



## Recovery of Rare Earth Elements from Acid Mine Drainage

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Rare Earth Elements (REE) are essential for advanced technologies from smart phones and robots to classified national defense systems. REE have remarkable chemical properties but are so evenly dispersed throughout the earth's crust that economically attractive concentrations, easily minable ore veins for example, are extremely rare. As a result, the U.S. imports nearly all of its rare earth elements from China, which supplies about 89 percent of the world's rare earth needs. India and Russia provide most of the world's balance of these strategically important materials. Recognizing the importance of REE, the US Department of Energy's National Energy Technology Laboratory solicited ideas for developing domestic sources of REE in 2015.

West Virginia University, in partnership with Rockwell Automation responded by proposing that acid mine drainage (AMD) from coal mines could be an attractive source of REE. We are now in the third year of a process to develop a cost-effective and environmentally benign process to recover REE from AMD. By 2018 we characterized the size of the domestic resource, its quality, a processing circuit and its commercial potential.

Our approach takes advantage of autogenous processes that occur in coal mines and associated tailings which liberate then concentrate mixed rare earth oxides (MREO). We are testing both untreated AMD and treated AMD residues. Thus far, we've produced pre-concentrates from untreated AMD of 2% MREO. Using hydrometallurgical methods at the bench scale, we produced concentrates exceeding 85% from treated AMD solids. AMD feedstock yields a favorable mix of valuable heavy and critical REE relative to many REE projects. A techno-economic analysis found that REE extraction from AMD feedstock is economically attractive with a refining facility projected to generate positive cash flow within five years. In 2018 we commissioned a pilot plant to demonstrate continuous operations yielding 3 g/hour of REE concentrate. Rockwell Automation is providing technical expertise as well as its sensor and control technology to accelerate market readiness.

The presentation will summarize progress to date, results and our plans to move the technology to





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commercialization.



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