Natural Resources Research Institute
University of Minnesota Duluth
Driven to Discover

NRRI *Now*

Monthly Edition March 2018 Issue 3, Volume 3

NRRI Mission:
Deliver research solutions to balance our economy, resources and environment for resilient communities.

www.nrri.umn.edu

FROM THE EDITOR:

This issue is oozing with innovation.

We've turned on our hydrothermal unit to expand our biomass options for energy. We are making steady progress on our five Mining & Water Innovation Initative projects. And we helped a UMD student apply her creativity to helping others.

Yes, NRRI is cooking on all four burners these days. And we're happy to share what we're learning, as many of our minerals researchers did in February at the national Society for Mining, metallurgy & Exploration conference, held for the first time in Minnesota.

Remember, you can sign up to receive these stories monthly by email from our website or by texting UMDNRRI to 22828.

June Breneman

Duluth Labs & Administration
5013 Miller Trunk Highway
Duluth, Minn., 55811
218-788-2694

Iron Range Labs
One Gayley Avenue
Coleraine, Minn., 55722
218-667-4201

Turning up the 'heat' on renewable energy

NRRI Chemical Engineer Andriy Khotkevych inspects the new HTC unit , now operating at the Coleraine. Labs.

Andriy Khotkevych had no problem finding materials for his research.

"I got wood from my backyard. I went into the swamp for cattails. We used corn husks and sugar beet pulp," then he added with a grin, "We tested cow manure. There are farms around here."

Khotkevych, a NRRI chemical engineer, started his research in 2012 to develop a process that turns moist, green harvested biomass into a renewable energy product. At the bench scale, hydrothermal carbonization -- a wet, pressure cooker-like process -- successfully produced an energy-dense mud for a variety of applications.

Khotkevych experimented with different types of biomass feedstock and process conditions until he had the right "recipes." In February, he moved the research from the bench to a larger, semi-continuous process pilot unit that can produce 100 pounds per day. The hydrothermal process produces a carbon material comparable to fossil coal in energy output. Better yet, it makes an excellent binder for dry roasted (torrefied) biomass that NRRI is also producing at a large pilot scale. In combination, the two materials result in a solid fuel that is moisture resistant with the same bulk density as fossil coal. This hydrothermal carbonization unit will allow for continued research into the energy balance of this process.

"This could be a game-changer in the bioeconomy and renewable fuel arenas," said Kevin Kangas, manager of NRRI's Renewable Energy Lab. "It's like what Mother Nature did to produce fossil coal, using time, heat and pressure to turn organic material into carbon. But instead of millions of years, we do it in a few hours."

And because this process does not take place within the mineralized geology of the earth, it is 90 percent lower in sulfur dioxide and essentially has no mercury or heavy metal emissions.

Hydrothermal carbonization has been in development for decades, but NRRI is applying the process to Minnesota's excess biomass resources and scaling up the production. The current goal is to produce about 1,000 pounds of solid biofuel to test in a coal-fired utility.

There are expanding opportunities for sourcing biomass feedstock. Aside from the cow manure and cattails, industries with organic waste materials are looking for value in their byproduct. The Minnesota Department of Natural Resources estimates it can sustainably harvest one million more cords of wood due to a decrease in demand from traditional wood products industries. And NRRI has developed a fast-growing hybrid poplar species that can be grown as an energy crop.

"Our goal is to establish a new, sustainable industry that can use a variety of plant material to better manage our forests, reduce forest fires, harvest invasive plants and reduce waste," said Kangas. "This is a great way to take something unwanted and put it to good use."

NRRI's Mining & Water Initiative: A progress report

In 2017, the Minnesota Legislature gave NRRI $2.6 million to fund five pilot projects intended to demonstrate promising technologies that will enhance the performance of the state's minerals industry.

Simulating a process to evaluate higher value iron production

This laboratory will give NRRI and industry partners the ability to fully evaluate both commercial and experimental processes for higher value iron products, like direct reduced iron (DRI). It will be used to define critical variables for processing of specific iron ore bodies, identify economically viable options and reduce risk for investment.

Industry partners are engaged in the design of this lab to define collaborative projects. The lab should be fully commissioned in September 2018.

A comprehensive data source: Natural Resources Atlas

Two case studies that are relevant to current Minnesota issues are being used to design a "mega-app" -- an online tool to access 175-plus databases. To understand the implications of wetland restoration projects and potential ilmenite mining, this atlas will layer data on mineral potential, biology, infrastructure, geology, water resources and more. The interactive platform will improve access to high quality and vetted databases in map format to improve transparency in decision-making.

A focus group will convene for testing and refinement. The public release of this demonstration atlas is slated for July 2018. Continued funding will be sought to expand the scope and content for the entire state.

Microbes that can remove sulfate

Microbes are prevalent in all natural systems. Some convert sulfate to sulfide, while other microbes release iron from iron-bearing minerals which can remove sulfides. NRRI's long-range, innovative research is to incorporate microbial processes that will deliver a cost effective and simple way to permanently address sulfate pollution levels in regional waters.

NRRI Researcher Don Reiser demonstrates a flotation minerals separation process.

This is a long-term study that is currently active at the lab bench scale and moving to pilot-scale testing. Systems will be evaluated this spring and a final report will be delivered in June 2018.

Testing filtering technologies to meet sulfate standards

Laboratory application of a technology that uses chemicals to create solid sulfates which may be filtered out of a water system are showing promising results. The goal is an inexpensive, efficient and easily managed sulfate removal system to complement reverse osmosis.

Water from a northern Minnesota city will be used for pilot-scale testing this summer with a variety of filtering technologies.

Increasing Iron Recovery

Current magnetic separation processes to harvest magnetite do not recover Minnesota's less magnetic iron resources of hematite and goethite. A new flotation process is being developed to try to recover all three ores at natural pH levels to expand the state's minable ores. This will also reduce mining waste.

Testing is focused on ores from the western Mesabi Iron Formation which is high in oxide minerals. Pilot testing will continue to understand the relevance to current and future iron mining in Minnesota.