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CONFERENCE TOPIC: REE Processing Technologies

Chelation-assisted ion-exchange leaching of rare earths

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ABSTRACT

Ion-adsorption type deposits containing rare earth elements (REE) are substantially lower grade than other lanthanide sources; however, this disadvantage is largely offset by the easier mining and processing costs, the relatively low content of radioactive elements (Th, U), and high HREE content. The ion-adsorption ores account for ~80% of the world's HREE production and up to 0.3 wt.% REE, out of which generally 60-80% occur as physically adsorbed species on clays. The conventional method of processing the ion-adsorption ores is by ion-exchange leaching using monovalent sulfate or chloride salt solutions at ambient temperature. During leaching, the adsorbed REE are substituted by the exchange ions and transferred into solution as soluble sulfates or chlorides. Ammonium sulfate is the established lixiviant for the recovery of lanthanides from ion-adsorption ores by either heap or *in-situ* leaching, due to its high extraction efficiency and low product contamination. However, recent trends in ion-adsorption ore research are focused on minimizing the usage of ammonium sulfate in an effort to reduce ammonia pollution of surface and ground waters.

In the present work we investigated an enhanced ion-exchange leaching procedure that is environmentally benign and allows high REE recovery while reducing ammonium sulfate usage by employing biodegradable chelating agents in conjunction with the main lixiviant. We established screening criteria for the selection of optimal chelating agents and compared the results with REE extraction levels obtained during conventional ion-exchange leaching with ammonium sulfate and

simulated sea water (SSW). The reagents selected are commonly available, poly-dentate compounds known to exhibit good chelating power for heavy metals, low toxicity and superior biodegradability:

It was found that 1:1 addition of N,N'-ethylenediaminedisuccinic acid (EDDS), nitrilotriacetic acid (NTA), aspartic and citric acids to 0.25 M NH_4^+ (as sulfate) resulted in 6 -10% increased extraction when compared to lixiviant only, while 2:1 stoichiometric excess did not lead to appreciable improvement (Figure 1). Although SSW did not perform well, 1:1 addition of chelating agents resulted in noticeably increased REE extraction (up to 20% for EDDS and NTA- Na_3), reaching levels close to the ones achieved with 0.25 M NH_4^+ (Figure 2). Glycine and asparagine did not enhance REE recovery in either lixiviant system. The chelating agents investigated did not offer selectivity towards REE, as higher Al concentration in the leachate was determined, when compared to leaching with ammonium sulfate or SSW alone, although EDDS and NTA- Na_3 appeared to slightly suppress Al desorption.

From a process perspective, the use of EDDS or NTA- Na_3 in conjunction with lower NH_4^+ concentrations and especially seawater appeared to be the recommended option, as these systems led to high TREE extraction, moderate Al co-desorption and circum-neutral pH in the final solution.

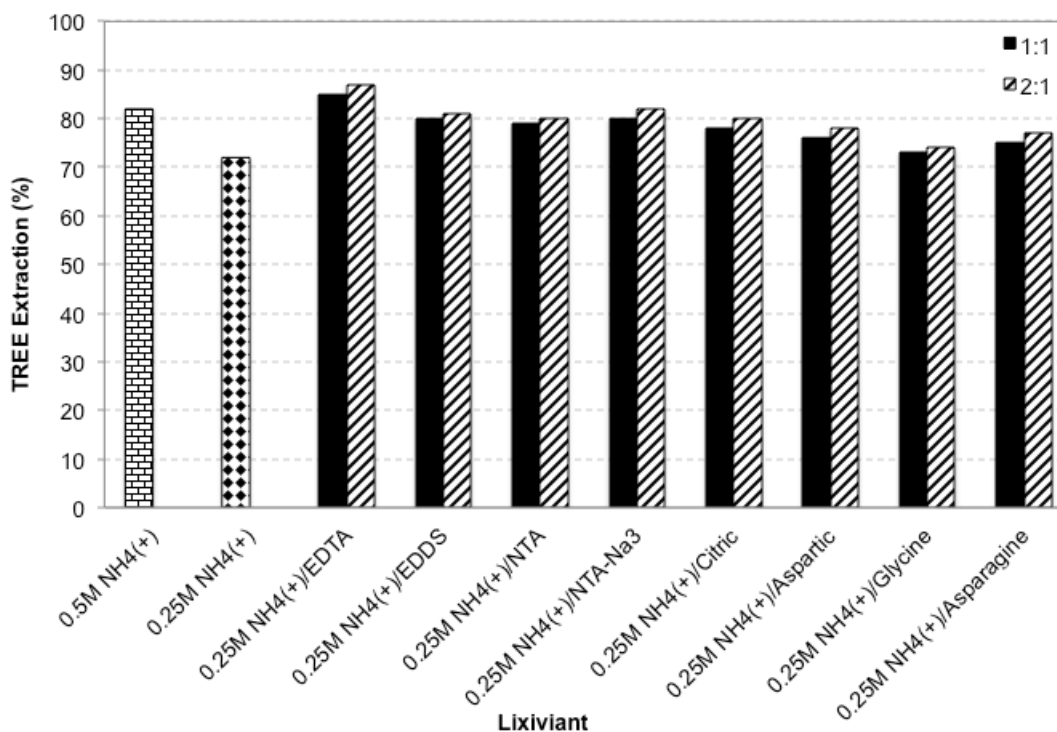


Figure 1. Influence of chelating agent addition on the TREE extraction with ammonium sulfate (ambient conditions, 30 min, L/S = 2/1)

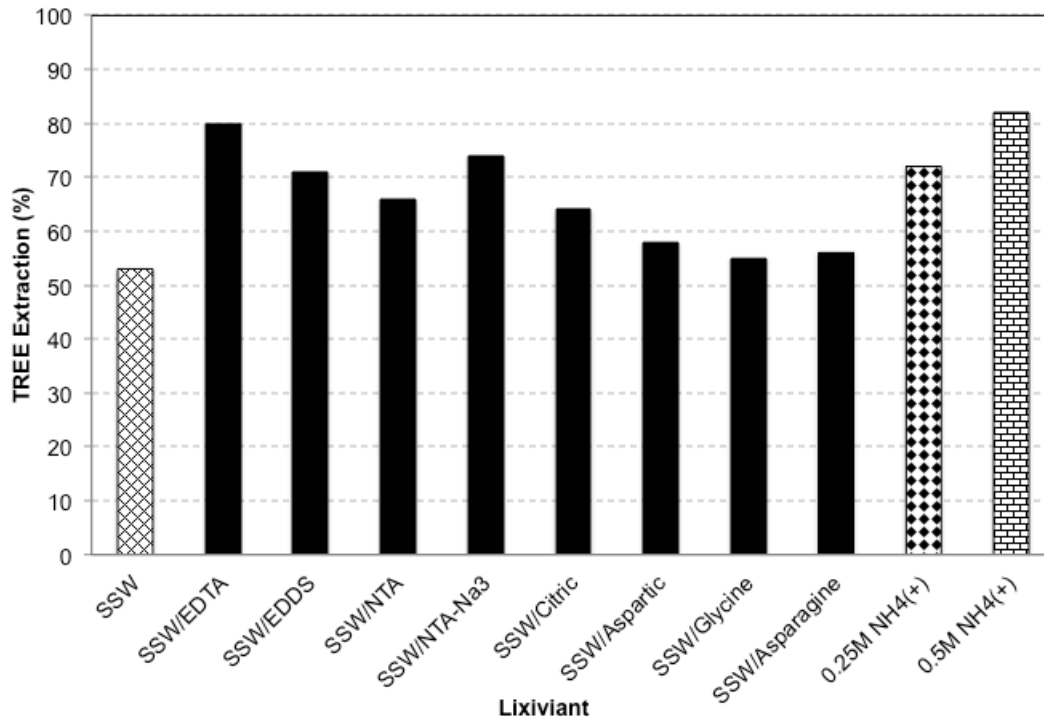


Figure 2. Influence of chelating agent addition on the TREE extraction with simulated seawater (ambient conditions, 30 min, L/S = 2/1, 1:1 chelating agents)

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