SULPHATION ROASTING AND LEACHING FOR THE SELECTIVE EXTRACTION OF LIGHT REES FROM VARIOUS SOUTH AFRICAN RESOURCES

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Abstract

Rare earth elements (REEs) are a group of seventeen metals (15 lanthanides, scandium and yttrium) that have similar chemical properties. These metals are highly sought after due to their unique metallurgical, magnetic, optical, electronic, catalytic, electrical and chemical properties which allow them to be utilised in a wide range of applications (Malaysia & Negara., 2011). REEs are commonly used in the metallurgical industry, and in the making of glass, electronics, catalytic converters and magnets. These metals have also found use in growing markets such as the renewable energy industry (Krishnamurthy & Gupta., 2004).

Rare earth elements are contained in several minerals, with bastnaesite, monazite and xenotime being the most exploited minerals. These metals do not occur in their metallic form in minerals, but instead occur as oxide compounds in varying concentrations (Krishnamurthy & Gupta., 2004). These metals are commonly extracted from the minerals using hydrometallurgical processes such as sulfuric acid and caustic soda decomposition. These processes are highly efficient and are associated with high REE recoveries. However, these processes tend to be highly unselective as there tends to be co-extraction of various gangue metals. The poor selectively of these processes generally results in process routes that are complicated, tedious and expensive (Chi et al., 2004).

The sulphation roasting and leaching process is proposed as an alternative process for the selective extraction of REEs from various resources. Sulphation roasting process is a pyrometallurgical process used for the conversion of metal sulphides/oxides to water-soluble sulphates. The roasting is followed by leaching in

water or dilute acid solutions. The sulphation roasting process is adequately selective and is currently being utilised in industry for the selective conversion and extraction of base metals (copper and cobalt) from iron-rich sulphide materials. The process is carried out using a mixture of gases, sulphur dioxide (SO_2) and air, to create a sulphatizing environment suitable for the formation of the metal sulphates (Guntner & Hammerschmidt., 2011).

The current research is focused on investigating the sulphation roasting and leaching process for the selective conversion and extraction of REEs from various South African resources. The research involved roasting the material in a sulphatizing environment using sulphur trioxide (SO_3)-rich, composed of stoichiometric ratios of sulphur dioxide and oxygen, atmosphere, followed by leaching in deionized water. The effect of different process parameters including the sulphatizing gas composition (oxygen-rich versus oxygen depleted), reaction time (1 hour, 4 hours and 8 hours) and reaction temperature were investigated for the selective extraction of LREEs. Leaching parameters such as particle size and leaching time were also investigated in the study.

Preliminary results from the scoping leaching tests at 700°C, for a reaction time of 1h, 4h and 8h in the two different gas compositions (oxygen-rich versus oxygen depleted) showed a maximum extraction efficiency of approximately 31% and 19% for the samples roasted for 8 h in an oxygen-rich and oxygen-depleted atmosphere respectively for the milled samples. The samples leached without milling showed extraction efficiencies of 25% and 27% when roasted for 8 hours in in an oxygen-enriched and oxygen-depleted gas atmosphere respectively. Extraction efficiencies of abundant gangue metals such as Fe, Mn and Mg under the sulphatizing conditions were also investigated in the study. The preliminary results showed co-extraction of Fe, Mg and Mn under the various roasting conditions for both the milled samples and the samples leached without milling.

Key words: Rare earth elements, sulphation roasting, leaching, fluidized bed

References

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