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Standard Guide for Evaluating Fabric Softeners[1]

This standard is issued under the fixed designation D5237; 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 guide evaluates the performance characteristics of fabric softener products. It provides guidance for evaluating the on fabric efficacy of treatment chemicals dosed into the wash, rinse, or dryer cycle in a home laundry washer or dryer. This guide can be used for screening of fabric softener products, or to evaluate the products through multiple accumulative cycles.

1.2 The relative ranking of products assessed by these procedures may be affected by such factors as machine type and settings, fabric load composition, as well as by the washing and drying procedures used.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E313 Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates

E1958 Guide for Sensory Claim Substantiation

E2164 Test Method for Directional Difference Test

2.2 *AATCC Standard:*[3]

AATCC Test Method 110-1994 Whiteness of Textiles

3. Terminology

3.1 *Definitions:*

3.1.1 *fabric softener, n*—laundry auxiliary product or laundry detergent ingredient that gives fabrics a soft feel, smooth surface, provides fragrance, or reduces static electricity, or a combination thereof.

3.1.2 *front-loading high-efficiency (HE) washing machine/washer, n*—horizontally or nearly horizontally oriented machine used for laundry that uses varying amounts of water to launder fabrics.

3.1.2.1 *Discussion*—

These washers *(1)* may not exhibit any visible free water or may show significant quantities of visible free water, *(2)* may lift and tumble the clothes load, *(3)* may employ both spinning and tumbling in both the washer or rinse processes, *(4)* may use jet sprays of wash solution or rinse solution, or *(5)* may use thermal or chemical inputs, or both, to offer sanitation or allergen claims. HE washers use considerably less water and energy than traditional deep-fill washers in the laundering process. HE washers are labeled

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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.

[3] Available from American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709.

by the appliance industry and may be recognized by the U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency (EPA) as Energy Star rated machines.

3.1.3 *home laundering, n*—cleaning or conditioning, or both, of textile materials using the washing and drying equipment commonly found in the home.

3.1.4 *top-loading high-efficiency (HE) washing machine/washer, n*—vertically oriented agitation machine that is used for home laundry, with the fundamental difference from a traditional top-loading washer being that this washer uses reduced water resources during the process.

3.1.4.1 *Discussion—*

This washer may *(1)* deep fill once (during the wash or rinse), *(2)* partially fill one or more times, *(3)* may have a full agitator, *(4)* may have an impeller in place of an agitator, *(5)* may use thermal or chemical inputs, or both, to offer sanitation or allergen claims, or *(6)* may use spray washing or spray rinsing technologies, or combination thereof. HE washers use considerably less water and energy than traditional deep-fill washers in the laundering process. HE washers are labeled by the appliance industry and may be recognized by the U.S. DOE and U.S. EPA as Energy Star rated machines.

3.1.5 *traditional deep-fill top-loading washing machine/washer, n*—vertically oriented agitation machine that is used for home laundry.

3.1.5.1 *Discussion—*

This washer fills to the basket top at least two times during the wash process: once for washing and once for rinsing. This type of washer may also include spray flushes in either the wash or rinse portions of the cycle.

4. Summary of Guide

4.1 Fabrics are evaluated for the impact of fabric softener products applied in the wash, rinse or dryer cycle for softness, whiteness retention, rewet or water absorbency, static control, or fragrance, or combination thereof, using test panels or instrumental methods.

5. Significance and Use

5.1 The methods in this guide can be used for screening of fabric softener products or to evaluate their performance, through a single cycle or multiple accumulative cycles, relative to a designated reference product or a comparative product(s).

5.2 A single assessment of each of the product characteristics tested by these methods will not predict overall performance of the softener product. A single test run under specified fixed conditions cannot be expected to reflect the comparative performance under many other possible conditions of use.

6. Fabric Preparation

6.1 *Scope:*

6.1.1 This section provides a procedure for preparing new or previously used textile specimens for further treatment and evaluation.

6.1.2 All new fabrics received directly from the mill or purchased from vendors must be stripped of mill conditioners and processing auxiliaries. Test fabrics are to be used for only a single evaluation while ballast used for load bulk may be reused indefinitely if stripping is done between each evaluation.

6.2 *Apparatus and Materials:*

6.2.1 *Automatic Washing Machine,*

6.2.2 *Automatic Laundry Dryer,* gas or electric.

6.2.3 *Test Fabrics,* white cotton or cotton/polyester loop terry cloth, or both, such as hand towels. Other fabrics suitable for fabric softener products are also acceptable. Care should be taken to use matched sets of fabrics of the same brand and manufacturing origin, and similar construction, weight, and fiber blend within each specific test.

6.2.4 *Fabric Load,* Minimum of 6 lb (2.7 kg) for each total load. Supplement test fabrics with ballast fabrics, such as pillow cases, terry towels, or commercially available yard goods cut in pieces no larger than 1 yd^2 (0.8 m^2) per piece. All ballast loads shall be the same composition for each run within a test. When running successive test loads, use fresh ballast or strip the ballast prior to use.

6.2.5 *Standard Reference Detergent,* such as, AATCC (American Association of Textile Chemists and Colorists), liquid or powder (suggested to use without brightener formula if testing whiteness retention), or a commercially built anionic detergent, if desired.

6.3 *Stripping Procedure*—The objective of this procedure is to remove finishes or residues, or both, from the ballast and test fabrics. The procedure below is one suggested way to meet this objective.

6.3.1 Load washer with appropriate amount of fabrics. Do not overload.

6.3.2 Add appropriate dosage of built anionic detergent.

6.3.3 Set machine for hot wash temperature setting. Allow washer to fill with water and continue on through the complete wash and rinse cycle.

6.3.4 Repeat 6.3.2 and 6.3.3 four more times.

6.3.5 Wash this load of fabric through an additional complete cycle three times with no detergent. If there appears to be residual detergent (as evidenced by sudsing during the previous cycle) repeat the water only cycles one or two more times or as needed to ensure removal of residual anionic detergent to a minimal level.

6.3.6 Dry fabrics in an automatic dryer at the *normal* or *hot* setting until the load is dry.

6.3.7 If fabrics are stored prior to evaluation, protect from environmental influences such as odor, moisture, dust, etc.

7. Fabric Treatment with Fabric Softener

7.1 *Scope:*

7.1.1 This section provides the procedure for application of the test products to the textile substrates.

7.2 *Fixed Test Conditions*—All test conditions not under study should be fixed within the range of normal household practice. The following are suggested as representative of many households.

7.2.1 *Matched Washing Machines*—All washings shall be performed in the same machine or in mechanically matched units of the same model machine using a controlled experimental design.

7.2.2 *Household Automatic Washing Machine:*

7.2.2.1 *Conventional Deep-fill Traditional Top Loader*—Normal/casual with 10-14 min wash cycle, appropriate water fill for load size, and regular spin speed.

7.2.2.2 *Front-loading High Efficiency*—Normal/casual or normal/colors setting, normal soil level, and high spin speed,

7.2.2.3 *Top-loading High Efficiency*—Normal/casual or normal/colors setting, normal soil level, and high spin speed.

7.2.3 *Household Automatic Laundry Dryer,* gas or electric.

7.2.4 *Stripped Test Fabrics,* defined in 6.2 and 6.3.

7.2.5 *Water Hardness*—35 ppm (2 grains/gal); 100 ppm (6 grains/gal); 150 ppm (9 grains/gal); and 260 ppm (15 grains/gal). 120 ppm (7 grains/gal) is suggested if only one level is tested.

7.2.5.1 The calcium/magnesium ratio of the hardness minerals (expressed as $CaCO^3$) should be adjusted to attain different water hardness as shown in Table 1.

7.2.5.2 *Hard Water Stock Solution*—For a 2:1 ratio, prepare a hard water stock solution by dissolving 2.940 g of calcium chloride dihydrate ($CaCl2{\cdot}2H_2O$) and 2.033 g of magnesium chloride hexahydrate ($MgCl2{\cdot}6H_2O$) in DI water. Dilute to a volume of 1 L with additional deionized (DI) water. This solution contains 3000 ppm hardness (expressed as calcium carbonate) with a Ca:Mg molar ratio of 2:1. For a 3:1 ratio, use 4.41 g of calcium chloride dihydrate ($CaCl2{\cdot}2H_2O$) and 2.033 g of magnesium chloride hexahydrate ($MgC12{\cdot}6H_2O$) in DI water. Larger batches or concentrations may be scaled up using this ratio of calcium chloride to magnesium chloride.

7.2.6 *Water Temperature*—Record temperature actually used. If only one treatment temperature is tested, use a warm wash/cold rinse setting. The suggested test temperatures for respective machine formats are as follows:

Conventional Deep-Fill Top Loader—86 ± 5°F (30 ± 5°C) wash cycle, 60 ± 10°F (15.6 ± 5.5°C) rinse.

Front-Loading High Efficiency—77 ± 5°F (25 ± 5°C) wash cycle, 60 ± 10°F (15.6 ± 5.5°C) rinse.

Top-Loading High Efficiency—75 ± 5°F (23.8 ± 5°C) wash cycle, 60 ± 10°F (15.6 ± 5.5°C) rinse.

NOTE 1—Within a single test, the respective wash and rinse temperature profiles should be consistent.

7.2.7 *Fabric Load Weight*—Dry ballast and test fabric load should weigh minimum 6 lb (2.7 kg). Towels preferably should be pre-weighed. Towels of similar weights (±1.0 g) should be compared, as different weights can impact results.

7.2.8 *Wash Detergent Dosage*—Use recommended dosage of AATCC Standard Reference Detergent WOB (without brighteners). If a commercial detergent is used, follow manufacturer's recommendation.

7.2.9 *Softener Product Dosage*—The amount of the softener dispersion to be used in each test is determined by the level of active softener ingredient desired per unit weight of dry fabric. If commercial products are being tested, follow manufacturer's dosage recommendations.

7.3 *Procedure*—Calculate the proper number of test fabrics to be used in your experimental design. One test fabric may be evaluated by up to five panelists. It is recommended that at least two, preferably three or more replicates are tested in each

TABLE 1 Water Hardness Range

Water Hardness Range	Ca/Mg Ratio
0 to 60 ppm	4:1
61 to 120 ppm	3:1
121 ppm and over	2:1

respective test wash. Multiple wash runs can also strengthen your experimental design. Determine the number of desired panelists (see Section 8) and calculate total number of test fabrics needed for each product tested.

7.3.1 *Traditional Top Load Deep Fill Washer:*

7.3.1.1 Set washer controls for *regular* or *normal* cycle with a wash period of 12 ± 2 min and a water fill level of 16 to 19 gal. The wash period and fill level chosen should be similar for all products being tested within the experiment.

7.3.1.2 Washing machine model safety and mechanical variations will impact specific procedural steps for adding product, fabric load, and fabric softener; therefore, inter-laboratory procedural steps may vary. It is recommended, if feasible, that your detergent dosage and fabric softener dosage (if applicable) are dispersed evenly into solution.

7.3.1.3 Place fabric bundle in dryer. Add dry cycle softener, if appropriate. Use the *regular* or *normal* dryer setting.

7.3.1.4 Dry fabric bundle for 45 min or until dry. Store the test fabric overnight so they equilibrate (see 8.1.2).

7.3.1.5 Equilibrate substrates to equal temperature and humidity, preferably overnight in a humidity controlled environment (see 8.1.2). Record conditions (RH and temperature).

7.3.2 *HE Washer:*

7.3.2.1 Set wash controls for *regular* or *normal* cycle, warm wash.

7.3.2.2 Place detergent and fabric softener (if applicable) in their respective dispenser drawers. If using unit dose product, place in machine drum.

7.3.2.3 Put fabric bundle in washer. Start wash.

7.3.2.4 Once finished, place fabric bundle in dryer. Add dryer cycle softener, if appropriate. Use the regular or normal dryer setting.

7.3.2.5 Dry test fabrics for 45 min or until dry.

7.3.2.6 Equilibrate substrates to equal temperature and humidity, preferably overnight in a humidity controlled environment (see 8.1.2). Record conditions (RH and temperature).

7.4 Treated test fabrics can now be evaluated for softness (Section 8), fragrance (Section 9) or absorbency (Section 10), or combination thereof.

8. Fabric Softness Evaluation by Test Panel Scoring or Instrumental, or both

8.1 *Procedure*—Fabric Softness Evaluation by Test Panel Scoring—These assessments are provided as guidance for evaluating softness by test panel scoring. Other suitable approaches may be used, for example, those referenced in Guide E1958 and sensory textbooks such as Sensory Evaluation Techniques, 4th ed.[4]

8.1.1 Note that anyone with a potential bias (for example, employees working on the development of the product) is not appropriate for conducting evaluations.

8.1.2 Condition the fabrics in a constant temperature-humidity room (if available) overnight prior to evaluation. Suggested controlled environments are between 65 to 75°F (18.3 to 23.9°C) and 50 to 65 % relative humidity. Measure and record temperature and humidity.

8.2 The panelists must clean and dry their hands and have no lotions or other products on them before handling the test fabrics. During the evaluation the panelists may need to re-clean and dry their hands to remove any softener or oily buildup that might interfere with the test.

8.3 Panelists should be chosen based on test objective and indicated in the report. “Screened” panelists are qualified or trained, or both, in a manner that indicates an ability to determine differences where differences are expected. “Naive” panelists typically have no prior training or qualification and are typically used for consumer testing. Descriptive panelists are highly trained and can also be used.

8.4 Individual panelists should use the same handling technique when evaluating each fabric in the test set.

8.5 *Ranking Comparison*—This evaluation uses three or more products/treatments. (For more information refer to Sensory Evaluation Techniques, 4th Ed.)[4]

8.5.1 Each panelist is given a group of test fabrics for scoring (for example, A, B, C, and D). Samples should be completely randomized and balanced such that order of appearance of each treatment is evenly distributed.

8.5.2 Each set of comparisons shall consist of 3-6 products/treatments. An increased number of product comparisons may decrease sensitivity.

8.5.3 Panelists should rank the samples from least to most soft. If desired, additional comments by the panel member on the feel of the fabric can be recorded, for example, oily, waxy, greasy, etc. Panelists may allow for ties in ranking. In this case both should be assigned a half grade, for example, if 4 fabrics are tested and 2 are judged to be a tie for the most soft, they may be assigned a score of 3.5 for each.

8.5.4 After each test the scores are evaluated using Friedman Analysis and Least Significant Rank Difference multiple comparison test (see Sensory Evaluation Techniques, 4th ed., pages 110-112).[4]

[4] Meilgaard, Morten C., *Sensory Evaluation Techniques*, 4th Edition, CRC Press, 2005.