Grass Combustion – EnviroMaxxM Pellet Stove

Purpose: The purpose of this publication is to describe grass pellet combustion in the EnviroMaxxM pellet stove.

Appliance Description

An Enviro Maxx-M pellet stove was installed in the office of the Catskill Watershed Corporation in January, 2012, and has been burning about two 40 lb bags of grass pellets per day for two years when heating is required. The Maxx-M has a rating of 16,000 to 60,000 BTU/hour, and has a hopper with a 130 lb capacity.

The Maxx-M model is designed as a multi-fuel stove that will burn a variety of biomass pellets. The burn pot is a rectangular metal box with perforations. A spiked agitator rod in the burn pot slowly rotates at the same time as pellet feeding events, helping to break up any clinker or ash and remove it to the ash pan below.

Fig. 1. EnviroMaxxM pellet stove installed in the offices of the Catskill Watershed Corporation.

Control Panel

The stove has a fuel type button, for selecting either wood pellets or other biomass pellets. There are three control modes: Manual, Hi/Lo, and Auto/Off. When thermostat contacts open under Hi/Lo, the heat level and fans drop to a low setting until the thermostat contacts close. When thermostat contacts open under Auto/Off, the heat level and fans drop to a low setting for 30 minutes. If the thermostat contacts do not close by then, the stove shuts down. It will re-light when the thermostat contacts close. There are 5 heat level settings, and a feed trim button to adjust the feed setting, but the feed trim option only works when in the wood pellet fuel mode. The heat exchanger tubes, door glass, ash pan and door gaskets, and ash box require at least weekly inspection/maintenance. High ash fuels will require more frequent maintenance.

When in the multi-fuel mode only, the stove is programmed to go into a cleanout mode every 30 minutes. There is one minute of no pellet feeding with constant rotating of the agitator in the burn pot, followed by a 12 minute period where the feed rate ramps up from zero to the current fuel setting. Since the five fuel settings in multi-fuel mode are all lower (longer OFF times) than the wood pellet mode, and since feeding is interrupted during periodic cleaning in multi-fuel mode, the effective pellet feed rate per hour is much lower for the multi-fuel setting at any given fuel feed level (Table 1).

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

Fuel	Heat level	Feed ON	Feed OFF	Feed rate	Smoke spot
	setting	Sec.	Sec.	Lbs/h	0-10
Wood	3	3	6.7	4.2	4.6
	5	3	2.5	7.4	4.8
Grass	3	3	9.8	1.9	6.5
	5	3	5.0	3.0	4.8

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%.

For the multi-fuel mode, feed rates (seconds OFF) are similar to wood at setting #1, but become progressively slower than wood pellet rates, so that at setting #5 the seconds OFF time for multi-fuel mode is double that of the wood pellet mode. Seconds ON/OFF varies with feed rate and fuel type setting, but cannot be modified by the user. Smoke spot tests indicated moderate to high levels of particulates in flue emissions, and the lower feed setting for grass had a higher smoke spot test than the other combinations.

Combustion Measurements

A Testo 350XL emissions measurement system determined CO, CO_2, O_2, H_2, NO, NO_2, and SO_2 concentrations in the flue exhaust. Runs were restricted to 15-30 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 10 minutes, depending on the CO concentrations of the past run. All emissions measurements varied with feed rate for both fuels.

Emissions Results

All emissions measurements varied with the feed rate for both pellet fuels. Oxygen and CO decreased with increased feed rate, while NOx, CO2, and stack temperature increased with increased feed rate. No gaseous sulfur was detected in grass or wood, indicating a faulty sensor. There was no detectable S for wood combustion emissions, and very low (1-3 ppm) S emissions for grass. Grass combustion was considerably less efficient than wood pellet combustion, based on the high CO concentrations from grass.

Table 2. Testo 350XL emissions readings, averages of three separate runs.

Fuel	Feed	CO	N0x	$C0_2$	Stack
	setting	ppm	ppm	%	^{O}F
Wood	3	535	49	4.7	251
	5	282	84	8.3	353
Grass	3	1437	79	3.2	212
	5	603	124	5.0	269

Issues When Burning Grass Pellets

There is a pair of heat exchanger scrapers, with handles under the grill on the top of the stove. They are moved up and down when the stove is cold, to clean fly ash off the heat exchanger surface. With age they are starting to bind, indicating that grass may have caused some corrosion on heat exchanger surfaces. The ash box is quite small on the MaxxM, high ash fuels will need frequent emptying of the container.

In 2013 this stove stopped functioning, due to the exhaust vent becoming clogged with fly ash. Professional cleaning of the exhaust vent is recommended biannually, but needs to be done more frequently when using high ash fuels.

Grass pellets are relatively high in potassium and chlorine content compared to wood pellets. Potassium and chlorine both cause significant corrosion of metal surfaces. Since the Maxx-M stove has a considerable amount of metal surface in contact with the burning pellets and with the combustion emissions, there is high risk of both the stove and the flue pipes rusting out.

Summary

The Enviro-MaxxM pellet stove did not burn wood pellets efficiently, and was considerably worse when using grass pellet fuel. Although the stove did not have a problem dealing with grass ash and clinkers, efficiency (implied by very high CO emissions) was unacceptable.

Additional Resources

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

Acknowledgments

Testing was supported by the Delaware County Cooperate Extension, the Catskill Watershed Corporation, and the Cornell University Agricultural Experiment Station.

For more information

Cornell University Cooperative Extension

Dept. of Crop & Soil Sciences
http://www.GrassBioenergy.org
J.H. Cherney, K.M. Paddock,M. Kiraly, and G. Ruestow, Fermata Consulting
Cornell University
JHC5@cornell.edu