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T 476

BALLOT NO. 03 - SARG

DRAFT NO. 03

DATE November 03, 2026

WORKING GROUP CHAIR Alan Jaenecke

SUBJECT CATEGORY Physical 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 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.

Abrasion Loss of Paper and Paperboard (Taber-Type Method)

(Five-year review of Official Method T 476 om-21)
(Changes from Draft 2 Incorporated)

1. Scope

1.1 This method determines the resistance of paper and paperboard surfaces to the action of abrasion, either wet or dry, by measuring abrasion loss. This test is not applicable to surfaces treated with wax or similar materials which would fill in the pores of the abrasive wheels.

2. Significance

2.1 The resistance to abrasion of paper or paperboard surfaces is quite complex and involves many factors including fiber type, material structure, and any additives or bonding agents used. Surface sizing may increase abrasion resistance.

2.2 By combining abrasion test results with actual end use results, it is possible to predict usefulness and suitability of a product for a particular application. Two examples include predicting the abrasion of paper caused from the feeder mechanism of a of laser printer system and evaluating the adhesion of fused toner.

3. Definitions

3.1 *Abrasion:* the wearing away of any part of a material by rubbing against another surface.
3.2 *Resilient wheels:* wheels that are rubber-based and embedded with abrasive grit particles.
3.3 *Non-resilient wheels*: wheels that are vitrified-based and embedded with abrasive grit particles.

4. Apparatus

4.1 *Abrading instrument*, consisting of the following elements (see Fig. 1):
4.1.1 A horizontal turntable with a center clamp, which revolves at 72 ±2 rpm, upon which the specimen is attached. The surface of the turntable is covered with a disk of soft rubber material (see A.3). When testing flexible specimens, the turntable will also include a clamp ring.
4.1.1.1 For the wet abrasion test, a turntable with an annular raised rim is used to permit the surface of the specimen to be covered with water during the test. The surface of the turntable is covered with a disk of soft rubber material.
4.1.2 Two weighted pivoting arms, each carrying a special abrasive-embedded wheel. In all cases, the type of wheels shall be agreed upon by user and supplier. Each abrasive wheel shall be cylindrically shaped; have a diameter 44 to 51 mm (1¾ to 2 in.) and width 12.7 mm (½ in.); include an axial hole 16.0 mm (⅝ in.); and be composed of a special finely screened and standardized abrasive. The lines of contact of the wheels on the specimen are at right angles to the two pivoting arms and situated such that the wheels satisfy the requirements specified in A.2.1. When in contact with the specimen during the test, the two wheels revolve in opposite directions approximately twice during each revolution of the specimen and exert a combined abrasive, compressive, and twisting action over a circular path approximately 3000 mm^2 (4.6 $in.^2$) in area. Each wheel freely rotates on a ball-bearing horizontal spindle and rests on the specimen with a known dead-weight load. Accessory weight references are per arm (not combined), and include the mass of the pivoted arm.
4.1.2.1 For the dry paperboard test, 1000 gf or 500 gf is used with non-resilient wheels.
4.1.2.2 For the dry paper test, 500 gf or 250 gf is used with resilient wheels.
4.1.2.3 For the wet test, 500 gf is used with the same wheels as used in the dry tests.
4.1.3 A revolution counter to count the rotations of the turntable.
4.1.4 An adjustable vacuum system to remove debris during dry abrasion tests.
4.2 *Brush,* soft brush about 12-13 mm (½ in.) wide with bristles about 25 mm (1 in.) long.
4.3 *Filter paper,* sintered-glass or Gooch crucible, for wet abrasion residue.
4.4 *Refacing disk*, for resurfacing of resilient wheels. The refacing disk shall be 150 grit silicon carbide coated abrasive product, approximately 102 mm diameter with a 7mm center hole.
4.5 *Wheel refacer,* with a diamond tool for resurfacing non-resilient wheels.
4.6 *Analytical balance,* accurate to the nearest 0.1 mg.
4.7 *Water*, distilled or demineralized (for the wet abrasion test).
4.8 *Glass dish (or beaker),* for collecting liquid and debris from the wet abrasion test.
4.9 *Specimen mounting card,* a cardboard piece with adhesive to attach the specimen. It is used to “stiffen” the test piece and make it easier to attach to the turntable (optional).

NOTE 1: To eliminate the need to remove the test specimen from the turntable during dry abrasion tests that exceed 1000 cycles, a second turntable may be used for resurfacing resilient wheels.

Fig. 1. Abrading instrument (vacuum not shown)

5. Test specimen

5.1 If a lot of paper is being tested, select the test specimens in accordance with TAPPI T 400 "Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard or Related Product."

5.2 From each test unit, cut three or more square, octagonal, or circular specimen disks approximately 110 mm (4 in.) across, with a 6.35 mm (0.25 in.) center hole to permit clamping on the turntable. For paperboards greater than 3 mm (0.118 in.) thick, especially for the wet test, it may be necessary to split or suitably reduce the thickness of the specimen, taking care not to affect the surface to be tested. For flexible materials, the specimen may be mounted on a rigid mounting card. The specimen and mounting card should then be treated as the specimen (i.e., conditioned, weighed, mounted, and tested as a unit).

NOTE 2: Unless it is specified which side of the specimen is to be tested, identify the sides in some appropriate manner, and report results for each side separately.

6. Conditioning

6.1 Condition the specimens in an atmosphere in accordance with TAPPI T 402 "Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets and Related Products." Conduct the dry abrasion test in the same atmosphere.

7. Procedures

7.1 *Dry abrasion test*

7.1.1 Prior to testing, prepare the test wheels in accordance with the manufacturer's recommendations (see Appendix A.1).

7.1.2 Carefully brush the surface and edges of each test specimen then weigh each specimen to the nearest 0.1 mg.

7.1.3 Clamp the specimen (and mounting card if being used) on the turntable. Mount the correct test wheels and accessory weights as per section 4.1.2.1 or 4.1.2.2 and carefully lower them onto the specimen. Adjust the vacuum nozzle gap to 3 – 6 mm (⅛ to ¼ in.) and vacuum suction to 100%.

7.1.4 Reset the counter to zero, then subject the test specimen to abrasion until the endpoint is reached. Periodically remove accumulated debris with a brush, being careful to not disturb the underlying surface. Do not blow off debris. It has been found that a vacuum system for debris removal is essential to the precision of this method.

7.1.4.1 The endpoint for uncoated specimens is the point at which fiber disruption occurs.

7.1.4.2 The endpoint for coated specimens is either when the surface coating is removed and the underlying layer is exposed (multilayer coating) or when the fibers of the underlying substrate are disturbed (single layer coating).

7.1.5 When the test is complete, record the counter reading, remove the test specimen, and carefully brush off any loose fibers or particles. To avoid the effect of possible moisture loss of the sample, allow the sample to condition for at least 5 min and reweigh. Record the weight loss in milligrams (*L*).

7.2 *Wet abrasion test*

7.2.1 Prior to testing, prepare the test wheels in accordance with the manufacturer's recommendations (see Appendix A.1).

7.2.2 Carefully brush the surface and edges of each test specimen then weigh to the nearest 0.1 mg.

7.2.3 Thoroughly clean the rimmed turntable and mount the specimen to be tested.

7.2.4 Mount correct test wheels (see section 4.1.2.3) and 500 gf load on each pivoting arm and lower them onto the specimen. Reset the counter to zero.

7.2.5 Add sufficient distilled or demineralized water, at 23 ± 2°C, to flood the upper surface of the specimen and immediately begin test. Allow the test to proceed for the agreed number of test cycles or a sufficient length of time so that the surface of the test specimen is just completely removed.

NOTE 3: During the wet abrasion test, the vacuum is not utilized, nor is debris brushed from the specimen or wheels.

7.2.6 At the completion of the test, record the counter reading.

7.2.7 To prevent spillage, use a syringe to transfer some of the liquid from the rimmed table to a clean glass dish or beaker. Remove the rimmed table, and pour off the remaining liquid into the glass dish. Remove the specimen and with a washbottle or gentle stream of distilled or demineralized water, wash all the loose material from the surface of the specimen and from the inside of the turntable into the dish. Using a clean brush, remove any fibrous particles adhering to the wheels into the dish.

7.2.8 If the integrity of the specimen is not compromised, carefully remove it from the rimmed table. Otherwise, filter the liquid and washings on a dried, tared filter paper, or sintered-glass or Gooch crucible. For either option, dry at 105 ± 3°C to constant weight.

7.2.9 Condition the specimen or air dry material in an atmosphere in accordance with TAPPI T 402. Weigh the specimen to the nearest 0.1 mg, then record the weight loss in milligrams (*L*). Otherwise, weigh the air-dry material removed.

NOTE 4: Whenever possible, a prescribed number of revolutions to determine the end of the test should be used. This becomes a constant and makes sample comparison simpler. Abrasion loss becomes actual rather than calculated and removes the subjective determination of surface disruption.

8. Calculation

8.1 Calculate the abrasion loss, per 1000 revolutions of the turntable, as follows:

$$\text{Abrasion loss} = 1000\ L/R$$

where
L = weight loss, mg (or air-dry material removed, mg for wet abrasion tests)
R = counter reading (turntable rotations)

9. Report

9.1 Report abrasion loss in milligrams/1000 revolutions as the average result from a specified side of at least three specimens and the number of turntable revolutions to the endpoint. Specify type of wheel used, test load and whether test was done wet or dry. When doing wet abrasion, state if abrasion loss was determined by change in specimen mass or air-dry material removed. Also report the number of revolutions and the actual weight loss to the nearest 0.1 mg.

10. Precision

10.1 Repeatability, (as defined by TAPPI T 1200 "Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility").

10.1.1 *Dry abrasion test:*

Coated side = 84.3% based on 9 labs and 10 replicate samples
Uncoated side = 35.7% based on 7 labs and 10 replicate samples

10.1.2 *Wet abrasion test:*

Coated side = 88.5% based on 4 labs and 10 replicate samples

10.2 Reproducibility, (as defined by TAPPI T 1200).

10.2.1 *Dry abrasion test:*

Coated side = 144.6% based on 9 labs and 10 replicate samples
Uncoated side = 136.6% based on 7 labs and 10 replicate samples

10.2.2 *Wet abrasion test:*

Coated side = 163.4% based on 4 labs and 10 replicate samples

10.3 The round robin test conducted by an independent laboratory with ten different laboratories showed wide variation in reproducibility. The reason for this wide variation was believed to be due to difference in endpoint consideration by each participating lab. Each lab defined the endpoint differently as per their needs. Each lab, however, considered the test valid and very useful. The condition of the instrument and the wheels (new vs. old) may also be a factor affecting variability. Individuals should determine if the repeatability's and reproducibility's are satisfactory for their specific purpose.

11. Keywords

Abrasion, Abrasion resistance, Bonding strength, Surface strength, Coatings.

12. Additional information

12.1 Effective date of issue: To Be Assigned.

12.2 The principal changes made in the 2011 revision are the addition of a figure, correction of the distance of the wheels from the center of the turntable, addition of wheel resurfacing equipment, addition of the inner diameter of the disk center hole, addition of a note in the Appendix, and some editorial changes.

12.3 The principal changes made in the 2016 revision are correction of the turntable speed, updates to the wheel position description; clarification for when to reface wheels, additional calibration information along with Figure 2, and some editorial changes.

12.4 The principal changes made in the 2021 revision include separating elements of the apparatus description and test procedures into subsections, eliminating the references to equilibrium moisture from the wet abrasion test and replacing it with preconditioning and conditioning after drying, adding vacuum gap and suction

values, correcting 0.001 mg to 0.001 g, correcting the acceptable deviation for the turntable platform to 0.20 mm, and some editorial changes.

12.5 The principal changes made in the 2026 revision include correcting 0.001 g to 0.1 mg.

12.6 The quantity of material removed as a result of wheel wear in the wet abrasion test increases the abrasion loss slightly, but in general, this increase will be insignificant. It may be corrected approximately by determining the ash of the filtered material and the ash of the original paper or paperboard in accordance with TAPPI T 413 “Ash in Paper and Paperboard” and making the proper adjustment.

Appendix A: Calibration and maintenance

A.1 Prior to testing, ensure that wheels have been resurfaced according to the manufacturer’s recommendation. Resurface the wheels as follows:

NOTE A1: Due to clogging of the surface crevices with abraded debris, the abrading wheels should be resurfaced after testing a fiber surface containing fillers or coatings. To ensure that the abrading function of the wheels is maintained at a constant level during higher cycles tests, wheels should be resurfaced before testing each specimen and after every 1000 revolutions.

A.1.1 When refacing resilient wheels attach a 150 grit abrasive disk to the specimen holder. Lower the resilient wheels on the surface with the 500 gf test load attached. Subject the wheels to 25 resurfacing cycles or until the wheel’s contact area returns to original color. Each refacing disk shall be used for one resurfacing, not to exceed 50 cycles. During the resurfacing operation, continually remove abraded particles from the wheels and disk with the vacuum system.

A.1.2 When refacing non-resilient wheels use a diamond wheel refacer. Mount both wheels on the arbor and tighten the nut. Lower the refacer wheel guard and turn the refacer on. Screw in the diamond tool until the diamond can be heard to just touch the wheel. Then move the diamond out of the wheel path with the feed screw handle and advance the diamond holder ⅛ to ¼ of a turn and tighten. Use the feed handle to *slowly* traverse the diamond point forward and backward across the two wheel faces until no contact is heard. Continue to take light cuts as above until uniform coloring shows that working surfaces have been renewed. Use 150-grit abrasive paper to slightly round corners of abrasive wheels on both edges.

A.2 Verify calibration of the instrument as directed by the equipment manufacturer.

A.2.1 *Wheel Alignment and Tracking*—The wheels should be spaced equally on both sides from the wheel-mounting flange to the center of the specimen holder. When resting on the specimen, the wheels will have a peripheral engagement with the surface of the specimen, the direction of travel of the periphery of the wheels and of the specimen at the contacting portions being at acute angles, and the angles of travel of one wheel periphery being opposite to that of the other. Wheel internal faces shall be 52.4 ± 1.0 mm apart and the hypothetical line through the two spindles shall be 19.05 ± 0.3 mm away from the central axis of the turntable (Fig. 2).

A.2.2 *Wheel Bearings Condition*—The wheel bearings should be able to rotate freely about their horizontal spindles and not stick when the wheels are caused to spin rapidly by a quick driving motion of the forefinger.

A.2.3 *Vacuum Suction Force*—Air pressure in the suction device must not be lower than 137 millibar, as measured by a suction gage. Vacuum suction force may be influenced by the condition of the collection bag, which must be emptied or replaced on a regular basis. Any connection or seal leaks will also influence suction force.

A.2.4 *Turntable Platform Position*—The vertical distance from the center of the pivot point of the abraser arms to the top of the turntable platform should be approximately 25 mm. The turntable platform shall rotate substantially in a plane with a deviation at a distance of 1.6 mm from its periphery of not greater than 0.20 mm.

A.2.5 *Turntable Speed*—The turntable should rotate at the speed stated in 4.1.1.

A.2.6 *Load*—The accessory mass marked 500 g shall weigh 250 ± 1 g and the accessory mass marked 1000 g shall weigh 750 ± 1 g.

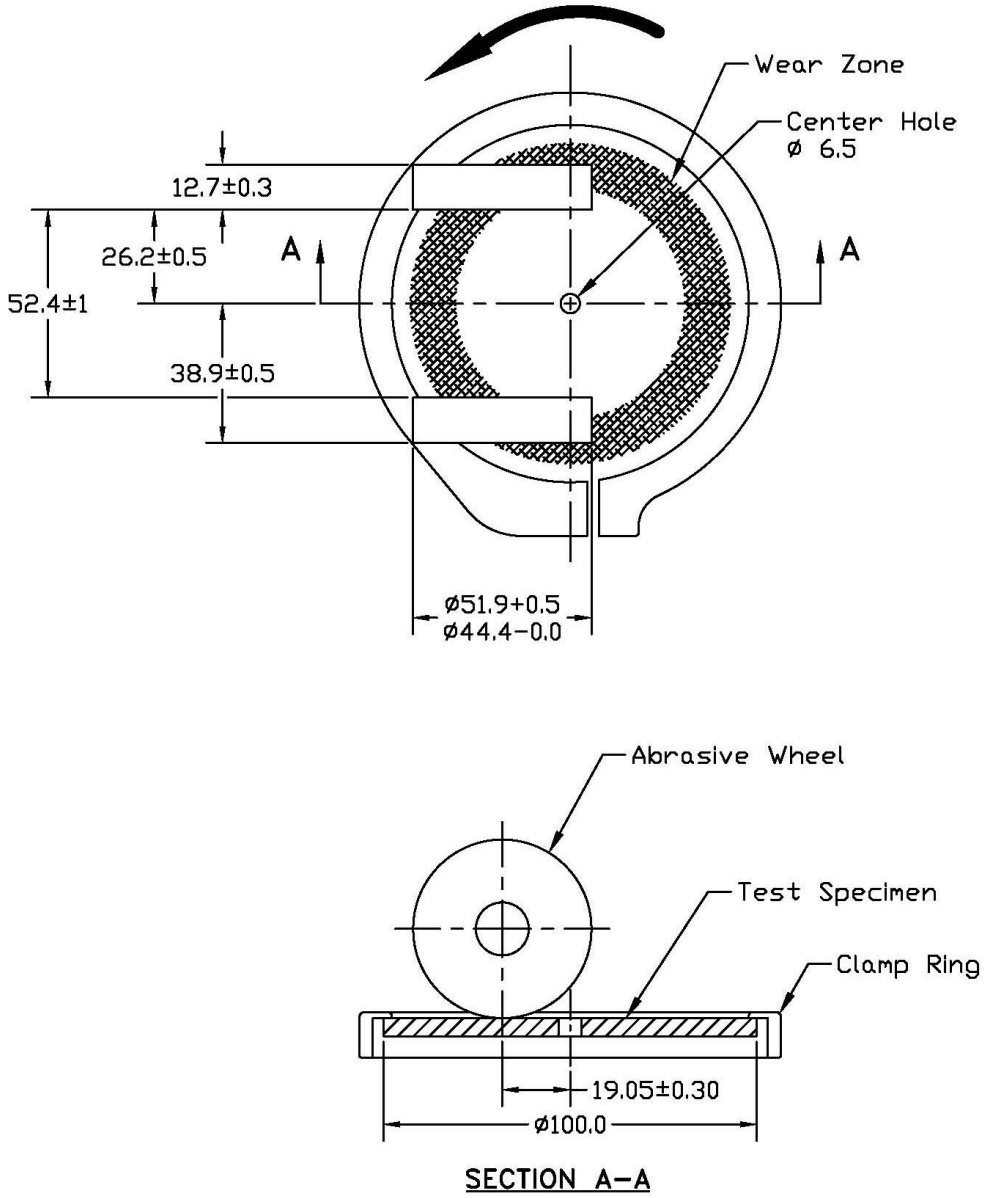

Fig. 2 Diagrammatic Arrangement of Test Set-up

A.3 The rubber platen pad of the instrument is to be maintained at 30 to 40 (Shore A) durometer per ASTM D 2240. The thickness of the platen pad shall be maintained at 6.35 mm to 8.89 mm and the thickness must not vary more than 0.508 mm over its entire area. If any wear is visually noticed (such as divots, dimples, eruptions, track marks or cracks), the platen pad must be replaced. The platen pad shall be replaced on a normal calibration cycle of between six months and two years, regardless of its wear properties.

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

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