February 2018
Volume 56
Number 1
Article # 1IAW3
Ideas at Work

Mobile Pyrolysis for Hazardous Fuels Reduction and Biochar Production in Western Forests

Abstract

Mobile pyrolysis is a novel approach to fuels reduction. In this article, we address the experiences of the Utah Biomass Resources Group in developing mobile pyrolysis technologies and generating the products derived from pyrolysis of woody biomass—biochar, bio-oil, and syngas. We describe development of a mobile pyrolysis platform for biomass conversion demonstration, its use in a series of demonstrations conducted in several western states, and the usefulness of the resulting products. Additionally, we discuss our outreach and communication efforts to date and speculate on the future of the technology.

Keywords: pyrolysis, biochar, charcoal, kiln

Darren McAvoy
Extension Assistant Professor
Darren.mcavoy@usu.edu

Megan Dettenmaier
Extension Educator
megan.dettenmaier@usu.edu

Mike Kuhns
Department Head, Wildland Resources
mike.kuhns@usu.edu

Utah State University
Logan, Utah

Introduction

Waste wood disposal is a problem in many western states due to the lack of profitable markets for such low-value wood. Although slash pile burning is a commonly accepted and inexpensive fuel reduction method (Busse, Shestak, & Hubbert, 2013), studies reveal persistent negative impacts on the health and productivity of soils where piles are burned. The heat destroys the soil structure and kills microorganisms in the soil where the pile was burned. Moreover, the timing of pile burning can be challenging because the material in the pile must be dry enough to burn but the surrounding countryside wet enough not to burn. The unpredictability of weather variables such as wind and snow, coupled with the need to keep nearby structures safe, contributes to the complexity of pile burning. Piles in close proximity to wildland–urban interface areas and/or highly valued watershed areas may go unburned for years, creating massive quantities of biomass and fuel (Hessburg, Raynolds, Keane, James, & Salter, 2007). These challenges create the need for alternative methods for removal and disposal of the millions of acres of beetle-killed pine, pinyon-juniper, and invasive Russian-olive and tamarisk trees that are common in western forests and rangelands. Biochar production through pyrolysis provides an alternative to pile burning that minimizes the fire risk and soil damage associated with pile burning while providing a potential source of revenue.

Pyrolysis and Biochar

The Utah Biomass Resources Group (UBRG), which the lead author on our team chairs, started working with Amaron Energy in 2011 in the group's first attempt to find a use for waste wood. Amaron, an energy-related research and development firm, had developed a demonstration-scale rotary-kiln pyrolysis machine that could be used to demonstrate an alternative way to treat slash piles and other accumulations of waste wood. Pyrolysis occurs when wood is cooked at temperatures between 400°C and 600°C in the absence of oxygen. This process thermally decomposes the material into three products: biochar, bio-oil, and syngas. Biochar is a charcoal product that can be used in a variety of agricultural and restoration applications; bio-oil is similar to crude petroleum oil, requiring further refining before use; and syngas is similar to propane or methane and can be used in electric generators. The UBRG is conducting studies on biochar uses in agriculture and mine reclamation and on creation of biochemical products from bio-oil, such as plastics and adhesives. Because shipping waste wood long distances from forests to processing plants is not economical for loggers, landowners, and foresters, a portable kiln presents a potentially economical way for these Extension target audiences to conduct pyrolysis in the woods, closer to the supply of biomass. Conducting pyrolysis on-site makes the materials that are moved from the site more energy-dense and, therefore, less expensive to move.

Mobile Pyrolysis

Simple approaches to pyrolysis have been used to make charcoal in western forests and woodlands since pioneer days, and studies indicate that pyrolysis has a 2,500-year history in the Amazon rainforest (Neves, Petersen, Bartone, & Silva, 2003). Historic charcoal kilns can still be found in Utah and surrounding states, demonstrating how pioneers made charcoal for smelting iron. Pyrolyzing wood creates charcoal, a lightweight fuel that burns hotter and more consistently than raw wood. In 2014, using federal funding, the UBRG partnered with Amaron to create one of the world's first mobile pyrolysis machines by mounting Amaron's kiln in an enclosed trailer. Feeding wood chips into the kiln yields biochar, bio-oil, and syngas. Demonstrating this new technology in the field was the next challenge.

Demonstrations

At a pyrolysis cook-off competition hosted by the Washington Department of Natural Resources in May 2014, Amaron demonstrated its mobile pyrolysis unit and took first place. Additionally, the company was awarded funding for a second Washington demonstration, which occurred in November 2014 in Cle Elum. This demonstration featured a newer, scaled-up version of the machine, with the unit housed in a 40-ft trailer and able to pyrolyze up to 20 tn of biomass per day. Funding to build this larger machine had come from a 2015 Sun Grant from the U.S. Department of Transportation.

The UBRG and Amaron demonstrated the mobile pyrolysis unit to an international audience at the International Union of Forest Research Organization's World Congress in Salt Lake City in 2014. Two international magazine articles were produced as a result (see a list at http://utahbiomassresources.org/biochar/biochar-presentations). The UBRG's comprehensive website at http://utahbiomassresources.org/ features these and other projects.

We demonstrated this technology in early 2017 at two locations in Colorado, with support from Colorado State University, Bioenergy Alliance of the Northern Rockies, and Southern Rockies Fire Science Network. In total, Amaron has successfully demonstrated the technology to more than 3,000 people. Participants at these demonstrations were surveyed regarding their perceptions of the usefulness of the events. Most attendees said the information was very useful or quite useful, and 100% were very satisfied or quite satisfied with the event. In addition, our YouTube video on the techniques (https://www.youtube.com/watch?v=1-sPK8qIBx4) has been viewed more 17,500 times. With these in-person and online demonstrations, the UBRG has raised awareness of and interest in mobile pyrolysis as an alternative to traditional forestry slash burning practices. The ultimate success would be a future in which a fleet of pyrolysis machines pull up to slash piles at timber harvest operations, wood chips are loaded directly into the machines, and high-value biomass products are created on-site.

Communication

Extension stakeholders prefer to obtain their biomass-related information at their own convenience, such as through websites, but research also has suggested that face-to-face demonstrations are vitally important because they allow attendees to ask their own questions and have personal interactions with experts (Moroney, Laninga, & Brooks, 2016). We observed significant interaction between stakeholders and those conducting the pyrolysis demonstrations. These small-scale workshop-type settings provided ample opportunities for dialogue, idea swapping, and discussions, which helped Amaron developers understand the needs of producers and helped Extension personnel understand where knowledge gaps remain.

References

Busse, M., Shestak, C., & Hubbert, K. (2013) Soil heating during burning of forest slash piles and wood piles. *International Journal of Wildland Fire*, *22*(6). http://www.publish.csiro.au/wf/pdf/WF12179

Hessburg, P., Raynolds, K., Keane, R., James, K., & Salter, R. (2007) Evaluating wildland fire danger and prioritizing vegetation and fuels treatments. *Forest Ecology and Management*, *247*(1–3), 1–17. http://www.sciencedirect.com/science/article/pii/S0378112707002320

Moroney, J., Laninga, T., & Brooks, R. (2016) Slash and learn: Revealing stakeholder knowledge, support, and preferred communication methods relative to wood-based biofuels projects. *Journal of Extension*, *54*(5), Article 5RIB10. Available at: https://joe.org/joe/2016october/pdf/JOE_v54_5rb10.pdf

Neves, E., Petersen, J., Bartone, R., & Silva, C. (2003) Historical and socio-cultural origins of Amazonian dark earths. In J. Lehmann, D. C. Kern, B. Glaser, & W. I. Wodos (Eds), *Amazonian dark earths: Origin, properties, and managements*, pp 29–50. Dordrecht, Netherlands: Springer. Retrieved from http://link.springer.com/chapter/10.1007/1-4020-2597-1_3#page-1