The Effects of Microwave Treatment on the Froth Flotation of Rare Earth Elements

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Introduction

Rare earth elements (REE) are a group of elements that have unique properties allowing them to be used in magnets, electronics, metal alloys, and other technological fields. China produces roughly 94% of the world’s REE. (3)

With China restricting its exports of REE to the rest of the world, other options must be explored to meet growing demand for these minerals. Avalon Rare Metals Inc. is currently exploring rare earth deposits in Thor Lake, NT. These deposits have the potential to be the largest producer of HREE. (6) However, there is no knowledge of how to process the ore.

Objective

• Determine possible reagents for froth flotation and the effects of microwaves on the Thor Lake RE ore.

Background

Froth Flotation of REE

A physico-chemical separation process using differences in the hydrophobicity of particles so that desired minerals rise as froth and gangue sinks at the bottom of the cell.

Method/Results

• The hydrophobicity can be altered using reagents, collectors, depressants, and pH modifiers.
• When floating RE ore, previous studies have shown:
  - Carboxylic Acids (Sodium Oleate)
  - Hydroxamic Acids (both Benzo-acids)
  - Organic Phosphoric Acids (both Flotinors) as effective collectors for separating RE minerals.

Effects of Microwaves on Flotation

• Microwaves are a form of electromagnetic radiation.
• Materials that absorb microwave radiation are called dielectrics.
• When a dielectric absorbs microwaves, the material loses stored energy as heat.
• Since ore is made up of various minerals, the differences in heating between each mineral causes stresses to occur within the structure of the ore.
• This could increase the recovery of REE due to the intergranular fractures between the ore’s particles.

• 500g samples were floated using collectors for each type of reagent.
• Three collectors (one from each type of reagent) were selected for further testing:
  - Sodium Oleate
  - Benzo hydroxamic acid
  - Flotinor SM15

• Samples were then used to test the effects of adding depressants to RE flotation:
  - Sodium Silicate
  - Citric acid
  - Combination

• Due to time constraints, only Sodium Oleate and Benzo hydroxamic acid were then treated with microwave radiation.
• For each collector, samples were microwaved at 800W for 2min and 4min before being ground and floated.
• Benzo hydroxamic acid showed an increase in the mass pull of microwaved samples compared to normal samples when floated (av. 13.49% to av.25.68% at 2min, av. 27.82% at 4min).
• Some microwave-treated concentrates using Benzo acid produced a stable froth that was not seen in untreated samples.

Conclusions/Future Work

• Due to time constraints of the project, there was no time to complete a mineral analysis of all tested samples. When samples have been analyzed, it will be possible to examine the recovery of REE in the concentrate and determine the effectiveness of each collector.
• When treated with microwave radiation, samples using Benzo acid showed an increase in mass pull and in some cases the production of a stable froth.
• Additional flotation tests to confirm results of tested collectors/depresants are needed.
• Complete mineral analysis of all tested samples is needed.
• Further research on the effects of microwave treated flotation using Benzo. acid and Flotinor SM15.

References

(2) Long, K. The future of rare earth elements: Will these high tech industries continue in short supply? Tucson,AZ: Western Mineral and Environmental Resource Science Center.