

Chemical Studies on the Recovery and Preparation of Pure Rare Earth Elements Oxide from Abu-Tartur Phosphate Ore

By

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To Chemistry Dept., Faculty of Science

Ain Shams University



AIN SHAMS UNIVERSITY Faculty of Science Chemistry Department

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Mohamed Farid Kamel Mahmoud

ABSTRACT

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Phosphate rock is one of the most important REEs secondary resources. Accordingly, it is an important to develop a convenient process for the recovery of REEs from phosphate rock. In a support to such trend, this research work reports the recovery of REEs from Abu-Tartur phosphate rock. Specifically, the dissolution of rare earth elements (REEs) from Abu-Tartur phosphate rock using tartaric acid was investigated using One-factor-at-a-time (OFAT) methodology. Accordingly, the impact of various parameters affecting the leaching process such as; reaction time, tartaric acid concentration, liquid/solid ratio, leaching temperature, and stirring speed have been examined in terms of the highest REEs leaching efficiency with the minimum P_2O_5 leaching efficiency.

The leaching kinetics of REEs and P_2O_5 was performed in order to obtain the leaching activation energy. The kinetic data show that the leaching rate was controlled by the diffusion of reactants through a porous ore, and the apparent activation energy were about 12.4 for REEs and 15.0 kJ/ mol for P_2O_5 .

Design of experiment methodology (DoE) has been applied to optimize REEs leaching process. In this respect, full factorial design 2⁴ is used to study the effect of tartaric acid concentration, liquid/solid ratio, leaching time, and reaction temperature on REEs leaching process. The process parameters were statistically analyzed using Design Expert 11.0.0 trial version. The obtained results clarify that the optimal conditions for REEs leaching from Abu-Tartur phosphate rock using tartaric acid were: 0.6 M tartaric acid concentration, liquid/solid ratio, ml/g, 3/1, reaction time of 45 min and room temperature. According to these optimal conditions, about 96.9 % of

the REEs and 27.1 % of P_2O_5 were successfully leached from Abu-Tartur phosphate rock using tartaric acid.

Extraction of REEs from Abu-Tartur phosphate rock leach liquor using D₂EHPA organic solvent was studied. The influence of different factors affecting the extraction process such as, D₂EHPA concentrations, aqueous/organic phase ratio, shaking time, temperature, and stirring speed have been studied. The isotherm of REEs extraction process has been investigated in order to evaluate the theoretical number of stages for REEs extraction. The obtained data indicated that 2 stages are sufficient for extracting about 95 % of the total REEs.

The stripping of REEs from loaded organic solvent by hydrochloric acid was studied. The effect of shaking time, hydrochloric acid concentration, temperature, aqueous/ organic phase ratio, and stirring speed on the stripping process has been carried out. The stripping isotherm has been performed, and the obtained results clear that 3 stripping stages are sufficient for removing about 96.5 % of the total present REEs in the loaded organic.

The obtained REEs loaded strip solution was introduced to precipitation process using oxalic acid. The produced REEs oxalate precipitate was calcined to obtain rare earth oxide (Σ REO). The purity of the produced rare earth oxide (Σ REO) was about 87.8 %. The produced REEs precipitate was collected for further separation of individual REEs.

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