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D3512

Standard Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Random Tumble Pilling Tester
Scope - This test method covers the determination of the propensity of a fabric to form pills and other related surface changes on textiles using the random tumble pilling tester. The procedure is generally applicable to all types of woven and knitted apparel fabrics.

Note:
Some fabrics that have been treated with a silicone resin may not be satisfactorily tested by this procedure because the silicone resin may transfer onto the cork liners in the test chamber and cause erroneous results.
Summary of Method

Pilling and other changes in surface appearance, such as fuzzing, that occur in normal wear are simulated on a laboratory testing machine. Pills are caused to form on fabric by a random rubbing action produced by tumbling specimens in a cylindrical test chamber lined with a mildly abrasive material.

To form pills with appearance and structure that resemble those produced in actual wear, small amounts of short-length gray cotton fiber are added to each test chamber with the specimens.

The degree of fabric pilling is evaluated by comparison of the tested specimens with visual standards that may be actual fabrics, or photographs of fabrics, showing a range of pilling resistance. The observed resistance to pilling is reported using an arbitrary rating scale.
Significance and Use

This method of testing fabrics for resistance to pilling is not recommended for acceptance testing. The pilling of textile fabrics is a very complex property because it is affected by many factors which may include type of fiber or blends, fiber dimensions, yarn and fabric construction, fabric finishing treatments and refurbishing method.

If it is used for acceptance testing, it should be used with caution because the between-laboratory precision is poor. In some cases the purchaser and the supplier may have to test a commercial shipment of one or more specific materials by the best available test method, even though the test method is not recommended for acceptance testing.
Apparatus

1. Random Tumble Pilling Tester

2. Cork Cylinder Liners, about 146 mm [5.75 in.] wide by 452 mm [17.81 in] long cut from 1.5-mm [.063-in.] thick flat sheets of Type P2117A material conforming to Classification System F104, Appendix X1. The original surface of the liner, produced by slicing the material, should be used without any further treatment such as sanding. Store liners in original packaging in a cool, dry place.
3. Air Injection Device to give 14-21 kPa [2-3 psi] air pressure in each test chamber, either included in new testers or a modification to older testers.

4. Adhesive, white all-purpose, for sealing edges of specimens. PlasticBottle, with dispensing spout and cap, for use with diluted adhesive.

5. Vacuum Cleaner, home canister type, to clean specimens after testing.

6. Cotton Sliver, 4301 tex [approximately 73 Grain Count], U.S. upland cotton with a micronaire range of 3.8 - 4.2 with a minimum staple length range of 1.08-1.10 in. (or 35/32 in., no metric conversion) measured by USDA High Volume Instrument Classification.
8. Apparatus for Fabric Evaluation—Facilities for illumination (cool white fluorescent tube) and simultaneous viewing of test specimen and fabric or photograph rating standards.

9. Rating Standards:
   a. Fabric—A series of tested specimens of a specific fabric type which shows degree of pilling or other distortion, or both, for each type of fabric to be tested.
   b. Photographic—A set of five photographs, 105-mm square [4.13 in.], numbered 1 to 5 illustrating varying degrees of pilling from "very severe pilling" to "no pilling". The photos should have a dull matte finish and be of the same size as the tested specimen.
   c. Digital Imaging or Rating System, or both.

10. Facilities for Laundering Samples—if needed.

11. Facilities for Dry Cleaning Samples—if needed.
Sampling and Test Specimens

- Samples may be washed or dry cleaned before cutting the test specimens, using conditions appropriate for the fabric end use or conditions agreed upon by all interested parties.

- Expose specimens and cork liners to moisture equilibrium for testing in the standard atmosphere for testing textiles as directed in Practice D3776.

- Cut specimens in squares 105 mm [4.13 in.] on the bias at an approximate 0.78 rad [45°] angle to the warp (wale) and filling (course) directions.

- Take three specimens from each laboratory unit and select them randomly across the width of the laboratory sample or from three different panels in a garment. Specimens should be staggered in such a manner that no two specimens contain the same yarns. Avoid areas with wrinkles and other distortions. Unless otherwise specified, do not cut specimens nearer the selvage than one tenth the width of the fabric.

- Mark replicate specimens in one corner on the face of the fabric with the appropriate number 1, 2, or 3.
Sampling and Test Specimens

• If loosely woven specimens fray when applying identification markings, cut the specimens with sides parallel to the warp and filling and ravel the sides no more than 5 mm [0.2 in.] on each side, leaving the fringe.

• Seal the edges of all specimens to a width not exceeding 3 mm [0.13 in.] on the face of the fabric with adhesive. Hang the specimens on racks until dry, and in any case for at least 2 h.

NOTE 3: Full-strength adhesive or any dilution down to 1 part adhesive with 1 part water may be used. Pressing the adhesive into the specimen face may be accomplished using the dispensing nozzle in a closed configuration. The rounded end of a glass stirring rod works well, also, but caution should be used to prevent breakage and possible injury from broken glass.

NOTE 4: Although the use of glued or not glued specimens is acceptable, the measurements should not be compared.
Preparation of Test Equipment

• Fit a cork liner snugly around the inside of a cleaned test chamber with an unused cork surface facing the rotor blades. The side against the chamber may or may not have been used. To eliminate any tendency for the liner to rotate, tape the outside edge of the liner to the chamber wall at the butt joint with a short piece of 25-mm [1-in.] wide masking tape. Or snip 3 mm from end and butt join the cork and force removal of wrinkle to lay flat.

• Discard cork liners that have been used for 1 h on each surface.

• After every hour of machine running time, remove the liner and clean the impeller by wiping with a cloth wetted in a solution of detergent and water. Allow the chamber to dry before the next use.

• Check the operation of the pilling tester with one or more standard in-house fabrics of known pilling resistance as follows:

If the equipment is in constant use, check the tester at least once a week; if testing is done infrequently, check the equipment each time it is used. Check, also, when test results appear questionable, or following a change in test equipment such as the use of a new shipment of cork liners.
Procedure

• Place three specimens, all from the same sample, and about 25 mg of 6-mm [0.2-in.] gray-dyed cotton fiber into the test chamber. Do not mix specimen types. NOTE: The mass of a 6-mm long section of 4301 tex sliver is about 25 mg.

• Turn the motor switch to "ON," push the "START" button, and start the airflow.

• In the course of the run, check each test chamber at frequent intervals. If a specimen wedges around the impeller without tumbling or lies inert on the bottom or side of the chamber, shut off the air, stop the machine, remove the face plate, and free the specimen. When a specimen wedges around the impeller during a run, stop the test, and clean the impeller blade.

• After each time run remove each specimen and clean off the excess cotton fiber that is not actually entangled in pills using the vacuum cleaner. Firmly grasp the specimen by a corner and allow the vacuum suction to draw the specimen inside. Repeat, holding an adjacent corner. Vacuum all specimens in this manner. Vacuum-clean the test chamber. Clean around the shaft of the impeller using a sharp instrument, such as a pick needle, to remove trapped debris.
Procedure

- Evaluate Using the Pilling Viewing apparatus
Evaluation

Assign a grade rating to each specimen

For pilling:
5—no pilling
4—slight pilling
3—moderate pilling
2—severe pilling
1—very severe pilling

For fuzzing:
5—no fuzzing
4—slight fuzzing
3—moderate fuzzing
2—severe fuzzing
1—very severe fuzzing

Note: Half steps may be applied
Result and Reporting

• State that the specimens were tested as directed in Test Method D3512. Describe the material or product sampled and the method of sampling used.

• Report the following information for the laboratory sampling unit and for the lot as applicable to a material specification or contract order.

• Ratings of each individual specimen, the average rating of the three specimens from each laboratory sampling unit, and the average for the lot

• Also report:
  • If the edges of specimens were glued or not glued with adhesive,
  • If the fabric was washed before testing, laundering conditions used,
  • If the fabric was dry-cleaned before testing, conditions used,
  • Running times, and
  • Type of viewing apparatus, viewing option, and rating standard used.
D4970

Standard Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Martindale Tester
Scope: This test method covers the determination of the resistance to the formation of pills and other related surface changes on textile fabrics using the Martindale tester. The procedure generally is applicable to all types of fabrics, being particularly suitable for woven fabrics.

This test method is not suitable for fabrics thicker than 3 mm [0.125 in.] because such fabrics cannot be mounted in the specimen holder.

The fabric may be laundered or dry cleaned before testing.
Summary of Method

Pilling and other changes in the surface appearance, such as fuzzing, that occur in normal wear are simulated on a laboratory testing machine. Fabrics are mounted on the Martindale Tester, and the face of the test specimen is rubbed against the face of the same mounted fabric in the form of a geometric figure, that is, a straight line, which becomes a gradually widening ellipse, until it forms another straight line in the opposite direction and traces the same figure again under light pressure for a specific number of movements. The degree of fabric pilling or surface appearance change produced by this action is evaluated by comparison of the tested specimen with visual standards that may be actual fabrics, or photographs of fabrics, showing a range of pilling resistance. The observed resistance to pilling is reported using an arbitrary rating scale.
Significance and Use

The pilling of textile fabrics is a very complex property because it is affected by many factors that include type of fiber or blends, fiber dimensions, yarn and fabric construction, and fabric finishing treatments. The pilling resistance of a specific fabric in actual wear varies more with general conditions of use and individual wearers than in replicate fabric specimens subjected to controlled laboratory tests. This experience should be borne in mind when adopting levels of acceptability for a series of standards.

Finishes and fabric surface changes may exert a large effect on pilling. It is recommended that fabrics be tested after laundering or drycleaning, or both. Testing before refurbishing also may be advisable.

This test method is applicable to a wide variety of woven and knitted fabrics that vary in pilling propensity as a result of variations in fiber, yarn and fabric structure, and finish. The applicability of this test method to nonwoven fabrics has not been determined.
Apparatus

• Martindale Tester
• Standard Felt, of mass $750 \pm 50 \text{ g/m}^2$ $[22 \pm 1.5 \text{ oz/yd}^2]$ and $3 \pm 0.3 \text{ mm}$ $[0.12 \pm 0.01 \text{ in.}]$ thick.
• Polyurethane Foam Backing—$0.12 \pm 0.04 \text{ in.}$ $[3 \pm 0.01 \text{ mm}]$ thick, $1.94 \text{ lbf/ft}^3$ $[29 \text{ to } 31 \text{ kg/m}^3]$ density, and $38.23 \text{ to } 47.22 \text{ lbf}$ $[170 \text{ to } 210 \text{ N}]$ hardness.
• Apparatus for Fabric Evaluation
• Standard In-House Pilling Test Fabric, having an established pilling resistance rating for checking machine performance.
• Rating Standards: Photographic or Fabric specimens
• Fabric Punches or Press Cutters, $38 \text{ mm}$ $[1.5 \text{ in.}]$ and $140 \text{ mm}$ $[5.5 \text{ in.}]$ in diameter.
• Facilities for Laundering Samples, if needed.
• Facilities for Drycleaning Samples, if needed.
Sampling and Test Specimens

Unless otherwise specified, samples should be washed or drycleaned before cutting the test specimens. Conditions appropriate for the fabric end-use or conditions agreed upon by interested parties should be used.

Randomly select and cut four pairs of circular specimens from each swatch in the laboratory sample with one of each pair of specimens being 38 mm [1.5 in.] in diameter and the other 140 mm [5.5 in.] in diameter.

Avoid areas with wrinkles and other distortions. Unless otherwise specified, do not cut specimens nearer the selvage less than $\frac{1}{10}$ of the width of the fabric.
Procedure

- Make all tests in the standard atmosphere for testing textiles.

- Mount one 140-mm [5.5-in.] diameter of standard felt and one fabric specimen on each table. Place one 38-mm [1.5-in.] diameter disk of 3-mm polyurethane foam and a specimen of the same fabric in each of the holders, making sure the face of the fabric is exposed for both specimens.

- Place the specimen holders on the same table as the other fabric specimen and insert a spindle into each specimen holder to give a pressure on the larger specimen of approximately 3 kPa [0.44 psi]. This pressure is the same as any other setup but without additional weights.

- Start the machine and allow it to run for 100 movements. Run additional movements in increments of 100 up to 1000 movements as directed in a material specification or contract. Rate the specimen at each specified interval and record the final rating.
Place the 38-mm [1.5-in.] disk specimen squarely on the double-faced tape / platform in the viewing cabinet. Rate according to scale below.

For pilling:
5—no pilling
4—slight pilling
3—moderate pilling
2—severe pilling
1—very severe pilling

For fuzzing:
5—no fuzzing
4—slight fuzzing
3—moderate fuzzing
2—severe fuzzing
1—very severe fuzzing
Result and Reporting

• Provide ratings of each individual specimen for pilling, the average rating of the four specimens from each laboratory sampling unit, and the average for the lot.

• Report if the fabric was washed before testing, laundering conditions used.

• Report if the fabric was drycleaned before testing, conditions used.

• Report Number of movements.

• Report Type of viewing apparatus, viewing option, and rating standard used.
ASTM D 3786

Bursting Strength, Diaphragm Method
ASTM D3786
Bursting Strength, Diaphragm Method

• Scope - this method describes the determination of the bursting resistance of a wide variety of textile fabrics using a hydraulic or pneumatic diaphragm type tester

• Summary of Method- a fabric (woven or knit) is clamped over an expandable diaphragm. The diaphragm is expanded by either fluid (liquid or air) to the point of specimen rupture

• Burst strength is reported either as total pressure to rupture minus the tare pressure required to inflate the diaphragm
Apparatus and Material

- Inflatable diaphragm bursting tester consisting of clamps to firmly hold the specimen; natural or synthetic rubber diaphragms; Bourdon type pressure gage with accuracy of 1% of capacity and will hold pressure until released; pressure application system either hydraulic or pneumatic; hydraulic fluid if this system is used, either 96% glycerin or ethylene glycol
Equipment Calibration

- Aluminum sheets for verifying performance of tester. Use sheets applicable to the type of tester.

- Periodically verify the calibration status of the machine by bursting 5 specimens of standard aluminum foil recommended by manufacturer. Record the average burst strength of the foil in the instrument verification log.

- The Bourdon pressure gage must be under calibration control. If an electronic pressure gage is used it too shall be under calibration control.
Sampling and Conditioning

• Select a lot sample as directed by material specification or test method. From each lot sample cut a full width fabric swatch or use a specified number of textile products to be used as lab sample.

• From each unit of the lab sample, cut test specimens at least 125 mm² or 5 in². The specimens may be either circular or square.

• Condition and test the lab specimens as described by the material specification or test method.
Procedure

- Zero the pressure gage or electronic unit. If a pneumatic type tester is used, adjust the control valve so that the burst occurs within $20 \pm 5$ sec. Determine tare pressure of the diaphragm by inflating without fabric specimen.

- Place a lab specimen between the instrument clamps and secure as directed by operation manual.

- Initiate the tester and continue applying pressure until the specimen bursts. When burst occurs immediate terminate the application of pressure.
Calculation and Reporting

- Record the burst pressure as burst strength
- Calculate the burst pressure of each test specimen by subtracting the tare pressure from the total pressure recorded by the pressure gage or electronic device

}\[\text{Bursting Strength} = \text{Total Pressure} - \text{Tare Pressure}\]
Calculation and Reporting

- Report the average burst pressure of all specimens tested as the burst strength
- Report which type of bursting tester used, hydraulic or pneumatic
D5034
Breaking Strength/Elongation Grab Method

• Scope: This method covers the breaking strength and elongation determined by the grab procedure

• This method is applicable to woven, nonwoven and felted fabrics. It is not recommended for glass or knit fabrics

• The grab method is a strength/elongation test in which the central part of the width of a specimen is gripped in the clamp for example- a specimen is 100 mm wide with a 25 mm clamp placed in the middle of the fabric. This determines “effective strength and elongation”; that is the strength of the yarns in a specific test width with the assistance of adjacent yarns. This cannot be used for direct comparison with yarn strength determinations
Summary of Test Method, Significance and Use

• A 100 mm wide fabric specimen is mounted centrally in clamps of a tensile tester and a force is applied until specimen rupture

• The grab method for the determining the breaking strength and elongation is considered satisfactory for acceptance test

• Comparison of results from tensile testers of different operating principles, i.e. Constant Rate of Extension and Constant Rate of Traverse, is not recommended
Equipment

- Tensile testing machine with working range of fabric strengths capable of operating at a speed of 300± 10mm/min.
Equipment

• Clamps and jaw faces - the front jaw measures 25 + 1 perpendicular to the direction of force application and not less than 25 + 1mm or more than 50 + 1mm parallel to the direction of force application. The back jaw shall be at least as large as its mate. Use of a larger back jaw reduces the problem of front jaw alignment and slippage. Modified jaw surfaces may be used to minimize slippage.

• An indicator for recording force and elongation. An interfaced computer program from the manufacturer to drive the tester and record results is recommended.
Preparation of Samples

• From the lab sample, cut 5 specimens in each of the warp and filling directions. Cut the warp specimens with the long dimension in the warp direction and filling specimens long dimension in filling direction.

• Cut each specimen 100mm ± 1 mm wide X at least 150mm ± 1mm long. The length of the specimen depends on the type of clamp used.

• Draw a line 37mm from the edge in the long direction of the specimen to align within clamps.
Preparation and Equipment Set-Up

- Prepare the tester as directed by the manufacturer’s instructions and verify the calibration of the tester.

- Set the distance between the clamps to 75± 1mm.

- Select the force range of the tester for the break to occur between 10 and 90% of capacity.

- Set the load rate (speed) to 300 ± 10mm/min.

- Check the jaw flatness and parallel- make a 4 ply sandwich of white paper and soft carbon papers. Place this between the clamps and close. The impression must show uniform impression.
Procedure and Report

- Mount the specimen between the top and bottom clamp jaw surfaces. Adjust the parallel drawn line to the outside of the clamp jaw and close the clamps. If pretension is required close the top clamp, add the pretension and close the bottom clamp.

- Mark the specimen at the front inner edge of the jaw and observe during testing to check for slippage.
Procedure and Report

- Operate the tester until specimen breaks
- Report the average force required to break and elongation at the break for the 5 specimens
ASTM D 5035

Breaking Strength/Elongation Strip Method
D5035
Breaking Strength/Elongation Strip Method

- Scope: This method covers the breaking strength and elongation determined by the cut or revel strip procedure.

- This method is applicable to woven, nonwoven and felted fabrics. It is not recommended for glass or knit fabrics.

- The strip method is a strength/elongation test in which the entire specimen width is tested.

- Summary of Test Method - A test specimen is clamped in a tensile testing machine and a force is applied until the specimen breaks. The breaking force and elongation are recorded. From these data, tensile strength, force/unit width, may be determined.
Summary of Test Method, Significance and Use

• A specific width of fabric (specimen) is mounted in clamps of a tensile tester and a force is applied until the specimen ruptures.

• The strip method for the determining the breaking strength and elongation is considered satisfactory for acceptance test.

• Comparison of results from tensile testers of different operating principles, i.e. Constant Rate of Extension and Constant Rate of Traverse, is not recommended.
Apparatus

- Tensile testing machine with working range of fabric strengths capable of operating at a speed of 300± 10mm/min.

- Clamps and jaw faces – each jaw face shall be at least 10 mm wider than the specimen being tested and at least 25 mm in the direction of application of force.

- An indicator for recording force and elongation. An interfaced computer program from the manufacturer to drive the tester and record results is recommended.
Preparation of Samples

• From the lab sample, cut 5 specimens in each of the warp and filling directions. Cut the warp specimens with the long dimension in the warp direction and filling specimens long dimension in filling direction.

• Cut each specimen width as directed by the material specification. If the specimen is to be raveled, cut the specimen at least 20 yarns wider than the test width. Ravel equal number of yarns from each side.
Preparation and Equipment Set-Up

• Prepare the tester as directed by the manufacturer’s instructions and verify the calibration of the tester.

• Set the distance between the clamps to 75\(\pm\)1mm.

• Select the force range of the tester for the break to occur between 10 and 90\% of capacity.

• Set the load rate (speed) to 300 \(+10\)mm/min.

• Check the jaw flatness and parallel- make a 4 ply sandwich of white paper and soft carbon papers. Place this between the clamps and close. The impression must show uniform impression.
Procedure and Report

- Mount the specimen between the top and bottom clamp jaw surfaces. If pretension is required close the top clamp, add the pretension and close the bottom clamp.
Procedure and Report

- Mark the specimen at the front inner edge of the jaw and observe during testing to check for slippage
- Operate the tester until specimen breaks
Procedure and Report

- Report the average force required to break and elongation at the break for the 5 specimens
Thank You!