Designation: D 4250 – 92 (Reapproved 2003)

An American National Standard

Standard Test Method for Water-Holding Capacity of Bibulous Fibrous Products[1]

This standard is issued under the fixed designation D 4250; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method is designed for determining the water-holding capacity, C_{wh}, of bibulous papers such as facial tissues, towels, wipes, nonwovens, etc., using predetermined times of soaking and excess water extraction under a predetermined low suction head resulting from a controlled capillary draining action.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, and Related Product

D 685 Practice for Conditioning Paper and Paper Products for Testing

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Summary of Test Method

3.1 Following an initial weighing of the specimen, it is laid upon water for a period of 1 min. The wetted specimen is placed on an excess water extractor for 15 s, during which time the specimen experiences a 5-mm water-extracting suction caused by the difference between the top of the excess water extractor and the water level in the tray. After this, the specimen is again weighed. The observed gain in weight is used to calculate the water-holding capacity of the sample. This is expressed both as grams per square metre (g H_2O/m^2) and as the water/fiber ratio: grams of water per 1 g of conditioned product (g H_2O/g conditioned fiber).

4. Significance and Use

4.1 This test method provides a measure of the ability of a towel, or like material, to soak up water in the drying of surfaces, absorption of spills, etc.

4.2 Water-holding capacity, as measured by this method, discriminates well among different absorbing products.

5. Apparatus

5.1 *Flat-Bottomed Tray*, with approximate inside dimensions of 200 by 300 by 50 mm (8 by 12 by 2 in.).

NOTE 1—Some common 2-qt borosilicate glass baking dishes are adequate. Two brass washers may be glued to the bottom of the tray with silicone marine sealant to prevent displacement of the excess water extractor; the two washers may accommodate any two of the three brass screws that support the excess water extractor.

5.1.1 *Small Circular Spirit Level*.

5.1.2 *Pin and Bar Elevation Indicator*, set for 5 mm, see Fig. 1. The tip should be dipped in hot wax from time to time.

5.2 *Excess Water Extractor*, see Fig. 2.

5.3 *Specimen Catcher*, comprised of a piece of sheet aluminum, about 0.12 mm thick, 100 mm wide, and 125 mm long (0.0046 by 4 by 5 in.).

NOTE 2—This item can be cut from the bottom of a lightweight aluminum cake pan. Plastic sheeting should not be used in place of metal.

5.4 *Specimen Holder*, see Fig. 3.

5.4.1 *Polystyrene Foam Piece*, measuring about 13 mm thick, 50 mm wide, and 100 mm long (½ by 2 by 4 in.), to serve as backup in the use of the specimen holder.

NOTE 3—This can be cut from ½-in. thick insulation board.

5.5 *Distilled Water*— A supply of room temperature 23± 1°C (73° ± 2°F) distilled water about 50 cm above the tray.

5.5.1 *Siphon and Flexible Tube*, terminating with a short length of capillary tubing.

5.5.2 *Pinch Cock* (screw type), to regulate the stream of water into the tray at a rate between two and three drops per second, more when a heavy material is under test. The flow rate should be such that the amount of water flowing in 1 min is several times the weight of water absorbed by a specimen.

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[1] This test method is under the jurisdiction of ASTM Committee D06 on Paper and Paper Products and is the direct responsibility of Subcommittee D06.92 on Test Methods.

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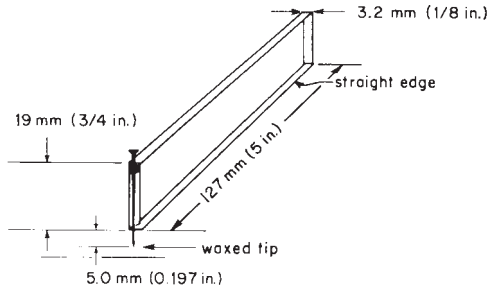
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.



NOTE 1—The apparatus is made from 3.2-mm (⅛-in.) methyl methacrylate sheet. The pin (an ordinary silk pin) may be glued to an end face of the bar with an epoxy glue. The 5-mm extension may conveniently be set by means of the depth indicator of a vernier caliper. The pin tip should be dipped in hot paraffin wax from time to time.

FIG. 1 Pin and Bar Elevation Detector

5.6 *Vertically Mounted Glass Eye Dropper*, tapered end down and with its tip immediately above the water surface in the tray. The inside diameter of the tapered end should be between 2.0 and 2.3 mm.

5.6.1 *Aspirator*—The eye dropper is connected to an aspirator, to remove excess water from the tray and to control the water level through vertical adjustment of the eye dropper.

5.6.2 *Holder*, for the eye dropper, see Fig. 4.

5.6.3 *Float Valve*— Alternatively, a float valve so designed that it will control the water level to the desired position to within ±0.3 mm.

NOTE 4—If a float valve is used, it should be freely connected to a siphon tube carrying water from the reservoir listed in 5.5, and the short length of capillary tubing and pinch cock there mentioned should be at the bottom end of a siphon tube running from the tray to a receptacle on the floor. See 5.5.2 for rate control.

5.7 *Top Platform Balance*, with accuracy of 1 mg.

5.8 *Stopwatch*, or equivalent timer, ±1 s at 60 s.

5.9 *Thermometer*, ±0.5°C.

5.10 *Paper Towels*, for blotting and wiping.

5.11 *Precision Die Cutter*, to ensure the tolerance in each dimension of 0.5 mm (0.02 in.).

6. Sampling

6.1 If applicable, sample in accordance with Method D 585.

7. Test Specimen

7.1 From each test unit of the sample, cut at least five conditioned specimens, each measuring 76.2 by 76.2 mm (3.00 by 3.00 in.), and indicate the machine direction on each specimen.

7.1.1 Do not subject the specimens to compressing, spreading, or stretching action at any time. No foam insert should be used in specimen die cutters.

8. Preparation of Apparatus

8.1 Clean the excess water extractor, tray and other apparatus with a dishwashing detergent, using a suitable brush. Rinse thoroughly with distilled or dionized water.

8.2 Locate the excess water extractor in the right half of the glass tray.

8.2.1 The slots in the excess water extractor should be perpendicular to the long dimension of the tray.

8.2.2 Position the excess water extractor such that a space of at least 25 mm (1 in.) exists between the right end of the excess water extractor and the inner right edge of the tray.

8.3 Place the circular spirit level on the top surface of the excess water extractor, and level the excess water extractor by means of the three brass screws.

8.4 Remove the spirit level and place the pin and bar elevation detector on the excess water extractor, with the pin located at least 15 mm, no farther than 30 mm, from the left edge of the excess water extractor, pointing vertically downwards.

8.4.1 Pour water into the tray until the waxed pin-point of the bar elevation detector touches the surface of the water.

8.4.2 Adjust the flow from the reservoir to be between two and three drops per second (see 5.5.2). Locate the eye dropper leveling device out of the way, near the back edge of the tray and vertically adjust the eye dropper in its holding clamp to control the water level as set in 8.4.1.

NOTE 5—With the aspirator turned off, this adjustment may be initiated by vertically adjusting the eye dropper so that its tip appears to be about 2.5 mm (0.1 in.) above the water surface. Precise adjustments can be made after turning on the aspirator. The operator should make certain that the water has risen uniformly in the slots and that no air is trapped under the specimen.

8.5 Place the specimen catcher on a paper towel at a point immediately to the right end of the tray.

8.6 Record the temperature of the water in the tray. Repeat at suitable intervals.

9. Conditioning

9.1 Precondition and condition the test units in accordance with Method D 685.

9.2 Cut specimens and perform test in the conditioned atmosphere.

10. Procedure

10.1 Weigh specimen catcher and record weight. If possible, tare catcher by zeroing balance with specimen catcher on pan.

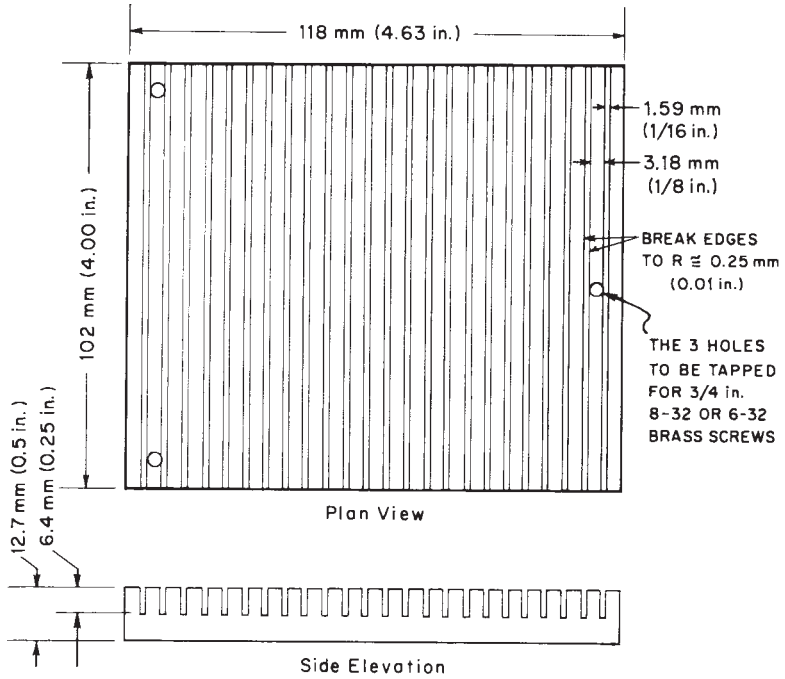
10.2 Weigh the combination of specimen catcher and specimen and record the result.

10.3 Place the specimen upon backup foam plastic (5.4.1) with the side that is to be laid in contact with the water facing up and with a cross machine edge of the specimen in approximate coincidence with a long edge of the back-up foam plastic.

10.3.1 With the row of bent pins of the specimen holder (5.4) pointing down, push the specimen holder hooks through the specimen, with the line of perforations 2 to 3 mm from the specimen edge. The use of a small bar over the bend in the pins minimizes the chance of bending the pins.

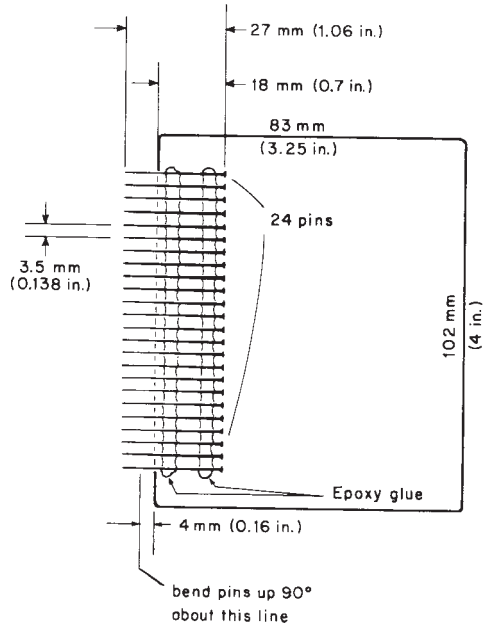
NOTE 6—Facilitate later manipulations by marking the perforations in the backup foam plastic with a sharply pointed black felt pen.

10.4 Invert the specimen holder and specimen so that the hooks point up.



NOTE 1—The apparatus is made from 12.7-mm (½-in.) aluminum plate, preferably by milling. The three holes are threaded to receive either 8-32 or 6-32 ¾-in. brass screws.

FIG. 2 Excess Water Extractor



NOTE 1—The apparatus is made from 1.6-mm (1/16-in.) aluminum sheet and the pins are ordinary silk pins. Placement of the pins may conveniently be done by leaving them partially in the paper into which they have been machine set for marketing. Bending of the pins (after the epoxy glue has set) may be done around the edge of a board having a corner radius of curvature of roughly .75 mm.

FIG. 3 Specimen Holder

10.4.1 Lay the specimen on the water (with the designated side down) in the area to the left of the excess water extractor, with the specimen holder on the right side of the specimen.

10.4.2 Start the stopwatch or timer at the moment the specimen contacts the water.

NOTE 7—If the specimen does not wet readily, it may be desirable to push it under. In this event, record the action.

10.5 At 59 s, deftly lift the specimen from the water and immediately lay it on the excess water extractor.

10.5.1 In the latter act, locate the left (trailing) edge of the specimen near the left edge of the excess water extractor, and hold the specimen holder at a low angle, with the back of the row of hooks resting on the excess water extractor.

10.5.2 Minimize the time between first and last contact of the specimen with the excess water extractor.

10.5.3 The specimen must lie flat on the excess water extractor, with no wrinkles or ruffles.

10.6 At 75 s (15 s on the excess water extractor) lift the specimen from the excess water extractor and lay it on the specimen catcher.

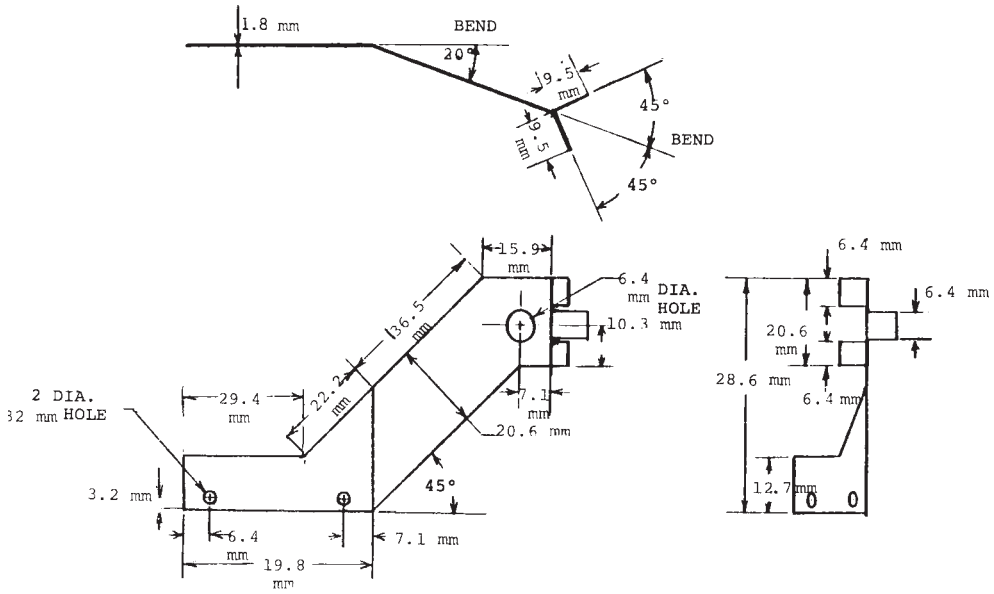
10.6.1 Perform the lift and transfer to the specimen catcher in about 3 s, and avoid a quick or jerking removal.

10.6.2 Avoid undue delay in making transfer as the loss of one drop of water could introduce a significant error in the testing of very light materials, if the drop misses the specimen catcher.

10.7 With the back of the row of hooks resting on the specimen catcher, disengage the specimen holder.

10.7.1 Rotate it counterclockwise (around the row of hooks) to about “11:00 o’clock.”

10.7.2 Move the holder off to the right in such a manner that the hooks cleanly disengage themselves from the specimen.



NOTE 1—mm = 0.04 in.

NOTE 2—The apparatus is made from 1/32-in. stainless steel sheet. Clockwise, lower left, side elevation, plan view, and view along upper vertical plane. Attachment of holder is to back edge of Excess Water Extractor, Fig. 2, by means of the two 1/8-in. holes. The tapped holes in the back edge of the Excess Water Extractor may be located 33.3 mm (1 5/16 in.) and 65.1 mm (2 9/16 in.) from the left end, and 3.2 mm (1/8 in.) above the bottom surface of the Excess Water Extractor. The eye dropper is held against the 90° V-notch (plan view) by means of a small extension spring or elastic band.

FIG. 4 Eye Dropper Holder

10.7.3 If the specimen tends to slide on the specimen catcher, restrain it by holding down with a clean, dry, narrow stainless steel spatula.

10.8 Weigh the combination of specimen catcher and wet specimen without delay and record the result.

10.9 Discard the specimen, lay the specimen catcher upon a paper towel, and blot and wipe both sides dry. Wiping strokes should be away from the held edge only, as back and forth wiping tends to damage the foil.

10.10 Test at least five specimens, all in the machine direction.

10.10.1 Repeat for other side unless the request specifies a designated side only.

10.11 Reject readings from individual tests in which any procedural step was questionable.

11. Calculation

11.1 Calculate and record the dry specimen weight, W_d, and the wet specimen weight, W_w, in grams, by subtracting the known weight of the specimen catcher from the combined weights observed in 10.2 and 10.8.

11.1.1 Taring of specimen catcher eliminates this calculation.

11.1.2 Calculate the dry grammage in grams per square metre by multiplying the dry specimen weight by 172 (= 10 000 cm^2/58.06 cm^2). Grammage = $W_d \times 172$.

11.2 Calculate the water held, W_h, by the specimen, in grams, by subtracting the dry specimen weight from the wet specimen weight.

$$W_h = W_w - W_d \quad (1)$$

11.3 Calculate the water-holding capacity as grams of water held per square metre by multiplying the water held by the specimen by 172.

$$C_{wh} = W_h \times 172 \quad (2)$$

11.4 Calculate the water-holding capacity of the water/fiber ratio by taking the quotient of the water held to the dry specimen weight.

$$C_{wh} \text{ of water/fiber ratio} = (W_h/W_d) \quad (3)$$

12. Report

12.1 Report the average dry grammage of the specimens in grams per square metre. Report also the minimum and maximum values or the standard deviation, if requested.

12.2 Report the average water-holding capacity as grams of water held per square metre (for each side if requested). Report also the minimum and maximum values or the standard deviation, if requested.

12.3 Report the average water-holding capacity as water to fiber ratio (for each side, if requested). Report also the minimum and maximum values or standard deviation, if requested.

13. Precision and Bias

13.1 *Precision*:

13.1.1 The repeatability and reproducibility given below are in accordance with the definitions of these terms in Practice E 691 (at 95 % probability level). These values have been calculated for test results, each of which is the average of five determinations as specified in this test method. The values are

based on an interlaboratory study involving seven laboratories in which each laboratory made six determinations of water-holding capacity on each of 19 towel products having water-holding capacity ratios from 3.2 to 16.4 g of water per 1 g of fiber. For each towel product the total number of required test specimens for all of the laboratories together were taken from a single roll or package and randomized before distribution to the laboratories.

13.1.2 Repeatability (within laboratory) 4.9 % (range 2.8 to 7.0 %).

13.1.3 Reproducibility (between labs) 22.8 % (range 7.7 to 34.3 %).

13.2 *Bias*—The procedure for this test method has no bias because the value of water–holding capacity is defined only in terms of this test method.

14. Keywords

14.1 bibulous fibrous products; facial tissue; towels; water absorption; water-holding capacity