovery is the ratio of HCl and slag. As shown in the Figure 1, when the ratio is high, % recovery is also high because the number of solvent in the extraction process is more.

Effect of HCl concentration and temperature in the extraction process is shown in Figure 2-5. Those figures show that % recovery increases with the increasing of HCl concentration and leaching time. At the same ratio of HCl/slag and HCl concentration, % recovery increases with the increasing of extraction temperature. The results show that the highest % recovery is 61.5% which is achieved when extraction temperature is 80 ^{o}C, 10 wt% of HCl concentration, ratio of HCl/slag is 7/1 with extraction time is about 30 min. % recovery that has been achieved in this study is not high enough. It may be caused by extraction time is not long enough, HCl concencentration is low, and stirred process is not good enough; thus, the contacting time between slag and solvent is ununiform.

This study shows that % recovery is affected by ratio of HCl and slag, extraction temperature and time, and concentration of HCl. From those results, by using regretion linear method the relation between % recovery and those influencing factor can be made as shown below:

$$\% \text{ Recovery} = 0{,}052 \times T^{0,75} \times C_{HCl}{}^{1,06} \times R^{0,30} \times t^{0,24}$$

where:

T = temperature (oC)
C_{HCl} = HCl concentration (wt%)
R = ratio of HCl/slag
T = leaching time (min)

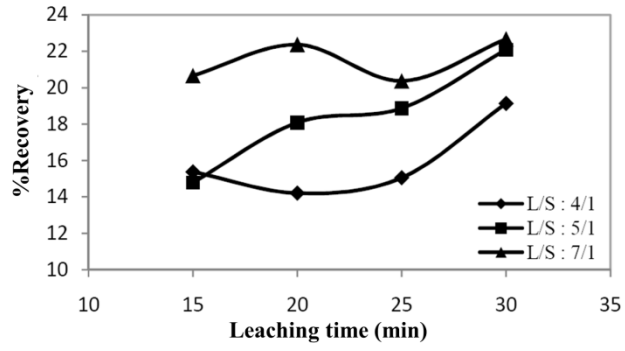

Figure 1. % Recovery vs extraction time for 5wt% of HCl concentration at 50^{o}C

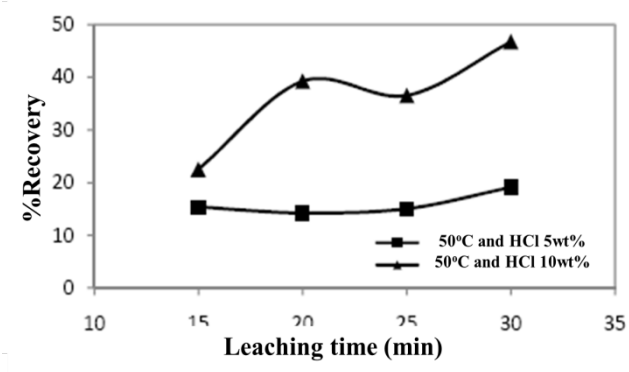

Figure. 2. % Recovery vs extraction time for 5wt% of HCl/slag 4/1 at 50^{o}C

IV. Conclusion

This study shows that % recovery increases with the increasing of ratio of HCl/slag, leaching time, temperature and HCl concentration which can be showed in this equation: $\% \text{ Recovery} = 0{,}052 \times T^{0,75} \times C_{HCl}{}^{1,06} \times R^{0,30} \times t^{0,24}$. The highest % recovery that has been achieved is 61.5% when extraction temperature is 80 ^{o}C, 10 wt% of HCl concentration, ratio of HCl/slag is 7/1 with extraction time is about 30 min.

Acknowledgements

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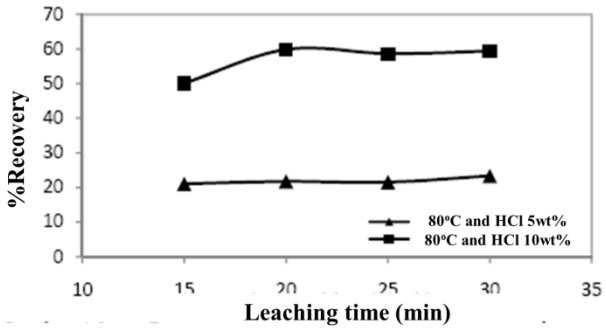

Figure. 3. % Recovery vs extraction time for 5wt% of HCl/slag 4/1 at 80°C

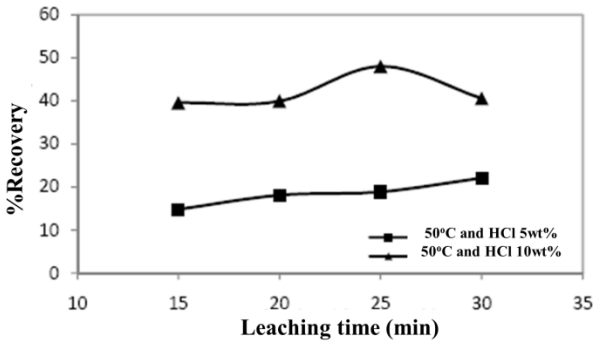

Figure. 4. % Recovery vs extraction time for 5wt% of HCl/slag 5/1 at 50°C

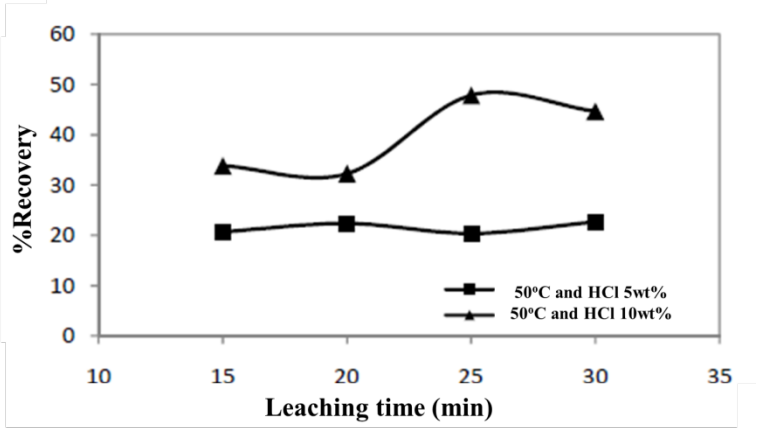

Figure. 5. % Recovery vs extraction time for 5wt% of HCl/slag 7/1 at 50°C