

## White Paper: Measuring Shives to increase Paper and Board making productivity



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The goal of any pulping operation is to completely convert wood into a papermaking quality pulp. As 100% efficiency is not economically feasible, all pulping operations produce shives that contaminate the produced pulp.

What is a shive?

In theory, a shive is any particle larger than a single fiber. In practice, a shive is a particle or fiber bundle large enough, or in enough quantity, to produce a paper and board quality or productivity problems. Normally this particle has a thickness, or third dimension, that separates it from being benign to being problematic.

For example:

- Shives in bleached pulps show up as dirt in paper or board.
- Shives in unbleached pulps reduce print quality, reduce end strength, decrease runnability, and present visual defects.
- Shives in mechanical pulps cause paper machine breaks, off set printer linting, pick outs, coater scratches, visual defects and reduce print quality.

In short, the presence of shives in pulp is problematic to meeting customer expectations and maintaining optimum production costs.

In any pulping operation, a practical balance is struck between theoretical desirability and economical feasibility.

This balance can be labeled and optimized by measuring the shives produced at each process location to develop a Shive Process Profile.

The quantity of shives in a pulp sample is normally only of concern when a pulp is delivered to a bleach plant or paper/board machine. However, both the quantity and the quality, or character, of the shive fraction is important when assessing the impact of changes in pulping condition. To comment on the quality and quantity of shives, they must first be isolated then measured.

A shive analyzer, such as the one make by Pulmac International, uses a low-consistency, rigidly controlled screening environment to repeatably separate a shive fraction from pulp using a pattern of narrow slots as a screening barrier.

The quantity of shives isolated by a shive analyzer depends on the percentage of shives in the pulp sample, the size of the pulp sample processed, and the specific dimensions of the screen plate slots. Control of the sample weight delivered to the analyzer and selection of the appropriate dimension for screen plate slots will ensure the isolation of a shive fraction that precisely reflects the character and quantity of shives in the original sample. Optical inspection of this shive fraction provides a reliable shive label. This optical analysis can be supplemented by weight determination for ongoing monitoring purposes.

Use of screen plates with different slot dimensions alters the shive retention probability. This is shown in Figure 1, where the retention probability of a shive is illustrated as a function of the shive size in relation to specific slot dimensions. The size relation of shives to fibers is also illustrated by including the particle size distributions for typical mechanical and chemical pulps. The data show that the selection of slot dimension is determined by particle size and quantity of the shive fraction. For example, typically 0.008" (200 um) slots are used for High Yield Kraft, 0.006" (150 um) for NSSC and bleachable grade chemical pulps, and 0.004" (100 um) for mechanical pulps.

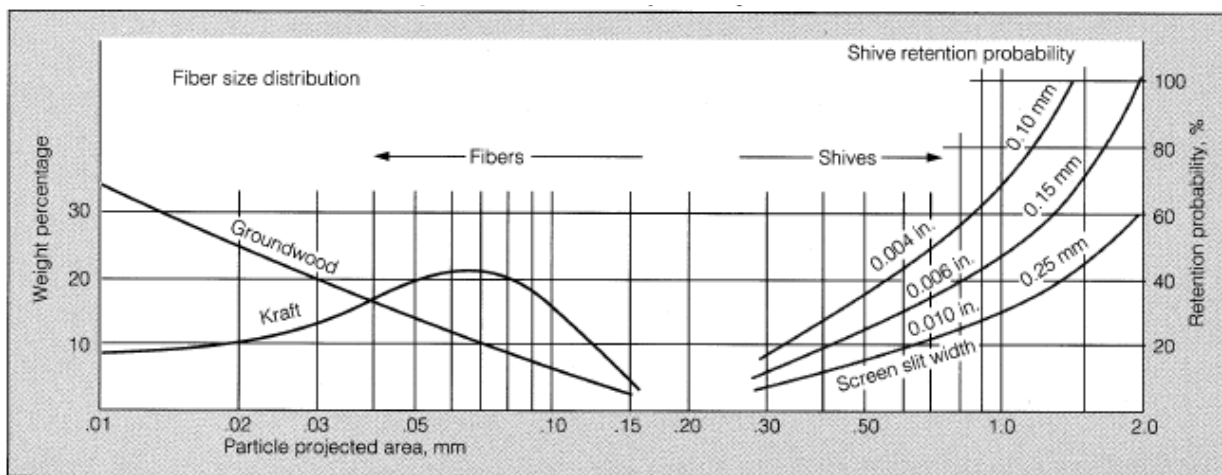


Figure 1: Shive retention probability compared to screen plate slot size

In chemical pulping, the kappa number is conventionally used to provide feedback that supports maintaining optimum pulping conditions. However, this test provides only partial and indirect statements of the papermaking quality of the pulp produced. Certain process variations can alter the papermaking quality of the pulp without inducing changes in the kappa number.

More directly related to the papermaking quality of pulp from any pulping operation is the quality and quantity of the shive fraction. A close relationship exists between the properties of the pulp produced by any pulping operation and the properties of the shive fraction. Both are an integral and inseparable part of the same material mix.

In a single pulping operation, it is not possible to “work” only on the shive fraction in the pulp without working on the rest of the pulp as well. So the properties of one part of the material mix will reflect those of any other part. It is for this reason that careful observation of the shive fraction can be used to label the papermaking quality of the pulp.

The general relationship between the kappa number of a particular unbleached kraft pulp and its shive content was measured. (see figure 2) Conventional wisdom suggests a strong relationship between kappa and shives where low kappa generates low shives and high kappa generates high shives. However, there are often conditions where shive content is increasing at a constant kappa. This occurs when the level of cook uniformity decreases. So non-uniform cooking will increase shives at the same kappa number. Increasing the H factor by temperature, chemical concentration or pressure to increase output (i.e. reduce overall cooking time) will target the same kappa number but can produce higher shive content. The more non-uniform chip size going into the digester, the higher the shive content will be. (Assuming the same kappa targets are in place.) Measuring shive content more accurately reflects chip variation than the kappa test. Information from shive analysis could be incorporated into digester control. (see figure 3)

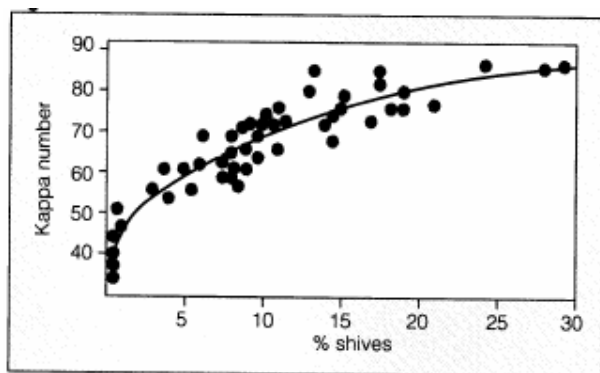


Figure 2: Date relationship between Kappa and shives.

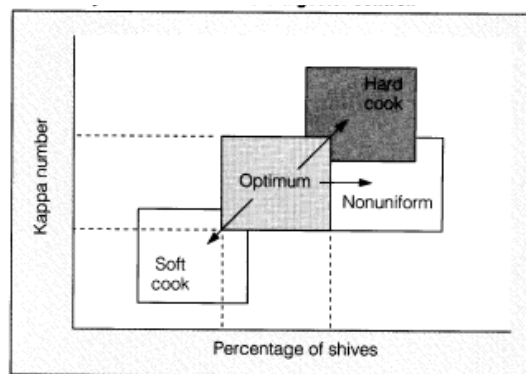


Figure 3: Qualitative relationship between Kappa and shives.

**SHIVE ANALYSIS.** The quantity of shives in a pulp sample is the only concern when a pulp is delivered to the bleach plant or paper machine. However, both the quantity and the quality, or character, of the shive fraction are relevant when assessing the impact of changes

in pulping conditions. This fact dictates the need to isolate and examine the actual shives in a pulp sample.

A shive analyzer, such as the one made by Pulmac Instruments International, uses a low-consistency, rigidly controlled screening environment to separate reproducibly a shive fraction from pulp using a pattern of narrow slits as the screening barrier. Automation simplifies the five-min test so a mill technician or operator can easily produce shive information by merely supplying the original pulp sample and pushing a start button.

The quantity of shives isolated by a shive analyzer depends on the percentage of shives in the pulp sample, the size of the pulp sample processed, and the specific dimensions of the screen plate slits. Control of the sample weight delivered to the analyzer and selection of the appropriate dimension for the screen plate slits will ensure the isolation of a shive fraction that precisely reflects the character and quantity of shives in the original sample. Visual inspection of this shive fraction in comparison with established standards provides a reliable shive label. This visual display is frequently augmented by a weight determination.

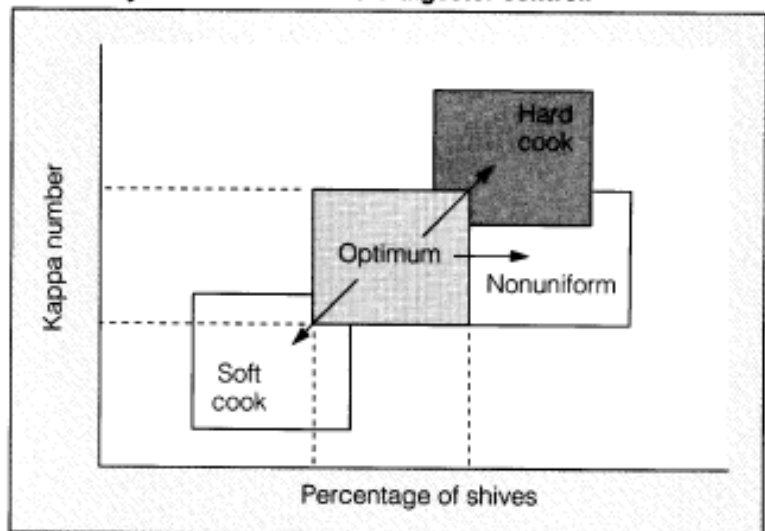
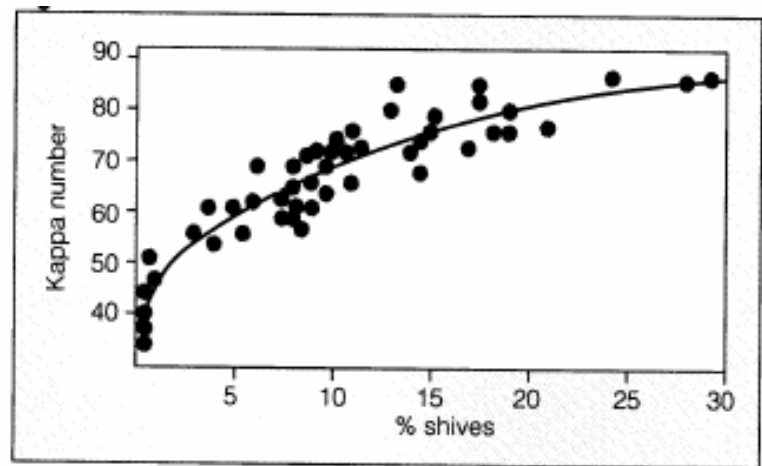
Use of screen plates with different slit dimensions alters the retention probability of shives. This is shown in Figure 1, where the retention probability of a shive is illustrated as a function of its size in relation to specific slit dimensions.

The size relation of shives to fibers is indicated by including the particle size distributions for typical mechanical and chemical pulps (Figure 1). The data show that the selection of slit dimension is determined by particle size and quantity of the shive fraction. For example, typically 0.010-in. slits are used for semichemical pulps, 0.004-in. slits are used for mechanical pulps, and 0.006-in. slits are used for bleachable-grade chemical pulps.

# Measuring Shives to increase productivity



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**SEMICHEMICAL PULPS.** A study of neutral sulfite semichemical pulp for production of corrugating medium investigated the use of shive analysis to monitor pulp production. Pulp at the washers and pulp after the deshive refiners were tested.

Optimum quality of ultimate product was associated with a washer pulp shive fraction of between 28% and 32% and a refined pulp shive fraction of 4% to 6%. Refiner input energy was adjusted to maintain these values. Increased shive levels, which coincided with a change in shive character from long/thin to short/fat, signaled the need for change of refiner plates.

Increased shives at the washer pulp, without change in character, signaled the need for a change in pulping conditions to increase the softness of the cook (Figure 4).

