Novel Refractory Materials for High-Temperature, High-Alkaline Environments

New Materials and Maintenance Techniques will Increase Efficiency and Lifetime of Furnaces and Process Vessels

A variety of factors limit the use of conventional refractory materials: chemical reactions, mechanical degradation by the service environment, temperature limitations, and costly installation and repair. All of these limitations reduce process energy efficiency, because degraded refractory insulation increases process heat loss. Frequent maintenance causes further energy loss due to cooling and reheating of the furnace or refractory lined vessel. In addition, maintenance sacrifices production time and capability.

This project aims to develop a new family of refractory compositions tailored for use in high-temperature, high-alkaline industrial environments. The proposed family of novel Mg-Al, MgAl, or other similar magnesia/alumina will utilize new aggregate materials, bond systems, protective coatings, and phase formation techniques. Researchers will use both practical refractory development experience and computer modeling techniques to design the materials. They will also develop new application techniques and systems to optimize installation, maximize lining properties, and facilitate hot installation and repair.

Benefits for Our Nation and Our Industry

Analyses performed for the aluminum, chemical, forest products, and glass industries predict that the use of new refractory materials and associated maintenance procedures will give the following savings by 2030:

- 67 trillion Btu per year
- $360 million per year in energy cost savings
- 1,940 metric tons of CO per year
- 7,150 metric tons of NOX per year
- 200 metric tons of VOCs per year

Applications in Our Nation's Industry

The technologies developed in this project will contribute to increasing the overall efficiencies of the furnaces and process vessels used in various industries such as the aluminum, chemical, forest products, glass, and steel industries by decreasing the amount of wasted heat, reducing downtime, and increasing the reliability of the operation systems.

Project Description

This project addresses the need for developing a family of novel refractory materials for application to boilers, furnaces, gasifiers, and other industrial energy systems.

Barriers

Major barriers to be overcome include:

- Lack of refractory compositions with reduced susceptibility to reactions and mechanical degradation between the service environment and the refractory material;
- Lack of installation techniques and processes for the application of newly developed refractories; and
- Lack of a broad suite of options for on-line (hot) maintenance.

Pathways

The objectives of the project will be achieved through (1) measuring and comparing key properties of currently used refractory materials; (2) developing a family of novel magnesium aluminate containing unshaped refractory materials; (3) measuring and comparing key properties of the newly developed refractory materials; (4) developing new refractory application techniques; and (5) creating a comprehensive database concerning currently used and newly developed refractory materials

Progress and Milestones

- Develop at four new refractory materials for application in the four targeted industries. These materials will have twice the life span of current materials and/or 20% better thermal efficiency than current materials.
- Complete the development of new refractory application systems which will optimize materials, properties, and installation costs.
- Complete the development of hot repair techniques which will lead to energy savings through reducing the need to shut down or fully cool refractory lined vessels in order to repair failed or deteriorating refractory, along with the ability to identify refractory deterioration in real time.
- Obtain six months of in-plant operating experience at industrial partner locations leading to validation of the 2X refractory lifetime improvement and/or the 20% increase in thermal efficiency over current materials.

Commercialization

The inclusion of four industrial participants from the glass, pulp and paper, chemical, and aluminum industries will allow for the technologies developed through this project to be immediately applied and transferred to industrial settings through in-plant introduction of promising materials. Technology developed in the laboratory will be produced on an industrial scale by MINTEQ and will be extended to the market place by their standard commercialization means. Presentation of successful results at academic and industrial meetings is expected to open up additional sites for in-plant trials and technology application at other related industrial sites and in industries not currently targeted.

Project Partners

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MINTEQ International, Inc.
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Weyerhaeuser Company
Federal Way, WA

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Ending FY10
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