



Grass Combustion – Harman P43 Pellet Stove

Purpose: The purpose of this publication is to describe grass pellet combustion in the Harman P43 pellet stove.

Appliance Description

The Harman P43, a smaller version of the Harman P68 stove, was installed in a meeting room at the Town of Franklin highway garage in Franklin, NY. The P43 provides 0 to 43,000 BTU, with automatic ignition. The feed auger pushes pellets into an upward-slanted burn pot. Repeated feeding pushed burning material towards the top lip of the burn pot, and pushes combusted material over the edge into a relatively large ash bin.



Fig. 1. Harman P43 pellet stove installed in the Town of Franklin highway garage.

Control Panel

The control panel also has a manual operation option, both for igniting and for operating. An external temperature sensor plus the control panel allow the user to set the desired room temperature. Manual mode allows the operator to have a larger flame for viewing, without blowing extra heat into the room. Manual mode allows for a constant feed rate for emissions testing, however the temperature control dial must be set above 5, or the distribution fan will not operate. Combustion and distribution fans do not have independent

controls.

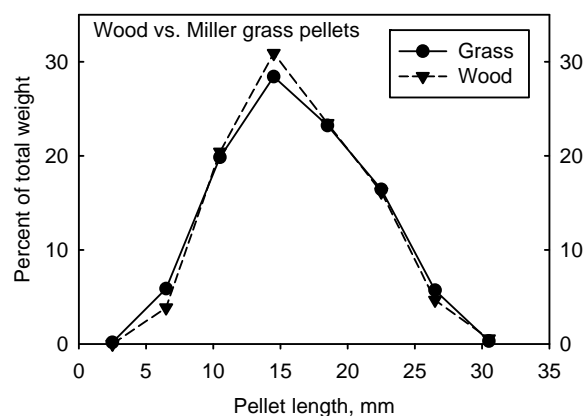


Fig. 2. Distribution of pellet length for wood vs. grass.

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 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.

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 very similar to premium wood pellets in the pellet length distribution (Fig. 2).

Average weight per pellet was 0.45g for wood, and 0.36g for grass, so an average grass pellet weighed about 20% less than an average wood pellet. Grass pellets had only 0.35% fines, a bulk density of 38.6 lbs/cu. ft. (or 35.6 lbs/cu. ft. on a DM basis), and a pellet durability score of 95.6%.

Stove Settings

Pellet feed rates were determined by difference, weighing in and out from the fuel bin over a period of time (Table 1). Grass pellets had feed rates about 15% faster than wood pellets at both feed rate settings. Smoke spot tests were collected every 30 seconds for 12 readings, and repeated 3 times, for a total of 36 smoke spot readings for each feed rate of each fuel.

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

Fuel	Feed setting	Temp setting	Rate Lbs/h	Smoke
Wood	3	5	3.4	1.1
	6	7	5.0	0.7
Grass	3	5	3.9	0.2
	6	7	5.8	5.4

Emissions Results

All emissions measurements varied with the feed rate for both pellet fuels. Oxygen and CO decreased with increased feed rate, while CO₂ and stack temperature increased with increased feed rate. NO_x increased with increased feed rate in wood, but decreased slightly for grass. No gaseous sulfur was detected in wood emissions, while grass had a small amount of S in emissions. Both nitrogen and sulfur emissions will be correlated with the concentrations of N and S in the feedstocks.

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

Fuel	Feed setting	CO ppm	NO _x ppm	SO ₂ ppm	CO ₂ %
Wood	3	233	72	0	5.1
	6	66	100	0	7.6
Grass	3	119	190	18	5.7
	6	268	174	16	8.7

CO emissions were relatively low in wood pellets at the high feed rate and in grass pellets at the lower feed rate, but were higher in wood pellets at a lower feed rate, and grass pellets at the high feed rate.

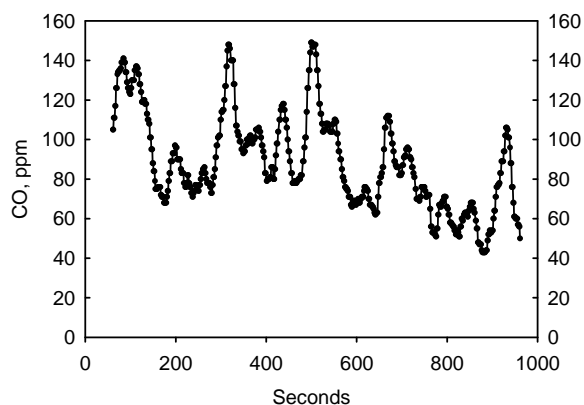


Fig. 3. Example CO emissions from Harman P43 burning grass pellets at a reduced feed rate.

Warranty Issues

The warranty is voided if burning non-wood pellet fuel. The warranty also is void if "The appliance has been over-fired or operated in atmospheres contaminated by chlorine", which would also disqualify grass pellets.

Summary

The Harman P43 is capable of burning high ash grass pellets, although there is some concern that clinkering could interfere with ash movement out of the burn pot. The stove also has considerable metal surface in contact with burning pellets, increasing risk of rust.

Additional Resources

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

Acknowledgments

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For more information



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