
An Overview on Rare Earth Management in Malaysia

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Abstract

The demand for rare earth elements (REEs) are rapidly increasing each year. The estimated world demand for rare earth elements is 136,000 metric tons per year. This demand is projected to rise to 185,000 metric tons annually by 2015. Currently, China is the global supply of the REEs. To overcome this problem, Malaysia has become one of the countries that provide rare earth production (separation and refining). One of the REEs industries in Malaysia was located in Pahang. Although relatively abundant in the earth's crust, the REEs rarely occur in concentrated forms, making them economically challenging to obtain. These elements constitute critical components of many important technologies and products, such as hybrid vehicles, wind turbines, and cell phones. The REEs are a group of 15 chemical elements in the periodic table. The REEs are all metals, and the group is often referred to as the "rare earth metals". The REEs need to be properly managed. Thus, this paper will discuss about management on the resources, the process (application), and the disposal of REEs in the industry. As a nation, Malaysia will significantly benefit from the contribution of rare earths by become the foundation industry for other high- technology industries that use rare earth and also can contribute and support the development of a green economy both domestically and globally.

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1. INTRODUCTION

Rare earth industry in Malaysia already started 20 years ago (Ali, 2014). It was owns by Mitsubishi as a bigger shareholder and was operated by Asian Rare Earth Sdn. Bhd. at Bukit Merah, Perak. Radioactive materials leakage from this site alerted the country regarding rare earth environmental concerns which were worsened by mismanagement of various aspects. There is a tendency to conflate the past and the present given the negative history of minimal engagement, even though current rare earth mining and processing technologies are very different from the case in Bukit Merah, (Ali, 2014). Thus, it is important to properly manage the REEs for sustainable environment with the key factors such as resources, processing, disposal and policy for the sustainable environment that last long for future generation. Figure 1 below gives an overview of the management of REEs in Malaysia.

2. RESOURCES

When the demand for these REEs is increasing due to industrialization and technological improvements in products which require the application of rare earth metals, competitive interests

in exploring and mining new rare earth supply sites is also emerging (Karpel 2012). The estimated world demand for rare earth elements is 136,000 metric tons per year; this demand is projected to rise to 185,000 metric tons annually by 2015. What makes the discourse about this industry more complicated is when international trade is factored in. For instance, as major REEs producer (Hurst, 2010), China’s output is projected to be 140,000 metric tons in 2015. However, due to its own internal demand and concerns for environmental issues, as well as a desire to control supply, it has placed restrictions on exports, sparking concerns among manufacturers from Japan and the USA. As a result, other countries like United States, Brazil and Australia has launched or revived their rare earth processing project. Australia’s Lynas Corporation has built the world’s largest extraction plant at Gebeng, near the city of Kuantan in Malaysia. The plant will extract about 22,000 tonnes of rare earth from materials shipped in from Mount Weld, Western Australia (Phua, 2012).

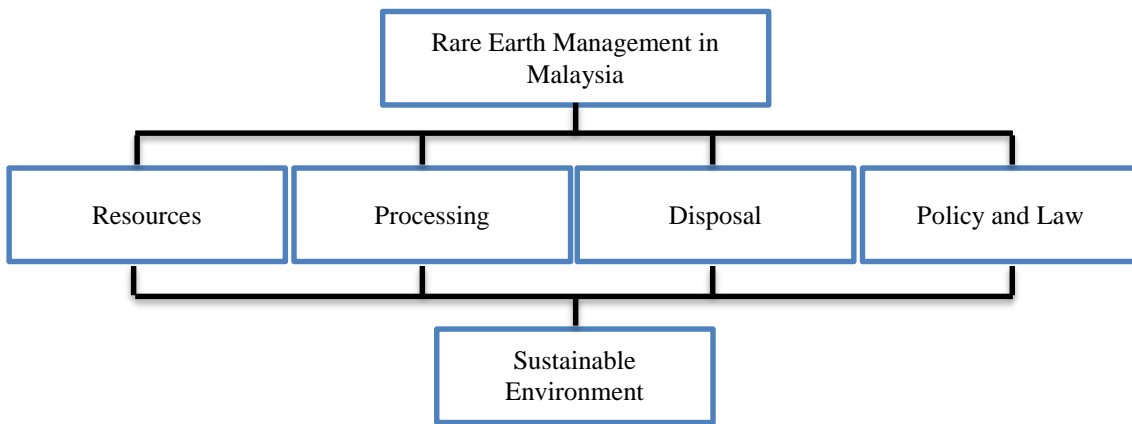


Figure 1: An overview of REEs management.

3. PROCESS

Wide variation in mining and processing technologies caused the diversity of the deposits. Usually, rare earths are exploited as a by-product of other metals. Furthermore, by-products from titanium or uranium mining operations are smaller REE extractions. Crude ore processing techniques after mining that widely used is the concentration by milling and floatation. This technique was used in Bayan-Obo, in the Sichuan mine, China, at Mountain Pass, USA and also was used in short period in Mountain Weld, Australia. The rock that contain rare earth minerals are processed by physical method in several step from mining, grinding and physical separation to produce mineral concentrate for further refinement. Further refinement is needed to complete the process of REEs until it can be used as a material for certain products. The basic steps in REEs mining are shown in Figure 2 below.

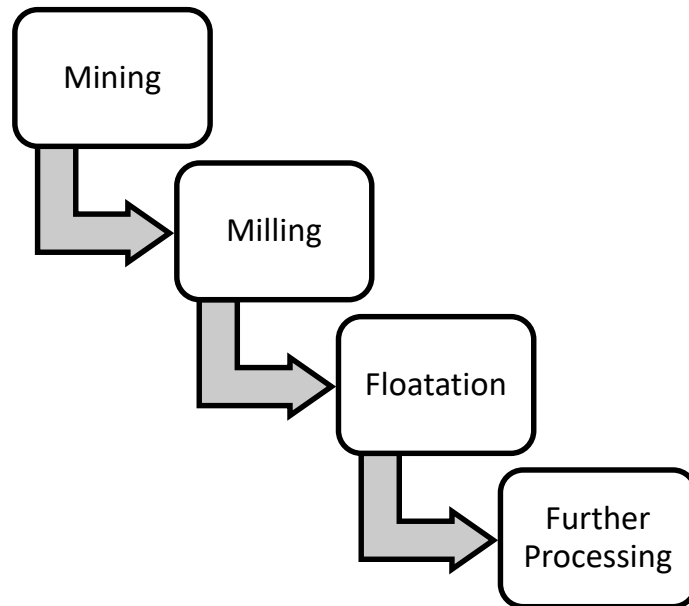


Figure 2 : The basic process steps in REEs mining (Source: Academy of Sciences Malaysia, 2011)

Open pit mining frequently uses for the rare earth ore mining. However, underground mining also needed to mine rare earth ore. Before reaching the ore rich in the metals to be extracted in open pit mining, the overburden material as well as the waste rock need to be removed and are stockpiled. The mined ore is crushed and subsequently ground to produce fine powder in the mill with the aim of creating a high surface which is needed for the further separation. Using physical method, the rare earth minerals are separated from the rest of the ore. Flotation is the most commonly used method, which requires a lot of water and chemicals as well as a high amount of energy. The milled crude ore with usually low concentrations of REO was the input into the flotation. The product of the flotation is an enriched concentrate with a higher REE-percentage. The huge waste streams, called tailings, are a mixture of water, process chemicals and finely ground minerals. Usually, the tailings are led to impoundment areas, which can be either artificial reservoir. The tailings contain about 500 ppm thorium oxide and 30 ppm uranium oxide. The concentrate undergoes further processing to extract the rare earth elements. It is transported to a refinery which can be off-site. There the REE are further extracted and separated into the different elements as required.

Another mining technology which is used in the Chinese heavy rare earth elements (HREE) mining from ion adsorption deposits is the in-situ leaching technology. The rare earth mine in the Mount Weld, Australia, is an open pit type where ore are mined with an average grade of 15 % REO. The minerals are further processed at the concentration plant to produce a concentrate of around 40 %. Further processing for rare earth elements extraction and separation will be carried out at the proposed Lynas Advanced Materials Plant in Gebeng, Pahang, Malaysia

4. DISPOSAL

In modern rare-earth processing plants, waste storage is an important risk mitigation measure. As the whole process involves the use of expensive solvents and leaching materials, ideally, it is economically advantageous to find use of all wastes generated. In this way, the plant in effect produces zero waste. The wastes generally contain phosphates and sulphates. The phosphates can be used as fertilizers, while the sulphates, occurring as calcium sulphate, or commonly known as gypsum, has multiple uses in industries. Those waste streams which do not contain the calcium sulphate and phosphates should undergo proper chemical treatment before they are discharged. An important safety requirement of the rare earth processing plant is the decommissioning of the plant at the end of its life. As radioactive elements occur in the waste, it is imperative that proper decommissioning practices are deployed. From project inception, there must be a proper

decommissioning plan based on industry best practices. In the case of the ARE Plant in Papan, Perak, the rehabilitation of the site has incurred a cost running into hundreds of millions of ringgit

5. POLICY

REEs industries in Malaysia have existed during late 1970s. Asian Rare Earth Sdn Bhd (ARE) was established to extract yttrium (REEs) from monazite. It is located at the Bukit Merah, Perak. After it several years of operation, ARE was fined because radioactive waste endangered their life. Then, it was finally closed on 1994. After more than 30 year, the Government allowed new REEs industry to be built in Gebeng, Kuantan, Pahang. The Government should take a lesson of what had happened long ago.

In China, Wang (2012) suggested that China government should integrate the mining rights and mining companies to get the highest efficiency of exploitation and the best effect of environmental protection. They should enforce environmental and resource exhaustible taxes soon and different domestic regulations for different rare earths according to the different production potential of different ores.

Establishment of rare earth industry in Malaysia has triggered the government to improve their policies and laws. Those changes potentially can assist the improvement of rare earths industry as well as heavy industry in general. In Malaysia, the rare earth industries need to comply with the safety provision of the Atomic Energy Licensing Act 1984 and Environmental Quality Act 1974.

6. RARE EARTH ELEMENTS (REES)

Rare Earth Elements consist of a group of fifteen elements known as the Lanthanides. The lanthanides are located in block 5d of the periodic table from Lanthanum to Lutetium. Figure 3 shows the position and location of rare earth elements in the Periodic Table. For industrial purposes, yttrium is considered as rare earth element.

Rare Earth Elements														Y 39
La 57	Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Th 69	Yb 70	Lu 71

Lanthanides
Lanthanum (La), Cerium (Ce), Praseodymium (Pr), Neodymium (Nd), Samarium (Sm),
Europium (Eu), Gadolinium (Gd), Terbium (Tb), Dysprosium (Dy), Holmium (Ho),
Erbium (Er), Thulium (Th), Ytterbium (Yb), Lutetium (Lu), Yttrium (Y)

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	An	Lr														

Figure 3: The Lanthanides (Source: Academy of Sciences Malaysia, 2011)

The rare earth elements have many scientific and industrial uses. Their compounds are used as catalysts in the production of petroleum and synthetic products. Lanthanides are used in batteries, catalysts, computer screens, glass additives, lamps, lasers, magnets, motion picture projectors, phosphors, and X-ray intensifying screens. Generally they are used in advanced materials in green technology also in high-tech products.

The unique properties of rare earth elements (Lanthanides and Yttrium), which make them ideally suited for green technology and other high-technology applications are as Table 1.

Table 1: Application of REEs and its benefit.

Application	Benefit
Chemical	Unique electron configuration
Catalytic	Oxygen storage and release
Magnetic	High magnetic anisotropy and large magnetic moment
Optical	Fluorescence, high refractive index
Electrical	High conductivity
Metallurgical	Efficient hydrogen storage in rare earth alloys

7. CONCLUSION

The rare earth industry is growing especially with the rising demand for green products and the global push to embrace the green economy. As a result, rare earth mining and processing investment have also grown. Many other countries have started to seriously allocate new investments in rare earth refining, apart from China. Some of the country has begun reconstructing their old rare earth mines which were abandoned during low pricing of rare earth. The upstream rare earth industry has to contend with some safety and health risks. The processing of rare earths produces some by-products which do carry some low level radioactive risks. As the IAEA Report has revealed, such risks are controllable. There are technologies available to effectively render the wastes harmless and safe.

Research by Ismail (2015) provides a detailed analysis of the local community acceptance regarding newly installed rare earth (RE) refinery facility. 41.36% of the community agreed with the presence of the facility and 41.62% was against it. Another 17.02% was unsure about the facility. This indicates that rare earth industry was slowly regaining its names in Malaysia. So, if the rare earth industry is properly managed with the supervision of responsible parties, beside it will protect the environment, it will also increase our economic.

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