The Metal's Edge

The Rare Earth Dilemma: China's Rare Earth Environmental and Safety Nightmare

Cindy Hurst November 15th 2010

Cutting Edge Energy Writer

Last week, the *Cutting Edge News* published the first article of a three-part series about rare earth elements, which focused on their role in energy security. This is the second of three articles, focusing on some of the environmental implications of rare earth elements.

The topic of rare earth elements (REE) has been drawing a lot of attention from the international media and at the Congressional level. China currently has an iron grip on the REE industry, supplying over 95 percent of the world's needs. This is significant because REEs are used in hundreds of high tech applications, including cellular telephones, laptop computers, iPods, critical military applications, and green technologies.

In an effort to reduce dependence on foreign imported oil and natural gas, many countries are turning more and more to green technologies, such as wind powered generators, plug-in hybrid vehicles, and energy saving compact fluorescent lamps, all of which require an abundance of REEs.

The fact that REEs are needed for green technologies is shrouded in irony because of the potential environmental implications of mining and processing them.

Mining and processing REEs presents environmental risks. Whereas the U.S. observes strict environmental policies on mining and other activities, a major concern surrounding China's practice of mining REEs is the negative impact it has had to the environment due to lax mining practices. Unfortunately, because of the revenue potential, many rare earth mines have been operating illegally, or with little supervision and little to no regulation, causing severe environmental hazards.

According to an article published by the Chinese Society of Rare Earths, "Every ton of rare earth produced generates approximately 8.5 kilograms (18.7 lbs) of fluorine and 13 kilograms (28.7 lbs) of dust; and using concentrated sulfuric acid high temperature calcination techniques to

produce approximately one ton of calcined rare earth ore generates 9,600 to 12,000 cubic meters (339,021 to 423,776 cubic feet) of waste gas containing dust concentrate, hydrofluoric acid, sulfur dioxide, and sulfuric acid, approximately 75 cubic meters (2,649 cubic feet) of acidic wastewater plus about one ton of radioactive waste residue (containing water)." Furthermore, according to statistics conducted within Baotou, where China's primary rare earth production occurs, "all the rare earth enterprises in the Baotou region produce approximately ten million tons of all varieties of wastewater every year" and most of that waste water is "discharged without being effectively treated, which not only contaminates potable water for daily living, but also contaminates the surrounding water environment and irrigated farmlands."

The disposal of tailings also contributes to the problem. Tailings are the ground up materials left behind once the rare earth has been extracted from the ore. Often, these tailings contain thorium, which is radioactive. Generally, tailings are placed into a large land impoundment and stored. In the United States strict controls are put into place and permits are required to store tailings. According to Wang Caifeng, China's Deputy Director-General of the Materials Department of the Ministry of Industry and Information Technology, producing one ton of REEs creates 2,000 tons of mine tailings. Wang said that China has sacrificed greatly in its extraction of rare earths.

While it has been taking steps to solve the problem, China still has a way to go before it achieves any semblance of control over the environmental damage that occurs from its mining and processing of REEs. According to a representative of one Chinese factory in Baotou, Inner Mongolia, money is one of the key issues behind the environmental damage from REEs. The representative pointed out that while companies will put some money toward more environmentally friendly mining processes, others opt to keep those expenses at a minimum to maintain their competitive edge in the market. The costs associated with environmental improvements are absorbed by the customers. Another factor within China's industry is that the land belongs to the government and not to the factories. Therefore, if a rare earth producer pays a large sum of money for machinery or processes that are more environmentally friendly, that investment could be suddenly lost because the government can choose to take back the land for any number of reasons, such as building a new road through the property. This reduces the incentive to meet any type of environmental standards. Furthermore, the Chinese government does not provide any financial support to help companies meet environmental standards.

In Bayan Obo, the ore is mined and then transported back to Baotou via open railway cars, where it is then processed. Unfortunately, with old, outdated technology, equipment, and little oversight, the waste finds its way into the Yellow River, which passes by the south side of Baotou and travels another 1,300 miles, through mountainous terrain as well as through heavily populated areas before finally dumping into the Yellow Sea.

In 2005, Xu Guangxian, who is considered the father of China's rare earth industry, wrote that thorium was a source of radioactive contamination in the Baotou area and the Yellow River. This seems to also be born out by local observers, such as one local man who stated, "In the Yellow River, in Baotou, the fish all died … They dump the waste— the chemicals into the river. You cannot eat the fish because they are polluted." Some 150 million people depend on the river as their primary source of water.

Under traditional technology means, refining REEs requires such chemicals as ammonium bicarbonate and oxalic acid. The potential health hazards of ammonium bicarbonate include: irritation to the respiratory tract if inhaled, irritation to the gastrointestinal tract if ingested, redness and pain if it comes in contact with the eyes, and redness, itching, and pain if it comes in contact with the skin. Oxalic acid is poisonous and potentially fatal if swallowed. It is also corrosive and causes severe irritation and burns to the skin, eyes, and respiratory tract, is

harmful if inhaled or absorbed through the skin, and can cause kidney damage. These and other chemicals often find their way into the Yellow River.

Rare earth extraction also takes place in Jiangxi province, and is reportedly more damaging to the environment than the operations in Baotou. In September 2008, villagers in Pitou county blocked lorries carrying chemicals and picketed the council. These villagers were angry because their fields had been ruined by the acid pumped from a “makeshift” rare earth processing plant into the earth. According to a woman, who would not reveal her name because her husband is still in prison for protesting, “We farm rice but cannot harvest anything any more. Fruit trees don’t bear fruit any more. Fish die in the river. We used to wash in the river and lots of fish would come to us, but there are none left. Even the weeds died.”

While China might have general pollution control standards, the country has never actually worked out pollutant discharge standards for the rare earth industry. As the rare earth industry in China has rapidly grown, there was no effective way to control the usual pollutants such as ammonia, nitrogen, and thorium dust, which are emitted during the production phase. Furthermore, general health and safety regulations are often ignored for a number of reasons, including:

- •The industry is too large, presenting numerous challenges when trying to monitor it.
- •People and companies are not being held accountable. For example, in Western society, if an employee dies or becomes ill, repercussions could include a lawsuit or life-long pension, which the company is obligated to fulfill. In China, however, such actions do not exist.

Environmental issues behind the mining of REEs are a huge concern. The differences between Western mining efforts and those seen in China today are staggering. Aware of the problem, the Chinese government is reporting to be trying to find ways to improve the situation.

In July 2009, the Ministry of Environmental Protection organized the “Rare Earth Industry Pollutant Discharge Standards.” These new standards will, it is hoped, “eliminate backward production abilities and promote the upgrading and updating of China’s rare earth industry.”

The Ministry of Environmental Protection set discharge standards for six types of atmospheric pollutants—sulfur dioxide, particles, fluoride, chlorine, hydrogen chloride, and sulfur trioxide. For water pollutants, discharge standards were set for 14 types of pollutants, including fluoride, total phosphorous, total carbon, total nitrogen, and ammonia nitrogen. In many southern regions with lakes, the new standards implement special discharge limits for ammonia nitrogen discharge concentrations. These new standards are split into two parts, one part for existing enterprises and the other part for newly built enterprises. Under the new standards, rare earth enterprises are required to increase their investment in environmental protection and improve production technologies and costs.

Of course, whether or not these new standards are ever successfully fully implemented remains to be seen. Based on China’s production of 150 tons of REEs, the cost for producers to implement some of the environmental protection efforts would be 1.1 billion yuan ($161 million) and there would be additional annual environmental protection costs of about 280 million yuan ($41 million) for the concentration of water pollutants discharged industry-wide. This would add an additional cost of 1,000 to 1,500 yuan ($145 to $220) to production costs for every ton of product.

While implementing stricter standards would be ideal for the environment, as long as producers feel as though their investments toward meeting these standards are not secure and the

Chinese government does not provide some type of financial incentive, the Chinese government might be hard pressed to fulfill these standards in the end.

Only time will tell if cleaning up the environment in China is achievable. On a positive note, according to some experts, China has been taking steps to crack down on illegal mining, where the worst damage is taking place, and consolidating larger operations under state owned enterprises to give the government better control over the industry.

In the past, China has been able to operate its rare earth mines at one third the cost in part because of the country's lax environmental standards. Additionally, efforts to clean up China's environment will require government funding and increased oversight, which will likely cost billions of dollars. Some analysts believe it will be years before China is able to clean up its environment.

Like environmental standards, safety standards in China have also historically been lax. "People in their 30s have died of cancer working around the mines, possibly from radioactive materials," said one local source. "I visited a factory many times. When I visit a factory or workshop, I tell the director of the workshop, 'would you tell the laborers to put their mask on when they are doing their job?' He said, 'Oh yeah. We do every time, but it's too hot. They don't want to keep their mask on.' You can see that the air is dirty and they are breathing it all in." The most common disease in Baotou is pneumoconiosis, better known as black lung. There are 5,387 residents in Baotou who suffer from black lung, which makes up more than 50 percent of the cases in the autonomous region.

What is ironic about the rare earth dilemma is that China needs to cut back its production and regain control of its industry so that it can figure out how to decrease the environmental damage caused by the industry. Meanwhile, the rest of the world needs these REEs to help clean up the environment through the innovative application of green technologies. Perhaps the only way China can resolve these issues is to cut back its production of REEs. It appears impossible for the country to meet the global demand for REEs, while also meeting its own domestic environmental and safety needs.

Cindy Hurst is an analyst for the U.S. Army's Foreign Military Studies Office in Fort Leavenworth, KS. The views expressed in this report are those of the author and do not necessarily represent the official policy or position of the Department of the Army, Department of Defense, or the U.S. Government.