Supply and Demand

Part 1: Neodymium

Over the past year, in this column and elsewhere, I have suggested that the recent rise in price of rare earth raw materials may not be a reversible trend any time soon, and that those elements of greatest importance to permanent magnets will carry an increasing share of the cost burden. Notwithstanding a number of major mines coming on stream elsewhere, China will remain the dominant source for rare earth ores for the foreseeable future. The variety of new measures implemented by the Chinese government to regulate this industry has been well documented, but I believe the future trend can be explained with a few relevant statistics and a couple of significant application examples.

For the year 2006, it is estimated that the total worldwide demand for rare earth oxide (REO) was 105,000 mT. During that year, its government imposed a limit of 86,520 mT of REO to be mined in China, about 90 percent of which is from the Bastnaesite type of rare earth ore mined in Baotou, Inner Mongolia and in Sichuan province. Bastnaesite from these regions is relatively rich in the light rare earths most commonly used in magnets, containing about 14 percent neodymium oxide. The worldwide yield of neodymium oxide for 2006 is slightly higher and estimated to total 18,000 mT. The worldwide production of neodymium-iron-boron (Neo) permanent magnets is also quite well documented, and was estimated to use 20,500 mT of rare earth oxides in 2006. Clearly this number means that almost all of the neodymium oxide produced that year (plus lesser amounts of other oxides such praseodymium, samarium, dysprosium and terbium) was already being consumed by permanent magnets rather than other products.

At a growth rate of about 10 percent a year, the total demand for REO is estimated to rise to 155,000 mT in 2010, Neo magnets requiring 33,000 mT of this, and 29,000 mT of which would be neodymium oxide. The supply gap will be partially filled from a number of new mines located elsewhere than China that will begin selling REO in the years leading up to 2010. Two that could make an important contribution are Mountain Pass in California, which will resume processing its bastnaesite ore, and Mt. Weld in Western Australia, which will be producing a monazite ore that is slightly richer in neodymium oxide (about 18.5 percent). Nevertheless, a significant part of the supply gap will have to be met from China, whose government will no doubt have to manage a gradual increase in output from its mines.

Given that the worldwide market for Neo magnets today already consumes all the neodymium oxide that can be produced, it is not hard to see how demand could grow at a rate of over 3,000 mT per year through 2010. For example, at the recent China Magnetics conference in Beijing, it was reported by the San Huan Company that the annual consumption of electric bicycles in China has reached 10 million units, the electric motor in each one containing 300 gm of sintered Neo magnets. Typically 30 percent of its alloy is neodymium metal, which requires 105 gm of neodymium oxide for each motor - a total of 1,050 mT per year. To separate this amount of neodymium oxide requires that about 6,200 mT of REO be produced, accounting for about 6 percent of the worldwide 2006 total (note that I have simplified this and not allowed for yield loss, nor for recycle on the other side of the equation).

Perhaps the most commonly cited new application that is pushing the demand for rare earths is the hybrid electric vehicle, which also uses sintered Neo magnets in its drive motor, in this case about 1,500 gm in each unit. A similar calculation yields 450 gm of neodymium metal and 525 gm of neodymium oxide per motor needed. Projections vary for the growth of this application, but one that is attributed to Toyota, the leading manufacturer of hybrid electric vehicles, estimates 2 million units per year by 2010. This amounts to 1,050 mT of neodymium oxide for this one application, and there are several others that will have comparable volume growth requirements by 2010. So it really isn't hard to justify that Neo magnets will continue to demand at least an additional 3,000 mT neodymium oxide each year.

Considering the major applications for all the other rare earth elements that exist in the ore, clearly it is the demand for neodymium oxide that is driving the supply gap now and will continue to do so for the next few years at least. Incidentally, the amount of REO that must be produced to satisfy this demand will provide more than enough of the other rare earths, such as the significant demand for

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lanthanum which is predominantly used in nickel-metal-hydride batteries for hybrid electric vehicles. But because additional REO must now be produced just to satisfy the market for permanent magnets, the price of neodymium will have to bear an increasing share of the REO refining cost, which would suggest that it will remain at or above today's high level.

Much of the data on this subject has been reported at recent magnetics conferences, and can be studied further at certain websites including Lynas Corp. (www.lynascorp.com), US Geological Survey (minerals.usgs.gov), and Metal-Pages (www.metal-pages.com).

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