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INTERNAL PROJECT INFORMATION NOTE 02/08

Title: Small Scale Chippers – Standards Review

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SUMMARY

Woodchips produced from ten small-scale chippers were assessed for particle size variability against the CEN/TC 335 biofuel specification. Sampling was in accordance with Technical Specification 14778-1:2005 and assessment carried out by TES Bretby, an independent accredited sampling laboratory.

Birch (*Betula pendula*) and Corsican pine (*Pinus nigra* var *maritima*) roundwood were used with respective average moisture content (MC[1]) of 44.41% and 59.16%.

All of the chippers were capable of producing the P45 specification as specified in the standard and three chippers produced the higher quality P16 specification from both species. The main difference between the two specifications is the size range of the main fraction (> 80%) of the woodchip sample. To achieve the P16 specification the main fraction must be between 3.15 mm and 16 mm. The size range of the P45 specification is 3.15 – 45 mm.

The results were compared with an earlier particle size assessment carried out in 2005[2]. Both showed the main fraction (>80%) to be within the P45 size category however the earlier results showed a greater percentage of particle sizes in the < 1mm and > 63mm categories.

INTRODUCTION

In supporting the development of the woodfuel industry in Great Britain (GB), Technical Development (TD) undertook a review of small-scale chippers in 2005 (Internal Project Information Note (IPIN) 06/05). The quality of woodchips in terms of particle size variability was assessed against the CEN/TC 335 biofuel standard from ten manually fed and one mechanically fed chipper. Testing was carried out by TD studymen using several specifically designed sieves, each having aperture sizes relating to the categories given in the woodchip standard. Although this gave some indication of the quality of woodchips achieved from a sample produced from each machine it was recognised that a sampling and particle size determination procedure as defined in the Technical Specification of the CEN/TC 14778-1:2005 should be carried out.

The samples of woodchips were sent to TES Bretby for MC and particle size determination. MC can affect the size quality of woodchips. The higher the MC in roundwood, the cleaner the cut from the chipper knives. Roundwood with a low MC is brittle and it tends to shatter when chipped rather than be cut. Anecdotal evidence suggests this causes more fines (i.e. small particle sizes less than 1 mm)

Objectives

The objectives were:

1. Define the standard of sampling for the 11 chippers studied according to CEN/TS14778 – 1:2005 Solid Biofuels – Sampling.

[1] MC – all references to moisture content in this IPIN have been calculated as wet basis i.e.
MC% = ((Wet weight –dry weight)/wet weight) x 100
[2] Results shown in IPIN 06/05

2. Assess the woodchips produced by the 11 chippers assessed in IPIN 06/05 against the CEN/TC 335 standard.

TRIAL SPECIFICATION

Two species were used for the trial, birch and Corsican pine. These were readily available in the specifications shown in Table 1 and represented the size of roundwood that would be manually fed into small-scale chippers.

Table 1 Roundwood specifications

Chipper	Species	Length (m)	Average Middle Diameter (cm)
TP 100VM	Birch	1.7	7.5
	Corsican Pine	1.7	7.5
All other chippers	Birch	2.9	11
	Corsican Pine	1.7	10

The specification for the TP 100VM was different as it had a maximum cutting diameter of 10 cm.

MACHINERY

The trial in 2005 investigated 11 chippers (IPIN 06/05). The Farmi CH 260 model was studied with two infeed options, one fed with a mechanical loader, the other manually fed. For the purpose of this trial it was decided that only the manually fed chipper would be included. The chippers used in the trial are shown in Table 2. All had sharpened or new knives before chipping. This is important as the sharpness of the knives affects the cutting ability and the quality of woodchips produced.

Table 2 Chippers and technical data

Model	Type	Feed Angle	Max. Diameter (cm)	PTO Speed	Weight (kg)	Horse Power Demand
Heizohack HM 5-400	Drum	To 90^{o}	40	540	3000	75+
Laimet HP 21	Screw cone	<90^{o}	18	1000/540	800	135+
Schliesing 550 ZX	Disc	90^{o}	26	540	1580	140
Farmi CH260	Disc	45^{o}	26	540/1000	1520	40 – 90
TP 100 VM	Drum	60^{o}	10	Self powered 16hp	245	------
TP 150	Disc	90^{o}	15	Self powered 27hp	800	------
TP 200	Disc	90^{o}	20	Self powered 52hp	1350	------
Jensen A 240	Disc	90^{o}	25	1000	1400	80+
Greenmech 19-28	Disc	90^{o}	22	Self powered 55hp	1380	------
Greenmech M220MT	Disc	90^{o}	18.75	Self powered 50hp	1220	------

CEN /TC 335 WOODCHIP STANDARD

Sampling procedure

Prior to chipping the operators were instructed to set the speed of the feed rollers or drum speed on the TP 100VM to produce woodchips that would conform to the P16 specification (Table 3). The function of the hydraulic feed rollers is to draw the roundwood towards the cutting knives. The rotational speed controls the rate of cutting and size of woodchips produced and can be adjusted. For example a slow roller speed will produce very small woodchips and a fast roller speed larger woodchips.

The Technical Specification CEN/TS 14778-1:2005 describes the different points of sampling, methods of sampling, size and number of increments to be taken from a 'stationary' heap of woodchips.

Woodchips were discharged from the chippers onto a clean surface to avoid contamination. This was either a large plastic sheet or bed of a pick up truck. The heap (stockpile) of woodchips was mixed before increments were taken to ensure any larger particles produced from the end section of the billet were mixed into the heap. Eleven elementary samples of 3.15 litres each were taken, providing a total sample of 34.65 litres, refer to Appendix 1 for the calculation of increment volume and number of increments.

The quantity of woodchips produced from each chipper was approximately 45 litres. This meant that virtually all the material was taken for sampling.

The sampled material was put in to airtight bags and sent to TES Bretby. The results of the MC and particle size distribution analysis are shown in Table 4.

Table 3 Woodchip quality as defined by the CEN/TC 335 standard

CEN TC/335	Coarse Fraction Maximum length of particle	Main Fraction > 80% weight	Fine Fraction < 5% weight
P16 Specification	<1%>45 mm, maximum length of particle < 85 mm	3.15 mm $\leq$P[3] $\leq$16 mm	<1 mm
P45 Specification	<1% > 63 mm	3.15 mm $\leq$P $\leq$45 mm	<1 mm
P63 Specification	<1% > 100 mm	3.15 mm $\leq$P $\leq$63 mm	<1 mm

[3] P refers to the dimension of the particle sizes

RESULTS

Table 4 Moisture content and particle size analysis for the different chippers and species. A tick indicates that the woodchips produced met the standard specification whereas a cross indicates a failure to meet the specification.

Chipper	MC % (wet basis)	Species	>63 mm	63–45 mm	45–16 mm	16–3.15 mm	3.15–1.0 mm	<1.0 mm	P45	P16
Heizohack HM 5 -400	62.7	Pine	----	----	7.1	81.0	10.3	1.6	✓	✓
	44.6	Birch	----	----	7.0	81.5	10.3	1.2	✓	✓
Laimet HP 21	58.3	Pine	0.8	4.8	84.3	9.9	0.2	0.1	✓	✗
	42.0	Birch	0.5	0.9	80.0	17.6	0.6	0.4	✓	✗
Schliesing 550 ZX	63.6	Pine	----	0.5	16.9	63.4	17.9	1.3	✓	✗
	43.7	Birch	----	----	13.3	66.4	17.7	1.9	✓	✗
Farmi CH260	61.4	Pine	----	----	8.7	83.4	6.9	1.0	✓	✓
	46.2	Birch	----	----	6.8	83.3	8.0	1.9	✓	✓
TP 100 VM	55.4	Pine	**----**	0.1	20.8	71.8	6.2	1.1	✓	✗
	46.6	Birch	0.1	0.4	27.6	62.6	7.0	2.3	✓	✗
TP 150	59.4	Pine	----	0.3	5.6	86.5	7.0	0.7	✓	✓
	42.7	Birch	----	3.7	3.4	82.2	9.2	1.4	✓	✗
TP 200	61.4	Pine	----	----	4.8	90.9	3.7	0.6	✓	✓
	46.2	Birch	**----**	----	3.6	90.1	5.3	0.9	✓	✓
Jensen A 240	53.8	Pine	----	0.9	26.8	69.0	2.6	0.7	✓	✗
	47.4	Birch	----	----	20.7	74.3	4.0	1.0	✓	✗
Greenmech 19-28	59.7	Pine	----	----	32.5	61.2	5.1	1.2	✓	✗
	43.3	Birch	----	----	23.0	71.7	4.5	0.8	✓	✗
Greenmech M220MT	55.9	Pine	----	----	14.2	78.6	6.6	0.6	✓	✗
	41.4	Birch	**----**	----	11.1	77.9	9.9	1.2	✓	✗

Discussion

The average MC of the woodchips produced from birch was 44.41% and from the Corsican pine 59.16%. All the chippers listed in Table 2 were capable of producing woodchips to the P45 specification when using the species and roundwood specification shown in Table 1. The Heizohack HM 5–400, Farmi CH 260 and TP 200 produced the P16 specification with both tree species as did the TP 150 for the pine. However for some unknown reason with this last machine the birch had 3.7% of woodchips in the 45–63 mm category and only met the P45 specification. A possible explanation is that high proportions of slivers produced from the end sections of the billets were in the sample.

The Laimet 21, a cone screw chipper was fitted with the SS screw. This type of chipper does not have feed rollers but relies on the screw to draw the roundwood to the cutting blade. Five different screw cones are available for this model. The SS screw was the most appropriate to produce the P16 specification however it produced a high proportion of larger sized woodchips with 1.4% produced from the birch being greater than 45 mm and 5.6% from the Corsican pine. The P45 specification for both species was achieved. Although a high consistency in size of woodchip was produced, the Laimet was not capable of producing the P16 specification.

The results in Table 4 were compared with the particle size assessments carried out in 2005 (IPIN 06/05). The woodchips were manually agitated in sieves which had square holes corresponding to the size categories of the CEN standard i.e. 3.15, 16, 45, 63mm etc. The sampling method used by TES Bretby included both manual and mechanical agitation of woodchips through sieves with circular holes. Both results showed that the main fraction (>80%) of woodchips produced by all machines were in the 3.15 – 45mm category except from the Laimet HP21 and Schliesing 550ZX. The results in IPIN 06/05 showed a higher percentage of woodchips in the <1 mm (fines) and > 63mm categories.

It is interesting to note that two of the chippers capable of producing the P16 specification are made in Scandinavia where the production of woodchips for heating has been well established for a number of years. The Heizohack (Germany) wood chipper is made specifically to produce woodchips for heating and was fitted with a screen. This prevents oversized woodchips from being discharged by rotating them in the drum until the size is reduced sufficiently to pass through the screen.

CONCLUSIONS

Some of chippers used in the trial had not been designed specifically to produce woodchips for heating however all were capable of producing woodchips from birch and Corsican pine roundwood that would conform to the P45 specification. Three of the chippers were capable of producing the P16 specification from both species.

BIBLIOGRAPHY

CEN/TS 14778–1: 2005 *Solid Biofuels Sampling - Part 1: Methods for sampling*
CEN/TS 14961: 2005 *Solid Biofuels – Fuel Specification and Classes*
P.J.Webster (2005). Technical Development Internal Project Information Note 06/05, *Chipper review* (unpublished).

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Appendix 1

Calculation of elementary increment volume and number of increments according to CEN/TS 14778-1:2005

$V_{min} = 0.05 \times d^4$

3.15 litres = 0.05 x 63 (the nominal top size used was 63 mm)

3.15 litres per increment

Biofuels are classified according to the heterogeneity of the material. Woodchips are considered homogeneous and the formula used to calculate the number of increments required from a stationary heap is:

$N = 10 + 0.040 \times M_{lot}$[5]

As M_{lot} for each trial was less than one tonne then N was taken as 11. For each chipper a total of 34. 65 litres (11 x 3.15) were sampled.

[4] V min is the minimum capacity of the sampling tool (litres)
d is the nominal top size (mm)

[5] Where N is the minimum permitted number of increments, rounded of to the nearest whole number.
M lot is the mass of the lot or sub-lot in tonnes