THE THERMOCHEMICAL CONVERSION OF MUSHROOM COMPOST

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Pennsylvania mushroom farms generate over 3.5 million cubic yards of mushroom compost (MC) or spent mushroom substrate (SMS) annually. As the use of Phase II and Phase III mushroom substrate (MS) becomes more popular, the volume of MC generated will also increase as more crops can be grown in each mushroom house per year. While the industry has made significant strides in finding beneficial uses for MC, there is still a need to discover new and responsible outlets for the material; particularly as the pressure builds from various environmental agencies to improve the health of our waterways.

One available method for handling MC is a thermochemical conversion process called gasification. Gasification is the conversion of biomass in an oxygen-starved, controlled environment using high temperatures, which produce solids (biochar or powdered activated carbon) and heat. Generically speaking, biochar is the solid material obtained from the carbonization thermochemical conversion of biomass (i.e. wood, manure, compost, etc.) in an oxygen-limited environment. The characteristics of biochar vary based on the feedstock, but it mostly consists of a small fraction of easily decomposable carbon and a much larger percentage of stable carbon. Scientists have shown that this stable form of carbon will persist in soils for decades and even millennia, which may ultimately help in mitigating the effects of climate change through the sequestering of atmospheric carbon dioxide.

Unlike pyrolysis, another thermochemical conversion process which uses an external heat source to dry the biomass to ~20 percent moisture, gasification uses the feedstock as fuel. The waste heat can be captured and used to produce steam or electricity. After the organic feedstock has been gasified, the volume of the material is reduced by 80 to 90 percent; providing significant savings in material handling.

In late December 2016, a plan was formulated to gasify MC using an existing system on a heifer farm in South Charleston, OH. Before this trial, it was believed that nowhere else in the U.S. had MC been processed using a large-scale animal waste gasification system, such as one that is capable of processing 2.5 tons of material per hour. Through this test run, the goal was to determine the feasibility of gasifying MC.

For the trial, approximately 32 tons of fresh MC were used from mushroom farms in both Chester and Berks counties, PA. Before loading into the triple-pass rotary drum dryer, the mois-

Figure 1. Fresh MC being transferred from the hopper to the conveyor belt and then to the rotary drum dryer.

Figure 2. Dried MC in the hopper, waiting to be loaded into the gasifier.

Figure 3. A view inside the gasifier.

Figure 4. Final product: MC Biochar.

ture content of the MC was measured at ~68 percent. After drying, the moisture content of the MC was reduced to ~18 percent. The dried MC was loaded into the gasifier to produce the biochar. Overall, the processing of the MC went well even though the moisture content of the fresh MC was higher than expected. The uniformity of the material makes it an ideal feedstock to gasify, and the texture of the fresh MC directly out of the growing houses allows for easy drying. It is estimated that approximately three tons of MC biochar was produced, which equates to a 90 percent volume reduction. Figures 1-4 show the different phases of the gasification process.

Visually, the MC biochar looks very similar to other manure-based biochars (swine, chicken and turkey) that have been produced using this same type of large-scale gasification system. It was thought that the MC biochar might have a slightly different color due to its higher ash content, but it appears just as black as the other biochars, and the particle size is slightly finer. Extensive research has already been conducted and is currently ongoing to develop the biochar market, but it is believed that the material has many potential uses such as animal bedding, odor control, livestock feed additive, soil amendment, peat moss substitute, wastewater treatment and heavy metal remediation.

To sustain the future growth of the mushroom industry, the challenge of dealing with the industry's waste products, such as MC, is going to continue to garner attention and effort. A new crop of mushrooms can't be grown unless the MC is removed from the houses and the MC can't be removed unless there is a place to take it. Using gasification technology to convert the MC into a beneficial byproduct like biochar, while also greatly reducing the volume of material that needs to be handled and generating enough waste heat to produce steam and electricity, certainly seems like an option that should be considered. ***mn***