Chip Size Distribution - A Lot Can Happen Over Its Variation

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ABSTRACT

Global competitiveness has forced mills to adopt the latest in technologies to be more energy efficient and environment friendly, in spite of high capital investment. Adopting the newer technologies also demand a higher uniformity in input parameters. Though many of the mills have switched over to the modernised kraft cooking process such as Superbatch, RDH, little importance has been bestowed on the input raw material. With depletion of forest resources, mills use variety of woods that are locally available. In this process the output chips generated from variety of woods of varying dimensions from a single chipper has a spectrum of chip size distribution forcing to vary the pulping conditions in the digester. Studies were undertaken on the effect of Overthick chips on various parameters, not only on pulping but also on the related effects such as alkali loss, effluent discharge properties etc and surprisingly a positive correlation between chips quality and different effects could be deduced, on a plant scale. Options for handling the overthick chips generated have also been discussed and effect of overthick chip pretreatment on pulping was also studied. The paper gives an overall picture of the effect of the chip size distribution variation on the pulpmill performance and ways to contain the effect.

Introduction

Modernisation of plant and machinery has become the order of the day to remain competitive in the industry. Improving the process efficiency through better manufacturing practices through implementation of novel technologies has paid back in spite of high capital inputs. Under such circumstances, though lot of thrust has been given to modernization of technologies, the required uniformity in inputs are seldom considered due to various reasons and constraints. Attacking problems at source is a preferred approach rather than solving it end of pipe.

With dwindling availability of raw material resources, mills have adopted the improved kraft technology viz Superbatch, RDH processes to have more uniform pulp quality and better yield. The new processes are only improvement over the conventional kraft process and the input raw material fluctuations do have similar impact as in case of conventional process. Mills becoming more and more concerned about the process performance in terms of specific consumptions, in order to reduce the cost, more controls are inevitable at the input to have improved uniform output.

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It is well known that several factors have an influence on the pulping process and thanks to modern automation; many of variables have been kept under control. However very little importance has been bestowed on the input raw material quality reasons being many. But it is important to note that the aim of modernization of plant and machinery are not fully met unless the desired output is achieved, for which the input material, i.e. the wood plays a major role. Various varieties of wood are used depending on availability and location. The type of raw material does not matter much as long as they are pulped individually. But the chip size distribution plays a major role which needs due consideration. The present study carried out on the influence of chip size distribution, an ignored parameter, not only on pulpmill performance but on the overall performance of the mill shows it is high time we pull up our socks to manage the variations through available solutions. The paper deals with the role of overthick chips on the mills performance and possible ways of combating the overthick chips problems, which of course cannot be controlled at source due to various reasons mentioned.

Chip Size Distribution

Hardwood chips are evaluated in laboratory for chips size distribution as per Scan method according to the following sizes.

Overs are the oversized or overthick fraction of the chips retained on as

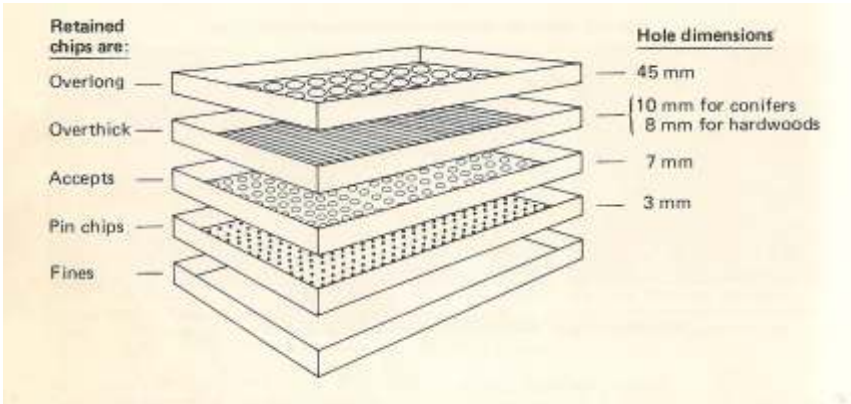


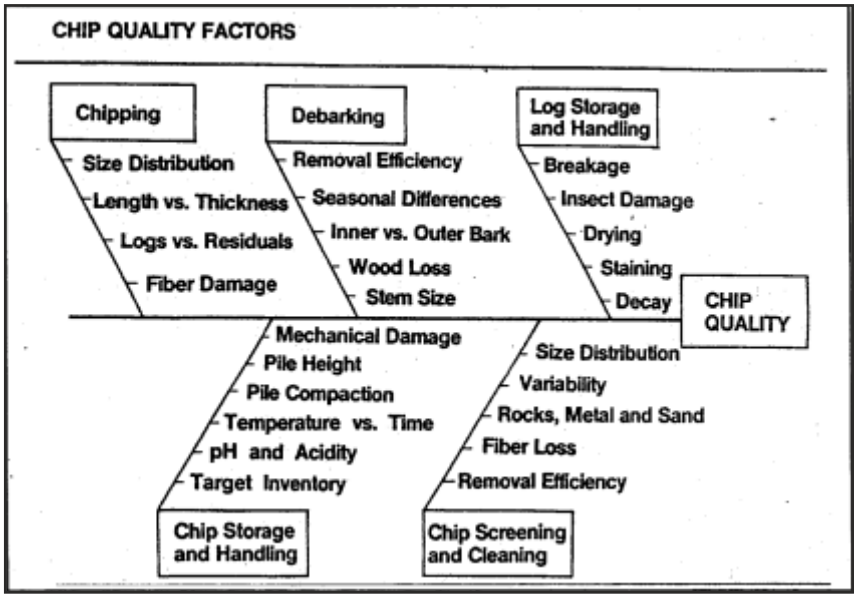
Fig 1: Chip size classification Sizes and designations

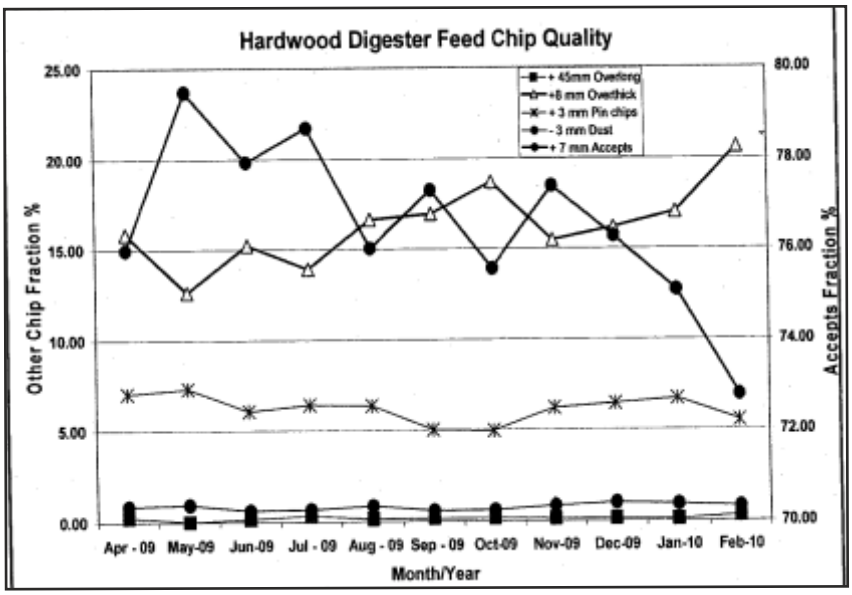
45mm (1.8 inches) diameter hole screen and is thicker than 10mm for the conifers (softwoods) and 8mm for hardwoods.

Accepts are the chip fraction of the ideal size distribution for pulping. These chips pass through an 8 to 10mm slotted screen and are retained on a screen with holes 7mm (0.276 inch) or 3/8 inch diameter.

Pin chips are chips that pass through a 7mm screen but are retained on a 3mm (0.118 inch) or 3/16 inch screen. Fines are the undersized fraction of chips (also known as sawdust) and are collected in the bottom pan.

The mills usually have the chips screening to separate over 35mm and 3mm screen for removing dust. The chips collected over 3mm screen are usually accepted for pulping and thickness screens are not installed. The overthick chips quantity vary between 7% and 27% which needs due attention. The normal chip size distribution in the mill, over a period of one year is presented in Fig 2.





As seen from the figure, the overlong and fines are usually under control. The remaining accepted chips size have a distribution of +7 mm (accepts) size and + 8 mm (Overthick) which are inversely proportional i.e. as the accepts increases, the overthick quantity decreases.

Various factors influence the kappa number variability which includes Chips, circulation in digester, Control mechanism, chemicals, Heating, blowing and dumping (2). The chip quality factors that influence the final chip quality are presented as cause effect diagram in fig 3.

The area of interest of our present study is only the chipping part ie size distribution, Length vs thickness.

Chip Thickness

Chip thickness is the critical dimension in determining the rate and uniformity at which the alkaline cooking liquor will penetrate chips during pulping. Use of thinner and more uniform chips was found to accelerate pulping, reduce alkali demand, lower pulp reject and improve pulp viscosity and strength. (1) .Reduction in chip thickness allows faster pulping rates and reduces the amount of rejects. However low thickness indicates the damage to the fiber.

Generally smaller length wood fragments like pin chips, fines, saw dust produce lower yield, weaker pulps and consume greater amount of alkali. A high percentage of fine material in the chip furnish will cause poor liquor circulation in both batch and continuous digesters.

Laboratory Studies

The influence of overthick chips which ranges about 10-25% in the digester feed chips was studied in the laboratory. Pulping of Eucalyptus hybrid chips was carried out in laboratory. The chips after screening in laboratory chips classifier were also subjected to pulping (Accepts). The over thick fraction (+8mm#) and the pin chips (+3mm) were also pulped separately, under identical conditions. The results are tabulated in Table 1.

As can be seen from the results, removal of overthick from whole chips results in screened pulp yield increase

Table 1 : Pulping of chips fractions of Euca hybrid

Sl no	Parameters	Unit	Whole chips	Overthick +8mm	Accepts +7mm	Pin chips +3mm
1	Chemicals	%	17	17	17	17
2	Total yield	%	44.0	45.1	44.6	43.0
3	**Sc rejects**	**%**	**1.9**	**4.0**	**0.5**	**0.1**
4	**Screened Yield**	**%**	**42.1**	**41.1**	**44.1**	**42.9**
5	Kappa number		22.4	25.5	21.7	21.0
6	Brightness	% ISO	27.5	28.6	30.8	30.2

Constant pulping conditions:

Cooking Temperature	164°C
Cooking Time	90 min
H factor	1000

by 2%, with lower unbleached kappa number and higher unbleached pulp brightness.

The studies were further extended to other woody raw materials like Acacia, Blue gum and Casuarina. Samples of whole chips and accepts (ie overthick removed) were subjected to laboratory pulping and the results are presented in Table 2.

Table 2 : Pulping of Whole and Accepts chips of different raw materials

Sl no	Parameters	Unit	Acacia		Blue gum		Casuarina	
			Whole chips	Accepts +7mm	Whole chips	Accepts +7mm	Whole chips	Accepts +7mm
1	Chemicals	%	15	15	15	15	15	15
2	Total yield	%	52.3	50.6	52.4	52.4	46.2	47.8
3	**Sc rejects**	**%**	**2.3**	**0.6**	**1.4**	**0.4**	**1.2**	**0.1**
4	**Screened Yield**	**%**	**49.0**	**50.0**	**51.0**	**52.0**	**45.0**	**47.7**
5	Kappa number		21.5	20.8	19.5	19.0	20.4	19.6
6	Brightness	% ISO	32.0	32.3	33.9	34.3	27.6	31.1

Constant pulping conditions: Cooking Temperature 164°C; Cooking Time 90 min; H factor 1000

The results above are in line with the findings with Euca hybrid, ie removal of overthick results in improved yield, lower kappa and increased unbleached brightness.

Impact Of Overthick Chips Quantity On Pulp Mill Parameters

The influence of overthick chips percentage on performance of the pulpmill was evaluated. The chips classification results over a period of 6 months and related parameters such as Kappa number, Alkali loss, effluent parameters such as TDS, Sodium were analysed and plotted against overthick chips percentage.

It is pertinent that when the overthick % increases, the pulping chemicals applied have to be increased to reduce the rejects generation to normal level and to maintain the required pulp throughput. Under such circumstances, the increased chemical charge results in lowering of kappa, impairs brown stock washing due to generation of higher fines content resulting in higher alkali loss and in turn higher TDS and Sodium in the effluent. Fig 4 below depicts the influence of percentage overthick chips on active alkali increase, to control the rejects.

Fig 5 below shows the impact of overthick chips % on kappa number of unbleached pulp and Post Oxygen stage due to increased chemical charge to control rejects.

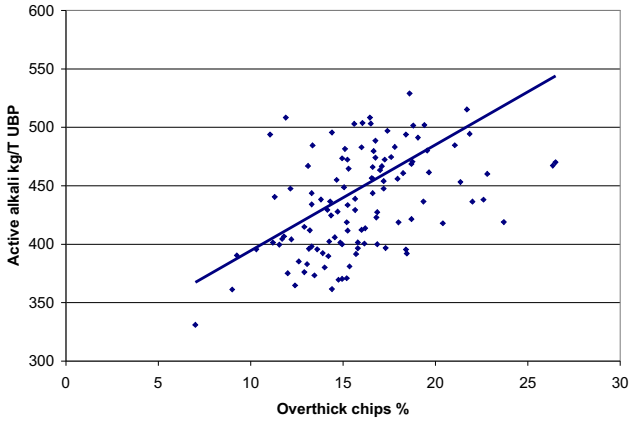
In doing so, the alkali loss carryover to bleach plant increases resulting in higher Total dissolved solids (TDS) and inorganics (TDSI) in the effluent. The impact of increased overthick chips on the above parameters is presented in fig 6 below.

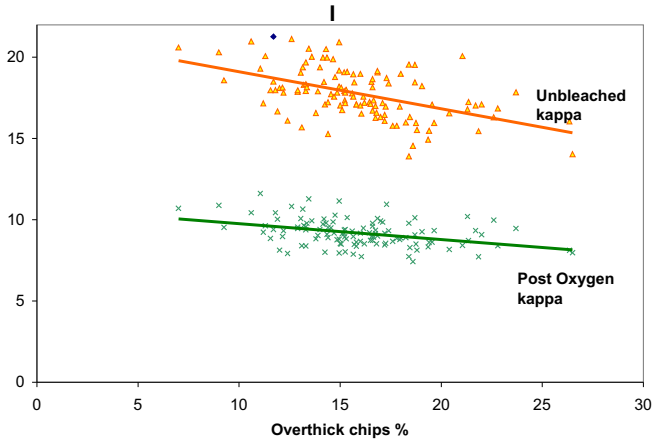
Thus it can be inferred from the above charts, that increase in overthick chips not only influences pulping process but indirectly it has a bearing on the effluent discharge also.

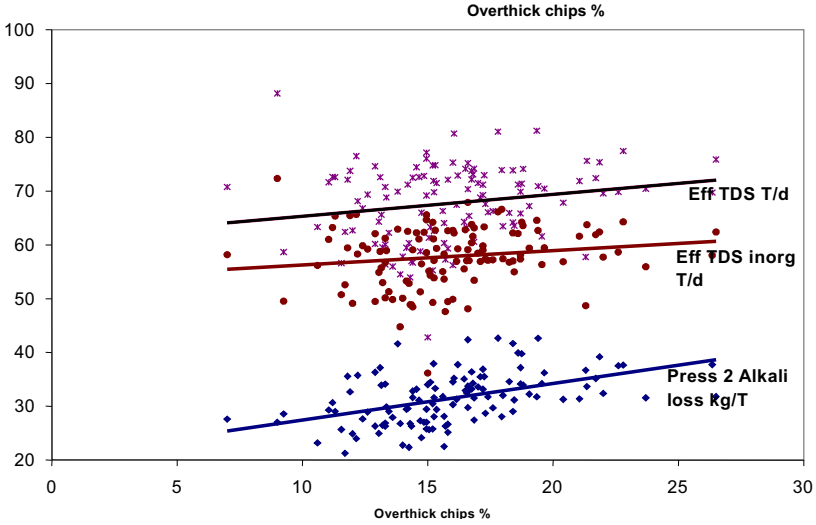
What Can Be Done With Overthick Chips?

The removal of overthick chips from the whole chips by screening is possible and thickness screens are available in market. But what can be done with the overthick chips? When overthick chips are subjected to rechipping, lot of pins chips generation is inevitable and thus the pulp yield and strength suffer.

Literature survey shows that in the 1980s chips thickness screening came into wide use and they are now considered an essential part of the design of most of the new kraft mills. (1). If the overthick chips are crushed and fissures are created, they behave like thinner chips in which liquor can penetrate more easily, rather going for slicers which generate lot of pin chips. In the 1990s industrial machines for







crushing of overthick chips have become available.

Once the overthick chips have been crushed, thickness classification does not show any difference while the crushed chips are destructed and have better liquor penetration. Chip conditioner, as they are called, are commercially available for handling overs.

Effect Of Crushing Of Overthick Chips

With the above approach, laboratory studies were undertaken to study the effect of chip crushing on pulping. Overthick chips were segregated by screening in laboratory chips classifier and the chips were crushed in laboratory creating cracks or fissures in chips. The crushed overthick were pulped and compared with uncrushed overthick to study the effect of crushing. The results are presented in Table 3 below

Table 3 : Effect of Crushing of overthick on pulping

Sl no	Parameters	Unit	Euca		Casuarina	
			Overthick	Crushed overthick	Overthick	Crushed overthick
1	Chemicals	%	17	17	15	15
2	Total yield	%	45.1	46.2	51.6	52.2
3	**Sc rejects**	**%**	**4.0**	**1.1**	**5.8**	**1.0**
4	**Screened Yield**	**%**	**41.1**	**45.1**	**45.8**	**51.2**
5	Kappa number		25.5	20.3	28.5	23.4
6	Brightness	% ISO	28.6	27.0	26.0	26.8

Constant pulping conditions:

Cooking Temperature	158°C
Cooking Time	90 min
H factor	700

As may be seen from the results, crushing of overthick chips makes it equivalent to normal chips and hence segregating, crushing and blending back with the accepts will result in higher pulp yield, lower rejects and of course lower pollution levels due to factors mentioned previously. Crushing the overthick (which is about 25%) and then mixing with accepts will result in an yield increase of about 1.5-2.0% with lower kappa number.

Commercial Chip Crushing Equipments

Commercially chip crushing equipments are available. There are low rpm crushers which squeeze and crack the chips. There are also heavy duty rolls with removable profiled pyramidal surfaces. These create fissures in over thick chips parallel with the grain. 88-96% fissuring efficiencies have been reported, with 1% fines and 3% pin chips generation.

Conclusions

It is impossible to have always low percentage of overthick chips at the chipper outlet as many variables affect the chipping performance such as wood density, log dimensions, moisture, knife angle etc. The chipper settings cannot be altered for each variable. Under such circumstances it is inevitable that overthick chips are generated.

The overthick chips, if ignored, result in higher rejects percentage and lower yield. They warrant usage of higher active alkali to control the rejects which have other environmental implications as well.

Chip crushing creating fissures in overthick chips, after thickness screening, will help to improve the pulpability of overs. Mixing the crushed chips back into the accepts will result in improved yield by 1-2% and lower active alkali consumption and lower H factor, which will have impact on pulp quality, by improving the uniformity in the residual lignin of the fibre population.

Lower H factor reduces the formation of chromophores resulting in lower bleach chemical requirement, leading to reduced pollution load and thereby better environment.

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