

Test Method for Acid Cellulase Enzyme Treatment of Cellulosic Fabrics

1. Purpose and Scope

1.1 This test method describes a procedure for evaluating the reaction of cellulosic and cellulosic blend fabrics to treatment with acid cellulase enzymes. Such treatments usually result in improvements in the hand, drape, fuzz and pill appearance of cellulosic fabrics together with the removal of linters and immature/dead cotton fibers. The agitation in a home washing machine simulates the action in rotary drum machines, paddle machines and jets.

2. Principle

2.1 This test method utilizes an automatic top-loading washing machine to simulate the action of rotary drum machines, paddle machines, or jets used in production type operations (that usually operate at low liquor ratios). The concentrations of enzyme, buffer, and detergent required in this test method are based on grams/liter (g/L), to compensate for the difference in liquor ratios. Other cellulase enzymes, e.g., modified acid and neutral types, may be evaluated by this test procedure; however, the concentration, pH, and time should be followed as recommended by the enzyme supplier.

2.2 Fabric hand is evaluated using AATCC EP5. Improvement in fabric fuzz, pill appearance, and degree of removal of linters and immature/dead cotton fibers is visually evaluated. Fabric strength, if applicable, is determined by ASTM D3786 or ASTM D5035.

3. Referenced Documents

NOTE: Use current versions of all publications unless otherwise specified.

3.1 AATCC EP5 Evaluation Procedure for Fabric Hand (see 12.1).

3.2 AATCC LP1 Laboratory Procedure for Home Laundering: Machine Washing.

3.3 ASTM D3786 Hydraulic or Pneumatic Bursting Strength of Knitted Goods for Knits.

3.4 ASTM D5035 Breaking Force and Elongation of Textile Fabrics-Strip Method for Woven Fabrics.

4. Terminology

4.1 **cellulase enzyme**, *n.*—an enzyme that attacks cellulose.

5. Safety Precautions

5.1 The safety precautions specified in

the method/procedure are ancillary to the testing procedures and are not intended to be all inclusive.

5.2 It is the user's responsibility to reference applicable safety data sheets, use safe and proper techniques, and wear appropriate personal protective equipment in handling materials in this standard.

5.3 Users MUST consult manufacturers for specific details such as equipment operating instructions and other recommendations. Consult and follow all applicable health and safety regulations (e.g., OSHA standards and rules).

6. Apparatus (see 12.2)

6.1 Standard washing machine (see Table I, 12.3).

6.2 Standard tumble dryer (see Table III, 12.3).

6.3 Laundering ballast, Type 1 or Type 3 (see Table IV).

6.4 Apparatus and conditioning facilities as needed for AATCC EP5, ASTM D3786 (optional, knitted or nonwoven specimens), and ASTM D5035 (optional, woven specimens). Refer to standards for details.

6.5 Reagents

6.5.1 Nonionic detergent; linear alcohol with 9 moles of ethylene oxide.

6.5.2 Buffer AC, sodium acetate.

6.5.3 Acid cellulase enzyme.

7. Specimens

7.1 Use four to eight garments, or four to eight full-width fabric specimens (0.9 m (1 yd) in length). Seal the cut edges of fabric specimens by sewing or some other means.

7.1.2 Use two to four garment/fabric specimens to run the test cycle with enzyme.

7.1.3 Use the other two to four garment/fabric specimens to run a control cycle without enzyme, for comparison.

8. Procedure

8.1 Enzyme Wash.

8.1.1 Set washing machine controls to obtain the parameters listed in Table I.

8.1.2 Load for laundering shall consist of half the specimens in the sample, plus enough laundering ballast pieces to make a total of 4 pieces. Record initial weight of ballast if used.

8.1.3 Begin selected wash cycle. Allow machine to fill to specified water level.

8.1.4 Add 1 g/L nonionic detergent

8.1.5 Add 6 g/L sodium acetate buffer.

8.1.6 Stir well and verify pH of 4.5-5.0. If too high, add acetic acid. If too low, add caustic, 50%.

8.1.7 Add acid cellulase enzyme as shown in Table II. Stir.

8.1.8 Add wash load (test specimens and ballast, if applicable), distributing evenly around center agitator. Restart wash cycle.

8.1.9 Stop wash cycle after 12 min. agitation and restart the agitation portion. Do not allow washing machine to drain or rinse. Repeat agitation as needed to reach the total time indicated in Table II. Specimens must be exposed to the enzyme bath for sufficient time to ensure treatment.

8.1.10 Allow washing to proceed through the final spin cycle.

8.1.11 Separate tangled specimens and ballast pieces, taking care to minimize distortion.

8.1.12 Place the washed load (test specimens and ballast) in the tumble dryer and set the temperature control to generate a maximum exhaust temperature of 66°C (see Table III). Allow the dryer to run until the load is fully dry. Remove specimens immediately. Avoid over drying.

8.1.13 In addition to acting on the cellulose of the test specimens, the cellulase enzyme used in this test will also act on the cellulose content of the ballast fabric. Hence, ballast used in this method may not be reusable to the same extent as in other methods. If ballast sheets are reused, weigh prior to each use to ensure that they have not incurred weight loss greater than 75% from their original weight. If they have, replace with new ballast.

8.2 Control Wash.

8.2.1 Repeat the wash procedure with the remaining specimens, omitting enzyme. Wash and dry specimens and ballast (if applicable) exactly as for enzyme wash.

9. Evaluation

9.1 Evaluate and compare the hand of tested specimens exposed to acid cellulase enzyme with that of tested specimens not exposed to acid cellulase enzyme using AATCC EP5.

9.2 Visually compare the appearance of tested specimens exposed to acid cellulase enzyme with that of tested specimens not exposed to acid cellulase enzyme to determine the degree of im-

Table I—Standard Washing Machine Parameters (see 12.3, 12.4)

Cycle	Normal
Water Level, L (gal) ¹	45 ± 4 (12 ± 1)
Agitation Speed (strokes/min.)	86 ± 2
Stroke Length	Up to 220°
Washing Time, min. ²	12 ± 1 (repeat as needed)
Final Spin Speed, rpm	660 ± 15
Final Spin Time, min.	5 ± 1
Wash Temp., °C (°F) ¹	Very Hot: 60 ± 3 (140 ± 5)

¹ Water Level and Wash Temperature indicated in the table may not correspond with standard machine settings. Verify and adjust as needed to achieve the indicated parameters.

² Extended agitation time is required for this test method. Stop and repeat agitation portion as needed before washing machine drains.

Table II—Acid Cellulase Enzyme Portions

Agitation Time ¹	Acid Cellulase Enzyme		Test Specimens
	(g/L)	g ⁴	
24 min. (2 cycles) (0.2-0.5)		9.0-22.5	100% linen and its blends
24 min. (2 cycles) (1.0 -2.0)		45-90	100% cotton and its blends ²
48 min. (4 cycles) ³ (4.0)		180	rayon or lyocell

¹ Repeat agitation portion of wash cycle as needed before draining and rinsing.

² Use the same enzyme concentration for 100% cotton and cotton/polyester blends to achieve the desired effect on the cotton portion of the fabric.

³ The acid cellulase enzyme attacks these fibers much more slowly; therefore a longer agitation (48 min) is required.

⁴ Quantity based on a 45 liter water volume.

Table III—Standard Tumble Dryer Parameters (see 12.3)

Cycle	Normal
Max. Exhaust Temp., °C (°F) ¹	66 ± 6 (155 ± 10)
Cool Down Time, min.	≤ 10

Table IV—Laundering Ballast Parameters

	Type 1	Type 3
Fiber Content	100% cotton	50% cotton/50% polyester ± 3%
Greige Fabric Yarns	16/1 ring spun	16/1 or 30/2 ring spun
Greige Fabric Construction	52 × 48 ± 5 yarns/in., plain weave	52 × 48 ± 5 yarns/in., plain weave
Finished Fabric Weight	155 ± 10 g/m ²	155 ± 10 g/m ²
Edges	All edges hemmed or over-edged	All edges hemmed or over-edged
Finished Piece Size	920 × 920 ± 30 mm (36.0 × 36.0 ± 1 in.)	920 × 920 ± 30 mm (36.0 × 36.0 ± 1 in.)
Finished Piece Weight	130 ± 10 g	130 ± 10 g

provement in fabric fuzz, pill appearance, and degree of removal of lint and immature/dead cotton fibers. Report visual grades for each property as none, slight, distinct, or considerable difference/improvement.

9.3 If desired, determine the strength of tested specimens exposed to acid cellulase enzyme and compare with that of tested specimens not exposed to acid cellulase using ASTM D3786 for knitted or nonwoven specimens or ASTM D5035 for woven specimens.

10. Report

10.1 Describe or identify the sample tested.

10.2 Report that the sample was tested using AATCC TM191-2020.

10.3 Report the testing conditions:

10.3.1 Number of specimens tested.

10.3.2 Cellulase enzyme used and concentration.

10.3.3 Type of ballast (Type 1, Type 3, or none).

10.4 Report the test results:

10.4.1 Average hand value for specimens treated in the enzyme wash (see AATCC EP5).

10.4.2 Average hand value for specimens treated in the control wash (see AATCC EP5).

10.4.3 Average visual fuzz, pill, lint, and immature/dead cotton fiber grades for specimens treated in the enzyme wash.

10.4.4 Average visual fuzz, pill, lint, and immature/dead cotton fiber grades for specimens treated in the control wash.

10.4.5 Average strength of specimens treated in the enzyme wash, if applicable.

10.4.6 Average strength of specimens treated in the enzyme wash, if applicable.

10.4.7 If desired, report difference between corresponding results for specimens treated in enzyme and control washes.

10.4.8 Describe any modification(s) of the published standard.

11. Precision and Bias

11.1 *Precision.* Precision for this test method has not been established. Until a precision statement is generated for this method, use standard statistical techniques in making any comparisons of test results for either *within-laboratory* or *between-laboratory* averages. Analysis of variance or *t*-tests may be used to compare averages. See any standard statistical text for more information.

11.2 *Bias.* The evaluation of acid cellulase enzyme effect on cellulose fabric can be defined only in terms of a test method. There is no independent method for determining the true value. As a means of estimating this property, the method has no known bias.

12. Notes

12.1 Available from AATCC, PO Box 12215, Research Triangle Park NC 27709, USA; +1.919.549.8141; ordering@aatcc.org; www.aatcc.org.

12.2 For potential apparatus, reagents or materials sources, visit the AATCC Buyer's Guide at www.aatcc.org/bg. AATCC provides its Corporate members the option to list their items and services. AATCC does not qualify, or in any way approve, endorse or certify that any of the listings meet the specifications in its standards.

12.3 For model number(s) of washer(s) and tumble dryers(s) reported to meet the standard parameters, visit www.aatcc.org/testing/laundry or contact AATCC, P.O. Box 12215, Research Triangle Park NC 27709; +1.919.549.8141; ordering@aatcc.org.

12.4 Prior to 2021, water temperature and agitation time were the only washing parameters defined for this test method. The additional parameters listed in Table I are standard conditions for testing purposes, selected to align with machines specified in other AATCC laundering methods. Note that this test method must be performed in a traditional top-loading washing machine.

13. History

13.1 Revised in 2021 to clarify and align with prescribed AATCC style guidelines.

13.2 Editorially revised 2019. Reaffirmed 2013. Editorially revised 2012. Editorially revised and reaffirmed 2009. Editorially revised 2008, 2005. Editorially revised and reaffirmed 2004. Reaffirmed 2003.

13.3 Developed in 2002 by AATCC Committee RR41. Maintained by RA99.