# Grass Combustion – Skanden (Reka) Pellet Boiler

**Purpose**: The purpose of this publication is to describe grass pellet combustion in the Skanden (Reka) HKRST/V-FSK 20 pellet boiler.

## Appliance Description

The Skanden (Danish Reka) pellet boiler HKRST/V-FSK 20, is a 65,400 BTU (19 kW) rated pushing grate boiler. Besides a moving grate in the combustion chamber, it has an ash auger for automated ash removal, and automatic cleaning of the heat exchanger tubes using compressed air. The pellet storage bin has a moving grate on the bottom, allowing the system to utilize chopped, undensified materials, such as small wood chips or chopped straw or grass. The feed auger is fitted with a sprinkler system to protect against back burning. Boiler startup is done manually.


Fig. 1. Skanden (Reka) pellet boiler.

## Control Panel

The touch control panel allows for control a wide range of parameters, including the moving grate, ash screw, fuel feed steps, fan speed, oxygen level, boiler maximum temperature, etc. There is an oxygen sensor in the flue, which generates readings 2-4 percentage units lower than those obtained with a Testo analyzer and flue probe.

## Pellet Feeding

Pellet feeding ON interval can be controlled but not the OFF interval, which is controlled by the $O_2$ concentration monitored by the Reka. The OFF interval varied from about 5 to 60 sec. during a given run. Nominal pellet feeding rate was determined as the highest feed rate that would not periodically shift the boiler into standby mode, due to exceeding maximum boiler temperature.

Fig. 2. Moving grate and ash auger.

Table 1. Pellet feed rate and thermal efficiency for wood, high and low ash grass.

| Fuel | Feed Setting | Feed rate | BTU X 1000 | Thermal Efficiency |
|---|---|---|---|---|
| | Sec. ON | lbs/h | fuel/h | % |
| Wood | 0.40 | 9.52 | 78.1 | 63.4 |
| | 1.00 | 16.95 | 139.0 | 68.1 |
| Grass, low | 0.33 | 10.60 | 82.1 | 59.1 |
| | 0.83 | 19.98 | 155.5 | 62.0 |
| Grass, high | 0.33 | 11.30 | 89.2 | 61.1 |
| | 0.80 | 20.30 | 160.2 | 66.4 |

Thermal efficiency was calculated as the percent of fuel BTU delivered to the water/water heat exchanger. Boiler IN and OUT water temperatures were monitored with thermocouples and flow rate was monitored.

## 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. The SO2 cell was inconsistent and readings are not reported. All emissions measurements varied with feed rate for all 3 fuels. All emissions tests were run in triplicate.

High ash grass pellets averaged 5.5% ash and 7891 BTU/lb. Low ash grass pellets averaged 3.0% ash and 7749 BTU/lb. Premium wood pellets averaged 1.1% ash and 8202 BTU/lb. The BTU values are on an "as is" basis.

## Emissions Results

All emissions measurements varied with the feed rate for all three pellet fuels. Oxygen and CO decreased with increased feed rate, while CO2, NOx and stack temperature increased with increased feed rate. CO emissions were relatively low for the nominal feed rate, but were considerably higher for the reduced feed rates. Grass pellets in the Reka boiler at the lower feed rate were considerably higher in CO emissions than wood pellets. This was not the case with previous appliances tested.

Table 1. Average emissions readings for wood, low ash and high grass pellets at nominal and 50-60% of nominal. (Ave. of 3 runs).

| Fuel | Setting | CO | NOx | $CO_2$ |
|---|---|---|---|---|
| | Sec. ON | ppm | ppm | % |
| Wood | 0.40 | 173 | 100 | 1.61 |
| | 1.00 | 46 | 134 | 2.03 |
| Grass, low | 0.33 | 466 | 167 | 1.57 |
| | 0.83 | 34 | 239 | 2.01 |
| Grass, high | 0.33 | 547 | 316 | 1.63 |
| | 0.80 | 73 | 389 | 2.05 |

## Concerns with Grass Pellets

The moving grate system generally prevented ash melting, although some clinkering was observed along the chamber walls when burning low ash grass pellets. Increasing the frequency of grate movement may have prevented this. When burning at lower than the nominal feed rate, grass pellets generated relatively high CO concentrations in the flue exhaust.

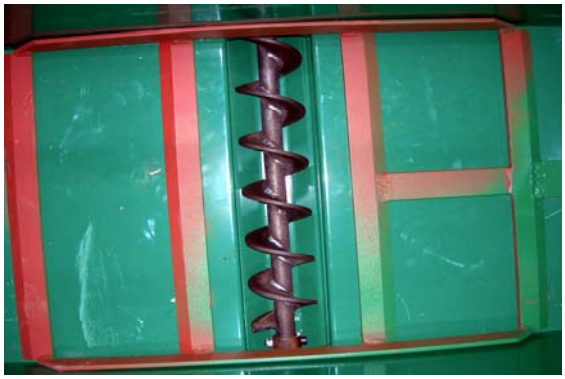

Fig. 3. Bottom of fuel bin, showing auger and moving floor to prevent fuel bridging.

## Summary

The Skanden (Reka) pellet boiler has heavy duty construction to withstand non-wood biomass combustion. The boiler has moving grates in the combustion chamber, as well as automatic heat exchanger cleaning and auto ash removal. It is capable of burning pellets, small briquettes, or coarse chopped biomass. Combustion appeared efficient at nominal rates, but not at reduced feeding rates when using grass pellets.

## 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

Cornell University Cooperative Extension

Dept. of Crop & Soil Sciences
http://www.GrassBioenergy.org

J.H. Cherney and K.M. Paddock
Cornell University
JHC5@cornell.edu