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Laboratory beating of pulp (PFI mill method)

1. Scope

1.1 This standard practice describes the processing of pulp by means of the PFI mill (1) to evaluate pulp quality for papermaking.

1.2 In principle, the standard practice applies to all types of pulp; in practice, the method may not give satisfactory results with certain very long fibered pulps such as cotton.

1.3 The standard practice is especially suited to processing small quantities of test specimens that are too small for processing in the Valley beater, as described in TAPPI T 200 "Laboratory Processing of Pulp (Beater Method)."

2. Applicable documents

2.1 TAPPI T 205 "Forming Handsheets for Physical Tests of Pulp."

2.2 TAPPI T 220 "Physical Testing of Pulp Handsheets."

2.3 TAPPI T 227 "Freeness of Pulp."

3. Summary

A measured amount of pulp at specified concentration is beaten between a roll with bars and a smooth-walled beater housing, both rotating in the same direction but at different peripheral speeds. Beating action is achieved through the differential rotational action and the application of a specified load between the beater roll and housing for a specified number of revolutions.

4. Significance

While no one laboratory method of beating pulp can simulate commercial refining practices, the PFI mill method is very well accepted for use on small sample sizes. Physical testing of laboratory-beaten pulps provides significant data that aid in determining the ultimate performance of pulp when converted to paper.

5. Definition

Beating is defined as the mechanical action applied to pulp between two parallel surfaces, under constant loading, moving differentially relative to one another. The PFI mill achieves this action by having the inner roll and outer casing rotate under constant load, in the same direction, but with differing peripheral speeds.

6. Apparatus

6.1 *PFI mill*¹ (see Figs. 1 and 2)², consisting of the following:

NOTE 1: The mill should be installed and leveled per manufacturer's instructions.

6.1.1 A stainless steel roll with chiseled bars and a stainless steel housing in the form of a container with a smooth cylindrical internal wall, into which the pulp sample is placed. Both housing and roll rotate on independent vertical axes in the same direction, the roll rotating faster than the housing. The number of revolutions of the roll is indicated by a counter.

NOTE 2: The first mills manufactured had beating elements made of bronze; however, the surfaces were conditioned to give the same results of beating as elements made of stainless steel.

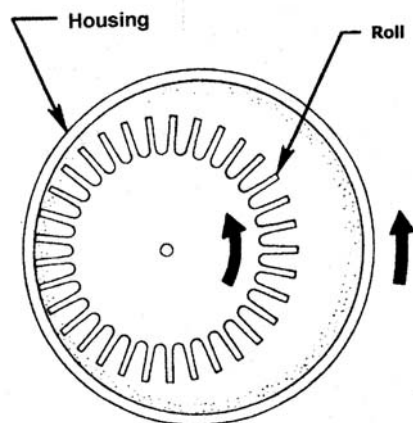


Fig. 1. The PFI laboratory beater elements.

¹Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Supplier's list in the set of TAPPI Test Methods, or may be available from the TAPPI Quality and Standards Department.

²Figures 1 and 2 are reproduced with permission of PAPTAC.

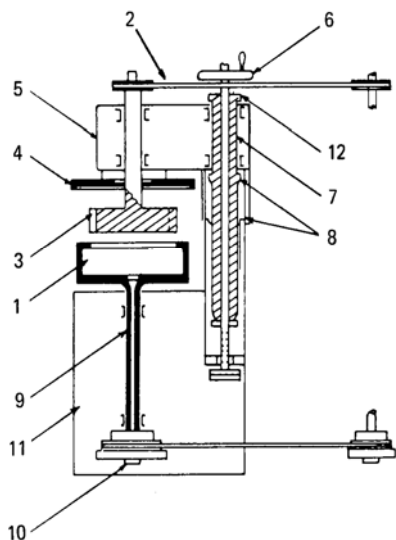


Fig. 2. The PFI laboratory beater (vertical section sketch). 1 = housing; 2 = timing belt; 3 = roll; 4 = cover; 5 = roll lever arm; 6 = handwheel; 7 = pillar; 8 = stop peg; 9 = shaft channel; 10 = screw nut; 11 = frame; 12 = cantilever.

6.1.2 The roll has 33 bars, each $50 \text{ mm} \pm 0.5 \text{ mm}$ long and $5 \text{ mm} \pm 0.2 \text{ mm}$ wide. The bars are spaced uniformly about the circumference of the roll and are parallel to the roll axis. The diameter of the roll, measured across the bars, is $200 \text{ mm} \pm 0.5 \text{ mm}$. Depth of the cavities between the bars is 30 mm. The rotation speed of the roll during beating (loaded) must not decrease by more than 50 rpm from the measured unloaded roll speed. The roll is driven by a 750-W (1.0-hp) motor. Rotation speed of the roll, unloaded, is $1460 \pm 10 \text{ rpm}$. The number of revolutions of the roll is indicated by a counter.

6.1.3 The beater housing has an internal diameter of $250 \text{ mm} \pm 0.5 \text{ mm}$ and is driven by a 375-W (0.5-hp) motor. The rotational speed of the housing unloaded is $720 \pm 20 \text{ rpm}$. During beating (loaded) the rotational speed of the housing must not increase by more than 25 rpm from the measured unloaded housing speed. The prescribed difference in peripheral speed between the beating elements is $6.0 \pm 0.3 \text{ m/s}$ with the roll rotational speed of 1460 rpm (unloaded).

6.1.4 Both the roll and the housing are to be driven by means of timing belts. The change in rotational speed of either element during beating is not to exceed 66 rpm.

6.1.5 The beating pressure is obtained by means of a load applied by a lever that presses the roll against the wall of the beater housing. Force applied is to be 3332 N/m of bar length, 17 kg total bar load.

NOTE 3: For very easily beaten pulps (e.g., hardwood sulfites) a smaller load, which gives a beating load of only 1765 N/m of bar length, 9 kg total bar load, may be applied, provided this is noted in the test report.

6.1.6 The mill is also equipped with a device which includes a Vernier adjusting screw regulating the distance between the roll and housing when grinding-in and conditioning the mill.

6.2 *Disintegrator*, as described in T 205.

6.3 *Water.* ASTM Type II water is preferred for the beating run and associated freeness determinations. For repeatable, reproducible results, and in all laboratory comparisons, distilled or deionized water must be used for both beating and freeness testing. Tap water will significantly affect the freeness values, beating times and test data. The relevant properties of ASTM Type II water (3) are as follows: