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Selective leaching of lead and zinc over iron from jarosite using methanesulfonic acid

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PURPOSE OF THE ABSTRACT

Jarosite is a solid residue generated by the zinc metallurgical industry. The residue contains iron as the main component and some amount of lead, zinc, and valuable metals such as indium, germanium and silver.(1)
Recovery of these metals from industrial process residues like jarosite is complex because they are present in very low concentrations and often locked in complex mineral matrices.(2) Conventional pyrometallurgical and hydrometallurgical routes suffer from high cost and poor selectivity,respectively. However, by replacing the aqueous phase in hydrometallurgical processes by organic solvents, it is possible to attain high reactivity and selectivity because non-hydrated anions have a greater affinity to bind to certain metal ions and the lack of water's high solvating power makes it impossible for some metals to enter into the solution. This new approach to extractive metallurgy, based on the use of organic solvents instead of an aqueous phase, is called solvometallurgy.(2)
In this work, solvometallurgical leaching was carried out on jarosite by using methanesulfonic acid (MSA). MSA is a strong organic acid and it is considered as a green solvent.(3) MSA has a low vapor pressure, low toxicity and it is readily biodegradable. Moreover, it is also a part of the natural sulfur cycle. A jarosite sample was provided by an European zinc producing company. The concentrations of the main metals in the residue are: 40g/kg lead, 24g/kg zinc and 174g/kg iron. The main mineral phases are natrojarosite, anglesite and sphalerite. The objective of this study is to selectively recover lead and zinc from the residue with minimum co-dissolution of iron.
The preliminary leaching tests were performed under the operating conditions of a liquid-to-solid ratio (L/S) of 10 mL/g, at 60 °C for 2 h. The effect of volume % of MSA in water was studied (Figure 1a). Presence of any amount of water results in very poor selectivity for lead over iron. However, pure MSA results in good selectivity for lead over iron. Leaching jarosite with undiluted MSA resulted in three different phases (Figure 1): 1) a liquid organic leachate, 2) a solid white precipitate and 3) a solid leaching residue. The liquid organic leachate contained 35% of lead, 7% of zinc and only 4% of iron originally present in the jarosite. Hence, lead preferentially reported to the leachate. In the white precipitate, 64% of iron, 27% of zinc were precipitated. There is selective precipitation of iron and zinc in the precipitate. The effects of temperature and L/S ratio were investigated to further improve the leaching efficiency (Figure 2). Increase in temperature and L/S ratio significantly increased the leaching efficiency of lead in the liquid organic leachate. On the other hand, the effect of L/S ratio on the leaching of zinc was minimal, but the effect of temperature is significant. Unfortunately, the leaching efficiency of iron in the organic leachate also increased with increasing temperature and L/S ratio.
Based on the leaching efficiency and selectivity of lead and zinc over iron, the leaching at 130 °C and L/S ratio 20 was chosen for further investigation. The leaching efficiency in the organic leachate at that condition was: 100%

lead, 50% zinc and 9% iron. Although a higher L/S ratio and temperature gave a higher leaching efficiency of zinc, the co-dissolution of iron also increased, so those conditions were not preferred. For the next steps, the effect of the leaching time will be further optimized. The optimal conditions will be tested on a larger scale to investigate the scalability of the process. The metal speciation in the leachate and metal phases in the precipitate will be studied to understand the reaction mechanism of the process. Finally, and very importantly, attention will be paid to the recovery of MSA so that it can be reused for leaching.

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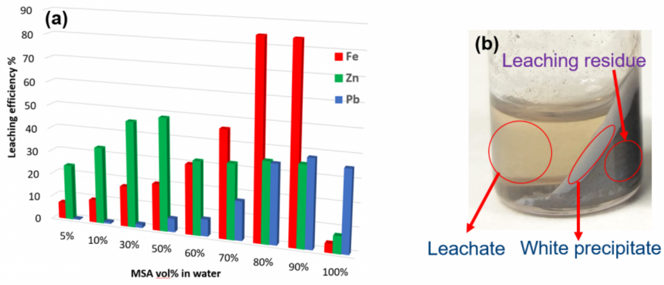
FIGURES



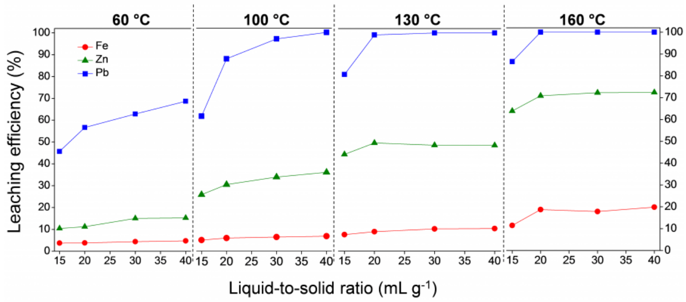


FIGURE 1

1 a) The effect of volume % of methanesulfonic acid in water and b)Three phases after leaching jarosite using pure methanesulfonic acid

1. liquid leachate
2. white precipitate
3. leaching residue

FIGURE 2

Effect of temperature and L/S ratio on the leaching efficiency (%) in the liquid leachate during leaching of jarosite with pure methanesulfonic acid.

Leaching parameters: contact time 2 h, stirring speed 600 rpm.

KEYWORDS

Green reaction | industrial chemistry | waste valorization | Alternative technologies

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