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Recovery of rare earths from ion-absorbed rare earths ore with $MgSO_4$-ascorbic acid compound leaching agent

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Abstract: The magnesium sulfate leaching technology for the ion-absorbed rare earths ore can solve the ammonia pollution problem existing in ammonium sulfate leaching process. However, the leaching capacity of magnesium sulfate is slightly weaker than that of ammonium sulfate, resulting in a bigger consumption of magnesium sulfate. In this paper, the $MgSO_4$-ascorbic acid compound leaching agent had been demonstrated to deal with the ion-absorbed rare earths ore. The ascorbic acid could form a stable coordination with rare earth ions, so that it can strengthen the leaching of ion-exchangeable phase. Moreover, ascorbic acid has a strong reductive property, it can leach the colloidal sediment phase rare earth as well. The present study investigated the effect of the initial pH and the composition of leaching agent on the rare earth leaching. It is determined that the rare earth leaching efficiency is 107.5% under the condition of pH 2.00, 0.15 mol/L magnesium sulfate and 1.0g/L ascorbic acid in leaching agent. In this case, the content of the ion-exchangeable phase and colloidal sediment phase rare earth in the leaching tailings are both only 0.02‰. The leaching efficiency of colloid sediment phase rare earth can be 85.7%, so that the Ce partition in the leaching liquor increases to be 5.77%. The magnesium-ascorbic acid compound leaching agent is proposed to be a promising choice to deal with the ion-absorbed rare earths ore, which can realize the efficient leaching, low consumption of $MgSO_4$ and environmentally friendly leaching.

Keyword: rare earth; leaching; $MgSO_4$; ascorbic acid; ion-absorbed rare earths ore;

1. Introduction

The ion-absorbed rare earths ore, first discovered at 1969, is mainly located in the seven provinces of South China. This kind of ore has many advantages, such as complete rare earth partition, low radioactivity, simple leaching process and rich in the middle and heavy rare earth elements, which makes it a valuable strategic mineral resource[1]. Its development and utilization make a significant contribution to the development of the global rare earth industry. Rare earth in the ion-absorbed rare earths ore exists in four phases[2]: water soluble phase, ion-exchangeable phase, colloidal sediment phase and minerals phase. The ion-exchangeable phase rare earth accounts for more than 80% of whole-phase rare earth. It can be easily exchanged and released when encountering the cations (such as NH_4^+, Mg^{2+})[3]. The leaching process is an ion-exchange process with the cations. Based on this principle, rare earth is recovered with $(NH_4)_2SO_4$ leaching agent in the industry nowadays.

The practice of *in-situ* leaching with $(NH_4)_2SO_4$ solution has caused serious ammonia-nitrogen pollution[4]. It has been reported that the concentration of $(NH_4)_2SO_4$ in the groundwater and surface water are up to 3.5–4.0g/L and 80–160 mg/L, which will result in water eutrophication[5]. In order to reduce the ammonia-nitrogen emissions, fulvic acid[6], sesbania gum[7], succinic acid[8], magnetism[9] etc., were used to strengthen the leaching process. But these methods could not completely solve the ammonia-nitrogen problem. Therefore, new non-ammonium leaching agents[10–12] were developed to replace $(NH_4)_2SO_4$, among which the magnesium sulfate leaching technology could realize the ecological-friendly leaching of the ion-absorbed rare earths ore[4,13]. However, the leaching capacity of magnesium sulfate is slightly weaker than that of ammonium sulfate, resulting in a bigger consumption of magnesium sulfate for the same leaching effect[14].

Researches show that the organic compounds can promote the leaching of rare earth from the ion-absorbed rare

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