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Particle Size Analysis of Wood Chips

High quantities of wood chips are used in pulp manufacturing and energy production. Wood chip size and shape vary depending on the chipper - or crusher - design parameters, chipper knife sharpness, and wood quality. The width of chips' size distribution may be a basis of payment for the load. Also many end-users prefer even particle size. So to determine chip load value, chip size and geometry is therefore important to measure. This info sheet concentrates on the methods using screening and optical analysis because those are fast and most commonly used methods.

INTRODUCTION

High quantities of wood chips are used in pulp manufacturing and energy production. Wood chip has three dimensions of which thickness is markedly smaller in comparison with width and length. Chips' size and geometry, or the width of size distribution, may even be a basis of payment for the load.

To determine chip load value in different applications, and to predict chip load behavior during processing, chip size and geometry is therefore important to measure. The irregular shape of a chip causes however problems in chip size analysis and special characteristics on chip behavior during processing.

The simplest way to measure particle size is to use ruler or vernier caliper, and air classification methods can be found for particle size determination, but this info sheet concentrates on the methods using screening and optical analysis those are fast and most commonly used methods.

THE IMPORTANCE OF CHIP SIZE MEASUREMENT

Several factors affect particle size

Wood chip size and shape vary depending on the chipper - or crusher - design parameters, chipper knife sharpness, and wood quality. Chipping using blunt knives or small aperture size in a chipper screen produces small chips and high amount of fines.

Crushing of fresh moist wood produces long and narrow chips and chipping of dry or small diameter wood and forest residues produces high amount of fines. Due to the irregularities in a wood, a single chipper comminuting a single roundwood, produces chips of many sizes and shapes. In addition, wood chips get broken during harsh handling. Therefore, a chip load always contains chips of many sizes and shapes (Figure 1).

End-users prefer even particle size

Particle size - especially chip thickness - is an important parameter in kraft pulping process whereas chip length has more pronounced effect on sulfite pulping. Wide size distribution, meaning uneven chip size, causes uneven cooking, low yield and poor pulp quality. Thus, chip has certain size requirements at the mill.

Wood chips used in heat and power production have certain size requirements to guarantee optimal burning and stable operation on chip handling machinery. Small scale heating plants need stable flow of high quality raw material that has good processability.

Figure 1. *Chips of small diameter roundwood produced with a mobile chipper.*

Flowability, compaction and segregation

Chip size alone has only small effect on chip flowability and handling properties in conveyors and chip silos, but particle shape - mainly length-to-thickness ratio - has marked effect on these properties. Long thin chips have poor flowing properties and high tendency to bridge in silos, for example. Therefore, the narrow size distribution and absence of elongated particles are required when good flowability is needed.

When particle size distribution is wide and material contains both big and small particles, small particles have a tendency to fill spaces between large particles. Therefore, the bulk density is high for this kind of material. High amount of small particles between chips causes poor air permeability and thus hinders drying so that a pile with low amount of fines dries faster than a pile containing high amount of small particles.

Therefore, particle size analysis is very important measurement giving information about the properties of comminuted wood. When measuring chip size distribution, chip sampling has to be performed with care because bulky particulate material has a tendency to segregate during handling: The vibration of the truck causes small particles to migrate between big ones. Therefore, wood chips segregate according to their size during transportation.

In addition, particles of different sizes fly different distances when discharged from a conveyor, chipper or crusher and chips are already segregated in a pile located next to the chipper. To get right result from a particle size analysis, a sample has to be representative over the whole material and sampling has to be performed by right way.

THE DETERMINATION OF CHIP SIZE DISTRIBUTION BY SCREENING

Due to the irregular shape of the chip, determination of chip size is not a straightforward procedure. In a mineral processing industry near spherical particles are processed and particle size analysis is performed using a screening method.

The diameter (or radius) of a sphere is a very unambiguous measure for the size of a sphere. A spherical particle either passes the screen (i.e. particle diameter is smaller than the screen aperture size) or remains on the screen (i.e. particle diameter is higher than the screen aperture size).

In the case of wood chips, however, the chip may pass the screen if two of its' dimensions are smaller than the aperture diameter and thus long narrow wood chip may pass the screen if only width and thickness are smaller than the aperture diameter. Therefore, screening methods do not give true measures of chip dimensions but only a share of particles retained on a screen having certain aperture size.

Different kinds of sieve series are used in the analysis of particulate material particle size. These series typically consist of flat sieve trays installed one on the other so that the aperture size decreases towards the lowest screens (see Figure 2). The vibration of the apparatus causes particle movement and segregation.

Particle size analysis of energy wood chips

The particle size analysis of energy wood chips can be performed using sieves having the round apertures of 63 mm, 45 mm, 16 mm, 8 mm and 3.15 mm, can be used (ISO 17827-1:2016). A standard applicable to fine material (ISO 17827-2:2016) uses sieves having round aperture of 3.15 mm and sieves of 2.8 mm, 2.0 mm, 1.4 mm, 1.0 mm, 0.5 mm and 0.25 mm made of wire cloth. A method utilizing a rotary screen is presented in CEN/TR 15149-3.

The drawback of this kind of screening methods is that elongated pin chips those have length markedly higher than the aperture size, can pass the screen and thus the analysis doesn't give actual particle size distribution. In

Figure 2. *A sieve series used in particle size analysis.*

Figure 3. *Wood chips on a perforated screen tray of SCAN CM 40-01.*

addition, pin chips have a tendency to clog the screen reducing the efficient screening area.

Particle size analysis of pulp chips

SCAN CM 40-01 is a useful method in the analysis of the content of acceptable pulp chips in a sample. It uses flat screen trays oscillating horizontally (see Figure 3). Perforated screen tray having an aperture diameter of 45 mm, a slotted screen having perforations of 8 mm and perforated screens of 13 mm, 7 mm and 3 mm are used in this analysis but sieve series having only perforated screen trays have been used in chip size analysis too. Automated screening classifiers are also available. Most of them utilize horizontal flat screens but rotary drum-style classifiers can also be found.

OPTICAL PARTICLE SIZE MEASUREMENT

An optical particle size analyzer is capable of giving accurate dimensions for chip length, width and thickness. In an optical particle size measurement, a digital image is taken from a chip and the dimensions of a particle are measured using a computer program. This method is fast and easy to use and provide accurate data from the chip quality. In addition to the particle size, analyzers measuring chip properties such as surface moisture content, surface chemistry and bark content in a sample are available. Both laboratory machines and ones to be integrated on the process lines and automation systems are available. High price of these machines prevents their use in small enterprises.

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