

Insects, Resistance of Textiles to

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1. Purpose and Scope

1.1 Biological test methods are given for evaluating the resistance of textiles that contain wool or other susceptible fibers to webbing clothes moths and to carpet beetles. The test methods described here are not concerned with the various procedures for treating textiles [e.g., dye-baths vs. padding application of moth-proofers] or with their subsequent handling, ageing, washing, etc. but only with the biological methods to be used to measure the resistance of the [treated or untreated] textiles to insect attack (see 15.1).

1.2 Two methods are provided for determining the extent of damage to test specimens. The *Excrement Weight Method* is used only for tests with carpet beetles. The *Fabric Weight Loss Method* is used for tests with webbing clothes moths and also may be used for tests with carpet beetles when preferred and when comparative tests with both insects are made (see Appendix D).

2. Principle

2.1 These methods measure quantitatively the amount of feeding on the test specimen by the specified number and type of insects for a prescribed time under controlled conditions of temperature and humidity.

3. Terminology

3.1 **insect resistance**, *n.*—*in textiles*, the capability to impede damage by insects.

4. Safety Precautions

NOTE: These safety precautions are for information purposes only. The precautions are ancillary to the testing procedures and are not intended to be all inclusive. It is the user's responsibility to use safe and proper techniques in handling materials in this test method. Manufacturers MUST be consulted for specific details such as material safety data sheets

and other manufacturer's recommendations. All OSHA standards and rules must be consulted and followed.

4.1 Insects should be handled by trained personnel.

4.2 Good laboratory practices should be followed. Wear safety glasses in all laboratory areas.

5. Apparatus and Materials

5.1 Test Cages.

5.1.1 The cage for conducting the tests may be any shallow glass or metal flat-bottomed container large enough to permit the test insects to be either in contact with or off the horizontally placed test specimen. It must be well ventilated and provided with a 60-mesh metal screen cover.

5.2 Test Insects.

5.2.1 **Black Carpet Beetle (*Attagenus megotoma* (F.))**—Larvae are used from cultures maintained as described in Appendix A. Larvae must be in the weight range of 6-7 mg each and of such size that they pass through a U.S. Standard Sieve Series No. 14 sieve and are retained on a No. 16 sieve as described in Appendix A, A10 and A11.

5.2.2 **Furniture Carpet Beetle (*Anthrrenus flavipes* LeConte)**—Larvae from cultures maintained as described in Appendix C may be used as alternative test insects with the black carpet beetle. Larvae must be approximately nine weeks old when put on test as measured from the time of egg deposition. The feeding propensities of the two species are similar.

5.2.3 **Webbing Clothes Moth [*Tineola bisselliella* (Hum.)]**—Larvae are used from cultures maintained as described in Appendix B. Larvae must be 25-27 days old as measured from the date of egg deposition to the time they are put on test since older larvae may pupate during the test period.

5.2.4 **Other Species**—Other species of insect pests may be used for obtaining supplementary data insofar as the test methods herein described are applicable.

5.3 **AATCC Moth Test Cloth**—(see 15.2).

6. Test Specimens

6.1 At least four test specimens and four control specimens are required for the excrement weight method and at least eight of each for the fabric weight loss method. The specimens must be free of any solvents or carriers used in applica-

tion of chemical treatments and of any solvents or auxiliary agents used in subsequent durability testing.

6.2 **Fabrics**—Test specimens, each with an area of 12.9 cm² (2 in.²), are cut from widely spaced portions of the fabric.

6.3 **Yarns**—Test specimens of each yarn are prepared by uniformly winding one layer of yarn on a square or rectangular piece of glazed cardboard, glass or metal with an area of 12.9 cm² (2 in.²). The surface of the glazed cardboard, glass or metal must be substantially covered by the yarn.

6.4 **Carpets**—Test specimens, each with an area of 12.9 cm² (2 in.²), are cut from widely-spaced portions of the carpet. The edges of the specimens are secured by coating the backing yarns with cellulose nitrate dissolved in acetone (see 15.3). For the weight loss method, specimens are prepared by stapling pieces of yarn removed from the specimen to pieces of glazed paper, each having an area of 12.9 cm² (2 in.²) so that the surface is covered substantially by the yarn.

6.5 **Control Specimens for Insect Activity**—Control specimens of the standard control fabric (see 15.2), each having an area of 12.9 cm² (2 in.²), are exposed under the same conditions as the test specimens. If the fabric or yarn to be tested has been treated with some form of insecticide for the purpose of increasing its resistance to insect pests, specimens of the same fabric or yarn in the untreated condition should be exposed for comparison, if possible.

6.6 It is important that various lots of fabric for control specimens and lots of fabric and other materials used as rearing medium be thoroughly checked to determine their suitability prior to use.

7. Procedure: Excrement Weight Method (For Carpet Beetles)

7.1 **Preparation**—At least four test specimens and four control specimens are prepared in accordance with Section 6. Each test specimen and control specimen is freed of any loosely adhering dirt or dust (see 15.3) and placed face down in a separate test cage. Ten larvae as specified in 5.2.1 or 5.2.2 are placed on the top of each specimen, and the cage covered as specified in 5.1.

7.2 **Incubation**—The cages containing the test specimens and larvae are kept for 14 days at 27 ± 1°C (80 ± 2°F) and 55 ± 5% relative humidity. Light is excluded.

8. Evaluation: Excrement Weight Method

8.1 Insect Survival—Remove and record living and dead insects. Survival counts are made in all cases, since they are important in demonstrating the validity of the test larvae.

8.2 Extent of Damage—Damage to the test specimens is determined by the quantity of excrement deposited during the test period as follows:

8.2.1 Remove test specimen from test cage and, by alternately tapping and brushing, transfer all loose material, excrement, exuviae, etc., back into the test cage.

8.2.2 Transfer contents of test cage into a No. 3 Gooch crucible and, by repeated tapping of the crucible, the excrement is sifted through the perforations into one of a pair of matched watch glasses.

8.2.3 Weigh the excrement on an analytical balance sensitive to at least 0.2 mg. For the purpose of this test, all material that sifts through the perforations of the Gooch crucible is construed as excrement.

9. Classification: Excrement Weight Method

9.1 The report must include the following information for each test specimen of the treated sample and the untreated controls:

- (a) Weight of excrement in milligrams.
- (b) Number of larvae alive.

9.2 The test textile is considered satisfactorily resistant to carpet beetles if an average quantity of excrement of not over 5 mg per specimen is deposited, provided that no single specimen shows more than 6 mg of excrement and that under the same conditions the controls show an average quantity of excrement of not less than 15 mg per specimen.

9.3 The test is invalid if the quantity of excrement deposited on the control specimens averages less than 15 mg per specimen, or if less than 90% of the control larvae survive.

10. Procedure: Fabric Weight Loss Method (For Carpet Beetles and Clothes Moths)

10.1 Preparation—Two sets of at least eight test specimens each, one set from the material to be tested and the other from the standard control fabric (see 15.2), are prepared in accordance with Section 6. Four specimens of each set are used for feeding tests, and the other four as humidity controls.

10.2 Humidity Control Test—Four specimens from each set are exposed to the same test conditions as the specimens used for feeding tests except that no larvae are added. A change in weight of the humidity check specimens is due to

change in moisture content only and is used to correct the weights of the feeding test specimens. (This method of humidity correction cannot be relied upon to correct for wide variations in humidity during the observation period.)

10.3 First Weighing—The test specimens and humidity control specimens are freed of any loosely adhering dirt or dust and placed in the test cages under controlled humidity and temperature conditions (see 7.2) for at least 48 h before weighing. They are weighed under the same conditions as specified in 8.2.3. The order of weighing is alternated between test specimen and humidity control specimen, and the same order is followed at the second weighing (see 11.2.2).

10.4 Incubation—Ten larvae as specified in 5.2 are placed on each test specimen and the test containers covered as specified in 5.1. The test cages and humidity check cages are held for 14 days as specified in 7.2.

11. Evaluation: Fabric Weight Loss Method

11.1 Insect Survival—Remove and record living and dead insects as in 8.1.

11.2 Extent of Damage—Extent of damage to the test specimens by the loss of weight due to feeding of the larvae is determined as follows:

11.2.1 Brush the specimens to free them of all loose material such as excrement, webbing, cast skins, loose fibers, etc. Forceps are usually necessary to remove masses of webbing and excrement from clothes moth test specimens and containers.

11.2.2 Second Weighing—The cleaned test specimens and control specimens and the humidity check specimens are again weighed in accordance with 10.3, after the test specimens have been reconditioned at controlled temperature and humidity for at least 24 h after cleaning and removal of insects.

11.2.3 Loss of Weight—The loss of weight, in milligrams, due to feeding of the test larvae, as adjusted for humidity changes, is calculated as follows:

$$L = \frac{AC}{B} - D$$

where:

- L = adjusted loss of weight in milligrams due to insect feeding.
- A = average weight of the four test specimens before testing.
- B = average weight of the four humidity check specimens before testing.
- C = average weight of the four humidity check specimens after testing.
- D = average weight of the four test specimens after testing.

This formula is applicable regardless of whether the humidity check specimens gain or lose weight.

12. Classification

12.1 The report must include the following information for the treated sample and the untreated control:

- (a) Loss of weight in milligrams.
- (b) Number of larvae alive.
- (c) Number of larvae pupated.

12.2 The test sample is considered satisfactorily resistant to the insect pests used if the average loss of weight due to feeding is not more than 8 mg, provided that under the same conditions the average loss in weight of control specimens is 30 mg or more. No individual test specimen should show more than 10 mg loss of weight.

12.3 The test is invalid if the amount of feeding results in less than 30 mg average weight loss per control specimen or less than 75% of the control larvae survive.

12.4 Individual weight records of test specimens and humidity checks before and after the test may be reported if desired. Humidity check should show no more than 5% variation in weight before and after the test.

13. Referee Test

13.1 In the event of dispute, a disinterested laboratory should conduct the test as follows:

- (a) Weight loss methods are used for both carpet beetles and clothes moths.
- (b) The number of test specimens is doubled.
- (c) All other conditions heretofore set forth apply.
- (d) The results of the referee test are final.

14. Precision and Bias

14.1 *Precision.* Precision for this test method has not been established. Until a precision statement is generated for this test method, use standard statistical techniques in making any comparisons of test results for either *within-laboratory* or *between-laboratory* averages.

14.2 *Bias.* The resistance of textiles to insects 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.

15. Notes

15.1 For evaluation of chemical treatments see AATCC Method 28, Insect Pest Deterrents on Textiles.

15.2 AATCC Moth Test Cloth is a standard pure, undyed, scoured wool fabric. Available from: Testfabrics Inc., P.O. Box 26, 415