Cadet Project Provides Cook Stove and Water Filtration

Keydets Without Borders May Implement New System This Summer in Bolivia

By Mary Price

To the casual observer, two cadets trying to light a fire in a coffee can behind Nichols Engineering Hall might look like mischief. Instead, it's research that very well could someday save lives in the developing world.

Tyler Brickles '15 and Peter Buehlmann '15, both civil engineering majors, have been working this semester to build a small stove capable of using llama or alpaca manure as the starting point for a carbon-based filtration system for drinking water in Bolivia, where much groundwater is contaminated with heavy metals from mining operations.

Tyler Brickles '15 and Peter Buehlmann '15 check the temperature of a pan of water heated over a cooking stove designed to refine llama droppings for use in biochar water filters. – VMI Photo by John Robertson IV.

The biochar cook stove, as the project is known, is scheduled to be implemented this summer in the small mountain village of Pampoyo, Bolivia, where Lt. Col. Tim Moore II '97, associate professor of civil and environmental engineering, has led a humanitarian group, Keydets Without Borders, each summer for the past several years.

In the past few years, Moore explained, much has been done to improve water conditions and sanitation in Pampoyo, but contaminated water is still a major threat to villagers' health.

"There's still a lot of heavy metals in the water that we need to remove, and that's the purpose of this carbon [filtration system]," said Buehlmann, who, like Brickles, traveled to Bolivia last year with the group and will do so again this summer.

Much of the work demonstrating that biochar could be used to remove heavy metals from water was done last year by Alexandria Gagnon '14. This year, using the results of her research, Brickles and Buehlmann have been working to create a workable stove.

Brickles and Buehlmann have come up with an intentionally simple design that can be easily replicated in the developing world. To construct the biochar cookstove, manure is placed inside a small can that is then placed inside a larger one.

Filling the gap between the small can and the large one are combustible materials such as wood and paper. When the cadets light the combustibles, the cook stove reaches a temperature of 1,300 degrees Fahrenheit, which is sufficient to burn away bacteria and viruses in the manure and reduce it to its carbon essence. The end product is not unlike the pellets commonly used to fire charcoal grills.

Those pellets, then, can be used as the basis of a filter to clean water that would otherwise be unsafe to drink. "It's the same stuff you find in your [household water] filter," explained Brickles, "activated carbon."

The biochar cook stove turns llama or alpaca manure into a product similar to charcoal pellets. – VMI Photo by John Robertson IV.

Now, with their May 17 departure date for Bolivia just weeks away, the cadets are busy fine-tuning their design and ensuring it works.

"We're testing the absorption kinetics – how well [the filter] attracts heavy metals – so we can remove them from the water cheaply and effectively," said Buehlmann.

In the lab, the cadets have been using water pre-treated with copper to see how much copper each round of filtration removes. The pH level of the water, Buehlmann explained, is an extremely significant variable, as more alkalinity means greater removal of metals.

The biochar cook stove is designed to be used inside the villagers' homes, where food is prepared over an open fire, so the villagers can "cook" biochar at the same time they are cooking food for meals. One obstacle has been determining the correct air-to-fuel ratio, as too much fuel and not enough air will generate a large amount of smoke.

"Emissions … [are] just so important when you're working inside of a home," said Buehlmann.

While Brickles and Buehlmann are hard at work on the stove design, the other 10 cadets in Moore's civil engineering capstone class have been busy with related projects.

One group is developing personal filtration devices for home use, with biochar as the basis of the filter, while the other is doing more extensive testing with absorption kinetics, to see how much carbon is needed per gram of contaminant.

All of these projects are part of VMI's clean energy and air resources project, which began in the 2012-2013 academic year. The goal of the CLEAR lab is to find organic alternative energy sources that are bioengineered to produce the smallest possible amount of pollutants. The lab has been funded by grants from the National Science Foundation, the Dominion Foundation (an arm of Dominion Virginia Power), and the Jackson-Hope Fund.

As for Brickles and Buehlmann, their looming departure date has added a sense of urgency, resulting in long hours in the lab. The two estimate that they've been putting 20 to 25 hours a week into the project and not just in hopes of a good grade or a pat on the back.

"There's people out there who are sick and dying," said Brickles. "We've got to do what we can."

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