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Noise emissions in wood chipping yards: Options compared

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HIGHLIGHTS

- Mean sound pressure (LAeq) was 1.5 dB(A) higher for the chipper.
- Single event level (SEL) was 1.2 dB(A) higher for the chipper.
- Chipper peaks were recorded at lower frequency bands than grinder peaks.
- Sound pressure was low for branches, medium for logs and high for pallets.
- Analysis of noise graphs allowed quantifying comminution efficiency.

GRAPHICAL ABSTRACT

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ABSTRACT

Industrial comminution is becoming increasingly popular, as the result of a growing demand for wood biomass. Such task is performed with either chippers or grinders, which are large, powerful machines, capable of generating much noise. In turn, high noise levels may have negative impacts on the health and comfort of workers, and of the people living in the surroundings of a wood fuel yard. This study gauged the difference between the two main technology options (i.e. chippers and grinders) in order to offer additional decision elements to wood yard planners. The chipper on test generated more noise than the grinder, due to its better ability to process wood and to transmit more energy into it. Since the chipper was equipped with less working tools and turned slower than the grinder, it generated its noise peaks at lower frequency bands. The grinder on test was more suitable for use in wood yards located near settled areas, and was an obvious choice whenever dealing with a diversified and occasionally contaminated raw material stream.

1. Introduction

The growing demand for wood fuel has motivated new efforts towards efficient wood residue recovery. Supply chains can be organized in many ways, depending on local conditions and raw material characteristics. However, they always include comminution, as the crucial

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process required for turning a very heterogeneous raw material into a regularly-sized fuel, suitable for feeding modern automated boilers. Comminution is heavy work, and has a strong impact on overall supply cost (Junginger et al., 2006). Hence the strong interest in maximizing its efficiency, by careful equipment selection - among others. Comminution machinery come in two main types: chippers and grinders. The former use sharp tools (knives) to cut the wood into thin slices, or chips. The latter use blunt tools (hammers) to smash the wood into splinters, thus producing so-called "hog fuel" (Pottie and Guimier, 1985). Chippers are mechanically more efficient than grinders, and they offer higher productivity, lower fuel consumption and better product quality (Spinelli et al., 2012). However, chippers are very sensitive to contamination, while grinders are not (Aman et al., 2010). For this reason, grinders are preferred when dealing with contaminated wood, whereas chippers are only used with clean wood (Dukes et al., 2013).

Use of powerful industrial machines raises justified concern about the exposure of operators to noise, which is an important and preventable cause of hearing loss (Dobie, 2008). Noise-induced hearing loss is still common in the woodworking sector, despite a significant trend for improvement (Johansson and Arlinger, 2001). Noise-induced hearing loss is attributed to unprotected exposures above 95 dB(A), and it becomes clinically apparent in middle age, when age-related threshold shifts are added to prior noise-induced damage (Sliwinska-Kowalska and Davis, 2012).

Recently, several studies have produced useful benchmark figures for the exposure of chipper operators (e.g. Brueck, 2008, Poje et al., 2015, Rottensteiner et al., 2013). In contrast, grinders are covered by one single study, with noise exposure determination as a secondary goal, after productivity benchmarking (Nuutinen et al., 2014). However, the noise emission of grinders becomes a strategic subject, if one considers that grinders are most popular as wood yard machines - not forest machines. In fact, a very effective strategy for wood waste recovery consists of setting up a collection point for intercepting multiple residue streams (Ward et al., 2004). That generally implies two things: vicinity to the main roads or industrial areas (Kühmaier et al., 2014) - which makes noise a crucial factor to consider (Van Renterghem et al., 2013) - and a large variability of the input material, which favours the use of a grinder, due to its better tolerance of poor feedstock quality (Asikainen and Pulkkinen, 1998).

For these reasons, it would be extremely useful to determine how much noise can a grinder produce, and also to compare the noise emissions of grinders and chippers, under equal conditions. Such information would provide an additional element when deciding whether to acquire a chipper or a grinder, and it would also help transferring to grinders the knowledge already available about chipper noise emissions.

Here, the difficulty is to arrange equal conditions for a fair comparison. It is very difficult to find a chipper and a grinder that share exactly all characteristics, except for the comminution device. Chippers and grinders are designed to process different materials, and they often have specific characteristics that make them radically different from each other. Fortunately, new versatile horizontal grinders have recently appeared on the market, which can be temporarily converted into chippers by replacing the standard hammers with chipper knives. The specifics of tool replacement vary with the model, but the result is always very similar.

Exploiting the opportunity offered by the new convertible grinders, a study was designed with the following goals: 1) to determine the noise levels generated by a representative grinder, when processing a range of different materials and 2) to compare the exposure values obtained for the grinder with those obtained for a chipper under the very same conditions.

2. Material and methods

The study was conducted in northern Italy, using a Caravaggi Bio 900 horizontal grinder. This machine is a convertible model, which can be configured as a grinder or a chipper in a matter of two hours.

In its grinder configuration, the high-speed drum structure was equipped with 44 hammers, in four rows of 11 hammers each. Rows were equally spaced on the drum surface, so that the wood was hit four times by 11 hammers at every full revolution of the drum. Hammers in the same row were kept in place by a robust pin rod, which passed through holes in the drum and the hammers. Hammers could swing around the rod, so that they bounced back and into the drum structure if they hit objects too hard to be crushed with a single blow.

In its chipper configuration, two pin rods at a time were used to hold 11 fixed knife mounts each, so that the total number of tools was halved

Fig. 1. The experimental set up.