

Test Method for Fiber Fragment Release During Home Laundering

Foreword

The use of the term “microfiber” in the context of environmental pollution is a source of ambiguity. AATCC has undertaken the initiative to develop definitions for fiber fragment and microfiber. Although there are still many questions regarding fiber fragments that occur, specifically in water, in the environment, textile industry stakeholders determined the development of a standard method for quantifying shedding propensity of fabrics was needed. Degradability, chemical toxicity, and physical hazards are other important components of the shedding of textiles and will need additional test method development. As research continues, some testing parameters may be revised to improve reproducibility and relevance of the method. Options are offered where best practices are not yet defined.

1. Purpose and Scope

1.1 This test determines the mass of fiber fragments released in an accelerated laundering testing machine. Accelerated laundering is expected to provide a relative approximation of fiber fragment release in full-scale home laundering, but an exact correlation has not been determined.

1.2 This test is applicable to textiles that are expected to withstand home laundering.

2. Principle

2.1 Specimens are tested under conditions of temperature, detergent (optional), and agitation such that fiber fragments are generated and released in a short time. Agitation of the canister speeds up abrasion of the fabric using stainless steel balls and a low liquor-to-fabric ratio. The wash liquor is filtered, and the fiber fragment mass is measured.

2.2 All parties should agree to Options before testing. Washing Option A uses a detergent solution to allow complete wetting of fabric specimens. Washing Option B uses water only. Drying Option A uses filters conditioned at standard textile testing conditions. Drying Option B uses oven-dried filters. Oven-drying may allow for tighter control of filter mass but is impractical for some labs due to space limitations and moisture regain during measurement.

2.3 Results are reported as the mass of fiber fragments deposited on the filter

and as a percentage of the original fabric specimen mass.

3. Referenced Documents

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

3.1 ASTM D6193, Standard Practice for Stitches and Seams (see 18.1).

3.2 ASTM E1402, Standard Guide for Sampling Design (see 18.1).

4. Terminology

4.1 **fiber**, *n.*—*in textiles*, a generic term for any one of the various types of matter that form the basic elements of a textile and which are generally characterized by flexibility, fineness and high ratio of length to thickness.

4.2 **fiber fragment**, *n.*—a short piece (typically $< 5 \times 10^{-3}$ m long) of textile fiber, broken away (or separated) from a textile construction.

NOTE: Fiber fragments are of concern as environmental pollutants; they are often referred to as “microfibers” due to their small size.

4.3 **microfiber**, *n.*—a fiber with linear density less than 1 denier or 1 dtex.

NOTE: Polyester microfibers typically have diameter of $< 10^{-5}$ m; this is a frequently referenced dimension, but not the formal definition of a microfiber.

NOTE: The term “microfiber” has been widely adopted as synonymous with “fiber fragment.” To avoid any ambiguity, AATCC uses “microfiber” ONLY as a category of linear density.

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. Limitations

6.1 This test method is not intended to provide an exact correlation to the mass of fiber fragments released from a fin-

ished product in a full-scale washing machine.

6.2 Results are reported as the mass change of a glass fiber filter. Other materials from the tested specimen, handling, or atmosphere may also deposit on the filter, increasing the apparent mass of fiber fragments. Loss of fiber fragments due to incomplete rinsing may also affect the apparent mass.

6.3 Because the glass fiber filter pore size is 1.6 μm , fibers of a smaller size have the potential of escaping through the filter. Because only one filter of one size is used, there is a potential for fibers bigger than 5 mm to be captured on the filter as well.

7. Apparatus (see 18.2)

7.1 Sewing machine capable of creating a single-needle lockstitch, type 301 (see ASTM D6193).

7.1.1 Sewing machine needle, 0.65 mm (size 9) or a size appropriate for specimen fabric (see 18.3).

7.2 Analytical balance, 0.0001 g readability.

7.2.1 Deionizer, recommended for accurate weighing results

7.2.2 Static free brush

7.3 Accelerated laundering testing machine.

7.3.1 A laundering machine for rotating closed canisters in a thermostatically controlled water bath at 40 ± 2 rpm.

7.3.2 Stainless steel lever lock canisters, Type 2, 1200 mL (2.54 pt), 90×200 mm (3.5×8.0 in.) with lids and neoprene gaskets.

7.3.3 PTFE canister seals.

7.3.4 Mechanism for holding canisters on the accelerated laundering testing machine shaft.

7.3.5 Stainless steel balls, 6 mm (0.25 in.) in diameter, 50 per canister.

7.4 Conditioning facilities and conditioning/drying racks with perforated shelves (Drying Option A, see 18.5).

7.4.1 Alternatively (Drying Option B), non-circulating air drying oven, capable of maintaining $70 \pm 2^\circ\text{C}$.

7.4.2 For Drying Option B (oven drying), Glass desiccator(s), with sufficient space for at least 20 aluminum weighing trays.

7.4.3 For Drying Option B (oven drying), Desiccant gel, indicating, such as silica gel.

7.5 Vacuum filtration system for 47-mm diameter filter.

7.5.1 Glass filtration funnel and clamp.

7.5.2 Filter support; fritted-glass, sintered-metal, or stainless-steel screen.

7.5.3 Vacuum flask.

7.5.4 Vacuum source.

8. Reagents (see 18.2)

8.1 Water, distilled or deionized (see 18.4).

8.2 For Washing Option A, detergent, AATCC High Efficiency (HE) Standard Reference Liquid Detergent WOB (without optical brightener) (see 18.5).

9. Materials (see 18.2)

9.1 Wipes, non-shedding, low-lint, or lint-free.

9.2 Nitrile gloves.

9.3 Lab coat.

9.4 Aluminum foil.

9.5 Filament sewing thread, appropriate for the specimen fabric (see 18.6).

9.6 Forceps, non-serrated tips.

9.7 Aluminum weighing dishes.

9.8 Sieve, with aperture size of less than 5 mm (0.2 in).

9.9 Beaker, at least 1500 mL.

9.10 Wash bottle.

9.11 Borosilicate glass fiber filter with no binder, 1.6 μ m pore size, 47 mm diameter.

9.12 Medicine dropper/bulb pipette, glass, 2 mL capacity, nominal 20 drops per mL.

10. Sampling

10.1 Test results are valid only when the samples are statistically representative (see ASTM E1402).

10.2 Sampling must be random. Every unit of product must have a mathematically equal chance of becoming a sample; and every portion of each sample must be equally likely to become a test specimen.

10.3 All specimens within the sample must be alike within the variations due to pure chance. There must be no differences within samples assignable to known causes.

10.4 All parties shall agree on the face and back of sample for testing purposes prior to testing.

11. Specimens

11.1 This test method measures very small mass changes. Minimize all sources of contamination.

11.1.1 Wipe all work surfaces with a non-shedding, low-lint, or lint-free wipe.

11.1.2 Wear a laboratory coat over clothing and tie back long hair.

11.1.3 Wear nitrile gloves. Do not handle filters, specimens or weighing dishes with bare hands. Analytical balances are sensitive enough to register touch contamination.

11.1.4 Clean sieve and all glassware, then triple rinse before use.

11.1.5 Avoid contamination of specimens by minimizing contact with other specimens. To remove contamination from common surfaces such as cutting table and sewing machine between samples, wipe with a non-shedding, low-lint, or lint-free wipe.

11.2 Cut 4 specimens, each 200 mm $\times$ 340 mm (8 in $\times$ 13.5 in), diagonally across the sample with the longest edge parallel to the selvege.

11.3 Finish all specimen edges with a clean-finish hem, seam type Efb-1 (see ASTM D6193).

11.3.1 Fold specimen edges under (to the back) 50 mm (2 in) from each edge. Do not press. Wide hem allows easier folding of bulky specimens. For consistency, use the same hem width for all test specimens.

11.3.2 Turn under raw edge to meet fold, leaving a clean-finish hem. Do not press. Stitch hem in place close to inner fold using lockstitch (stitch type 301), 2.0-2.5 mm per stitch (10-12 stitches per inch). Backstitch to secure stitching. Trim sewing threads.

11.3.3 Finished specimen size is 100 $\pm$ 10 mm $\times$ 240 $\pm$ 10 mm (4 $\pm$ 0.4 in $\times$ 9.5 $\pm$ 0.4 in).

11.3.4 In rare cases where seam type Efb-1 is not feasible with a fabric specimen, an alternate seam and/or edge finish may be used and a detailed description shall be included in the test report.

11.4 Avoid marking specimen identification before laundering. Marking may affect fiber fragment shedding due to damage from marking pens or contamination from pigment flakes.

12. Conditioning

12.1 Drying Option A: Place fabric specimens in a standard atmosphere of 21 $\pm$ 2°C (70 $\pm$ 4°F) and 65% $\pm$ 5% RH for at least 4 h, laying each specimen separately on a screen or perforated shelf of a conditioning rack. Cover specimens with aluminum foil to reduce possible contamination from air deposition.

12.2 Drying Option B: Place fabric specimens in clean, non-air circulating oven at 70°C for at least 4 h. Place oven-dried fabric specimens in desiccator for at least 30 min. to cool. Clean oven and desiccator again after removing specimens to minimize fiber contamination on the filters.

12.3 Filters are conditioned or oven dried and cooled after rinsing (see section 13.3). No additional conditioning is required.

13. Preparation

13.1 Label each aluminum weighing dish BEFORE pre-weighing.

13.2 Rinse each filter and place in a separate labeled aluminum weighing dish. Carefully place one filter in the sieve. Use a wash bottle with distilled/deionized water to rinse the filter to remove soluble compounds. Using forceps, remove the filter from the sieve and place in a dish.

13.3 Condition or oven-dry filters.

13.3.1 Drying Option A: Place filters (in weighing dishes) in a standard atmosphere of 21 $\pm$ 2°C (70 $\pm$ 4°F) and 65% $\pm$ 5% RH for at least 4 h. Keep filters covered with aluminum foil to avoid contamination.

13.3.2 Drying Option B: Dry filters (in weighing dishes) in a non-air-circulating oven at 70 $\pm$ 2°C for at least 1 h. Use oven-dried filters for testing. Place oven-dried filters and dishes in desiccator for 30 min. to cool. Maintain filters in the desiccator until immediately before use.

13.4 Washing Option A: Prepare 0.25% detergent solution.

13.4.1 Add 2.5 g detergent per 1000 mL distilled water. Stir until well combined.

13.4.2 Use fresh solution for each test or re-stir to ensure consistency and include solution creation date in test report

14. Procedure

14.1 Place each filter and weighing dish on the balance and record the total pre-test mass to the nearest 0.0001 g (W_i). Keep filters away from possible contamination sources.

14.1.1 Drying Option A: If testing is not performed in a conditioned atmosphere, return filters to conditioned atmosphere immediately after measuring mass.

14.1.2 Drying Option B: Return filters to oven, desiccator, or other enclosed environment immediately after measuring mass.

14.2 Place each fabric specimen on the balance and record the total pre-test mass to the nearest 0.0001 g (S_i). Keep specimens away from possible contamination sources. Remove loose fibers from balance between specimens using a static-free brush. Use a deionizer to minimize static interference with the mass.

14.3 Fill the accelerated laundering testing machine with water to the designated level. Adjust temperature to 40 $\pm$ 2°C (104 $\pm$ 4°F).

14.4 Ensure all canisters, lids, seals, gaskets, and balls are thoroughly cleaned and rinsed before use.

14.5 Add 50 stainless steel balls and 360 mL of detergent solution (Washing Option A) or 360 mL of water (Washing Option B) to each canister.

14.6 Place one neoprene gasket inside each canister lid. Place a PTFE seal over the gasket to reduce contamination of the