POLYTESTS
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TEST REPORT

TEST OF A WOOD BURNING PELLET BOILER model AHB 170P by America's Heat

EMISSIONS AND EFFICIENCY

PER

EPA Method 28 WHH and ASTM 2515

Client:
America's heat

model tested:
AHB 170P

Attention: Rafael Sanchez
TESTED BY:
Services Polytests
695-B Gaudette
St-jean-sur-richelieu

TEST DATES: 2015 December 15th to 2015 December 17th

REPORT DATE: 2016 January 15th

Project number: PI-20114

Tested by: Maxime Martin & Danick power

Written by: Danick Power

Third party certifier (UL)

SUMMARY

Appendix

1 INTRODUCTION

1.1 GENERAL

Laboratory

- Location: Services Inc., 695-B Gaudette St-jean-sur-richelieu.
- Elevation: 100 feet above sea level.

Test program

- Purpose: EPA Hydronic Heater Subpart QQQQ Standard of performance for new residential hydronic heater
- Test dates: December 7th to 17th 2015
- Test methods used: EPA Method 28 WHH and ASTM E2515

1.2 TEST UNIT INFORMATION

General

- Manufacturer: America's Heat
- Product type: Automatic feed Pellet boiler
- Combustion system: Pellet boiler
- Unit tested: AHB 170P
- model name and description : AHB 170

Particularities

- Options: none
- Product line similarities: none

1.3 RESULTS

Emission results obtained

- Weighted average emission rate wood pellet : 0.108 lbs/MMBTU output
- Maximum rate cap: 1.68 grams/hour at run # 1 cat 4

Conformity: Step 1 of EPA Hydronic Heater Subpart QQQQ Standard of performance for new residential hydronic heater from May 2015 to May 2020, 0.32Lb/MMbtu heat output (weighted average)

1.4 PRETEST INFORMATION

Unit condition: The unit was received by the client, inspected and found to be in good condition

Set up

- Venting system type: 6 inch Steel pipe and insulated chimney
- System height from floor: 15 feet

- Particularities: the pretest run was done with the same calibrated pellet as four official tests run

Break in period

- Duration: the preburn has been done by the manufacturer, data provided in appendix E
- Average burn rate: 20% of the maximum heat output
- Fuel: Pellet

2 SUMMARY OF TEST RESULTS

2.1 TABLE 1A: DATA SUMMARY PART A

							Wfuel	MCave	Qin	Qout
CAT	Run #	Load % Capacity	Tgt Load (Btu/h)	Act Load (Btu/h)	Act Load (% max)	Test Duration (h)	Wood Wt (lb)	Wood Moisture (%DB)	Heat input (Btu)	Heat output (Btu)
1	4	<15% of max	11 200	10348	92%	4,12	10,47	5,90	85 919	42 598
2	3	16-24 % of max	17 600	14324	81%	4,12	13,97	5,90	114 672	58 966
3	2	25-50 % of max	36 000	36933	103%	4,03	29,90	5,90	245 404	148 963
4	1	max capacity	80 000	77771	97%	4,07	60,57	5,90	497 066	316 269

2.2 TABLE 1B: DATA SUMMARY PART B

			T2 min	Et (g)	E (lb/Mmbtu out)	E (g/MJ)	E (g/hr)	E (g/kg)	hdel (%)	hslm (%)
CAT	Run #	Load % Capacity	Min return water temp	Total PM Emissions	PM output based	PM output based	PM rate	PM factor	Delivered efficiency	Stack loss Efficiency
1	4	<15% of max	145	2,5	0,129	0,055	0,60	0,55	50%	68%
2	3	16-24 % of max	144	3,6	0,133	0,057	0,86	0,59	51%	69%
3	2	25-50 % of max	141	4,4	0,064	0,028	1,08	0,34	61%	65%
4	1	max capacity	127	6,8	0,048	0,020	1,68	0,26	64%	70%

2.3 TABLE 1C : HANG TAG INFORMATION

Manufacturer	America's Heat		
Model Number	AHB 170P		
Maximum output rating		80 000	BTU/hr
Annual efficiency rating	η_{avg}	54%	(using higher heating value)
Particle emissions	E_{avg}	0,997	GRAMS/HR (average)
		0,108	LBS/ MILLION Btu OUTPUT
Carbon monoxide	Cog/min	0,477	Grams/minute

2.4 TABLE 2: ANNUAL WEIGHTING

CAT	Weighting Factor (F_j)	η_{del} X F_j	$E_{g/MJ,\ j}$ X F_j	$E_{g/kg,\ j}$ X F_j	$E_{lb/MMBtu\ Output,\ j}$ X F_j	$E_{g/h,\ j}$ X F_j
1	0,437	0,217	0,024	0,242	0,056	0,264
2	0,238	0,122	0,014	0,141	0,032	0,205
3	0,275	0,167	0,008	0,093	0,018	0,297
4	0,050	0,032	0,001	0,013	0,002	0,084
Totals	1,000	0,538	0,046	0,490	0,108	0,850

2.5 TEST FACILITY CONDITION

Run Number	Room Temperature		Barometric pressure		Relative humidity		Air Velocity	
	Before (F)	After (F)	Before (in.Hg)	After (in.Hg)	Before (%)	After (%)	Before (ft/min)	After (ft/min)
1	70	71	29,412	29,471	39,7	34,3	22	24
2	68	71	30,209	30,209	34,5	29,5	21	22
3	69	70	30,209	30,121	34,5	29,9	24	26
4	67	78	29,884	29,737	33,2	29,6	23	21

2.6 DILUTION TUNNEL FLOW RATE MEASUREMENTS AND SAMPLING DATA (SECTION 6.23 ASTM E2515)

Average dilution tunnel measurements				Sample Data			
Run Number	Burn Rate (Min)	Volumetric Flow Rate (dscf/min)	Total Temperatures (°R)	Volume sampled (DSCF)		Particulate catch (mg)	
				1	2	1	2
1	244	173,63	657,29	41,633	40,280	6,50	6,70
2	242	170,91	598,77	41,645	40,352	4,20	4,70
3	247	181,69	561,30	42,442	41,074	3,60	3,30
4	247	186,91	554,93	42,806	41,279	2,50	2,60

2.7 DILUTION TUNNEL DUAL TRAIN PRECISION

Run Number	Sample Ratio		Total Emission (g)		
	Train 1	Train 2	Train 1	Train 2	% Deviation
1	1017,59	1051,78	6,61	7,05	3,17%
2	993,19	1025,01	4,03	4,68	7,42%
3	1057,37	1092,58	3,65	3,45	2,83%
4	1078,53	1118,43	2,38	2,59	4,26%

2.8 1ST HOUR EMISSION & CO TOTAL EMISSIONS

Run Number	ASTM E2515 Emissions – First Hour (gr/hr)	CSA B415.1 CO emission (gr/hr)
1	1.73	7.62
2	0.60	30.27
3	1.48	35.2
4	0.86	26.21

3 PROCESS DESCRIPTION

3.1 DISCUSSION

The unit was received at the lab by a carrier during the month of September 2015, the preburn was done on the unit the week before official testing in December 2015 with the same pellet fuel.

Appliance Manufacturer: America's Heat

Model: AHB 170P

Type: Automatic feed Pellet boiler

Materials of Construction: The unit is constructed primarily of middle steel. The firebox has no refractory brick. The door has a no glass panel and one gasket.

Internal Baffles: A Steel baffle is mounted in the upper portion of the firebox. The flame path is forced to the bottom of the firebox where it travels up through the opening between the baffle and front of the firebox.

Other Features: na

Flue Outlet: The 6-inch diameter flue outlet is located in the back of the unit.

3.2 AIR SUPPLY SYSTEM

Air Introduction System: combustion air enters through the combustion air blower on the burner the lower row of hole in the burner is primary air and a second upper row of holes is the secondary combustion air.

Combustion Control Mechanisms: Example: Combustion air is modulated by cycling the combustion fan speed. The fuel delivery auger is cycling as well, to achieve the different burn rate, one aquastat activate or turn off at the same time the auger and the combustion fan.

Combustor: No electric ignition is available in this model.

3.3 PROCESS OPERATION DURING TEST

During the 1st run (cat.4) we set the flow rate of the load to aim for the maximum power of 80 000 Btu/hr. The flow of the water in the heat exchanger was set at 8.2 liter/min., 2 hours before the beginning of the sampling and maintained during 4.07 hours for the test. The boiler delivers during the test an average of 77 750 Btu/hr, and reach the targeted output delivery category of the maximum burn rate. The unit at this burn rate category get 63.6 % delivery efficiency with 0.0476 lb/MMBtu output, 60.57 lbs of fuel have been consume with 6.8 gr total emission During this test the boilers combustion run at maximum.

During the 2nd run (cat. 3) we set the flow rate of the load to aim for the maximum power of 36 000 Btu/hr. The flow of the water in the heat exchanger was set at 3.1 liter/min., 2 hours before the beginning of the sampling and maintained during 4.03 hours for the test. The boiler delivers during the test an average of 36 900 Btu/hr, and reach the targeted output delivery category of the maximum burn rate. The unit at this burn rate category get 60.7 % delivery efficiency with 0.064 lb/MMBtu output, 29.9 lbs of fuel have been consume with4.4 gr total emission During this test the boilers combustion run at maximum.

During the 3rd run (cat. 2) we set the flow rate of the load to aim for the maximum power of 17 600 Btu/hr. The flow of the water in the heat exchanger was set at 1.26 liter/min., 2 hours before the beginning of the sampling and maintained during 4 hours for the test. The boiler delivers during the test an average of 14 300 Btu/hr, and reach the targeted output delivery category of the maximum burn rate. The unit at this burn rate category get 51.4 % delivery efficiency with 0.13 lb/MMBtu output, 14.0 lbs of fuel have been consume with 3.6 gr total emission During this test the boilers combustion run at maximum.

During the 4th run (cat. 1) we set the flow rate of the load to aim for the maximum power of 11 200 Btu/hr. The flow of the water in the heat exchanger was set at 0.7 liter/min., 2 hours before the beginning of the sampling and maintained during 4 hours for the test. The boiler delivers during the test an average of 10 350 Btu/hr, and reach the targeted output delivery category of the maximum burn rate. The unit at this burn rate category get 49.6 % delivery efficiency with 0.128 lb/MMBtu output, 10.5 lbs of fuel have been consume with 2.5 gr total emission During this test the boilers combustion run at maximum.

Test fuel

- Test fuel: wood pellet (model: Hotzpellets),
- Description: The pellet for each test and pre-burn period was sent to Twin ports Testing inc for test fuel calorific analysis. This laboratory is ISO/IEC 17025 recognize. For the test fuel property refer to test fuel analysis in the appendix D Calibration data.
- Sourcing: Pellet already at the laboratory from another project
- Handling and storage: keep all bags in the same room (at 20C ambient and 50% humidity) all wrap together to ensure the stability of the moisture.

3.4 START-UP OPERATION

The complete firing procedure of each burn rate category is fully described in appendix.

4 SAMPLING SYSTEMS

4.1 SAMPLING LOCATIONS

Particulate samples are collected from the dilution tunnel at a point 15 feet from the tunnel entrance. The tunnel has two elbows and two mixing baffles in the system ahead of the sampling section. The sampling section is a continuous 10 foot section of 6 inch diameter pipe straight over its entire length. Tunnel velocity pressure is determined by a standard pitot tube located 48 inches from the beginning of the sampling section. Thermocouple is installed on the pitot tube to measure the dry bulb tempo MC is assumed, as allowed, to be 2%. Tunnel samplers are located 56 inches downstream of the pitot tube and 16 inches upstream from the end of this section.

4.2 DRAWINGS

Various drawings of the stack gas sampling train and of dilution tunnel system are found in Appendix 9.

4.3 EMISSIONS EFFICIENCY TESTING EQUIPMENT LIST

The complete test equipment list together with all corresponding calibration data can be found in Appendix D.

5 SAMPLING METHODS

5.1 PARTICULATE SAMPLING

Particulates were sampled in strict accordance with ASTM E2515. This method uses two identical sampling systems with Gelman AIE 61631 binder free (or equivalent), 47 mm diameter filters. The dryers used in the sample systems are filled with "Drierite" before each test run.

6 QUALITY ASSURANCE

6.1 INSTRUMENT CALIBRATION

6.1.1 GAS METERS

At the conclusion of each test program the gas meters are verified using the reference dry gas meter. This process involves sampling the train operation for 1 cubic foot of volume. With readings made to .001 fr', the resolution is .1 %, giving an accuracy higher than the 2% required by the standard.

6.1.2 STACK SAMPLE MASS FLOW CONTROLLER

The stack sample mass flow meter regulates each flow rate used during the test program. The flow rate is acquisition every minute during the test run and use for the proportionality calculation.

The dry gas meter volume measured is then corrected to standard temperature and pressure conditions.

6.1.3 GAS ANALYZERS

The continuous analyzers are zeroed and spanned before each test with NBS traceable gases. A mid-scale multi-component calibration gas is then analyzed (values are recorded). At the conclusion of a test, the instruments are checked again with zero, span and calibration gases (values are recorded only). The drift in each meter is then calculated and must not exceed 5% of the scale used for the test.

At the conclusion of each unit test program, a three point calibration check is made and must meet accuracy requirements of the applicable standards. Consistent deviations between analyzer readings and calibration gas concentrations are used to correct data before computer processing.

6.2 TEST METHOD PROCEDURES

6.2.1 LEAK CHECK PROCEDURES

Before and after each test, each sample train is tested for leaks. Leakage rates are measured and must not exceed 0.02 CFM or 4% of the sampling rate. Leak checks are performed checking the entire sampling train. Pre-test and post-test leak checks are conducted with a vacuum of 5 inches of mercury. Vacuum is monitored during each test and the highest vacuum reached is then used for the post-test vacuum value. If leakage limits are not met, the test run is rejected. During these tests, the vacuum is typically less than 2 inches of mercury. Thus, leakage rates reported are expected to be much higher than actual leakage during the tests.

6.2.2 TUNNEL VELOCITY FLOW MEASUREMENT

The tunnel velocity is calculated from a center point pitot tube signal multiplied by an adjustment factor. This factor is determined by a traverse of the tunnel as prescribed in EPA Method 1. Final tunnel velocities and flow rates are calculated from EPA Method 2, Equation 6.9 and 6.10. (Tunnel cross sectional area is the average from both lines of traverse.)

Pitot tubes are cleaned before each test and leak checks are conducted after each test.

6.2.3 PM SAMPLING PROPORTIONALITY (ASTM E2515)

Proportionality was calculated in accordance with ASTM E2515. The data and results are in appendix.

6.2.4 HEAT OUTPUT MEASUREMENT

With water-to-water heat exchanger, PT100 insertion probe (+-0.25°F) and flow meter within 0.5% accuracy.

Appendix A Unit Operating Procedures

Appendix B Raw data, forms and Results

Appendix C Drawing and specifications

Appendix D Equipment list and calibration certificates

Appendix E Unit pre-burn

Appendix F Operator's manual

Appendix G unlock data & calculation forms

Appendix H Proportionality results

Appendix I Test load photographs and fuel analysis

Appendix J photograph of the test setup

Appendix K Drawing of air and water flow pattern

Appendix L: example calculation