



Grass Combustion – LEI BB500 Boiler

Purpose: The purpose of this publication is to describe grass pellet combustion in the LEI BB500 hydronic heater.

Appliance Description

The LEI Bioburner (BB500) is an approved indoor or outdoor boiler, rated at 150 kw (500,000 BTU). It was installed in the Town of Franklin highway garage in Franklin, NY, and burned grass pellets for several years. The fuel bin is external, with augers to remove fuel from the bin and elevate fuel into the combustion chamber.

Ignition is accomplished using propane or natural gas, which can also be used as a back-up fuel source. It has a fuel stirring “T-shaped” pipe in the burn chamber. Vertical heat exchanger tubes have turbulators, cleaned by attaching a hand or power drill to the top of each turbulator. It also is equipped with a fire suppression tank to protect against backfire into the fuel bin. Ash is automatically removed via auger into a holding bin.



Fig. 1. LEI BB500 installed in the Town of Franklin highway garage.

Control Panel

The BB500 has touch screen computer control of all functions. Combustion temperature, flue exhaust temperature, and heat exchanger temperature can be displayed or graphed over time. There are control settings for minimum air flow rate and maximum air flow rate, which only functions if combustion temperature setting is set at maximum.

This boiler was developed primarily for burning undensified feedstocks (1 ¼” chips or smaller), with a large feed auger and relatively high fuel delivery rate. Fuel moisture can be as high as 50%. Pellet fuel delivery is controlled by pulsed feeding, adjusting the ON and OFF times for the feed auger, with a minimum 3 second ON time. Maximum OFF time is around 20-25 seconds, if longer OFF times are selected, burning becomes erratic.

Maximum combustion temperature can be set, up to a maximum of 1600° F. Settings of up to 4 ON and as low as 22 OFF at maximum combustion temperature of 1600° permitted continuous running for both fuels tested. This LEI boiler is being operated at a maximum combustion temperature of 1250° F, to avoid any potential melting of ash to form clinkers. For the smaller BB100, when combustion temperature is restricted, the boiler goes into standby mode (ceases pellet feed) until combustion temperature drops back below the high temperature limit.

The smaller LEI boiler cycles in and out of standby every few minutes. For the BB500 set at a maximum 1250° F, the boiler does not cycle in and out of standby, even though boiler temperature will exceed 1250° F. The automatic program on the BB500 operates quite differently than that of the BB100 tested previously.

Sampling was not initiated until boiler stack temperature stabilized. Feed rates were determined by weighing fuel in, and weighing leftover fuel after a quantified time interval.

Feedstocks Used

Wood pellets averaged 1.1% ash and 8202 BTU/lb. Miller grass pellets averaged 5.8% ash and 7591 BTU/lb (7% moisture). These BTU values are on an as-is basis, not a dry matter basis. Grass pellets were similar to premium wood pellets in physical quality. Grass pellets had only 0.35% fines, a bulk density of 38.6 lbs/cu. ft., and a pellet durability of 95.6%.

Table 1. Boiler settings, feed rates, and smoke spot readings (ave. of 36 readings).

Fuel	Feed ON	Feed OFF	Feed rate	Smoke spot
	Sec.	Sec.	Lbs/h	0-10
Wood	3	25	16.5	1.8
	4	22	28.9	2.0
Grass	3	25	24.7	1.2
	4	22	32.3	1.0

The relatively small change in settings from 3/25 to 4/22 resulted in a large change in feed rate, and also affected grass differently than wood. Smoke spot readings were quite low for both wood and grass. However, since grass soot is often not black in color like wood, this test may be giving erroneous results for grass.

Combustion Measurements

A Testo 350XL emissions measurement system determined CO, CO₂, O₂, H₂, NO, NO₂, and SO₂ concentrations in the flue exhaust. Runs were restricted to 10 minutes in duration, to eliminate the possibility of overloading the CO sensor. After each run the probe filter was backwashed, and the Testo was allowed to rinse detection cells for at least 15 minutes.

Table 2. Testo 350XL emissions readings, averages of three separate runs. Boiler temperature set at 1250°F in all cases.

Fuel	Feed ON	Feed OFF	CO	NOx	CO ₂
	Sec.	Sec.	ppm	ppm	%
Wood	3	25	1438	22	2.8
	4	22	585	37	4.0
Grass	3	25	2952	71	2.8
	4	22	1547	98	3.7

Emissions Results

Stack temperatures were considerably higher with grass pellets compared to wood. As expected, wood has lower NO_x emissions, simply due to a lower N concentration in the feedstock. CO emissions were different between feed rates and between fuels and were very high. The higher feed rate resulted in lower CO concentrations, about 60% lower in wood and 50% lower in grass. CO emissions from wood were about 50% lower than grass at the lower feed rate, and about 60% lower than grass at the higher feed rate.

Issues When Burning Grass Pellets

This LEI boiler is not well set up to handle pellet feeding, but was designed to feed chopped feedstocks. The LEI Bioburner, set at a maximum combustion temperature of 1250° F, avoids melting of ash and clinker formation with grass pellets, but most likely also reduces combustion efficiency. A fuel feeding system designed for feeding pellets would likely increase combustion efficiency.

Summary

The LEI BB500 is capable of burning high ash grass pellets, as long as combustion temperature is not high enough to cause excess clinkering of ash. Efficiency indicated by CO emissions, however, was very low.

Additional Resources

Cherney, J.H. and K.M. Paddock. 2013. Basic emissions testing for residential appliances. Bioenergy Information Sheet #18. www.grassbioenergy.org.

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For more information



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