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T _____ 580 _____

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WORKING GROUP
CHAIRMAN _____ Steve Berg _____

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 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.

Thickness (caliper) of towel, tissue, napkin and facial products

***(Revision and upgrade to Official Method of T 580 pm-12)
(no changes from Draft 2; editorial corrections incorporated)***

1. Scope

1.1 This method describes the procedure for measuring bulking thickness and variations in tissue paper and tissue products.

1.2 This test method uses a relatively low pressure 2 kPa (0.3 psi) because of the collapsible structure of tissue paper. TAPPI T 411 "Thickness (caliper) of paper, paperboard, and combined board" uses a relatively high pressure 50 kPa (7.3 psi).

1.3 An essentially identical method is described in ISO 12625-3 "Tissue paper and tissue products -- Part 3: Determination of thickness, bulking thickness and apparent bulk density."

2. Summary

The method involves measuring the thickness of a sheet or ply of tissue paper/product by the use of an automatically operated micrometer when a specified static load is applied for a specific time.

3. Significance

3.1 Thickness is an important property of tissue paper/products.

3.2 The thickness of tissue paper will determine end product properties such as stack height for folded products and roll diameter/firmness for rolled products.

3.3 Thickness is also important to the end consumer. Thick products are perceived to be stronger and more absorbent and of value to consumers.

4. Definition

Thickness or caliper of tissue paper/products as measured by this method is defined as the perpendicular distance between two principal surfaces of a sheet or ply of tissue paper under prescribed conditions, as measured between metal platens. This should not be confused with “apparent thickness,” which is calculated from basis weight and bulking thickness, (typical units are grams per cubic centimeter).

5. Apparatus

5.1 *Automatically-operated micrometer*, a dead-weight type instrument, provided with:

5.1.1 A flat ground circular movable face (hereafter called the pressure foot), having an area of 10.0 cm² (1.5 in.²) and corresponding diameter of 35.7 ± 0.1 mm (1.40 ± 0.04 in).

5.1.2 A flat, ground, circular, fixed face (hereafter called the anvil) of such size that it is in contact with the whole area of the pressure foot in the zero position. In practice, the anvil should have minimum dimensions 20% larger than the pressure foot.

5.1.3 Surfaces of the pressure foot and anvil shall be parallel within 0.003 mm (0.00013 in.). The pressure foot movement shall be on an axis perpendicular to the anvil. The opening between the pressure foot and the anvil is set by agreement between the instrument supplier and the customer. For most measurements, an instrument with an opening of 2 mm to 3 mm (0.08 in. to 0.12 in.) is sufficient.

5.1.4 Pressure foot lowering speed of 2.0 ± 0.2 mm/s (0.08 in./s).

5.1.5 Pressure foot, when lowered, exerting steady pressure of 2.0 ± 0.1 kPa (approximately 0.3 psi) for 2 ± 1 s.

5.1.6 The instrument read-out/scale shall be graduated in increments of 0.001 mm (0.00004 in.).

5.1.7 The accuracy of measurements is dependent upon the range of thickness being measured. The accuracy of the instrument readings should be within 0.25% of the thickness test range.

6. Calibration

6.1 *Accuracy of dial indications.* Use standard steel gauge blocks whose thickness is known to within 0.0005 mm (0.00002 in.). Use gauge blocks corresponding to approximately 10%, 30%, 50%, 70% and 90% of the full-scale reading of the micrometer. Prepare a calibration curve or table if necessary.

6.2 Digital instruments capable of greater accuracy may require standard steel gauge blocks accurate to within 0.00025 mm (0.00001 in.) or better.

6.3 *Parallelism of the faces.* Use a uniform diameter wire of any size up to half the operational opening of the faces, e.g., 0.05 mm (0.20 in.) diameter. Place the wire alternately on the left side, right side, front side, and back side approximately 3 mm (0.125 in.) from each respective edge of the foot and note the readings. Adjust anvil so that all readings are within 0.003 mm (0.00013 in.) of one another. A thickness gauge may be used if a uniform wire is not available.

6.4 *Pressure between the faces.* Within the normal thickness measuring range, measure the pressure exerted by the deadweight mechanism. The pressure foot on the anvil shall be 2 ± 0.1 kPa. Verify with any suitable means.

7. Sampling

Obtain a sample in accordance with TAPPI T 400 "Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Product."

8. Test specimens

8.1 Select each test piece so that it is free from perforations and faults not normally inherent in the tissue.

8.2 Cut test pieces to have a minimum dimension of 80 mm (3 in.) in any direction. Cut large test pieces to a reasonable size using scissors, a suitable cutting board, or die press. During this operation, the test pieces shall not be subject to pressure that could alter the thickness measurement.

8.3 *Single-ply thickness.* From each test unit of the sample, cut ten specimens, each specimen consisting of one ply of tissue. Take samples either directly from the tissue machine, or if practicable, from individual plies of a multi-ply product, sampled during or after the converting process. In the latter cases, take care to identify the location of individual plies in the product. Do not attempt to separate plies that are bonded with adhesive or pressure.

8.4 *Single-sheet thickness.* Prepare ten test specimens from a single- or multi-ply product sampled during or after the converting process.

9. Conditioning

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

10. Procedure

10.1 Before using the micrometer, make sure the pressure foot and anvil surfaces are clean, the calibration of the instrument has been verified and a calibration curve has been prepared, if necessary, and the instrument is mounted on a solid level surface free from noticeable vibration.

10.2 Allow the instrument to “warm-up” according to the manufacturer’s instructions.

10.3 Place the specimen on the anvil so that all points on the peripheries of the contact surfaces are at least 6 mm (approximately 0.25 in.) from the edges of the specimen.

10.4 Measure the thickness of ten specimens. Between successive readings, make sure that the working faces remain free from dust.

11. Report

11.1 Report the TAPPI method, the date and place of testing, the tester’s name and reference to the micrometer used. Report all details necessary to identify the material tested. Report the type of test; single-ply, or single-sheet thickness. For single-sheet tests, report the number of plies.

11.2 For each test unit of the sample, report the overall average of the 10 readings in millimeters (or inches) to the nearest 0.001 mm or in inches to the nearest 0.00004 in.) Also report the minimum, maximum and standard deviation for each sample set.

12. Precision

12.1 Repeatability (within a laboratory)

Facial Tissue	3.93%
Bath Tissue	1.58%
Kitchen Towel	1.43%

12.2 Reproducibility (between laboratories)

Facial Tissue	13.32%
Bath Tissue	4.97%
Kitchen Towel	5.08%

Repeatability and reproducibility are estimates of the maximum difference (at 95% confidence) that should be expected when comparing test results for materials similar to those described below under similar test conditions. These estimates may not be valid for different materials and testing conditions.

12.3 The precision estimates of repeatability and reproducibility are based on data from six different samples with 30 specimens per sample. One measurement per specimen for a total of 30 measurements for each sample type. Six laboratories were included in the facial tissue calculations and seven laboratories were included in the bath and kitchen towel calculations.

Units in mils

Material	Sample	Grand Mean	r TAPPI Repeatability	%r Repeatability	R TAPPI Reproducibility	%R Reproducibility
Facial Tissue	01	10.19	0.526	5.16%	1.251	12.27%
	02	6.84	0.185	2.70%	0.983	14.37%
Bath Tissue	01	19.31	0.177	0.92%	0.788	4.08%
	02	22.51	0.503	2.23%	1.321	5.87%
Kitchen Towel	01	40.43	0.417	1.03%	2.121	5.25%
	02	33.03	0.606	1.84%	1.626	4.92%

13. Additional information

13.1 Effective date of issue: To be assigned.

13.2 The thickness determined by this method cannot be used reliably to determine lineal footage or weight of a given diameter roll. This test specifies a compressive force of approximately 0.3 psi. Winders often develop compressive forces much higher than 0.3 psi. Tissue paper and products are usually highly compressible under force and consequently the calculation of footage or weight will not be accurate.

14. Keywords

Toweling papers, Tissue papers, Facial tissues, Napkin papers, Thickness

Appendix A.

A.1 To support the need for this procedure several different micrometers were used to measure the thickness of bond paper versus some kitchen towel product. Five different micrometers were employed. The micrometers differed mostly in the pressure applied to the material. The micrometers ranged in pressure from 0.7 psi to 7 psi. Table 1 shows the results from these measurements.

Table 1. Micrometer measurements.

Ordinary Copier Paper - 75 gsm					
Micrometer pressure	0.066 psi	0.21 psi	0.29 psi	0.52 psi	7.25 psi
	0.4 kPa	1.4 kPa	2 kPa	3.6 kPa	50 kPa
	4.0	4.1	4.0	3.9	4.1
	4.0	4.0	4.0	3.9	4.0
	4.1	4.1	4.1	3.9	4.0
	4.1	4.0	4.1	4.0	4.0
	4.1	4.0	4.1	4.0	3.9
	4.1	4.2	4.1	3.9	4.1
	3.9	4.1	4.1	3.9	4.1
	3.9	4.2	3.9	4.0	4.0
	4.2	4.1	3.9	3.9	4.0
	4.1	4.0	4.2	4.1	4.0
Average	4.1	4.1	4.1	4.0	4.0
Standard deviation	0.1	0.1	0.1	0.1	0.1
Ordinary Kitchen Towel Product - 50 gsm					
Micrometer pressure	0.066 psi	0.21 psi	0.29 psi	0.52 psi	7.25 psi
	0.4 kPa	1.4 kPa	2 kPa	3.6 kPa	50 kPa
	28.8	24.0	20.4	18.6	6.7
	28.8	23.5	21.3	20.2	6.7
	26.5	20.0	21.3	18.1	6.6
	29.0	23.0	21.9	17.5	6.8
	29.5	20.8	22.1	15.6	6.5
	29.8	22.8	21.8	20.7	6.4
	28.2	20.2	22.5	18.2	6.6
	27.4	21.0	22.7	20.1	6.5
	26.7	21.4	22.4	18.4	6.5
	27.7	22.2	22.1	21.1	6.6
Average	28.2	21.9	21.9	18.9	6.6
Standard deviation	1.1	1.4	0.7	1.7	0.1

A.2 Clearly the use of TAPPI T 411 using a 50 kPa pressure is not appropriate for measuring the caliper of compressible tissue products.

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