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WORKING GROUP  
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SUBJECT  
CATEGORY \_\_\_\_\_ Pulp Properties \_\_\_\_\_

RELATED  
METHODS \_\_\_\_\_ See "Additional Information" \_\_\_\_\_

**CAUTION:**

This Test Method may include safety precautions which are believed to be appropriate at the time of publication of the method. The intent of these is to alert the user of the method to safety issues related to such use. The user is responsible for determining that the safety precautions are complete and are appropriate to their use of the method, and for ensuring that suitable safety practices have not changed since publication of the method. This method may require the use, disposal, or both, of chemicals which may present serious health hazards to humans. Procedures for the handling of such substances are set forth on Material Safety Data Sheets which must be developed by all manufacturers and importers of potentially hazardous chemicals and maintained by all distributors of potentially hazardous chemicals. Prior to the use of this method, the user must determine whether any of the chemicals to be used or disposed of are potentially hazardous and, if so, must follow strictly the procedures specified by both the manufacturer, as well as local, state, and federal authorities for safe use and disposal of these chemicals.

## **Laboratory beating of pulp (Valley beater method) (Five-year review of Standard Practice T 200 sp-15) (Changes from Draft 1 incorporated)**

### **1. Scope**

1.1 This procedure is used to define the papermaking quality of pulp, by subjecting it to a controlled mechanical treatment in a laboratory beater; see also TAPPI T 248 "Laboratory Beating of Pulp (PFI Mill Method)."

1.2 The beating procedure may be used with any pulp, suitably modifying the withdrawal schedule to provide the number of samples required for a satisfactory beater curve. The method may not give satisfactory results with certain extremely long-fibered pulps, such as cotton fibers or jute since the fibers entangle and tend to rope in the beater.

## 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 of specified stock concentration is beaten between the roll bars and bedplate of a laboratory beater. Samples are withdrawn at regular intervals during treatment to determine their beating degree and to be made into laboratory handsheets for evaluation.

## 4. Significance

The term beating denotes a specific type of refining, but is now commonly used to describe refining in a laboratory. This procedure is used by market pulp mills as a basis for product quality claims, in research studies, to evaluate new pulps, and to provide a basis for process control when using variable pulp sources.

## 5. Apparatus

5.1 *Disintegrator*<sup>1</sup>, as described in TAPPI T 205.

5.1.1 *Large container for standard pulp disintegrator*, the container shall be 300 mm ID, have a height of 200 mm and 12.70 mm radius at the bottom. It shall have a disintegrating capacity of 11 liters and shall have smooth interior walls. The container shall be made of 316 stainless steel. The container must have a suitable cover.

5.2 *Beater*<sup>1</sup>, with controlled bedplate.

5.2.1 A dimensioned drawing of the 0.7-kg (1.5-lb) beater is shown in Fig. 1. The bedplate and roll shall be made of Type 410 heat-treatable stainless steel (chromium content, 11.5 to 13%) or its equivalent. The diameter of the roll with flybars inserted (32 in number) shall be 193.8 mm (7 5/8 in.). The thickness of each flybar shall be 4.8 mm (3/16 in.) and the width of the roll shall be 152.4 mm (6 in.). The Brinell hardness of the flybars shall be 350 to 400 and bedplate bars 325 to 375.

5.2.2 The bedplate assembly shall consist of 7 bars, each 3.2 mm (1/8 in.) thick, 15.9 mm (5/8 in.) high, and spaced 2.4 mm (3/32 in.) apart. These shall be bent into a V-shaped form, having an angle of 5° with the roll axis, with the apex of the V pointing in the direction of movement of stock over the plate. The grooves between the bedplate bars shall be filled with strips of kiln-dried white oak. The projected length of the bedplate assembly shall be 158.7

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<sup>1</sup>Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers list, available as part of the CD or printed set of Standards, or on the TAPPI website general Standards page.

mm (6 1/4 in.) and its projected width 42.8 mm (1 11/16 in.) and shall be ground in to conform to the bars in the roll. The bedplate bar assembly shall be securely mounted in the bedplate with a low-melting-point bismuth alloy, to prevent heat damage to the wooden spacers.

5.2.3 The lever arm of the controlled bedplate shall have a ratio of 17.5 to 9, as indicated in Fig. 1. When the standard weight of 5500 g is positioned at the end of the bedplate lever arm, a force of  $104.9 \pm 1 \text{ N}$  (10,700 g) is applied upwards against the roll.

5.2.4 The bedplate-lever arm assembly shall be sealed to the body of the beater through a diaphragm of 1.6 mm (1/16 in.) live rubber, installed in such a way that there is no tension in the diaphragm when the bedplate and beater roll are in contact.

5.2.5 The beater roll shall be driven at  $500 \pm 10 \text{ rpm}$ . A 1-hp, 1200-rpm motor with belt drive is recommended (see also Additional Information).

5.2.6 The beater may be equipped with a water-level marker to facilitate adjustment of the volume to 23.0 L. A threaded screw may be permanently attached to the beater body and adjusted to indicate the water level at 23.0 L.

5.3 *Lever-arm clamp*, designed to adjust and maintain the position of the bedplate relative to the beater roll.

5.4 *Carborundum hone*, No. 149 or equivalent.

5.5 *Precision straightedge*.

5.6 *Silicon carbide powder*, 80 mesh (180  $\mu\text{m}$ ), 120 mesh (125  $\mu\text{m}$ ), and 325 mesh (45  $\mu\text{m}$ ).

5.7 *Reference pulp*, a large quantity of air-dried, randomized pulp of the type being regularly evaluated should be set aside and maintained for use as a reference material. An unbleached softwood kraft pulp that has been stored for at least two years can be expected to remain relatively stable for long periods, if kept protected from heat, light, and severe cycles of humidity.

**NOTE 1:** As a periodic check on the performance and calibration of the beater, it is essential to routinely process a reference pulp. If the reference pulp is purchased from a commercial source, care should be taken to closely follow the exact referenced procedures provided with the sample. Failure to follow the referenced procedures, calculation method, and withdrawal schedule will change the test results.

5.8 *Sampling cups* to remove the required amount of stock for making sheets of standard area and grammage.

5.9 *ASTM Type II Water*, is preferred to run the beater curve and associated freeness determinations; however, water quality with a conductance of less than 4  $\mu\text{S}/\text{cm}$  has been found acceptable for accurate and repeatable test results.

## 6. Calibration

6.1 The following calibration procedure is designed to bring the beater to a condition which will remain stable during repeated use, and will maintain reproducible handsheet properties at a given beating degree (freeness), within a narrow range of beating times.

**NOTE 2:** Caution is required when working on electrically operated equipment. Disconnect the power to the beater using a lock out/tag out procedure prior to working on the beater.

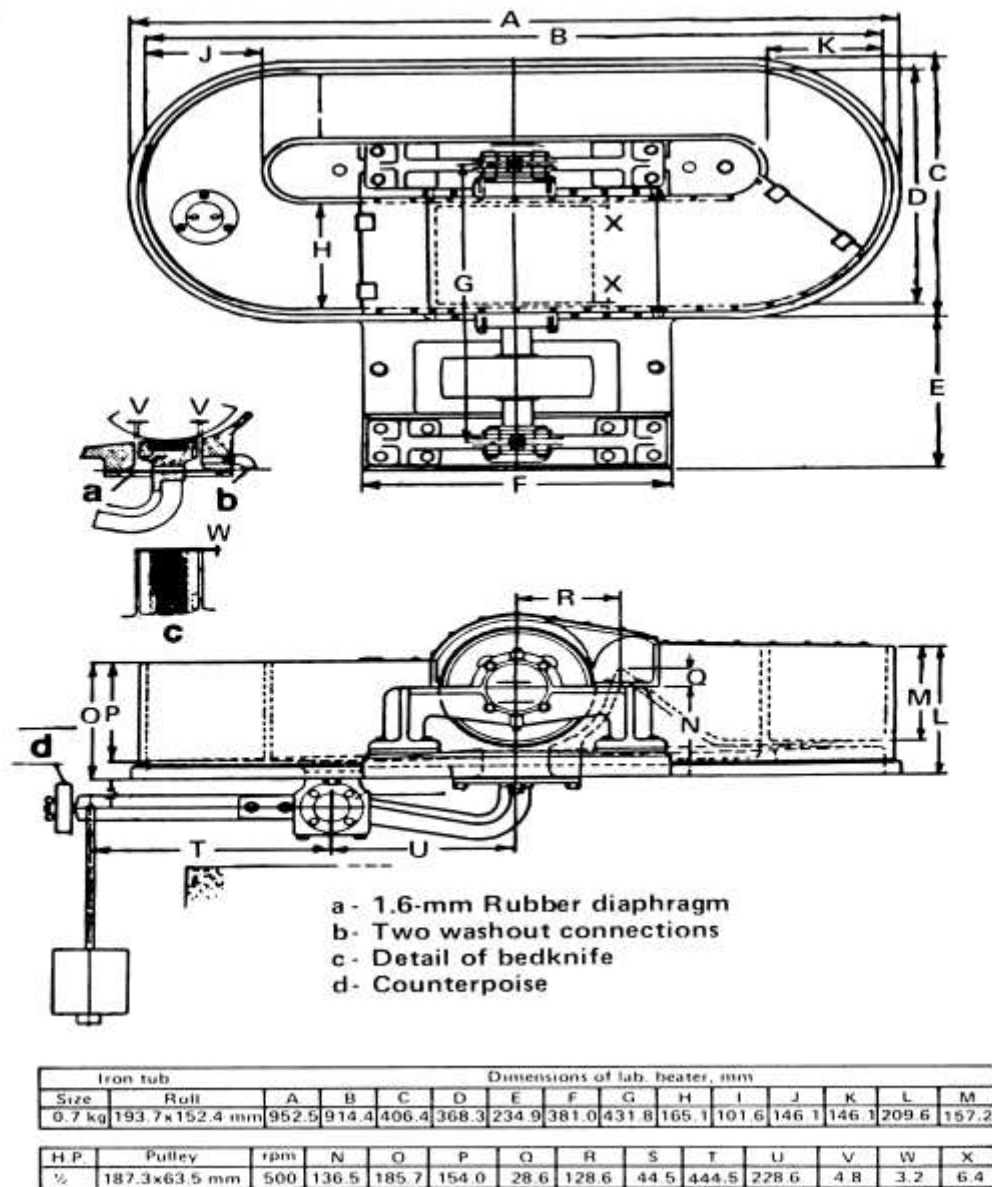


Fig. 1. Beater with controlled bedplate.

6.2 This alignment grinding and stabilization procedure should be applied whenever a carbon paper impression indicates a serious misalignment between the bedplate bars and the beater roll, after the installation of a new bedplate assembly, rubber diaphragm, beater roll, or roll bearings.

6.3 *Alignment grinding.* Before calibration, check the beater roll and flybars to be sure they are not loose. Check the beater roll, and if it is out of round, grind it on a grinder or lathe. Because of the change in beater geometry, replace flybars if they have worn down more than 2 mm (5/64 in.), i.e., if the diameter of the roll is less than 190.5 mm (7 1/2 in.).

6.3.1 New bedplate bars measure 15.9 (5/8 in.) high, 3.2 mm (1/8 in.) thick, and are spaced 2.4 mm (3/32 in.) apart. Replace the bedplate assembly when the bedplate bars have worn below 3.2 mm (1/8 in.). Soak new bedplate assemblies and beaters which have been dried out with water for more than 24 h to permit the wood spacers to swell. Unless the beater is to be put in storage, do not allow the bedplate to dry out. Do not remove the bedplate from the lever arm unless the bedplate must be replaced. If bedplate inspection or work is needed, remove the lever arm with the bedplate still attached. This helps to prevent alignment problems.

6.3.2 To replace the bedplate assembly, remove the lever arm with the bedplate attached. Before installation of a new bedplate assembly, examine the leading (front) bedplate support. Scrape the excess mounting metal from the leading edge of the bedplate bars to a depth of 1.0 mm threshold. Scrape or hone the burred edges of the bedplate bars, and remove any loose debris in the areas between them. Grind or file off the raised shoulders at the ends of the bedplate bars below the level of the contact area. Inspect the diaphragm. Using the bolts on the lever-arm, remount the bedplate assembly and diaphragm. Any time the bedplate or diaphragm is changed, or the lever arm removed, make a calibration check.

**NOTE 3:** The extent to which the bed knives are raised above the wooden separators is self-adjusting during grinding.

**NOTE 4:** The 1.0-mm (1/25-in.) threshold should be extended horizontally along the full width of the bedplate.

6.3.3 Attach the lever-arm clamp to the beater body by means of the bolts. The lever arm extends through the slot in the clamp, and its position can be regulated and maintained by means of the two set screws bearing on the upper and lower surface of the lever-arm. Before grinding commences, adjust the clamp to prevent contact between the bedplate and the beater roll.

6.3.4 Prepare a standard 360 g (o.d.) beater charge by adding a pulp sample which has been defibrated in water to the beater. Fill the beater to 23 L and operate it for a few minutes while adding 120 g of 80 mesh (180 µm) silicon carbide to form a homogeneous mixture.

6.3.5 With the beater running, adjust the set screws on the lever-arm clamp to bring the bedplate gradually into contact with the beater roll. Continue grinding with occasional adjustment to maintain bedplate contact until a smooth, vibration-free operation is achieved and there is a shiny, ground surface evenly across the flybars on the beater roll; otherwise, continue the grinding operation until these conditions are met. With proper alignment, this condition should be attained in approximately 30 minutes if the bedplate and beater roll are new. If they have been in use, a few minutes should be satisfactory.

6.3.6 Empty the pulp and abrasive from the beater, and retain this mixture for further grinding. Wash the beater thoroughly, and dry the area around the bedplate with blotters.

6.3.7 Take a carbon-paper impression of the condition of the bedplate and flybars as follows: Place a sheet of carbon paper between two papers sheets to give a total thickness of 0.15 mm (0.006 in.). Cut to 160 × 250 mm (6 1/4 × 9 7/8 in.). Place the prepared paper between the bedplate and the beater roll, and apply pressure to the lever arm. Hold the paper firmly to prevent slippage, and rotate the roll by hand. If properly taken, the exact impression of the bedplate bars and grooving will be transferred to the paper.

**NOTE 5:** A similar impression can be attained using a sheet of household aluminum foil covered with paper to a total thickness of 0.15 mm (0.006 in.).

6.3.8 Continue grinding with the original pulp-abrasive mixture until the carbon-paper impression shows complete contact between the bedplate bars and the beater roll. The bedplate bars should exhibit a shiny surface over the entire surface when they are in complete contact with the flybars.

6.3.9 Once complete contact is achieved, empty the beater, and retain the pulp-abrasive mixture. Remove the bedplate and diaphragm as a unit, and repeat the removal of any excess mounting metal from the leading edge of the bedplate bars to a depth of 1.0 mm (1/25 in.)

6.3.10 Scrape or hone the burred edges of the bedplate bars, and remove any loose debris in the areas between each bar. Grind or file the raised shoulders at the end of the bedplate bars and replace in the beater.

6.3.11 Pour the pulp-abrasive mixture into the beater, and grind for approximately 5 min with the standard 5500-g weight on the lever arm to correct any misalignment caused by the removal of the bedplate assembly.

6.3.12 Empty the beater, dry the bedplate area and check the bedplate contact with a carbon-paper impression. If contact is complete, remove the splash cover from the beater roll. Rotate the beater roll by hand, and check that each flybar is straight with a precision straightedge. Carefully hone the metal burr from the trailing edge of each flybar using the hone and light machine oil.

6.3.13 Carefully hone the leading edge of each flybar. Do not attempt to modify the grooved surfaces of the flybars at this stage. This treatment is intended to smooth the edges of the bars, remove the burrs from the trailing edge, and should be identical for each bar.

6.4 *Stabilization.* The stabilization step is required to condition the grooves on the surface of the flybars and bedknife assembly.

6.4.1 Remove the lever-arm clamp from the beater. Prepare a standard 360-g beater charge by defibering a pulp sample in water. Add the pulp to the beater and fill to 23 L with water.

**NOTE 6:** The use of a pulp sample which represents the type of pulp being regularly evaluated will help condition the beater at a bedplate-beater roll gap normal for that type of pulp (*I*).

6.4.2 Add 50 g of 325-mesh (45 μm) silicon carbide powder to the beater charge, and circulate with no weight on the beater arm until uniformly mixed.

6.4.3 Place the standard 5500-g weight on the beater arm, and run the pulp-abrasive mixture for 2-3 min. Discharge the mixture, and wash all traces of abrasive from the diaphragm area.

6.4.4 Beat at least three standard charges of the reference pulp to approximately 200 mL Canadian standard freeness (CSF). Discard these runs, unless a freeness time check is required.

6.4.5 Check the beater calibration by making a complete beater run using the reference pulp (see 5.7). At the end of this treatment, the beater should be capable of reproducing the test results established for the reference pulp within the established repeatability limits. If not, proceed to the touch up grinding procedure and continue grinding until the test results of a complete reference beater run fall within the established repeatability limits of the reference pulp.

**NOTE 7:** Changes in water quality can cause significant changes in both beating rate and handsheet properties. Use ASTM Type II water for checking the reference pulp; however, water quality with a conductance of less than 4  $\mu\text{s}/\text{cm}$  has been found acceptable for accurate and repeatable test results.

6.5 *Touch-up grinding.* The touch-up procedure (2) should be used whenever: (a) the bedplate assembly chatters or vibrates excessively during the later stages of beating; (b) the beater gives reference-pulp results that fall outside the normal control limits, either in beating time or handsheet properties, (c) the impression does not show the complete mating of the flybars and bedplate bars.

6.5.1 Inspect both the bedplate bars and beater roll for excessive wear, misalignment or looseness. Replace the bedplate if the bars are worn more than 3.2 mm (1/8 in.) and the beater roll flybars if worn more than 1.6 mm (1/16 in.) from their original specifications. Check the clearance between the mounting metal and the leading edge of the bedplate bars, and adjust to provide a clearance of 1.0 mm (1/25 in.). Make a carbon paper impression to be sure the flybars and bedplate bars are mating and aligned.

6.5.2 If the beater chatters or develops freeness too slowly, grind the beater with a standard pulp charge containing 50 g of 120 mesh (125  $\mu\text{m}$ ) silicon carbide powder, using the standard weight on the lever arm, and continuing the treatment for 3 to 5 min. This treatment should be followed by the stabilization step and three beatings before checking the reference pulp.

6.5.3 If the beater develops freeness too quickly, hone the leading edges of the beater roll flybars to a radius of approximately 0.8 mm (1/32 in.) and repeat the stabilization step, followed by three beatings of high freeness pulp.

6.5.4 After touch up grinding, check the beater calibration by making a complete beater run using the reference pulp (See 5.7). At the end of this treatment, the beater should be capable of reproducing the test results of the reference pulp within the established repeatability limits. If not, repeat the touch up grinding procedure and continue grinding until the test results of a complete reference beater run fall within the established repeatability limits of the reference pulp.

6.5.5 Make periodic checks on the beater by making a carbon paper impression to check the alignment and mating of the flybars and bedplate bars. Then, process a complete reference pulp run for a calibration check. The beater is in calibration if the test results fall within the established repeatability limits of the reference pulp.

6.5.6 To keep the beater in calibration, prevent the beating action from continuing below the point where the pulp has reached 250 Canadian standard freeness. At lower freeness values, the wear on the beater bars becomes excessive and the beater will not remain in calibration as the beater will develop the properties too rapidly. Similarly, repeated processing of high-freeness, high-kappa pulps will dull the beater bars as the beater will develop the properties too slowly.

## 7. Sampling

7.1 When dealing with mill consignments, take samples of pulp of about 25 cm<sup>2</sup> (about 4 in.<sup>2</sup>) from the interior of every bale sampled in the official test for moisture (disks bored for the moisture test *but not dried* may be used). In the case of a shipment of chemical pulp where the cook numbers are known, take samples in proportion to the number of bales representing each cook, provided no fewer than three samples from each cook are obtained. When neither of these methods is possible, select enough samples to represent the quality of the whole consignment. For a single run, the weight of the samples required shall total at least 400 and preferably 450 g of moisture-free fiber.

7.2 Store moist pulp samples under water with a preservative and keep in a cool place away from direct sunlight. Store dry pulp samples away from heat or light.

**NOTE 8:** If prolonged storage is required, use of a preservative such as cupric sulfate (crystal), at a level of 0.1 to 0.5 ppm based on dry pulp weight, will permit storage at 9°C for at least 18 months without changes in freeness, strength, and optical properties. The use of formaldehyde, glutaraldehyde, or similar preservatives is discouraged because of their potential carcinogenicity.

## 8. Procedure

8.1 A normal beater curve shall consist of a zero-minute or unbeaten strength point and a series of five beaten strength points, taken at approximately equal freeness intervals during the beater run. Because of the wide variation in the freeness-time or maximum strength-time relationship, sampling schedules can be expected to vary for different pulps.

**NOTE 9:** Due to lower initial freeness values, bleached hardwoods may run only 4 more beaten points.

8.2 The use of Canadian standard freeness as an index of beating degree provides a basis for comparing beating behavior, providing that *the same type of beating apparatus is used for all tests*. The freeness-strength relationship may not be the same for different types of laboratory beaters.

8.3 For repeatable, reproducible results, and in all interlaboratory comparisons, distilled or deionized water must be used for both beating and freeness testing. Tap water will significantly affect the freeness values, beating time, and test data.

8.4 *Unbeaten strength or zero-minute point.*

8.4.1 Determine the unbeaten or zero-minute strength of the pulp on a separate portion of samples as specified in Section 6. Soak a 24 g (o.d.) test specimen in 2 L of water (1.2% consistency) for not less than 4 h before



testing. Disintegrate this test specimen in the standard disintegrator up to 75,000 revolutions, or 25 min at 3000 rpm, as described in TAPPI T 205.

**NOTE 10:** Fully bleached pulps usually need a less severe disintegration than the 25 min (75,000 rev) prescribed. A shorter time may be used but must be noted in the report. A good method is to make sequential visual checks for fiber bundles in slurry and terminate disintegration when none are present.

8.4.2 Withdraw 250 mL of stock and dilute to 1000 mL with deionized or distilled water adjusted to  $20 \pm 2^\circ\text{C}$ . Determine the CSF according to TAPPI T 227. Discard the pulp used in this test. Use additional 400 mL portions for handsheet preparation. For greater accuracy of sheet weights, TAPPI T 205 includes alternative acceptable dilutions and procedures.

#### 8.5 *Disintegration.*

##### 8.5.1 *Disintegrator method*

8.5.1.1 The disintegrator method of pulp dispersion is preferred to avoid the possibility that one or more pieces of dry lap pulp may not fully disintegrate in the beater.

8.5.1.2 Weigh the equivalent of two  $180 \pm 3$  (o.d.) gram portions representative of the original sample. For composite dry lap samples, take an equal weight of pulp from each of the sampled dry lap pulp sheets. Tear the test specimen, rather than cut it. Avoid the use of cut edges.

8.5.1.3 Soak the test specimen in deionized or distilled water, preferably overnight, but not less than 4 hours. (It is not necessary to soak pulps containing at least 50% moisture.) It has been found that increasing the soaking time for dry lap pulps from 4 hours to overnight may increase the tear strength for pulps beaten in a valley beater. Before charging the beater, the lever and bedplate should be balanced, with the roll running and with the beater filled with 23 L water at  $23 \pm 2^\circ\text{C}$ . The movable weight on the lever arm should be adjusted until the slightest pressure (approx. 50 g) on the lever will cause the bedplate to make contact with the roll. When the bedplate is in balance, drain the beater.

8.5.1.4 For each portion, add sufficient deionized or distilled water to bring the final volume to 10 L (1.8% consistency) and disintegrate the pulp using the standard disintegrator with the large container.

8.5.1.5 Add the two disintegrated portions of pulp and sufficient deionized or distilled water at a suitable temperature to give a final volume of 23 L, a pulp consistency of  $1.57 \pm 0.04\%$ , and a final temperature of  $23 \pm 2^\circ\text{C}$ .

8.5.1.6 Run the beater with no load for three min. After three minutes, stop the beater and check the consistency.

8.5.1.7 Alternative methods of disintegration are not in the scope of this method. An alternate procedure may change the freeness and/or the pulp properties.

**NOTE 11:** Using a low-shear laboratory mixer for dispersion may change the freeness, as well as pulp properties, burst, tensile, and tear. Dispersion in the beater may cause beater wear and incomplete dispersion.

#### 8.6 *Beating.*

8.6.1 When the pulp is properly disintegrated, remove the clamp from the lever arm, add the standard 5500-g weight to the lever arm, and start to time the beater operation.

8.6.2 If the beating characteristics of the pulp are known, withdraw a 1200-mL sample from the beater at successive time intervals (see Table 1) to yield a total of five samples at approximately equal freeness intervals. Each withdrawal shall provide a sample of 18.8 g (o.d.), to yield sufficient pulp for a freeness determination and 12 standard 1.2-g test handsheets.

**NOTE 12:** Regardless of the amount of beaten pulp required for testing, adoption of a standard withdrawal schedule is essential to maintain a uniform beating rate. Any change in the volume withdrawn can be expected to change the beating time, and the freeness-time relationship.

8.6.3 If the beating characteristics of the pulp are not known, take the first sample following 5 min of beating. Withdraw one sample of 1000 mL and a second sample of 190 mL, and stop the beater and timer.

8.6.4 Dilute the 190-mL sample to 1000 mL (0.3% consistency) with deionized or distilled water adjusted to  $20 \pm 2^\circ\text{C}$ . Determine the CSF as given in TAPPI T 227 and discard the pulp used in this test. Reserve the 1000 mL sample for handsheet forming.

8.6.5 Restart the beater and timer, and continue beating for an additional 10-15 min with a softwood sample (5 min with a bleached hardwood sample). Stop the beater and timer, withdraw a 190-mL sample, and determine its freeness. Freeness drop is approximately linear with time, and this test should be used to establish the sample withdrawal schedule for the unknown sample. If the freeness drop is satisfactory, withdraw an additional 1000-mL sample for handsheet forming.

8.6.6 Withdraw additional 1200-mL samples by the established schedule, to provide a total of 5 (or 4 with bleached hardwood) samples from the beater.

8.7 *Clearing and handsheet forming.*

8.7.1 Samples withdrawn from the beater must be cleared to avoid the effect of freeness reversion immediately prior to freeness testing or handsheet forming. Dilute each 1200-mL sample to 2000 mL in the container of the standard disintegrator (0.94% consistency). Clear the pulp by disintegration for 15,000 revolutions (5 min at 3000 rpm). All samples must be tested and processed within 30 min of clearing.

8.7.2 After clearing, if the freeness has not been determined, withdraw 319 mL of well-mixed sample. Dilute this stock with deionized or distilled water to  $20 \pm 2^\circ\text{C}$ . Determine the freeness according to TAPPI T 227. Dilute the remaining stock to 5280 mL (0.3% consistency) with deionized or distilled water. Make 1.2-g handsheets using 400 mL of diluted stock, as prescribed in TAPPI T 205. For greater accuracy of the final sheet weights, TAPPI T 205 includes alternate acceptable dilutions and procedures.

8.7.3 Where the freeness test has been determined on a separate 190-mL portion, dilute the remaining 1000-mL sample to 2000 mL (0.79% consistency) and clear by disintegration for 5 min. Dilute this sample to 5230 mL (0.3% consistency) in a suitable container. Make standard 1.2-g handsheets using 400 mL of the diluted stock.

**Table 1.** Suggested removal schedule.

	<i>Time, minutes</i>				
Weak bleached coniferous sulfite or deciduous alkaline pulps	5	10	15	20	30
Unbleached coniferous sulfite or bleached coniferous alkaline pulps	5	15	30	45	60
Strong unbleached coniferous alkaline and other very strong pulps	5	15	30	60	90

**Table 2.** Typical properties of unbleached kraft softwood reference pulp<sup>a</sup>.

<i>Beating time, min.</i>	<i>CSF<sup>b</sup>, mL</i>	<i>Bulk<sup>c</sup>, cm<sup>3</sup>/g</i>	<i>Burst index<sup>c</sup>, kPa.m<sup>2</sup>/g</i>	<i>Tear index<sup>c</sup>, mN.m<sup>2</sup>/g</i>	<i>Breaking length<sup>c</sup>, km</i>
0	694 ± 15	1.92 ± 0.10	1.83 ± 0.29	19.52 ± 2.67	3.31 ± 0.36
20	629 ± 29	1.64 ± 0.07	6.08 ± 0.33	14.38 ± 1.68	8.74 ± 0.94
49	518 ± 39	1.55 ± 0.04	8.39 ± 0.55	11.58 ± 1.58	11.19 ±
1.23					
70	400 ± 58	1.51 ± 0.04	9.10 ± 0.62	10.72 ± 1.00	12.10 ±
1.07					
82	324 ± 57	1.49 ± 0.04	9.49 ± 0.58	10.55 ± 1.19	12.46 ±
1.09					

<sup>a</sup>Data source: Standard Reference Pulp No. 4-84 (unbleached eastern softwood kraft pulp), Pulp and Paper Research Institute of Canada. The data is based on 17 beater runs with the limits expressed in accordance with the definition of repeatability in TAPPI T 1200.

<sup>b</sup>Freeness (CSF) see TAPPI T 227 "Freeness of Pulp."

<sup>c</sup>TAPPI Method T 220 can be referenced for bulk, burst index, tear, tear index, and breaking length; however, the results are calculated and reported on the oven dry grammage (mass per unit area), not conditioned, as noted in the method.

## 9. Report

9.1 Test the standard handsheets in accordance with TAPPI T 220. For comparing pulp behavior, the strength properties at 300 mL CSF are conventionally used. Many pulps show a maximum strength development at that freeness value.

9.2 Tests at 500 mL CSF may be considered more suitable for evaluating the response of a pulp to mill processing or stock preparation treatments.

## 10. Precision

10.1 Table 2 gives an example of the test results and repeatability limits of a typical unbleached softwood kraft reference pulp.

10.2 Beaters that have been calibrated using the prescribed standard practice were found capable of providing test results within those established limits. However, those test results and repeatability limits will vary depending on the pulp species, pulping process, and lignin content of the pulp selected as the reference pulp. For the individual tests, the precision statements for the referenced TAPPI methods are applicable and are in accordance with TAPPI T 1200 "Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility."

## 11. Keywords

Beaters, Beating, Beating time, Beating degree, Laboratory beating, Laboratory refining, Valley beater, Pulp.

## 12. Additional information

12.1 Effective date of issue: To be assigned.

12.2 The beater manufacture now recommends the use of a 1-hp motor; the 0.5-hp motor is still considered suitable.

12.3 Related methods: Canadian PAPTAC C2, SCAN C-25, ISO 5264 (Part 1).

12.4 This method has been corrected or revised in 1934, 1940, 1945, 1954, 1961, 1966, 1970, 1985, and 1996.

12.5 The 2006 revision includes a revised method for disintegration in order to simplify the procedure and standardize the nature of disintegrating equipment and simplify the calibration procedure.

12.6 The 2010 revision includes only grammatical and editorial changes.

## Literature cited

1. Poole, V. H., "A Method of Grinding and Calibration of the Valley Beater," *Tappi* **43** (3): 248 (1960).
2. Dinger, F., "The 80-Grit Touch-Up Method for Maintaining Calibration of the Valley Beater," *Tappi* **39** (10): 183A (1954).

3. Thomas, B., "Effects of Electrolytes in the Valley Beater Test," *Tappi* **43** (5): 447 (1960).

*Your comments and suggestions on this procedure are earnestly requested and should be sent to the TAPPI Standards Department.* ■