

Aqueous Liquid Repellency: Water/Alcohol Solution Resistance Test

Developed in 2004 by AATCC Committee RA56; reaffirmed and editorially revised 2005; editorially revised 2006.

1. Purpose and Scope

1.1 This test method can be used to determine the efficacy of a protective finish that is capable of imparting a low energy surface on all types of fabrics, by evaluating the fabric's resistance to wetting by a selected series of water/alcohol solutions of different surface tensions.

2. Principle

2.1 Drops of standard test liquids, consisting of a selected series of water/alcohol solutions with varying surface tensions, are placed on the fabric surface and observed for wetting, wicking and contact angle. The aqueous repellency grade is the highest numbered test liquid which does not wet the fabric surface. (The scale ranges from zero to eight, with a rating of eight signifying the most repellent surface.)

3. Terminology

3.1 **grade, n.**—*in textile testing*, the symbol for any step of a multi-step standard reference scale for a quality characteristic.

NOTE: The grade is assigned to test specimens exhibiting a degree of the quality comparable to that step of the standard.

3.2 **aqueous repellency, n.**—*in textiles*, the characteristic of a fiber, yarn or fabric whereby it resists wetting by aqueous liquids.

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 also be consulted and followed.

4.1 Good laboratory practices should be followed. Wear safety glasses and impervious gloves when handling test liquids in all laboratory areas.

4.2 The alcohol specified in this method is flammable. Keep away from heat, sparks and open flame. Use with adequate ventilation. Avoid prolonged

breathing of vapor or contact with skin. Do not take internally.

4.3 Exposure to chemicals used in this procedure must be controlled at or below levels set by governmental authorities [e.g., Occupational Safety and Health Administration's (OSHA) permissible exposure limits (PEL) as found in 29 Code of Federal Regulations (CFR) 1910.1000 of January 1, 1989]. In addition, the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) comprised of time weighted averages (TLV-TWA), short term exposure limits (TLV-STEL) and ceiling limits (TLV-C) are recommended as a general guide for air contaminant exposure which should be met (see 12.1).

5. Uses and Limitations

5.1 This test method is not intended to give an absolute measure of the resistance of the fabric to staining by all aqueous materials. Other factors, such as composition and viscosity of the aqueous substances, fabric construction, fiber type, dyes, other finishing agents, etc., also influence stain resistance. This test can, however, provide a rough index of aqueous stain resistance, in that generally the higher the aqueous solution repellency grade, the better resistance to staining by aqueous materials, especially liquid aqueous substances. This is particularly true when comparing various finishes for a given fabric.

6. Apparatus and Materials

6.1 Test liquids prepared and numbered according to Table IV (see 12.2).

6.2 Dropping bottles (see 12.3).

6.3 White AATCC Textile Blotting Paper (see 12.4).

6.4 Laboratory gloves (general purpose is sufficient).

7. Test Specimens

7.1 Test two specimens approximately 20×20 cm (8×8 in.) from each sample. Condition the test specimens for a minimum of 4 h at $21 \pm 1^\circ\text{C}$ ($70 \pm 2^\circ\text{F}$) and $65 \pm 2\%$ RH prior to testing.

8. Procedure

8.1 Place the test specimen flat on the white textile blotting paper on a smooth, horizontal surface.

8.1.1 When evaluating open weave or "thin" fabrics, conduct the test on at least two layers of the fabric; otherwise, the

test liquid may wet the underlying surface, not the actual test fabric, and thereby cause confusion in the reading of the results.

8.2 Wearing clean laboratory gloves, brush the pile of napped or pile fabrics lightly with your hand in the direction giving the greatest lay of the surface prior to placing the drops of the test liquid.

8.3 Beginning with the lowest-numbered test liquid (AATCC Aqueous Solution Test Grade Liquid No. 1), *carefully* place small drops [approximately 5 mm (0.19 in.) in diameter or 0.05 mL volume] on the test specimen in three locations along the filling direction. The drops should be approximately 4.0 cm (1.5 in.) apart. The dropper tip should be held at a height of approximately 0.6 cm (0.25 in.) from the fabric surface while placing drops. DO NOT TOUCH THE FABRIC WITH THE DROPPER TIP. Observe the drops for 10 ± 2 s, from approximately a 45° angle.

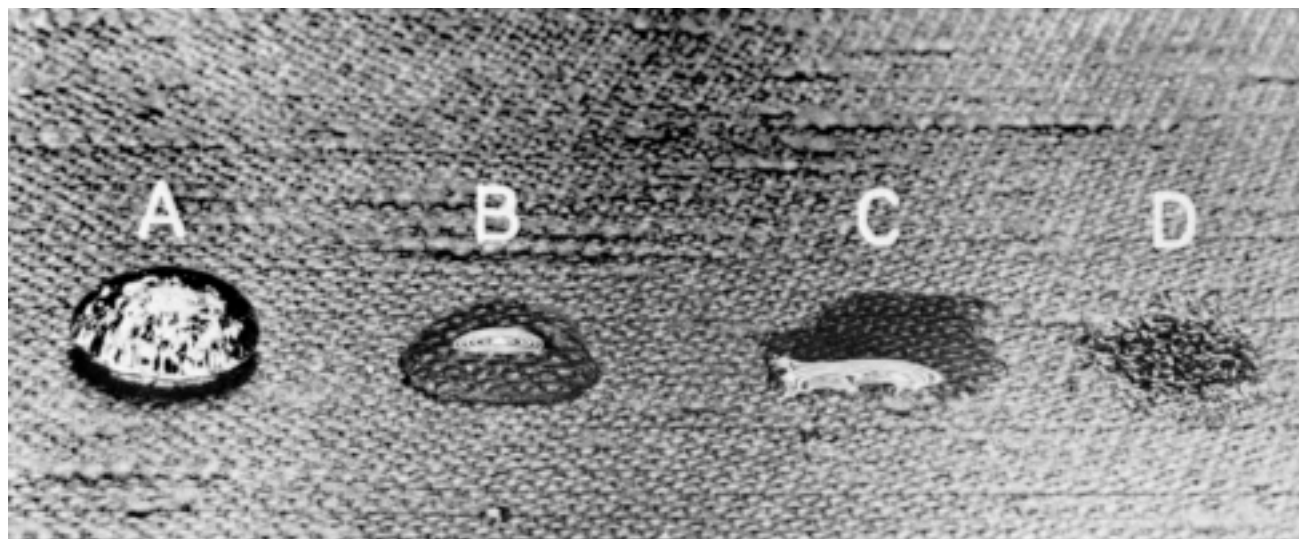
8.4 If no penetration or wetting of the fabric at the liquid-fabric interface and no wicking around the drops occur, place drops of the next higher-numbered test liquid at an adjacent site on the fabric and again observe for 10 ± 2 s.

8.5 Continue this procedure until one of the test liquids shows obvious wetting or wicking of the fabric under or around the drop within 10 ± 2 s.

9. Evaluation

9.1 The AATCC Aqueous Solution Repellency Grade of a fabric is the numerical value of the highest-numbered test liquid which will not wet the fabric within a period of 10 ± 2 s. A grade of zero (0) is assigned when the fabric fails the 98% water solution test liquid. Wetting of the fabric is normally evidenced by a darkening of the fabric at the liquid-fabric interface or wicking and/or loss of contact angle of the drop. On black or dark fabrics, wetting can be detected by loss of "sparkle" within the drop.

9.2 Different types of wetting may be encountered depending on the finish, fiber, construction, etc.; and the determination of the end point can be difficult on certain fabrics. Many fabrics will show complete resistance to wetting by a given test liquid (as indicated by a clear drop with a high contact angle, see Fig. 1, Example A) followed by immediate penetration by the next higher-numbered test liquid. In these instances the end point, and aqueous solution repellency grade, is



A = Passes; clear well-rounded drop
 B = Borderline pass; rounding drop with partial darkening
 C = Fails; wicking apparent and/or complete wetting
 D = Fails; complete wetting

Fig. 1—Grading example.

obvious. However, some fabrics will show progressive wetting under several test liquids as evidenced by a partial darkening of the fabric at the liquid-fabric interface (see Fig. 1, Examples B, C and D). For such fabrics, the point of failure is considered to be that test liquid which exhibits complete darkening of the interface or any wicking within 10 ± 2 s.

9.3 A **failure** occurs when two (or more) of the three drops applied from a given test liquid show complete wetting (Fig. 1[D]) or wicking with loss of contact angle (Fig. 1[C]). A **pass** occurs if two (or more) of the three drops applied show clear well rounded appearance with high contact angle (Fig. 1[A]). The grade is expressed as the integer value of the pass test liquid immediately prior to the fail test liquid. A **borderline pass** occurs if two (or more) of the three drops applied show the rounded drop with partial darkening of the test specimen (Fig. 1[B]). The grade is expressed to the nearest 0.5 value determined by subtracting one-half from the number of the borderline pass test liquid.

10. Report

10.1 The aqueous solution repellency grade should be measured on two separate specimens. If the two grades agree, report the value. When the two grades are not in agreement, a third determination should be made. Report the grade of the third determination if that value is the same as either of the first two determinations. When the third determination is

different from either of the first two, report the median value. For example, if the first two grades are 3.0 and 4.0 and the third determination is a 4.5 value, report the median value of 4.0. Report the aqueous solution repellency grade to the nearest 0.5 value (see Fig. 1 and 9.3).

11. Precision and Bias

11.1 *Summary.* Intralaboratory tests were conducted in November 2002 and January 2003 to establish the precision of this test method. Both intralab testings involved two participants in one laboratory rating two specimens of each of seven fabrics each day for three days. The grades of these intralabs use the scale from 1-10. All materials necessary for the intralabs were provided by customer fabric trials and were processed at two finish load levels. The fabrics used included nylon, polyester, cotton and polyester/cotton materials. The unit of measure was the median of the grades of the two (or three) specimens rated each day.

11.2 The components of variance as standard deviations of the aqueous solution repellency grade were calculated as shown in Table I.

Table I—Components of Variance
Table for Alcohol/water test

Single operator	0.26
Between operator/within laboratories	0.43

11.3 *Critical differences.* For the com-

ponents of variance in 11.2, two observations should be considered significantly different at the 95% probability level if the difference equals or exceeds the critical differences shown in Table II.

11.4 *Bias.* The true value of the aqueous solution repellency grade can only be defined in terms of this test method. Within this limitation, this test method has no known bias.

Table II—Critical Differences^a

No. of Observations ^b	Single Operator	Within Laboratory
1	0.50	0.79
2	0.18	0.59
3	0.15	0.48

^a The critical differences were calculated using $t = 1.950$, which is based on infinite degrees of freedom.

^b An observation is a unit of measure obtained from the median of the grades for 2 (or 3) specimens.

Table III—Mean Values from Testing of Specimens

Fabric	Finish load level	
	Low	High
Cotton	3.5	5.5
Polyester		7.5
Cotton/Polyester	1.5	2.5
Nylon	6	8