Aprovecho Research Center
Advanced Studies in Appropriate Technology
76132 Blue Mountain School Road, PO Box 1175
Cottage Grove, Oregon, 97424 - USA
(541) 767-0287
www.aprovecho.org

Results of Testing the SSM/S22-13
May 2017

Figure 1 The SSM/S22-13 shown in its stock configuration.

The SSM/S22-13 was tested by Aprovecho staff at the Aprovecho laboratory in Cottage Grove, Oregon, USA in May of 2017. Aprovecho conducted standard laboratory testing [WBT 4.2.3, LEMS] to determine performance metrics related to the stove's fuel use and emissions.

Methods

The pot dimensions were 27 cm in diameter, and 16 cm in height. It was filled with 5 L of water. A 15 cm tall skirt was used. The skirt had a 6 mm gap.

The stove was continuously fed with sticks of Douglas fir. The fuel had a moisture content of 12% (wet basis). The sticks were cut with a cross section of 2x1 cm.

Test Results

The IWA test results for each test are shown in Figure 2. A statistical analysis of the IWA metrics is presented in Figure 3. In Figure 4 the following metrics are provided for each phase: temperature corrected time to boil, firepower, thermal efficiency, and turn down ratio (simmer only). The calculation of each of the metrics is provided in the WBT protocol. The IWA results are also shown in Figure 5 in the GACC format. The individual safety scores are shown in Figure 6.

Stove type/model		SSM/S22-13 T1	SSM/S22-13 T2	SSM/S22-13 T3	SSM/S22-13
Location		apro	apro	apro	Average
Wood species		df sticks	df sticks	df sticks	**df sticks**
Date		4.27.17	4.27.17	5.1.17	**4.27.17**
IWA Performance Metrics	**units**	**Value**	**Value**	**Value**	
High Power Thermal Efficiency	%	43.1%	38.1%	37.2%	39.5%
Low Power Specific Consumption	MJ/min/L	0.013	0.026	0.025	0.021
High Power CO	g/MJ$_d$	4.57	5.06	4.38	4.67
Low Power CO	g/min/L	0.08	0.08	0.07	0.08
High Power PM	mg/MJ$_d$	276.3	369.3	340.2	328.6
Low Power PM	mg/min/L	1.28	2.07	1.92	1.76
Indoor Emissions CO	g/min	0.36	0.34	0.33	0.35
Indoor Emissions PM	mg/min	18.8	23.4	23.7	21.9
Safety	Index	94.5			95
		Tier	**Tier**	**Tier**	
High Power Thermal Efficiency		3.8	3.3	3.2	3.4
Low Power Specific Consumption		4.2	3.1	3.2	3.6
High Power CO		4.4	4.3	4.4	4.4
Low Power CO		4.1	4.1	4.1	4.1
High Power PM		2.5	2.0	2.2	2.2
Low Power PM		3.7	2.9	3.0	3.2
Indoor Emissions CO		4.1	4.1	4.2	4.1
Indoor Emissions PM		1.9	1.7	1.7	1.7
Safety					3.9

Figure 2 IWA metrics for each of the test iterations

Stove type/model	SSM/S22-13			N =	3				
Location	Average	High Tier Estimate	Low Tier Estimate	Stdev	Interval	COV	Average Tier	High Tier Estimate	Low Tier Estimate
Wood species	df sticks								
Date	4.27.17								
IWA Performance Metrics	**units**								
High Power Thermal Efficiency	%	39.5%	47.4%	31.5%	3.2%	8.0%	8%	3.4	4.0	2.6
Low Power Specific Consumption	MJ/min/L	0.021	0.004	0.038	0.007	0.017	32%	3.6	4.7	2.0
High Power CO	g/MJ_d	4.67	3.81	5.53	0.35	0.86	7%	4.4	4.5	4.3
Low Power CO	g/min/L	0.08	0.07	0.09	0.00	0.01	4%	4.1	4.2	4.0
High Power PM	mg/MJ_d	328.6	210.4	446.7	47.6	118.2	14%	2.2	2.8	1.8
Low Power PM	mg/min/L	1.76	0.71	2.80	0.42	1.04	24%	3.2	4.2	2.5
Indoor Emissions CO	g/min	0.35	0.31	0.39	0.02	0.04	5%	4.1	4.2	4.0
Indoor Emissions PM	mg/min	21.9	15.1	28.8	2.8	6.8	13%	1.7	2.2	1.4
Safety	Index	95						3.9		

Figure 3 Statistical analysis of the IWA metrics.

Stove type/model		SSM/S22-13 T1	SSM/S22-13 T2	SSM/S22-13 T3	SSM/S22-13 Average
Basic Operation					
COLD START					
Temp-Corrected Time to Boil	min	28.9	32.0	28.1	29.6
Firepower	watts	2,624	2,772	3,121	2,839
SIMMER					
Firepower	watts	1,006	1,919	1,864	1,596
Turn down ratio	--	2.61	1.44	1.67	1.91

Figure 4 Fuel related metrics

IWA Tiers of Performance Report

Cookstove Manufacturer	SSM
Model	S22-13
Testing Center	Aprovecho Research Center
Protocol	WBT4.2.3, LEMS
Fuel Used	Douglas Fir Sticks 2x1 cm cross section
Pot Used	Flat bottom, stainless steel with 27 cm diameter, 16 cm height, 15 cm tall skirt with 6 mm gap
Test Dates	April 27 to May 1, 2017

These results were obtained in accordance with the IWA and the Global Alliance for Clean Cookstoves' reporting requirements. [1] This data and additional supporting data are shared publically through the Stove Performance Inventory.

Signature	
Name	Sam Bentson

[1] Interim Stove Performance Reporting Requirements: http://community.cleancookstoves.org/files/318

		Metric	Value	Unit	Sub-Tier
Efficiency/Fuel Use					
Tier	**3**	High power Thermal Efficiency	39%	%	3
		Low power Specific Consumption	0.021	MJ/min/l	3
Emissions					
Tier	**2**	High power CO	4.67	g/MJ_d	4
		Low power CO	0.08	g/min/l	4
		High power PM 2.5	328.56	mg/MJ_d	2
		Low power PM 2.5	1.76	mg/min/l	3
Indoor emissions					
Tier	**1**	High power Indoor emissions CO	0.31	g/min	4
		Low power Indoor emissions CO	0.35	g/min	4
		High power Indoor emissions PM 2.5	21.94	mg/min	1
		Low power Indoor emissions PM 2.5	7.89	mg/min	3
Safety					
Tier	**3**	Points from 10 weighted safety parameters	95	points	

Tier 0 → Improving Importance → Tier 4

Figure 5 Test results in GACC format.

Individual Scores for Safety Assessment Criteria

Assessment Criteria	Score (1 – 4)	Multiplier
Sharp Edges and Points	4	1.5
Cookstove Tipping	4	3
Containment of Fuel	3	2.5
Obstructions Near Cooking Surface	4	2
Surface Temperature	4	2
Heat Transmission to Surroundings	4	2.5
Temperature of Operational Construction	4	2
Chimney Shielding	4	2.5
Flames Surrounding the Cookpot	3	3
Flames/Fuel Exiting Fuel Chamber, Canister, or Pipes	4	4

Figure 6 Individual Safety Scores

References

LEMS
http://aprovecho.org/software/

Safety
https://cleancookstoves.org/binary-data/DOCUMENT/file/000/000/407-1.pdf

WBT 4.2.3
http://cleancookstoves.org/binary-data/DOCUMENT/file/000/000/399-1.pdf