Rare Earth Elements from Coal Byproducts

Extracting Rare Earth Elements from Coal-based Sources Using Innovative Patented Technology

Concurrent Technologies Corporation (CTC) has received a grant from the Commonwealth of Pennsylvania to advance the concept of extracting and processing rare earth elements from a byproduct of abandoned coal mines and coal-burning power plants. On one hand, the innovative process addresses legacy pollution; on the other hand, it supports domestic rare earth element (REE) supply chain development. Our high-temperature process is applicable to raw feedstock such as coal fly ash and off-specification coal, as well as concentrated rare earth oxides (REOs) extracted through alternate processes.

Securing a reliable domestic REE source has become a national imperative to maintain the nation's economic competitiveness and military position. It's more important than ever for the U.S to find alternate sources to foreign produced and/or processed REEs, since the demand for REEs is expected to grow. REEs are critical elements in national defense weapons systems, electronics, advanced motors and power generation equipment. It's equally important to monitor the development of a domestic supply chain that transitions REE processing and production to the U.S.

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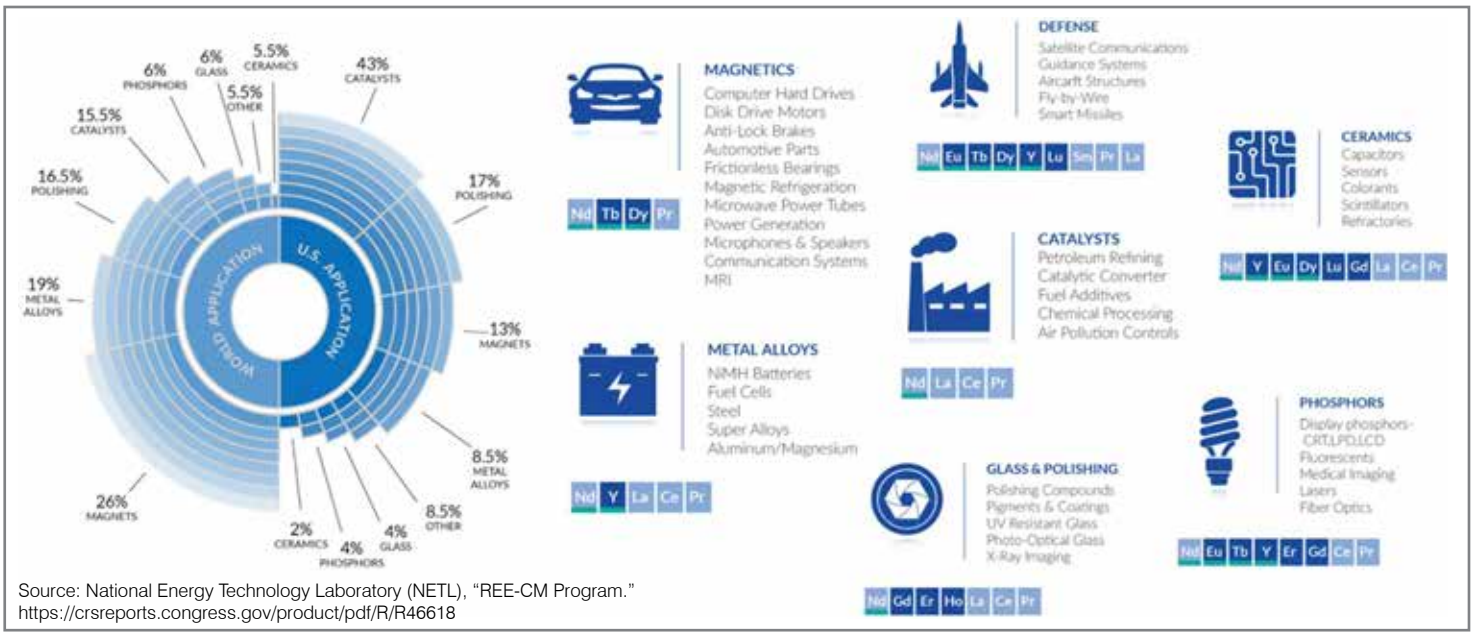
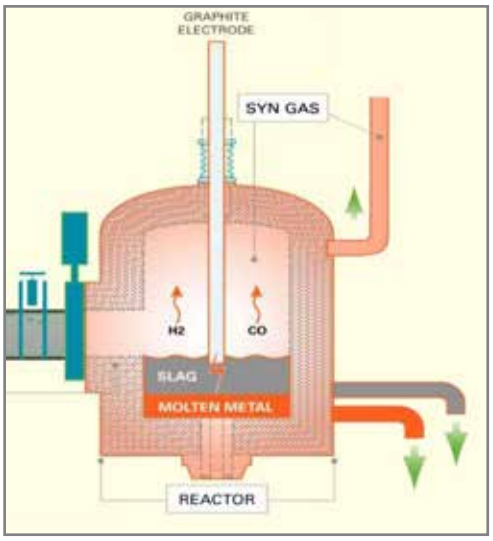


Source: National Energy Technology Laboratory (NETL), "REE-CM Program." https://crsreports.congress.gov/product/pdf/R/R46618

Global Demand and Domestic Consumption of REE



Primary Electric Arc Furnace Concept

Patented Technology Adapts Steelmaking Process to Extract REEs

REEs can be extracted from various feedstock, including coal fly ash, using adapted high-temperature steelmaking technology. When REE-rich materials are introduced into the carbothermic system, they break down into three distinct segments: metals, inorganics, and organics. The metallic fraction is further separated to concentrate REEs, while additional metals will be captured and reclaimed as metallic ingots. The inorganic fraction will float over the metals as they become molten and is recovered as a vitreous slag. The slag is a coarse sand-like material, very similar to basalt, that can easily pass the Environmental Protection Agency's Toxicity Characteristic Leaching Procedure tests. This slag will be used to create an aggregate for concrete or chemically converted to fibers similar to rock wool or mineral wool. The organic fraction is gasified and leaves the electric arc furnace (EAF) reactor vessel as a syngas. Concentrated REEs, in a metallic state, are then super-heated to vaporize and individually condense into their respective metallic form. The technology is based on a modified EAF operating in a highly reducing environment. The boiling points of REEs and their reformation into REOs are known and most are separated enough that vaporizing them independently is possible, with minimal dangers of an incomplete (azeotropic) distillation.

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