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PERFORMANCE COMPARISON OF VERDO RENEWABLES MANUFACTURED WOOD BRIQUETTES WITH WOOD LOGS AND HOUSE COAL

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COMPARISON OF VERDO RENEWABLES MANUFACTURED WOOD BRIQUETTES WITH WOOD LOGS AND HOUSE COAL

1 INTRODUCTION

At the request of Mr R Smith of Verdo Renewables, a comparison of two samples of manufactured wood briquettes compared to natural wood logs and house coal has been carried out. A comparison of performance on an open fire was made with wood logs and house coal and a comparison with wood logs was made in a typical wood burning stove. Also carried was a chemical analysis of the briquettes. The two samples of briquettes were from different manufacturing plants, one from a Grangemouth plant, and the other from an Andover plant.

2 FUELS

Verdo Renewables supplied the samples of logs. The samples were logged into the test laboratory's records and given the Fuel Reference Numbers F/1158/01and F/1158/02 for the Grangemouth sample and the Andover sample respectively. The natural wood logs were supplied by the testing laboratory and were taken from its own stock of test logs used for testwork to BS EN 13240[1]. The wood logs comply with the requirements for test fuel specifications given in the standard. The house coal used for the comparison was a typical commercially available bituminous coal.

3 TEST METHOD

3.1 Stove Tests

Tests were performed to compare the performance of both briquettes with natural wood logs in a typical dry-back wood-burning stove. Duplicate measurements of efficiency and output were undertaken on each fuel. The method described in BS EN 13240 for performance test at nominal heat output was used, with the exception of calculating the fuel load. For the tests reported here a suitable load for the size of the firebox was used which, in the case of the briquettes was two whole logs. For the natural wood logs a load approximately equivalent in weight to that for the briquettes was used as the fuel load. The tests were conducted under the same flue draught condition and with an identical air control setting for each fuel. Also determined and compared was the amount of ash residue produced during the tests after allowing the fire to burn out completely.

3.2 Open Fire Tests

Comparison of the radiation output performance of the briquettes with natural wood logs and house coal were carried out in an open fire. The firefront was a typical open fire-front which was fitted into a standard 400 mm Milner fireback.

The test method adopted was an ad hoc method. For the testwork the appliance air control was set at fully open and the fire was allowed to burn at that setting, after an ignition and pretest period, for a period of 6 hours. Refuels to a predetermined datum level were made at suitable intervals based on the firebed level being in a condition such that it would normally be refuelled by a user. Adopting this method gave varying refuel intervals for each of the three fuels, see 4.2 below. The radiant output from the fire was measured using a cage radiometer. Again the ash residue produced during the tests was measured and compared.

4 RESULTS

The analyses of the two samples of briquettes are given in Table 1, along with the analysis of the wood logs for comparison. The results of the thermal performance measurements in a typical wood burning stove are given in Tables 2, 3 and 4. Table 5 gives the results of the tests in an open fire. Tables 6 and 7 give the results of the ash comparisons.

4.1 Stove Tests

Tables 2, 3 and 4 give the results of the thermal performance testwork in a typical wood burning stove. The tests were undertaken at an identical air control setting for both fuels and at the same nominal flue draught.
The refuel charges for each of the fuels were as follows: Wood logs, test one 3.45 kg, test two 3.44 kg; Grangemouth Briquettes, test one 3.61 kg, test two 3.57 kg; Andover Briquettes, test one 3.22 kg, test two 3.19 kg. In both briquette tests the refuel charge was two whole logs. It is clear from the weights of the logs that the Grangemouth logs are slightly denser than the Andover logs.
Both manufactured logs were more difficult to light and took longer to establish a good fire than did the wood logs.

As can be seen from the tables, there is a slight difference in performance with respect to output. The Grangemouth sample gave a slightly higher output, 9.3 kW, than the wood logs and the Andover sample which both gave a very similar output, 7.6 and 7.8 kW respectively.
There was also a slight difference in the measured efficiency, with the Andover sample giving the highest result. However, taking the the natural wood logs result as the base line, the variation in efficiency is within the uncertainty for efficiency determination which is approximately 2 percentage points. It is therefore concluded that the use of the manufactured logs in a stove would not give a significant difference in efficiency when operated under identical operating conditions.
Both manufactured briquettes gave lower ash than the wood logs.

4.2 Open Fire Tests

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The results of the open fire tests are summarised in Table 5 below. As described above the tests were conducted with the fire-front air control full open with the fire being refuelled to a datum level when the firebed had burned down to a suitable level. This resulted in varying refuel intervals for the three fuels. Natural wood logs gave a refuel period of 45 minutes, the manufactured briquettes gave a refuel period of 90 minutes and the bituminous house coal gave a refuel period of 180 minutes. In each case, following a suitable ignition and pretest period the fire was deashed and refuelled to the datum level at the start of the test and then at each refuel period over total test duration of 6 hours. Owing to the size and shape of the fire the manufactured briquettes were broken in half for the refuels.

The results show that house coal gave the highest radiant output and the highest radiant efficiency (the efficiency being calculated on a net calorific value basis based on fuel burnt on an as charged basis). The results from natural wood logs and the manufactured briquettes were very similar with slightly higher outputs and efficiencies from the briquettes, although not significantly higher. The briquettes do require less frequent re-fuelling when compared to natural wood logs, with a refuel period of 90 minutes, twice that of wood logs.

As for the stove tests, it was again noted that the briquettes were relatively difficult to light when compared to wood logs. It took longer to establish a good burning firebed with the briquettes.

During the test period the briquettes were observed for swelling which is a common feature of this type of fuel. The two briquettes tested both showed some swelling, with the Andover sample seeming to swell slightly more than the Grangemouth sample, although for both fuels the swelling was not excessive and was not enough to be problematic.

Again both manufactured briquettes gave lower ash, than both the wood logs and house coal.

5 REFERENCES

5.1 BS EN 13240:2001 Roomheaters fired by solid fuel – Requirements and test methods.

Table 1

Fuel Analysis

		Wood Logs		Grangemouth Briquettes		Andover Briquettes	
		As received	Dry basis	As received	Dry basis	As received	Dry basis
Carbon	%	39.2	50.4	44.6	50.0	44.8	50.4
Hydrogen	%	4.8	6.1	5.3	6.0	5.1	5.8
Nitrogen	%	0.2	0.3	0.4	0.4	0.3	0.4
Sulphur	%	0.02	0.02	0.02	0.02	0.05	0.05
Oxygen*	%	33.18	42.58	38.58	43.28	38.15	42.75
Ash		0.4	0.6	0.3	0.3	0.5	0.6
Volatile Matter	%	65.2	83.8	75.4	84.6	74.2	83.5
Moisture	%	22.2	-	10.8	-	11.1	-
Net Calorific Value	$kJ\ kg^{-1}$	14109	18842	16874	19218	16748	19156

* By Difference

Table 2

Performance tests burning wood logs in a wood burning stove

		Test No 1	Test No 2	Mean
Total efficiency	% (net basis)	73.7	73.6	73.7
Burning rate (as charged)	kg h^{-1}	2.61	2.22	2.42
Nominal heat output	kW	8.2	7.0	7.6
Mean Flue Draught	Pa	12.4	12.5	12.5
Mean CO_2 emission	%	10.81	9.63	10.22
Mean CO emission	%	0.61	0.57	0.59
Mean flue gas temperature	℃	341	313	327
Flue gas mass flow	gs^{-1}	6.64	6.30	6.47
Test duration	h	1.32	1.55	1.44

Table 3

Performance tests burning Grangemouth Briquettes in a wood burning stove

		Test No 1	Test No 2	Mean
Total efficiency	% (net basis)	73.0	70.9	72.0
Burning rate (as charged)	kg h^{-1}	2.84	2.68	2.76
Nominal heat output	kW	9.7	8.9	9.3
Mean Flue Draught	Pa	12.2	12.0	12.1
Mean CO_2 emission	%	11.78	10.89	11.34
Mean CO emission	%	0.88	0.85	0.87
Mean flue gas temperature	℃	385	393	389
Flue gas mass flow	gs^{-1}	6.88	6.98	6.93
Test duration	h	1.27	1.33	1.30

Table 4

Performance tests burning Andover Briquettes in a wood burning stove

		Test No 1	Test No 2	Mean
Total efficiency	% (net basis)	74.5	76.9	75.7
Burning rate (as charged)	kg h^{-1}	2.35	2.06	2.21
Nominal heat output	kW	8.2	7.4	7.8
Mean Flue Draught	Pa	12.2	11.7	12.0
Mean CO_2 emission	%	10.77	11.69	11.23
Mean CO emission	%	0.66	0.97	0.82
Mean flue gas temperature	℃	342	315	329
Flue gas mass flow	gs^{-1}	6.35	5.03	5.69
Test duration	h	1.37	1.55	1.46

Table 5

Performance tests in an open fire

		Wood Logs	House Coal	Grangemouth Briquettes	Andover Briquettes
Mean radiant output	kW	2.26	3.13	2.40	2.34
Burning rate (as charged)	$kg\ h^{-1}$	4.14	1.63	3.59	3.36
Radiant efficiency	% (Net basis)	13.4	23.9	14.3	15.0
Peak radiant output	kW	3.38	3.85	3.90	3.65

Table 6

Ash from Stove Tests

Fuel		Wood Logs	Grangemouth Briquettes	Andover Briquettes
Mass	g	163	112	88
Volume	cm^3	1030	840	500
Density	$g\ cm^{-3}$	0.16	0.13	0.18
Ash per fuel burned	$g\ kg^{-1}$	15.6	10.4	9.2

Table 7

Ash from Open Fire Tests Tests

Fuel		Wood Logs	House Coal*	Grangemouth Briquettes	Andover Briquettes
Mass	g	203	911	79	133
Volume	cm^3	1160	2780	480	750
Density	$g\ cm^{-3}$	0.18	0.33	0.16	0.18
Ash per fuel burned	$g\ kg^{-1}$	6.9	50.5	2.9	5.3

*Undergrate material only, i.e. excluding combustible material remaining on the grate.