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Tests of a screening system

-Upgrading of comminuted and heterogeneous materials

The aim of this study was to try to find an operational system that separats comminuted materials into different size classes and hence, get better qualities of fuel chips.

BACKGROUND

The quality of fuel chips produced by comminution is normally defined in terms of their moisture content, heating value, ash content and particle size distribution. Variation in the particle size and particle shape distribution and moisture content of different wood chip deliveries is the cause of most problems encountered during the operation of feeding systems and combustion processes. Other important factors are the fuel's contents of impurities (e.g. soil particles).

AIM

The objective of this study were to test an operational system for separating comminuted materials into different size classes (qualities) when considering different settings of the system.

MATERIALS AND METHODS

The trials were carried out at the SLUs BTC plant in Umeå, Sweden November 2017. A 43 t pile of five months stored and crushed logging residues from the region was used in the trials as initial material (Fig. 1).

Figure 1. Crushed stored logging residues used in screening trials at BTC.

A mobile star screen "Backers 3mal" powered by a 130 kW diesel engine and equipped with a 5-50 mm fine deck was used in the study (Fig. 2). The star screen separated the logging residue chips into three fractions: fine, medium and coarse. In addition, a windshifter "Norditek VS1200" was used to separate contaminants (e.g. stones and gravel) from the medium fraction (Fig. 2).

The crushed materials were fed onto the hopper of the star screen by a wheeled front-end loader. Oversize materials were separated from the smaller particles since they could not fall through the openings formed between the stars of the coarse screen deck. Fine particles were separated from medium particles since they fell through the openings formed between the stars of the fine screen deck. After separation of coarse and fine particles, the contaminants in the medium particles were removed by using the windshifter (Fig. 2 and 3).

Figure 2. To left, the mobile star screen "Backers 3mal", to right, the windshifter "Norditek VS1200".

Figure 3. The screening system in operation at BTC.

Six different machine settings were analyzed in the study by changing the rotation speed of stars in the fine deck and the speed of the feeder. Three different rotation speeds of the fine deck stars were tested: 80%, 90% and 100% of the maximum speed (120 rpm, 158 rpm and 170 rpm, respectively); and two different speed of the feeder: 61% and 80% of its maximum speed. The other parameters were kept constant. The angle of the fine deck was fixed to 18%.

The speed of the feeder was chosen based on recommendations and experience of the machine operators (Norditek personnel). The speed was reduced from 80% to 61% when using the windshifter. Higher feeder speed would prevent the windshifter from working properly. On the other hand, according to the machine operator (Norditek), lowering the speed of the fine deck stars to 70% or less would cause interruptions on the screening process and possible damages to the equipment. Therefore, this option was not considered. After each screening setting, the mass of the different fractions was weighted. The coarse fraction and contaminants in the medium fraction were discharged into containers and immediately weighted; the medium and fine fractions were weighted using the front-end loader and a weight-bridge. In order to ensure that the mass flow results were reliable, three screening settings were repeated and the mass flow of the different fractions was determined. On average, 2.4 t of wood chips were screened in each setting.

Fine and medium fractions were sampled in each screen setting. Three samples of the same fraction were taken each time. In total, 36 samples were collected from the fine and medium fractions. Unscreened material was sampled four times during the trials. In total, 12 samples of initial material were collected. Fine and medium particle samples were taken directly from the material flow discharged from the screen. Unscreened material samples were collected from several locations in the pile. The samples were stored in 10-liter buckets. All buckets were closed to minimize the risk of evaporation. The samples were weighted, oven dried at 105 C for 16 h. and weighted again in order to determine their wet basis moisture content. The particle size distribution of each oven dry sample was carried out using a horizontal sieve shaker. The following sieves were used to categorize the material: 63 mm, 45 mm, 31.5 mm, 16 mm, 3 mm and <3mm.

CONCLUSIONS

The mass percentage of the fine fraction varied from 15.6% to 47.4% of the total mass, depending on the machine settings. The share of the coarse fraction varied less, from 1.5% to 4.6%. Increasing the rotational speed of the fine deck stars decreased the share of fines fraction when other operational parameters were kept constant. However, the results showed that the speed of the feeder had an important influence on the mass percentage of fines fraction. When reducing from 80% to 61% the speed of the feeder the percentage of fines fraction increased from11% to 16%, depending on the screen setting.

The moisture content was slightly lower in the medium fraction than in the fine fraction. The average moisture content was on average 63%, 65%, and 61% for the initial material, fine fraction, and medium fraction, respectively.

It was possible to reduce the amount of fines (particles <3mm) with 43.5-88.3%, depending on the screen setting. The highest reduction was observed in the screen setting with the lowest rotation speed of the fine deck stars (80% of the maximum) and the lowest speed of the feeder (61%).

The amount fines when the speed of the feeder was 80% of its maximum were 14.7%, 13.9% and 11.7% for rotation speed of the fine deck stars of 100%, 90% and 80% respectively. When the speed of the feeder was 61%, the amount of fines were 10.9%, 6.5% and 3.1% for rotation speed of the fine deck stars of 100%, 90% and 80% respectively. Therefore, the speed of the feeder had a higher impact on the reduction of fines than the rotation speed of the fine deck stars.

On the other hand, the amount of acceptable particles (3-63mm) in the fine fraction varied from 34.5% to 44.5%. The screen setting with a speed of 80% in both, the fine deck stars and the feeder showed the lowest value. The highest value was given by the screen setting with a rotation speed of the fine deck stars of 80% and a speed of the feeder of 61%.

This study shows that it is possible to tailor operational settings to produce different qualities of comminuted and heterogeneous materials. Further analysis of ash content, chemical composition etc. of the different fractions produced will discover even more benefits of the operation.

AUTHORS

Teresa de la Fuente, Gunnar Kalén, Marcus Segerström, Sylvia Larsson, Mikko Karjalainen*, Dan Bergström
Swedish University of Agricultural Sciences (SLU)
*Natural Resources Institute Finland (LUKE)
teresa.de.la.fuente@slu.se, gunnar.kalen@slu.se, marcus.segerstrom@slu.se, sylvia.larsson@slu.se, mikko.karjalainen@luke.fi, dan.bergstrom@slu.se

EUROPEAN UNION Interreg Botnia-Atlantica European Regional Development Fund
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