The Race for Rare Earth Metals

Posted on Friday 12th April 2013

In the last couple of years the rare earth elements have hit the headlines due to supply issues for these often overlooked materials. In the 1980's rare earth minerals were mined and separated primarily in the US. However in the 1990's China began to produce rare earth oxides and elements. Eventually this drove western producers out of the market and left China with a stranglehold on the industry. China has made full use of this leverage to work their way up the value chain and they now produce rare earths alloys and many products that contain these materials.

Rare earth metals are used in a wide variety of modern day technologies including catalysts, lighting and batteries. However the largest application is in permanent magnetic materials, which account for around 20% of the market by volume and 37% by cost. The rare earth metals used in permanent magnets include neodymium (Nd), samarium (Sm) and dysprosium (Dy). The most common rare earth magnets are based upon an alloy of neodymium iron boron (which also contain small amounts of Dy). NdFeB magnets are critical components in many high tech applications and clean technologies including consumer electronics, motors in electric/hybrid vehicles and generators in offshore wind turbines.

Currently, China produces more than 95% of the world's rare earth elements but in 2006 it began to impose export quotas and duty on these materials. In 2010 the export quota was cut by around 40%, which produced a shortfall of rare earth material on the world market particularly for magnets and resulted in neodymium and dysprosium prices soaring from around $20/kg and $150/kg to $450/kg and $4500/kg respectively. Although, subsequently, the prices for these rare earth metals has fallen to around $100/kg for Nd and $800/kg for Dy, the price volatility has driven a significant number of users out of the market. The result of this may be that devices become less energy efficient due to the loss of this critical material. Despite this, it is predicted that the use of rare earth magnets will increase significantly in the coming years due to their unique properties.

The good news is that the name "rare earth" is, in most cases, a misnomer. Many of the rare earth elements are not rare, including neodymium which is more abundant than tin. Another relevant fact is that the Chinese reserves of rare earth metals only account for around 30% of the potential worldwide supply. However, one of the most pressing issues is the supply of dysprosium. In some magnets the dysprosium content can be as high as half the total rare earth content and is added to increase the thermal stability. This is much higher than the ratio of Dy in the average ore body.

There are many possible solutions to the current rare earth shortages including (a) opening rare earth mines in countries outside of China, (b) using alternative technologies that do not contain rare earths, (c) reducing the amount of rare earth metal used in applications such as magnets or (d) recycling the existing stock of NdFeB magnets contained within electrical equipment.

In the last two years, a large number of exciting projects have begun worldwide covering all of these subject areas. The Magnetic Materials Group (MMG) at the University of Birmingham has been able to tap into its considerable expertise in the application of hydrogen to the primary production of rare earth magnets to develop an effective means of extracting and reprocessing these materials from scrap electrical devices. The result is a processing route with a very small environmental footprint compared to that of primary production routes.

These developments show how vital it is to take into account the importance of hydrogen not only as a zero carbon fuel for transportation and as a means of storing renewable energy but also as a vital processing agent. Together they will ensure its predominant role in the drive to combat the coming ravages of climate change.

Dr Allan Walton BSc, PhD
Senior Science City Research Fellow
School of Metallurgy and Materials