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WORKING GROUP
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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.

Thickness of paper and paperboard (soft platen method)

Five-year review of Official Method T 551 om-18

1. Scope

1.1 This method describes a procedure for measuring the thickness of a single sheet of paper or paperboard using soft synthetic rubber platens against the paper to minimize the effect of surface roughness. This method is not to be confused with nor substituted for TAPPI T 411 "Thickness (Caliper) of Paper and Paperboard and Combined Board." It is to be used primarily for sheet density calculations. Because of the relatively high pressure (50 kPa), this method may not be suitable for measurement of tissue or other soft or low density materials, because the structure may collapse at the prescribed pressure of 50 kPa (7.2 psi).

1.2 Other methods which yield similar results are the mercury displacement method and the effective thickness concept (*I*).

1.3 TAPPI T 411 "Thickness (Caliper) of Paper, Paperboard, and Combined Board" describes a method

for measuring thickness using hard platens. This method is affected by surface roughness, and the measured thickness is always higher than that determined by the soft platen method.

2. Summary

This method measures the thickness of a single sheet of paper or paperboard using a micrometer equipped with soft synthetic rubber platens. The calibration and testing procedures are significantly different from methods using hard platen micrometers.

3. Significance

Paper thickness as measured by TAPPI T 411 (hard-platen method) is useful for product control purposes, design of end use products, and for acceptance testing for conformance to specifications. It is known, however, that the test result is affected by the surface roughness and compressibility of the paper being tested. The soft platen method largely eliminates the surface roughness effect and, because the platen closing pressure is more uniformly distributed over the test area, partially eliminates the compressibility effect. Hence, the soft platen method is preferred when the measured thickness is used to calculate sheet density (2). Soft platen thickness gives the same results as effective thickness, which is defined as theoretical thickness obtained from the relationship of extensional stiffness to bending stiffness.

4. Apparatus

4.1 A dead-weight type micrometer¹ provided with:

4.1.1 A flat ground circular movable face (the pressure foot) having an area of $200 \pm 5 \text{ mm}^2$ ($0.31 \pm 0.01 \text{ in.}^2$) and covered with a disc of soft, synthetic rubber (Durometer test 30 ± 2 Shore A scale) having a thickness of $0.86 \pm 0.02 \text{ mm}$ ($0.034 \pm 0.001 \text{ in.}$). See Appendix 1 for synthetic rubber recipe.

NOTE 1: The synthetic rubber discs should be equal or larger in diameter than the pressure foot face and their thickness should not vary more than 0.01 mm (0.0005 in.) within the active contact area. Preferably they should be held in place against their respective faces by mechanical or magnetic means thereby eliminating the error introduced by hard bonding epoxies. The synthetic rubber discs should be changed after approximately 100,000 cycles or two years whichever comes first. Frequency of replacement can be determined by calibration "drift."

4.1.2 A flat ground circular fixed face (the anvil) of such size that it is in contact with the whole area of the pressure foot in the zero position. The anvil shall be covered with a similar disc of soft synthetic rubber.

4.1.3 The pressure foot and anvil surfaces shall be parallel to within 0.01 mm (0.0005 in.) and the pressure

¹Names 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.

foot shall move on an axis perpendicular to the anvil.

4.1.4 Means for lowering the pressure foot at a velocity of 1.35 ± 0.55 mm/s (0.053 ± 0.022 in/s) and constant within ± 0.1 mm/s (0.004 in/s).

4.1.5 The pressure foot, when lowered, shall exert a steady pressure on the specimen of 50 ± 2 kPa (7.2 ± 0.3 psi) (500 g/cm²) for 3.0 ± 0.5 s.

4.1.6 Means for indicating the separation of the pressure foot and platen with an accuracy of 0.001 mm (0.00004 in.). A digital display with both zero and range adjustment is desirable.

4.1.7 Aluminum shims of various thicknesses and wider than 16 mm (active diameter). The thinnest shim should be about 0.020 mm (0.001 in.) and the thickest greater than the sample to be measured. The shims are used to calibrate the apparatus, and intermediate shims can be used to check linearity. All shims should be traceable through secondary standards to N.I.S.T.

NOTE 2: Shims of any hard, smooth and flat material can be used as long as the thickness is accurately known and their width is greater than 16 mm (0.628 in.). Aluminum is convenient since it is readily available in pure form, and the thickness of small pieces can be calculated using the density of aluminum. If roll stock is used it must be free of curl and must be wider than the pressure foot.

5. Calibration

5.1 Calibration against shim standards should be conducted daily.

5.2 For calibration and subsequent measurements the cycling rate of the pressure foot must remain constant so that the synthetic rubber experiences the same compression time and the same relaxation time during each cycle. Extended periods under compression or relaxation will require at least six full cycles of operation to achieve repeatable readings.

5.3 To calibrate the micrometer, insert the thin shim under the cycling pressure foot and adjust the zero control to read the shim thickness. Then insert the thicker shim and adjust the range or span control to read that shim's thickness. Repeat this process two or three times, fine tuning the adjustments until no significant change is observed. If this process is done carefully the calibration curve will intercept zero if a theoretically infinitely thin shim could be used.

5.4 Parallelism of the opposing faces is extremely important. Check this parallelism by removing the synthetic rubber discs and then following the same procedure required by hard anvil caliper methods, e.g. TAPPI T 411. The parallelism of the faces can be checked using a uniform diameter wire of any size up to half the operational opening of the faces, e.g. 0.5 mm (0.02 in.) diameter. Place the wire alternatively on the left side, right side, front side and back side approximately one-eighth in. from each respective edge of the foot and note the readings. Adjust anvil so that all readings are within 0.0125 mm (0.0005 in.) of one another.

5.5 Check the pressure between the faces by measuring the force required to just prevent the movement of the pressure foot.

6. Test specimens

For conformance testing, obtain a sample in accordance with TAPPI T 400 “Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard or Related Product.” Otherwise, select a sample appropriate for the purpose of testing. Cut ten representative specimens from the paper to be tested. Each specimen should be at least 40×40 mm ($1\frac{1}{2} \times 1\frac{1}{2}$ in.).

NOTE 3: If instrument is equipped with feed mechanism then cross machine strips may be used.

7. Conditioning

Precondition, condition, and test the specimen in accordance with TAPPI T 402 “Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets, and Related Products.”

8. Procedure

8.1 Mount the instrument on a solid level surface free from noticeable vibration, and calibrate the instrument as described in paragraph 5.3.

8.2. Place the specimen on the anvil so that all points on the periphery of the contact surfaces are at least 6 mm ($\frac{1}{4}$ in.) from the edges of the specimen. Lower the pressure foot at the prescribed speed, and record the thickness after 3.0 ± 0.5 s dwell time.

NOTE 4: If the meter reading continues to drift after 5 s dwell time, check the lowering mechanism for excessive friction. Continued drift might also indicate that the adhesive film, if used to hold the rubber disc in place, is too thick or of irregular thickness.

8.3 Take one reading on each of the ten test pieces.

NOTE 5: The pressure foot must be held in the raised position during the time readings are not being taken. Continued load on the synthetic rubber discs will cause a shift in calibration.

9. Report

Report the average and standard deviation of the ten tests to the nearest 0.1 microns as thickness (soft platen). Report the apparent density (soft platen) in g/cc^3 , if required, from (r/t) where r is the grammage in g/m^2 and t is the thickness in microns. Other units acceptable as agreed upon between users. Refer to TAPPI T 410 “Grammage of Paper and Paperboard.”

10. Precision

10.1 *Precision.* The following estimates of repeatability and reproducibility are based on data from an interlaboratory trial involving 11 laboratories and 6 different samples of linerboard and corrugating medium in the range of 7 to 9 mils (26 and 33 lb/1000 ft² medium, and 36, 42 and 69 lb/1000 ft² linerboard). The trial was conducted in May 1997 using the "om-92" revision of this method. Testing is based on 10 determinations per test result and 1 result per lab, per material. It was found that medium and linerboard performed differently in this interlaboratory trial.

10.2 *Linerboard:*

10.2.1 Repeatability (within a laboratory) = 6.5%

10.2.2 Reproducibility (between laboratories) = 10.0%

10.3 *Medium:*

10.3.1 Repeatability (within a laboratory) = 10.7%

10.3.2 Reproducibility (between laboratories) = 16.7%

10.4 Repeatability is an estimate of the maximum difference (at 95%) which should be expected when comparing replicate measurements for materials similar to those described above under similar test conditions. These estimates may not be valid for different materials or testing conditions.

11. Keywords

Thickness, Paper, Paperboard

12. Additional Information

12.1 Effective date of issue: To be Assigned

12.2 The soft platen instrument is basically an adaptation of one designed for T 411 with foot and anvil changes and cycle speed changes.

12.3 Soft rubber discs available only through instrument manufacturer.

13. Literature cited

1. Setterholm, V.C., *TAPPI* **57**(3): 164 (1974)
2. Wink, W.A. and Baum, G.A., *TAPPI* **66**(9): 131 (1983)

Appendix A

Synthetic rubber recipe for those who may wish to manufacture their own soft platens.

Synthetic Rubber recipe

	grams
Hycar 1042	1170.0
Hycar 1312	90.0
Agerite Staylites	25.2
Spider Sulfur	12.6
Vanfre AP 2	12.6
Stearic Acid	37.8
Zeolex 23	550.8
N-330 Carbon	30.0
Paraplex G-54	675.0
Diethylene Glycol	25.2
Zinc Oxide CNR	63.0
TMTD	6.3
Durax	37.8

Cure at 177°C (350°F) for six minutes.

Storage: Keep out of direct sunlight. Best to keep in cool dry place. Room temperature OK.

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

