NATIONAL ENERGY TECHNOLOGY LABORATORY

ACCOMPLISHMENTS

Q2 FY20

U.S. DEPARTMENT OF ENERGY

NETL ACCOMPLISHMENTS

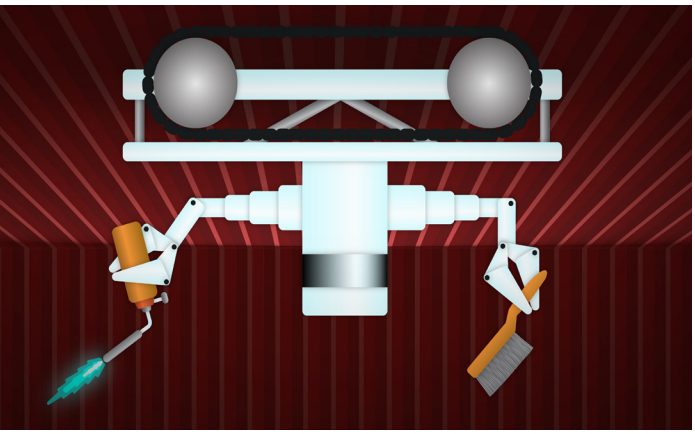
Quarter 2 – Fiscal Year 2020

New REE Extraction Tests Showed Promise for Efficiency & Cost Savings

NETL and its research partners made progress toward refining a method to clean up acid mine drainage (AMD) to extract vital rare earth elements (REEs). With its dedicated Rare Earth Extraction Facility on campus supported by NETL, researchers at the West Virginia University (WVU) Research Corporation evaluated the potential of precipitating (causing solid constituents to be physically separated out of) REEs upstream of the AMD treatment stage. The techniques tested at WVU showed that nearly 100 percent of all the REEs in the raw AMD or sludge can be recovered, which is a significant development toward realizing commercialization. By using the naturally acidic, raw AMD instead of AMD sludge, target REE oxide purities can be recovered while lowering the costs of extraction. This is a significant step forward to encourage further investment and show that a domestic supply of rare earth elements is feasible.

The Power of Plasma: Extracting REEs From Coal

NETL is collaborating with the University of Kentucky and Virginia Tech to demonstrate a novel process that could make American coal a new supplier of vital REEs. Collaborators researched low-temperature plasma to pretreat coal-based materials resourced from Kentucky. Surface area measurements found that plasma treatment provided increased surface area and pore volume, which made other processes more effective at recovering REEs. This novel technology integrated with traditional leaching and extraction processes effectively recovered REEs from coal samples. NETL and its academic partners are now investigating how to make this process economically attractive.



AI-Enabled Smart Robots For Inspecting, Repairing Power Plant Boilers

NETL partnered with the Colorado School of Mines to develop artificial intelligence-enabled robots capable of evaluating and repairing power plant boilers, ensuring safer and more affordable energy production. Successful robotic inspection will limit or eliminate the need to send inspectors to assess difficult-to-access or hazardous areas. The robots will also allow automated live inspection, reduce risk to human operators during maintenance or unplanned outages, and enable smart collection of comprehensive and well-organized data. The impact of this new capability will be increased boiler reliability, usability and efficiency.

NETL Worked to Fill the Data Gap to Design Advanced Alloys

The availability of high-quality data to design advanced alloys, which are needed to manufacture stronger, heat-resistant power plant components, is limited, with no central repository. An NETL research team is addressing this deficiency with a novel methodology to assess data quality and ensure the reliability of data used in analytics to develop new materials for the power generation sector and to predict the performance of established materials in current use. Once data are organized and curated, machine learning algorithms can be used to analyze the collected data, find trends and connections in the data to support materials property prediction, and increase the efficiency of materials design.

NETL-Supported Research Demonstrated REE Recovery Process

In collaboration with NETL, Ohio State researchers demonstrated that a conceptual three-stage trap-extract-precipitate (TEP) process can successfully extract REEs from coal mine drainage. The TEP process relies on the use of environmentally benign industrial byproducts to trap the REEs and an organic chelating agent to recover the REEs from the mine drainage. This approach generates lower post-extraction waste and minimizes the associated environmental impacts when compared with other REE extraction techniques.

NETL Supported Lower-Cost, Longer-Life SOFC System in Connecticut

An NETL-supported solid oxide fuel cell (SOFC) technology began to provide safe, clean energy at the University of Connecticut. The 10 kW Cummins-Ceres Power SOFC system is a novel application because it involves the use of a scalable lower-temperature electrolyte and metal-supported cell architecture. This unique SOFC architecture offers greatly enhanced robustness under real-world operating conditions at a lower cost than conventional SOFC designs while retaining the advantages of fuel flexibility, high efficiency, reduced emissions and low degradation.

NETL Researcher Honored with Distinguished Alumni Award

NETL's McMahan Gray was honored with a 2020 Distinguished Alumni Award from the chemistry department at the University of Pittsburgh. Gray was recognized for advancing innovative technologies to save lives and serving as a mentor who has inspired hundreds. He has a long commitment to innovating new technologies that improve the world's air, water and the economy coupled with dedication to training future scientists to carry the work forward. Gray developed the basic immobilized amine sorbent (BIAS) process to remove carbon dioxide from power plant emissions. Gray then advanced the technology to develop other uses for BIAS. For example, he adapted BIAS to create a product that can remove heavy metals, including lead, from water.

Whole Core Extracted from Caney Shale Formation in Oklahoma

The first-known complete core of the Caney Shale formation was obtained as part of an NETL-supported project to find more efficient methods to extract petroleum from unconventional shale deposits and further U.S. energy independence. The work is expanding knowledge about the geomechanical properties of clay-rich ductile shale, which, unlike other shale formations, can withstand greater force before fracturing or breaking. The project will help determine the economic feasibility of extracting oil from similar shale formations.

NETL-Supported Petra Nova Project Celebrated Three Years of Sustainable Operation

Petra Nova, the world's largest operating post-combustion carbon dioxide (CO_2) capture system, observed its third anniversary. The NETL-supported project is demonstrating how carbon capture, utilization and storage technologies can economically support the flexibility and sustainability of fossil fuels at commercial scale. Commencing operation in 2017, the Petra Nova project uses an advanced amine-based process to capture CO_2, which is then compressed, dried, and transported for enhanced oil recovery at the West Ranch Oil Field in Jackson County, Texas, to boost oil production.

Additional Pipeline Capacity and Baseload Power Generation Needed to Secure Electric Grid

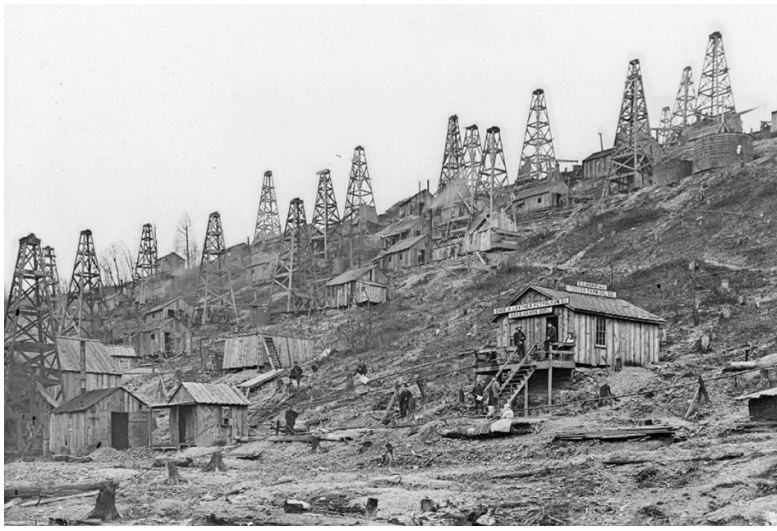
A new NETL report and case study showed that additional natural gas pipeline capacity and baseload generation units — such as coal and nuclear generation — are critical to providing reliable and affordable electricity during extreme weather events. The study, which is Volume II of NETL's "Reliability, Resilience and the Oncoming Wave of Retiring Baseload Units," followed two previously published NETL reports that examined the performance of electricity generation units during the "bomb cyclone" of 2018. NETL's review of the event showed that natural gas demand, coupled with natural gas infrastructure constraints, led to significant spikes in natural gas prices.

NETL Project Validated Geologic Storage of CO_2 to Boost Energy Production, Reduce Carbon Footprint

Work completed as part of the NETL-backed Plains CO_2 Reduction (PCOR) Partnership demonstrated the ability to reduce carbon dioxide emissions across a large section of the country while enhancing the efficiency of oil production. PCOR is one of seven DOE Regional Carbon Sequestration Partnerships (RCSPs), which have been laying the groundwork since 2003 for large-scale geologic carbon storage in the United States as a means of mitigating effects of climate change while still allowing for the efficient and affordable use of fossil fuels for energy production.

Efforts to Catalog Methane Emissions from Abandoned Wells Captured in Story Map

NETL researchers developed an online story map that explores how Laboratory scientists are addressing the ongoing environmental issues from northwestern Pennsylvania's oil boom in the 1800s. The story map features strategies NETL researchers deployed to address the area's proliferation of abandoned wells, some of which continue to emit methane decades after they were taken out of production. The Lab has worked closely with state officials to find abandoned wells in the region, document their locations and determine if they leak methane and other gases. The story map highlights researchers' use of drones, airborne magnetic surveys and LiDAR technology. It also reviews how NETL scientists tested abandoned wells for methane emissions and the presence of other gases, including ethane, propane, and pentane and butane, and collected samples.



NETL Received 2020 Carnegie Science Award for Innovation

NETL researchers won a Carnegie Science Award for their investigation into single-crystal optical fibers capable of measuring numerous environmental parameters anywhere the fiber is installed, including the extreme environments of power generation systems. To create more durable sensors, researchers built a machine known as a laser-heated pedestal growth (LHPG) system, which they used to fabricate custom single-crystal optical fibers from bulk materials, such as sapphire or yttrium aluminum garnet, that can withstand ultra-high temperatures. The single-crystal fiber sensors can provide sensory information all along their length, and NETL researchers discovered a new means of controlling the LHPG system that permits the growth of single-crystal fibers of theoretically infinite length.

NETL Drove Efficiency Improvements in Fossil Fuel-Based Power Plants

An NETL-supported project showed promise toward addressing fouling, the buildup of scale on interior and exterior cooling tubes, which inhibits heat transfer and reduces efficiency in power plants that burn fossil fuels. NETL industry partner Oceanit Laboratories Inc. tested their HeatX™ coating technology extensively at the Hawaiian Electric Company's Kahe generating station. The ultrathin, non-toxic HeatX coating is applied to the surfaces of condenser components and forces the condensing water to form into droplets that quickly roll off, rather than adhere to, condenser surfaces. In field tests, HeatX reduced fouling on condenser units, increased heat transfer rates and significantly extended the amount of time a unit can remain in service before it must be taken down for maintenance.