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Effect of Temperatures on Dissolution Performance of Scrap Lead Paste in Sodium Citrate Solution

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Abstract

People should appear arrhythmia, renal failure, convulsions, coma and even death if blood lead levels were more than 1000 μg/L. Lead impacts the body's nervous system and blood system significant. And in recent years, lead poisoning events occurred frequently. Therefore, it is very important for survival of human to research the properties of heavy metal lead. In this paper dissolution performance of scrap lead paste has been researched in sodium citrate solution at different temperature (20~80 ºC). The pH values of filtrate were all higher than 7 but lower than 7.51. 0.057~0.168 g sodium citrate was consumed by scrap lead paste per gram at 20~80 ºC. 0.575~1.815 g solid materials were residue, lowest at 80 ºC. 10.677~24.404g·L^{-1} lead in filtered liquor was tested, lowest at 50 ºC. Dissolution rates of scrap lead paste were 9.544~17.883 %, also lowest at 50 ºC.

Keywords

Dissolution Performance, Scrap Lead Paste, The pH, Temperature

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1. Introduction

Our society and technology have more and more development and our living standard has been continuously improved, however, the resources also been unceasingly consumed, and the environmental problem has been increasingly serious. Energy and environmental protection have become two hot issues.

People should appear arrhythmia, renal failure, convulsions, coma and even death if blood lead levels were more than 1000 μg/L. Lead impacts the body's nervous system and blood system significant. And in recent years, lead poisoning events occurred frequently. Therefore, it is very important for survival of human to research the properties of heavy metal lead.

At present, lead acid battery has become the one kind of widespread used second batteries for the advantages of simple construction, reliable performance, lower price, easy getting of raw materials, convenient to use, and many other advantages [1-2]. It is mainly used as power source for automobile start and as auxiliary power supply for illumination, mintype electrombile and UPS[3-5]. Lead acid battery has become a primary consumption product all over the world; however, it also has become the mainly resources of lead renewable. Lead as a kind of highly toxic heavy metal, recycling and reusing it from the scraped lead acid battery is very important in environmental view.

When charging, the cathode material of lead acid battery turns into PbO_2 and anode material turns into Pb. While discharging,

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the cathode and anode electrode active materials all turn into $PbSO_4$. The reactions of materials when discharging are as follows,

Cathode reaction, $PbO_2 + HSO_4^- + 3H^+ + 2e^- \rightarrow PbSO_4 + 2H_2O$

Anode reaction, $Pb + HSO_4^- \rightarrow PbSO_4 + H^+ + 2e^-$

Overall reaction, $Pb + PbO_2 + 2H_2SO_4 \rightarrow PbSO_4 + 2H_2O$

The manufacturing processes of lead acid battery mainly include exploiting and transformation of resource, preparation of material for battery and assembling of battery. Among the process of preparation of material and assembling of battery, especially the process of preparation of electrode, plenty of lead pastes will fall off as scrap lead pastes. Cyclic utilization of scrap lead paste is a significance measure which should reduce the batteries production fee and environmental pollution of heavy metal lead. The scrap lead paste mainly contains $PbSO_4$ and PbO_2. Therefore, desulphurization methods for scrap lead paste are important among cyclic utilization of scrap lead paste. The mainly desulphurization methods are Pyrometallurgy [6-7] and Hydrometallurgy method [8]. Among Hydrometallurgy method, the flow desulfurization agent will be usually used: Carbonate [9-10](RSR[11-12] and USBM[13] technologies use $(NH_4)_2CO_3$ as desulfurization agent, CX-EW[14] technology uses Na_2CO_3 as desulfurization agent); NaOH [15-16]; NaCl-HCl [17]; citric acid-sodium citrate ($C_6H_8O_7 \cdot H_2O$-$Na_3C_6H_5O_7 \cdot H_2O$) [18-22]; sulfate-reducing bacteria (CX-EWS technology) [23] and so on.

At this stage, many researchers used sodium citrate hydrometallurgy[18-22] to dope with scrap lead paste; therefore, dissolution performance of scrap lead paste at different temperature in sodium citrate aqueous solution is very important for doping with scrap lead paste.

2. Experimental

The sodium citrate aqueous solutions which the concentration was 10 percent were prepared as follows: 16.7 ml of $Na_3C_6H_5O_7 \cdot 2H_2O$ (30%) were constant volume to 50 ml by deionized water.

Experimental process was as follows: 5 g of scrap lead paste was added into 50 ml $Na_3C_6H_5O_7 \cdot 2H_2O$ aqueous solution under vigorous stirring. Stirred for 5 min at different temperature (20~80 °C) in air atmosphere, filtered and washed for three times, then dried at 60 °C. The volume, pH value of filtrates and the masses of filter cakes were write down. Filtrates were diluted 2000 times then the concentrates of Pb^{2+} in filtered liquor was tested used atomic absorption spectroscopy (AAS). The dissolution rates of scrap lead paste(r) were calculated by follow pattern.

$$r = \frac{c(g/L) \bullet V(L)}{m(g)}$$

r, dissolution rate; c, concentrates of Pb^{2+} in filtrates; V, volume of filtrates; m, mass of scrap lead paste.

3. Results and Discussion

3.1. The pH Value of Filtrates

The pH curve of filtrates at 20~80 °C was shown in fig 1. It shows that pH values of filtrates all higher than 7 but lower than 7.51 after dissolved by $Na_3C_6H_5O_7 \cdot 2H_2O$ at different temperature. Therefore, filtrates are neutral after dissolved by sodium citrate at 20~80 °C.

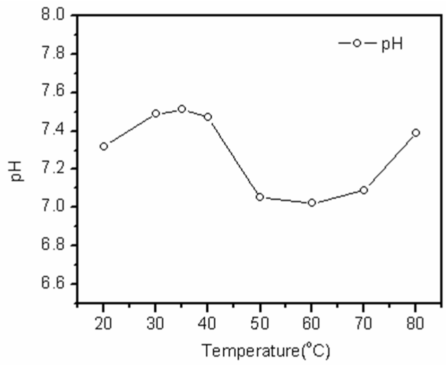

Fig 1. The pH curve of the filtrates at 20~80 °C

3.2. Mass of Sodium Citrate Consumed by Scrap Lead Paste per Gram

Fig. 2 shows the mass of sodium citrate was consumed by scrap lead paste per gram at 20~80 °C. They were from 0.0571 g to 0.1680 g; the mass of sodium citrate be consumed by scrap by lead paste per gram was lowest as 0.0571 g at 50 ºC. Therefore, a dissolution rate of scrap lead paste was lowest at 50 ºC in sodium citrate solution.

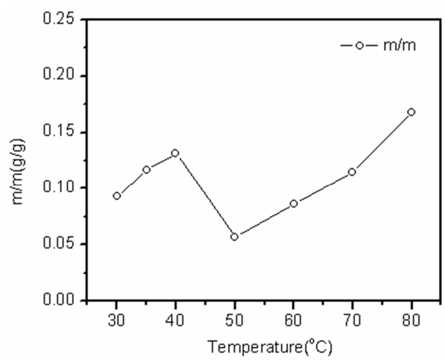

Fig 2. Mass of sodium citrate consumed scrap lead paste per gram at 20~80 °C

3.3. Percentages of Solid Remaining in Sodium Citrate

Fig. 3 shows the percentages of solid remaining in 10% sodium citrate aqueous solution at 20~80 °C. The percentages of solid remaining were from 9.657% to 30.93% doped with 10% sodium citrate aqueous solution at 80~20 °C. It shows a decrease of the percentages of solid remaining with higher the solution temperatures.

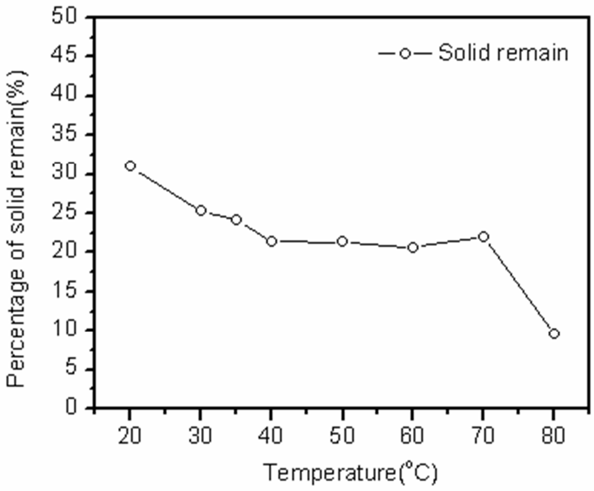

Fig 3. Percentages of solid remaining at 20~80 °C in 10% sodium citrate aqueous solution

3.4. Concentrations of Pb^{2+}in Filtrates

Fig. 4 shows the concentrations of Pb^{2+} in filtrates at 20~80 °C in 10% sodium citrate aqueous solution. The concentrations of Pb^{2+} in filtrates at 20~80 °C in 10% sodium citrate aqueous solution were from 10.677 to 24.404 g·L^{-1}. It was lowest at 50 ºC as 10.677 g·L^{-1}. Therefore, a dissolution rate of scrap lead paste was lowest at 50 ºC in 10% sodium citrate aqueous solution. This result was consistent with the result of fig 2.

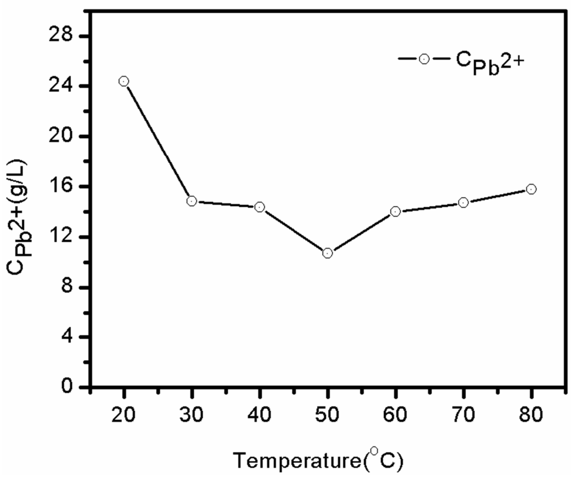

Fig 4. Concentrations of Pb^{2+} in filter liquor at 20~80 °C

3.5. Dissolution Rates of Scrap Lead Paste

Fig. 5 shows the dissolution rates of scrap lead paste at 20~80 °C in 10% sodium citrate aqueous solution. The dissolution rates of scrap lead paste at 20~80 °C in 10% sodium citrate aqueous solution were from 9.544 % to 17.883 %, lowest at 50 ºC as 9.544 %. Therefore, a dissolution rate of scrap lead paste was lowest at 50 ºC in 10% sodium citrate aqueous solution. This result was also consistent with the results of fig 2 and fig 4.

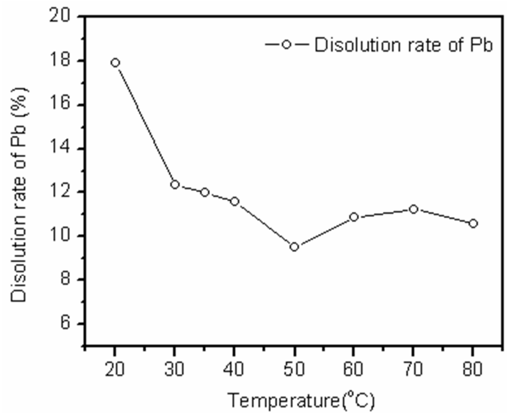

Fig 5. Dissolution rates of scrap lead paste at 20~80 °C in 10% sodium citrate aqueous solution

4. Conclusions

Filtrates were all neutral after dissolved by 10% sodium citrate aqueous solution at 20~80 °C. 0.057~ 0.168 g sodium citrates were consumed by scrap lead paste per gram. Concentrations of Pb^{2+} (10.677 ~ 24.404 g·L^{-1}) in filtered liquor was lowest at 50 ºC as 10.6772 g·L^{-1}. The dissolution rates of scrap lead paste in 10% sodium citrate aqueous solution at 20~80 °C were from 9.544% to 17.883%. A dissolution rate of scrap lead paste was lowest at 50 ºC in this sodium citrate aqueous solution. These dissolution performances of scrap lead paste in 10% sodium citrate aqueous solution are very important for the survival of human to research the properties of heavy metal lead.

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