RECOVERY OF THE TOTAL OXIDES OF THE RARE EARTHS FROM MONAZITE IN QUANG NAM

Vo Van Tan\(^1\) and Truong Thi Cao Vinh\(^2\)
\(^1\) College of Education, Hue University
\(^2\) Quang Nam University

Abstract. The application of the normal hydrothermal and microwave hydrothermal process to recover the total oxides of the rare earths from monazite in Quang Nam by acids HCl, HNO\(_3\), H\(_2\)SO\(_4\) and alkali NaOH have been studied.

Research results show that the best conditions to obtain the total rare earth oxide in Quang Nam and with the highest performance microwave hydrothermal metallurgy ore monazite in Quang Nam particle size < 0.076mm in the rate of 12M H\(_2\)SO\(_4\) /ore is 5:1 (ml/g) in 60 minutes in the microwave power 450W.

1 Introduction

In Viet Nam, the rare earths reserve from central provinces of coastal mineral sand are rather high \([1, 3, 4, 5]\). In Quang Nam, central coastal mineral sand is disposed mainly from the area of Cua Dai coast in Cam An, Hoi An to Dung Quat pool. This mineral sand gather in long, narrow strips along water edge, which is convenient for exploitation. The main ingredients in mineral sand are quarts, ilmenit, zircon, rutin and monazite containing the rare earths element. Mineral mines rich in the rare earth elements are located in Northern Cua Dai and Ky Ha in Tam Hai, Nui Thanh. The content of the rare earths such as Er, Pr, Gd,… in the total oxides of the rare earths from monazite Quang Nam are of high economic value and occupy a high percentage \([6][7]\).

With the hope of having some contribution in collecting the rare earth elements, we, within this article, introduce some results from our research.

2 Experiments

2.1 The chemicals, tools and equipments

- NaOH, NH\(_4\)OH, H\(_2\)C\(_2\)O\(_4\), CH\(_3\)COOH, HCl, H\(_2\)SO\(_4\), HNO\(_3\) have PA.
- The glassware, pHmet, ore refining mills PM400/2 heat proof, 1200\(^\circ\)C, incinerator, microwave farnace NE-5670 has 2.45 GHZ frequency, 100-800W power.
2.2 Experiments

In Quang Nam, monazite ore were enriched by flotation magnetic field method, crystal ore were dewatered and fine stage reduction size ore smaller than 0.076mm to 0.125mm. Tests were used by 10.000g ore crystal, taken on abreaction(?) vessel. Then acid solutions or alkali solutions were added within their concentration limits and the survey condition was rationed. The lid was put on by refluxpipe cooler.

We did water response training and conducted monazite ore in normal and microwave oven at certain power levels. After that, it was treated by cooling, filtered from precipitated rare earths hydroxide and washed with water. Rare earths hydroxide was dissolved in acid at the pH of 3.5, filtered from the solution and the rare earth precipitate quantitatively with saturated oxalic acid solution at the pH of 1.5 at 80°C. It was left to be mature in 12 hours and the total rare earth oxides collected.

Acquisition efficiency of rare earth oxides total:

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HS\% = \frac{\text{(rare earth oxides recovery total).100%}}{\text{rare earth oxides total in the ore}}
\]

3 Results and discussion

3.1 Microwave oven power affects the performance of acquired rare earth total oxides from monazite ore in Quang Nam by acid and alkali

![Graph](image)

**Fig1. Microwave oven power affects the performance of acquired rare earth total oxides**

From Fig. 1, we can see when the microwave oven power at 400W by alkali method gives the highest efficiency (58.2%) and microwave power at 450W by acid method. The acquisition performance of 88.7%, which was higher than the control methods, should be used with a capacity of 450W H₂SO₄ acid. This method proved to be more economically effective.
3.2 Acids and alkali solution concentrations affect the performance of acquired rare earth total oxides from monazite ore in Quang Nam

To examine the influence of HCl, HNO$_3$, H$_2$SO$_4$ and NaOH concentrations performance rare earth oxides total by microwave total, similar experiments were conducted: size ore <0.076mm, time 60 minutes, the microwave power 450W/acid and 400W/NaOH; HCl, HNO$_3$, H$_2$SO$_4$ and NaOH concentrations changed from 1M to 12M.

The results obtained are presented in Fig. 2.

![Fig. 2. Acid and alkali solution concentrations affect the performance of acquired rare earth total oxides](image)

As can be seen from Fig. 2, when the concentrations of HCl, HNO$_3$, H$_2$SO$_4$ and NaOH increase from 1M to 10M, the acquisition performance of rare earth total oxides increases. However, when the concentrations increase more than 9M, the increase in acquisition performance is not significant. For NaOH, concentration of about 10M was selected to study the later effects. When conducted in the same reaction conditions, acquisition performance of rare earth total oxides increases gradually from HCl, HNO$_3$ then NaOH. H$_2$SO$_4$ concentration of 12M gives the highest acquisition performance (88.7%).

3.3 The ratio of acids or alkali solution to ore affects the performance of acquired rare earth total oxides from monazite ore in Quang Nam

From Fig. 3 we see the same reaction conditions, in the ratio of ore compared to different acid and alkali, when the ratio of [H$^+$] or [OH$^-$] / ore = 5:1 (ml/g) receiving performance of the highest rare earth oxides. The rate of turning three types of acids HNO$_3$, HCl, H$_2$SO$_4$ and NaOH compared to the ores is generally taken as 5:1(ml/g) H$_2$SO$_4$, then the acquisition performance of rare earth oxide is the highest (88.7%) with HCl, HNO$_3$ and NaOH. The use of H$_2$SO$_4$ to conduct experiments is the best economic performance.
Fig. 3. *The ratio of acid or alkali solution to ore affects the performance of acquired rare earth total oxides*

3.4 Reaction time affect the performance of acquired rare earth total oxides from monazite ore in Quang Nam by 9M NaOH and by 12M H$_2$SO$_4$

We can see from Fig. 4, in the same reaction conditions, when the reaction time is 50 minutes, the highest efficiency (58.2%) for 9M NaOH is obtained. But for 12M H$_2$SO$_4$, the highest efficiency (88.7%) is obtained with the reaction time of 50 minutes. Thus, between these two methods, one with the acquisition performance of rare earth oxides by acid which is more effective would have been more economically applied.
3.5 Monazite ore size affect the performance of acquired rare earth total oxides from monazite(?), ore in Quang Nam by H$_2$SO$_4$ 12M

Fig. 5 shows results of experiments conducted in the same reaction conditions of H$_2$SO$_4$ 12M, microwave power 450W, reaction time 60 minutes for different ore particle sizes (from 0.076mm to 0.125mm). Results show that acquisition performance is the best when ore particle size is 0.076mm.

![Graph showing the effect of monazite ore size on the performance of acquired rare earth total oxides](image)

**Fig. 5.** Monazite ore size affects the performance of acquired rare earth total oxides

4 Conclusion

It is the first time that the rare earth oxides total in Quang Nam has been studied and recovered by microwave hydrothermal method with acids and alkali. The results show that the favourable conditions for the effective recovery of rare earth total oxides from monazite Quang Nam are:

- Acquisition efficiency of rare earth total oxides by H$_2$SO$_4$ 12M microwave hydrothermal method is higher than that by alkali microwave hydrothermal method.

- In three kinds of acids which were surveyed (HCl, H$_2$SO$_4$, HNO$_3$), and NaOH we can see that H$_2$SO$_4$ gets the highest efficiency (88.7%) .

- H$_2$SO$_4$ 12M/ore ratio is 5:1 (ml/g).

- Monazite size is smaller than 0.076mm.

- Reaction time is 60 minutes.

- Microwave oven power is 450W.
References


5. Vo Van Tan, Vu Hoang Thanh, *Recovery of the total oxides of the rare earths from monazite in Binh Dinh*, Journal of Chemistry and Application, No 5(53), (2006), 41-44.
