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Fiber length of pulp by projection

1. Scope and summary

1.1 This is a projection method (1) by which the weighted average fiber length of a pulp may be measured relatively quickly and easily.

1.2 If l is the length of any fiber in a sample of pulp, w its weight, and if N fibers are measured, their total length (Σl) being L , the numerical or arithmetical average length is $\Sigma l/N$ or L/N ; their weighted average length by length $= \Sigma(l^2) \Sigma l$ and their weighted average length by weight $\Sigma(lw)/\Sigma w$.

1.3 The numerical or arithmetical average fiber length of paper pulps is a not a commonly used value, since the pulps consist of whole tracheids and shorter elements down to submicroscopic lengths, which are included in the arithmetic fiber length and there tends to be a larger quantity of them as fiber length decreases. The stated average is especially meaningless if the least length arbitrarily adopted as the lower length limit for a "fiber" or particle is not also given. The shortest fibers contribute very little to the total measured length, but numerically they are just as important and influence the final result of an arithmetical average just as much as the longest fibers. On the other hand, the weighted average fiber length is a fundamental property of pulps and relates directly to paper properties (2). The shortest fibers in an average specimen of pulp contribute very little, either to length or to weight in the calculation of the weighted average length and hence have an almost negligible effect on most test results. This corresponds in many cases to their almost negligible effect on the common properties of a pulp other than groundwood, except for its freeness and the transverse tensile strength, light scattering, or the air permeability of test sheets made from it. Fines and short fiber influence paper properties in a very different way from long fibers, thus, it is generally best to look at fines and longer fiber separately.

2. Summary

2.1 For the most accurate determination of the weighted average fiber length of a pulp, the sample should be fractionated and the result calculated from the individual fractions as described in TAPPI T 233 "Fiber Length of Pulp by Classification." In any case, if any appreciable portion of the sample consists of very short fibers or debris, it is necessary to find the weight of the portion that does not contribute to the property of length so that the weighted average length by length, or by weight, may be decreased accordingly.

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2.2 A companion method for measuring the coarseness, or weight per unit length of the sample, is described in TAPPI T 234 "Coarseness of Pulp Fibers." Although for the present method it is not necessary to employ a quantitative procedure to prepare specimen slides as there described, if this is done, measurements of both fiber length and fiber coarseness may be made using the same slide.

3. Significance

3.1 This is a non-automated historical method for determining the weighted average fiber length. It is important in that it provides a benchmark for comparison with the more automated methods.

3.2 If an ordinary horizontal projector or a vertical projector such as shown in Fig. 2 is used, the grid may then comprise thin lines drawn in permanent ink on a screen made of hard paper or a sheet of white plastic with a matte surface.

3.3 The ground plate-glass grid for the arrangement shown in Fig. 1 may be made as follows: On its underside, preferably the smooth or unground side, stretch threads across the plate parallel and 25 mm (1 in.) apart, fastening their ends with adhesive tape. Across the other two sides of the plate, stretch similar threads at right angles to the others. The thread shown at a distance of 212 mm ($8\frac{1}{3}$ in.) is to define the length of the lines for coarseness measurements according to T 234. For hardwood or short-fibered pulp, have the threads spaced 12.7 mm (0.5 in.) apart if a projector is used.

3.4 *Multiple tally counter* (desirable but not essential). One with eight keys and preferably also with a totalizer, for example, the counter commonly used for recording the numbers of the different cells in a specimen of blood.

3.5 *Screen* (for pulp containing an appreciable quantity of debris), preferably a pulp classifier with a 100 to 150-mesh screen, or, if not available, a small 200-mesh sieve.

3.6 *Magnification scale*. A short piece of transparent millimeter scale or a slide scratched with two parallel lines 0.5 ± 0.005 cm apart.

3.7 *Other equipment*: Microscope slides, preferably large size, 3.8×7.6 cm ($1\frac{1}{2}$ by 3 in.); microscope needle; 2.5×10 cm test tube; coarse fritted glass crucible; 30-50 mL weighing bottle (for 1 g moist pulp).

4. Apparatus

4.1 *Projector* to project the images of fibers on a glass slide to a screen, the magnification and distances preferably such that 1 mm on the slide equals 1.0 in. on the screen (25.4:1). A standard 35-mm slide projector or enlarger may suffice and provide an enlarged image on a vertical or horizontal screen. For some purposes a more convenient design of the apparatus is shown in Fig. 1. The projector (1) accommodates a slide at least 50 mm wide. Its rays are turned by a prism (2) into a room (dark room or constant humidity room) then turned up by a chromium-plated and polished, rolled-brass plate (3) to the underside of a 30.5×30.5 cm (12×12 in.) ground plate-glass screen (4) with its upper surface frosted. Figure 2 shows an arrangement using a vertical projector.

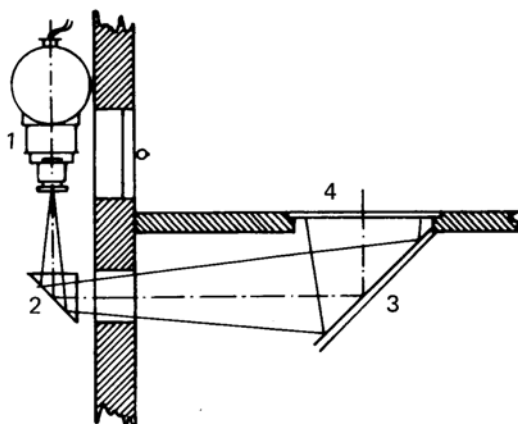


Fig. 1. Diagram of projection apparatus

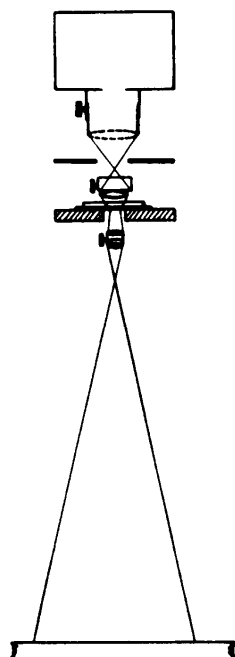


Fig. 2. Vertical projector

4.2 *Image grid for screen* (see Fig. 3). The one illustrated is a composite one suitable for both fiber length and fiber coarseness measurements. Distinguishing marks are made to identify the 9 (as shown) or preferably 16 squares in the center of the field which are used as the basic area for the length measurement. For samples of hardwood or any other pulps with the majority of fibers 1.5 mm or less, it is a good idea to use a grid having the equivalent of 0.5 mm spacings.

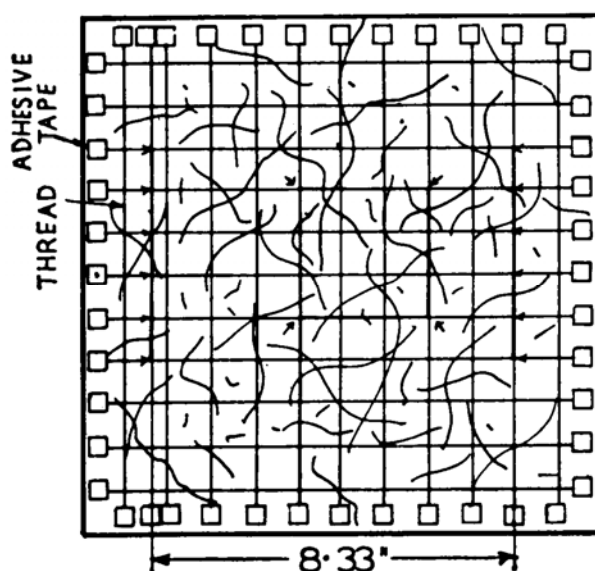


Fig. 3. Grid for fiber lengths and weight per unit length.

5. Test specimen

Required is a representative specimen of a dispersed sample of pulp weighing a few milligrams. The sample is required to be either free from debris or its percentage of debris known. If this percent is not known, one gram or more of pulp is needed.