Track #2 – Non Peer-Reviewed Proceedings Paper
Presented at the 41st Annual Council on Forest Engineering Meeting, Williamsburg, Virginia, July 15-18, 2018. ***Revolutionary Traditions, Innovative Industries.***

Effects of microchip production on chipper efficiency

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Abstract

Microchips is used as raw material in pelletizing, for co-firing with other fuels in power and combined heat- and powerplants. Microchips is also interesting to increase the surface area before chemical processing of woody biomass. Earlier studies have shown that a reduction of chip size reduces chipper productivity and increases fuel consumption. A Bruks 806ST chipper, using a standard and a micro-chip drum, was studied when chipping aspen dominated fuel wood logs to determine how productivity and fuel consumption was affected by drum type.

The standard drum has two knives and produces chips with an expected length of 45 mm. The microchip drum has 4 knives and produces chips with an expected length of 11 mm. Time and fuel consumption was measured during chipping of three wood piles for each drum. Each pile had a weight of 5.3 metric tonnes and a moisture content of 33%.

Chipper productivity decreased from 32.9 oven dry tonne (odt) per effective chipping hour with the standard drum to 29.5 odt with the micro-chip drum, i.e. by 10.5%. As the chipper was studied in a controlled environment using small quantities of wood per replication, productivity can be expected to be a bit high. As a comparison, productivity with the standard drum was 9 % higher than for forwarder-mounted 806STC chippers in commercial operations.

Using the standard drum, fuel consumption was 1.41 l per odt, and chipping using the micro-chip drum increased fuel consumption by 23.9% per odt. In commercial operations fuel consumption using the standard drum was about 10% higher.

Introduction

Microchips has many uses, today and in the future. It is used as raw material in pelletizing, for co-firing with other fuels in large power and combined heat and powerplants, and it is an interesting raw material for chemical processing of woody biomass. However, earlier chipper studies have shown that a reduction of the target chip size reduces chipper productivity and increases fuel consumption (e.g. Johannesson et al. 2012). This has raised a concern for the overall energy efficiency when producing micro-chips.

To be able to measure the effects on productivity and fuel consumption with so few influencing factors as possible we studied production of standard chips and microchip using the same chipper. This necessitated replacement of the drum in the chipper between the treatments.

Material and methods

A trailer mounted Bruks 806ST chipper was studied with a standard and a micro-chip drum to determine the effects on productivity, fuel consumption and chip size distribution by the drum type. The chipper was studied when chipping aspen dominated fuel wood logs. The standard drum has two opposing knifes and an expected chip length of 45 mm. The microchip drum has 4 knifes evenly spread around the drum and an expected chip length of 11 mm.

The study was made on a wood yard behind the Bruks factory, enabling us easy access to their workshop for the change of drum in the machine. Before the study wood piles were weighted upon delivery and after the study each pile of chips were sampled to determine moisture content and chip size distribution. On average each pile of wood had a weight of 5.3 metric tonnes and a moisture content of 33 per cent. Piles were randomly assigned to the drum studied, but all three piles that should be chipped with the same drum was chipped in sequence. Between the study of each pile a break was made for chip sampling and scaling of the fuel used.

Time studies as well as measurement of fuel consumption were made during chipping of three wood piles for each drum type. Time studies were made using the same method as in earlier studies of chippers (cf. Lombardini et al. 2013; Eliasson et al. 2014).

Fuel consumption was measured by rewiring the fuel lines to and from the engines to a 40 l can that replaced the ordinary fuel tank. This can was placed on an accurate scale and fuel consumption was calculated as (Fuel weight before chipping-fuel weight after chipping)/0.815, where 0.815 is the fuel density. Before chipping commenced on the next pile the fuel can was topped up with diesel. Fuel consumption was only measured for the chipper, not the loader feeding it.

The studied machine at work.

Results

Chipper productivity was reduced by 10.5 % when the standard drum was substituted with the micro-chip drum. On average, the chipper produced 32.9 oven dry tonne (odt) per effective chipping hour using the standard drum compared to 29.5 odt using the micro-chip drum.

As the chipper was studied in a test setting in a controlled environment and using small quantities of wood per replication, the productivity can be expected to be a bit high. As a comparison, the productivity with the standard drum in the current study was 9 % higher than the productivity of forwarder mounted 806STC chippers equipped with standard drums studied in commercial chipping operations (Lombardini et al. 2013; Eliasson et al. 2014).

Chipping using the micro-chip drum increased fuel consumption by 12.5 % per hour and by 23.9 % per produced odt of chips. Using the standard drum, the chipper used 1.41 l of diesel fuel per odt which increased to 1.74 l of diesel fuel per odt when the micro-chip drum was used. This can be compared to the 1.55-1.6 l per odt consumed by the above mentioned 806STC chippers used in commercial operations.

As expected the micro-chip drum produced finer chips than the standard drum (figure 1), i.e. significantly more chips in the 8-16 mm (5/16 to 5/8 in) class. However, the amount of chips in the 16-31.5 (5/8 to 1¼ in) mm class was higher than expected. Most of these chips were rather thin but wide pieces, see figure 2, and will probably crack during further handling, e.g. loading, thus reducing their size to the 8-16 mm class.

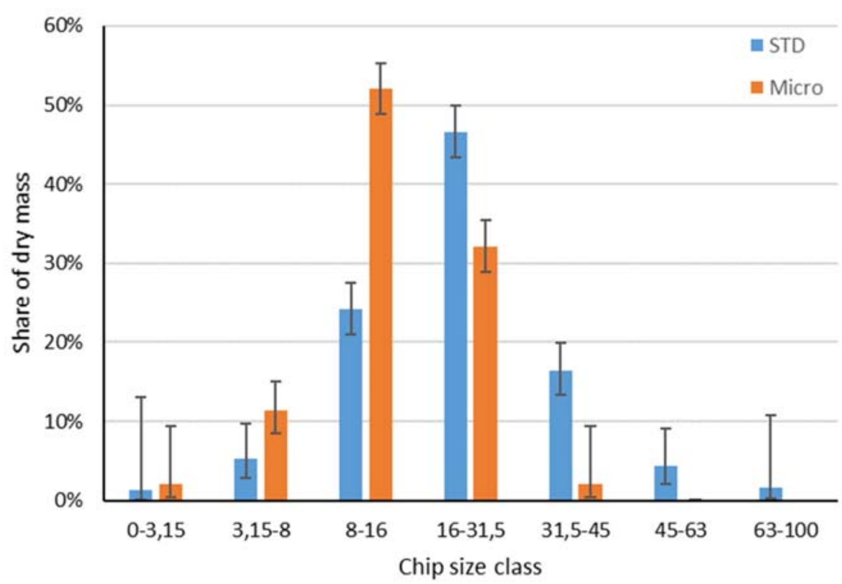

Figure 1. Chip size distribution for the standard (STD) and micro-chip drums. Error bar denotes a 95% confidence interval.

Discussion

Productivity and fuel consumption was not as affected by the change of drum as expected. As the expected chip length for the microchip drum was about a quarter of that for standard chips and the microchip drum just had the double amount of knives productivity could have been reduced by 50% in a theoretical worst-case scenario. The 10.5 % reduction that was measured is anyhow low compared to the fact that a reduction in expected chip length from 40 mm to 15 mm decreased productivity by 27 % for a smaller Bruks chipper (Johannesson et al. 2012). However, in that case there was 2 knives in the drum regardless of treatment.

The studied setup gave higher productivity and lower fuel consumption using the standard drum than our previous studies of the same type of chipper in commercial operations. This can to a large extent be blamed on good working conditions and that the machine was one of Bruks own test machines, tuned in and maintained by their staff.

Figure 2. Examples of chips in the 16-31.5 mm class. Each large square = 10×10 mm, subdivisions 1 mm

The sampled micro-chips had an unexpectedly high amount of chips that were in the 16-31.5 mm (5/8 to 1¼ in) class (figure 2). The majority of these were however quite thin (<2.5 mm 1/10 in) and will probably break up during handling, but as it not was studied we cannot confirm this hypothesis.

There is a further need for studies of micro-chip production and preferably during commercial operations.

Acknowledgement

Thanks to Bruks AB for making the chipper available and performing the change of chipper drum.

References

Eliasson, L., Granlund, P. and Lundström, H. 2014. Bruks 806 STC – performance and fuel consumption when chipping logging residues of Beech. Skogforsk, Arbetsrapport 833, 7 pp. ISSN 1404-305X. In Swedish with english abstract.

Johannesson, T., Fogdestam, N., Granlund, P. & Eliasson, L., 2012. Effects of chip-length settings on productivity and fuel consumption of a Bruks 605 drum chipper. Skogforsk, Arbetsrapport Nr. 782. In Swedish with english abstract.

Lombardini, C., Granlund, P. and Eliasson, L. 2013. Performance and fuel consumption of the Bruks 806 STC chipper. Skogforsk, Arbetsrapport 793, 7 pp. ISSN 1404-305X. In Swedish with english abstract.