

# Biomass Gasification and Biochar Applications R&D at Butte College, Oroville, CA

Research and development in biomass gasification and biochar applications is being carried out at Butte Community College in Oroville, California since 2011. It is part of the MESA (Math Engineering Science Achievement) Internship Program, which introduces student interns to hands-on, applied research and development in engineering and in the basic scientific disciplines applied to real-life challenges. The program is directed by faculty, but is mentored by private industry experienced volunteer professionals from local communities.

The biomass gasification and biochar applications R&D project was initiated to address the challenge of environmentally acceptable and beneficial disposal of agricultural biomass residues (waste), such as rice hulls and straw. These biomass residues are abundant byproduct of the large rice growing industry in Northern California. Traditionally, they were burned in the fields after harvest, or used in biomass power plants for energy production. Recently, open burning of rice straw is increasingly prohibited and biomass power plants have shut down due to uneconomic operating conditions. Some of the rice straw is plowed back into the soil, but rice hulls and other biomass residues are accumulating unprocessed in huge stockpiles. In either case the biomass eventually decompose and contribute greenhouse gases to the atmosphere. Gasification converts the biomass residues to syngas and biochar, which can be used to generate energy and as beneficial soils additive, respectively.

The biomass gasification experiments at Butte College are carried out with the use of a simple rice hulls gasifier shown in Figure 1. It burns with a clean, smokeless

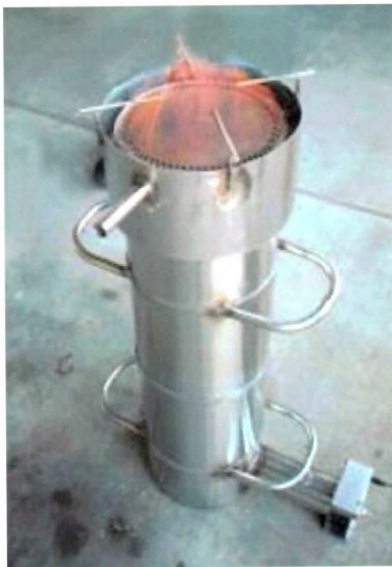


Figure 1. Rice hull gasifier.

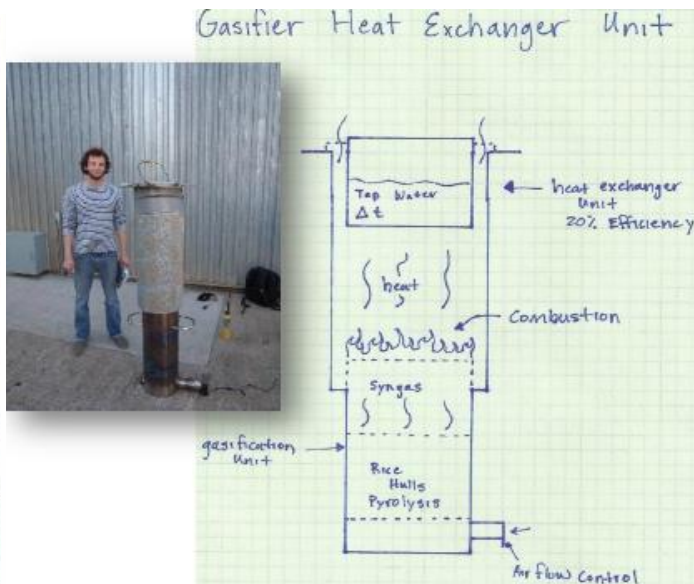


Figure 2. Heat exchanger experiment.

flames, suitable for indoor cooking, requiring only a small electric fan to force air flow from the bottom up through the gasifier. Figure 2 illustrates the heat exchanger experiment, which measures the thermal energy generated by a given quantity of rice hulls burned in the gasifier. This experiment teaches the students the basic principals of gasification and scientific methods of measuring the thermal energy generated. Students also experiment with the parameters of gasification, most importantly by varying the amount of airflow through the gasifier affecting the pyrolysis process and the amount of syngas and biochar produced. They learn that thermal energy can be used for various purposes as demonstrated by the heating of water in the heat exchanger experiment, or alternatively the syngas generated can be used to fuel various heaters or boilers replacing natural gas or propane use. The syngas can also power internal combustion engines which in turn can power generators to produce electric power as students observe during annual field trips to All Power Labs (APL) in Berkeley, California. APL conducts frequent open house seminars to educate the public in biomass power generation technology.



Figure 3. Biochar agricultural benefits experiments at Butte College.

Butte College student interns also conduct experiments to study agricultural benefit of using biochar as soils additive, as shown in Figure 3. Laboratory scale biochar application experiments have demonstrated the positive benefits of biochar to promote root formation and enhance plant growth in certain plants. Butte College is continuing biomass gasification and biochar applications R&D during the 2016-17 academic year, aided by an EPA-P3 (Planet, People, Prosperity) grant. Future R&D will include optimization of biochar production using various biomass feed stocks, including walnut shells, also orchard and forestry cuttings. Biochar agricultural experiments will include field scale studies in rice paddies, walnut orchards. In situ pyrolysis of olive grove cuttings to produce biochar and its use will be also studied.