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# Standard Test Method for Resistance to Airflow as an Indication of Average Fiber Diameter of Wool Top, Card Sliver, and Scoured Wool[1]

This standard is issued under the fixed designation D 1282; 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 test method covers the estimation of the average fiber diameter of wool fibers by use of the Port-Ar and the WIRA Fiber Fineness Meter instrument, which operate on the air-flow principle. Other air-flow instruments have not been tested with this method. The method is directly applicable to non-medullated, carded wool and wool top.

1.2 This test method is applicable to grease wool and scoured wool after the samples of such materials have been prepared as directed in Test Method D 2130.

NOTE 1—The use of the Micronaire instrument for measuring the fineness of cotton fibers is covered in Test Method D 1448. The assignment of grade for wool and mohair is covered in Specifications D 3991 ~~and D3992~~ and D 3992.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

D 123 Terminology Relating to Textiles

D 1060 Practice for Core Sampling of Raw Wool in Packages for Determination of Percentage of Clean Wool Fiber Present

D 1448 Test Method for Micronaire Reading of Cotton Fibers

D 2130 Test Method for Diameter of Wool and Other Animal Fibers by Microprojection

D 3991 Specifications for Fineness of Wool or Mohair and Assignment of Grade

D 3992 ~~Specification for Fineness of Wool Top or Mohair Top and Assignment of Grade~~ Specifications for Fineness of Wool Top or Mohair Top and Assignment of Grade

D 4845 Terminology Relating to Wool

2.2 *Other Standard:*

IWTO-6-92(E) Method of Test for the Determination of The Mean Diameter of Wool Fibers in Combed Sliver Using the Air-Flow Apparatus

IWTO-28-82(E) Determination By The Airflow Method of the Mean Fibre Diameter of Core Samples of Raw Wool

## 3. Terminology

~~3.1 *Definitions:*~~

~~3.1.1 *sliver*, *n*—a continuous strand of loosely assembled fibers that is approximately uniform in cross-sectional area and without twist.~~

~~3.1.2 *specific area*, *n*— *of wool*, the ratio of the fiber surface to fiber volume.~~

~~3.1.3 *top*, *n*—*in wool*, a continuous untwisted strand of wool fibers from which the shorter fibers or noils have been removed by combing.~~

~~3.1.4 *wool*, *n*—the fibrous covering of the sheep, *ovis* species.~~

~~3.1.5 For definition of other textile terms used in the method, refer to Terminology D123~~

3.1 For all terminology related to wool and wool felt, refer to Terminology D 4845.

3.1.1 The following terms are relevant to this standard: sliver, specific area, top, and wool.

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.13 ~~on Wool and Wool Felt~~. ~~Current edition approved Jan. 1, 2005. Published March 2005. Originally approved in 1953. Last previous edition approved in 1996 as D1282–96.~~on Wool and Felt. Current edition approved July 1, 2009. Published August 2009. Originally approved in 1953. Last previous edition approved in 2005 as D 1282 – 05.

[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.

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3.2 For all other terminology related to textiles, see Terminology D 123.

## 4. Summary of Test Method

4.1 The resistance to air flow of predetermined mass of wool compressed to a fixed volume is measured. The instruments approved for use have been calibrated to read average diameter in micrometres. Specimens of wool top are rated with a Wool Top Scale and specimens of carded, scoured wool and scoured ½-in. (13.0-mm) cores are rated with a Scoured Wool Scale. If instruments are properly calibrated, results are interchangeable.

## 5. Significance and Use

5.1 This test method is not recommended for the acceptance testing of commercial shipments of wool top, card sliver, or scoured wool since the referee method, Test Method D 2130, is recommended for that purpose. Although this test method is not recommended for acceptance testing, it is useful for fast quality control checks.

~~5.1.1In case of a dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens which are as homogeneous as possible and which are from a lot of material of the type in question. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using Student's *t*-test for unpaired data and an acceptable probability level chosen by the two parties before testing is begun. If a bias is found, either its cause must be found and corrected or the purchaser and the supplier must agree to interpret future test results in view of the known bias.~~

5.1.1 .If there are differences of practical significance between reported test results for two laboratories (or more), comparative test should be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, use the samples for such a comparative test that are as homogenous as possible, drawn from the same lot of material as the samples that resulted in disparate results during initial testing and randomly assigned in equal numbers to each laboratory. The test results from the laboratories involved should be compared using a statistical test for unpaired data, a probability level chosen prior to the testing series. If bias is found, either its cause must be found and corrected, or future test results for that material must be adjusted in consideration of the known bias.

5.2 The specific area of the wool fibers is measured by the resistance in air flow. The resistance to air flow has been related to average fiber diameter measured by the microprojection method. The instruments have been calibrated to read average diameter

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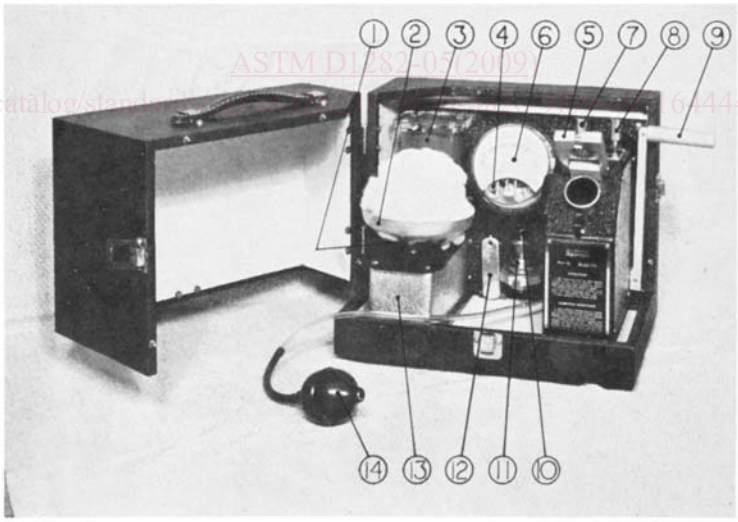
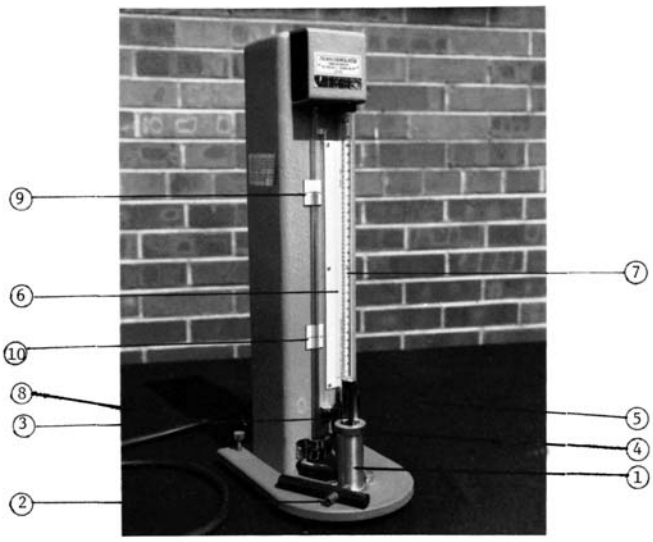



1) Balance Adjustment Knob
2) Balance Pan
3) Air Reservoir
4) Meter Zero Adjustment Screw
5) Porosity Test Chamber Lid
6) Differential Pressure Gage
7) Porosity Zero Control
8) Porosity Calibration Control
9) Compression Lever
10) Calibrator Plug Plunger
11) Porosity Calibrator Plug
12) Calibration Weight
13) Weighing Balance Mechanism
14) Atomizer Bulb

**FIG. 1 Port-Ar Apparatus**




*1*) Metal specimen container
*2*) Packing rod
*3*) Plunger
*4*) Retaining collar
*5*) Control knob
*6*) Gage tube
*7*) Millimetre scale
*8*) Vacuum supply
*9*) Upper gage tube mark
*10*) Lower gage tube mark

**FIG. 2 WIRA Fiber Fineness Meter**

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in micrometres. Although the reading is affected by the average fiber diameter distribution of the specimen, the results secured by the instruments give no indication of this distribution. However, in converting the micrometres reading to millitex units (Annex A1), low, medium, and high standard deviations were used in the calculations to arrive at the range of millitex units which accordingly reflect the distribution of fiber diameters.

## 6. Apparatus, Materials, and Reagent

6.1 *Port-Ar*[3], described in this method and shown in Fig. 1.

6.2 *WIRA Fiber Fineness Meter*[4], described in this method and shown in Fig. 2.

6.2.1 Scale graduated in millimetres.

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6.2.2 Calibration chart converting float height in millimetres to diameter in micrometres.

6.2.3 Air pump capable of furnishing a constant vacuum of 609.6 mm (24 in.) of mercury.

6.2.4 Tables of correction values to correct observed results in micrometres to deviations from standard conditions, 20°C (68°F) and 65 % relative humidity, as shown in Annex A2.

6.3 *Trichloroethane* or equivalent solvent.

6.4 *Working Reference Samples*, three, prepared by each laboratory for use in checking the instruments. One working reference sample should be selected from each of the following ranges of grade: (*1*) up to and including 48's, (*2*) 50's to 60's inclusive, and (*3*) 62's or finer. These samples of uniform fineness with a low standard deviation, as explained in Appendix A1.1, must be thoroughly tested both by the air-flow instrument being used and by the microprojection method.

6.5 *Standard Reference Samples*[5]—Three samples are available with the following average fiber diameters: 20.7 µm, 27.3 µm and 37.4 µm.

## 7. Hazards

7.1 Refer to the manufacturer's material safety data sheet for information on handling, use, storage, and disposal of trichloroethane or equivalent solvent.

7.2 Use trichloroethane or equivalent solvent in well-ventilated hood due to the associated health hazards.

## 8. Calibration of Apparatus

8.1 Calibrate the instrument on arrival in accordance with instructions in Annex A2.

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[3] The Port-Ar instrument, trademark for a product manufactured by Zellweger Uster, 456 Troy Circle, P.O. Box 51720, Knoxville, TN 37950, has been found satisfactory for this purpose.

[4] The WIRA Fiber Fineness Meter, trademark for a product manufactured by Reynolds and Branson Ltd., for Thorn Bendix Ltd., Beech Ave., New Barford, Nottingham NG7 7JJ England. This instrument is available from Lawson-Hemphill Sales, Inc., P.O. Drawer 6388, Spartanburg, SC 29304.

[5] May be obtained from Agricultural Marketing Service, Livestock and Seed Division, 711 "O" Street, Greeley, CO 80631.

8.2 Recalibrate the instrument each day. Verify calibration after each 4 h of use or whenever an operational problem is noted.

## 9. Sampling

9.1 *Lot Sample*—For acceptance testing, take at random the number of shipping containers directed in an applicable material specification or other agreement between the purchaser and the supplier, such as an agreement to use Practice D 1060. Consider shipping containers to be the primary sampling units.

NOTE 2—A realistic specification or other agreement between the purchaser and the supplier requires taking into account the variability between shipping containers, between laboratory samples within a shipping container, and between specimens within a laboratory sample so as to provide a sampling plan which at the specified level of the property of interest has a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

9.2 *Laboratory Sample*—As a laboratory sample for acceptance testing, take the number of subsamples from each package in the lot sample as directed in an applicable material specification or other agreement between the purchaser and the supplier, such as an agreement to use Practice D 1060 if baled or bagged wool is to be tested.

9.3 *Test Specimens:*

9.3.1 *Port-Ar Procedure*—Take one specimen per laboratory sampling unit.

9.3.2 *Wira Procedure*—Take one specimen per laboratory sampling unit.

## 10. Specimen Preparation

10.1 Prepare test specimens of wool top, card sliver, scoured, or grease wool as directed in Test Method D 2130.

10.2 If no mechanical card is available, take two subsamples of scoured wool, each weighing approximately 4 g more than the mass of wool required for measurement in the air-flow instrument being used; hand card these subsamples at least 30 strokes each and prepare a test specimen from each of them.

10.3 Rinse all test specimens in the recommended solvent to reduce the extractable matter to less than 1 % of the specimen mass. Condition the test specimens as prescribed in 11.1 or 11.2. From the conditioned test specimen, weigh the amount of wool required for measurement in the air-flow instrument being used.

10.3.1 *Port-Ar*—Place approximately 12.5 g of the conditioned wool specimen in the balance basket. One pump of the atomizer bulb will indicate whether the specimen is too light or too heavy: If the meter reads above the red triangle, the specimen is too heavy; if below, the specimen is too light. Adjust the specimen to 12.5 g by adding or removing small amounts of wool. The meter indicates the mass of the specimen to within ± 0.5 % if the pointer is on scale, so the mass needs to be adjusted only until the pointer reads within the red triangle.

NOTE 3—The accuracy of the balance should be thoroughly checked before and while using the Port-Ar. The specimen may be weighed on a separate balance.

10.3.2 *WIRA Fiber Fineness Meter*—Weigh a 2.500 ± 0.005 g test specimen. Remove pieces of vegetable matter and other impurities before weighing.

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## 11. Conditioning

11.1 For tests made on the Port-Ar as directed in 11.2, reasonable results may be obtained even if the standard atmosphere for testing is not available since the instrument uses low-pressure ambient air. Keep the instrument in a draft-free room, away from radiators, sunlight, and other elements which disturb temperature or air. Allow the instrument and the well-opened wool to be tested to remain in the same atmospheric conditions for approximately 4 h before the specimens are tested.

11.2 For tests made on the WIRA Fiber Fineness meter as directed in 12.2, bring the test specimen to moisture equilibrium with the standard atmosphere. A 4 h conditioning period is usually sufficient.

## 12. Procedure

12.1 *Procedure with the Port-Ar*:

12.1.1 *Wool Top, Card Sliver, Scoured Wool, Grease Wool*—Using the weighed test specimen, (see 10.3.1) place one end of the sliver in the chamber and tamp in the remainder. Do not fold the wool top before placing in the chamber. When all of the specimen

**TABLE 1 Components Of Variance As Standard Deviations, μm**

| Names Of The Properties | Single-Operator Component | Within-Laboratory Component | Between-Laboratory Component |
|---|---|---|---|
| Fiber diameter, Port-Ar procedure | | | |
| Single-material comparisons | 0.21 | 0.20 | 0.72 |
| Multi-material comparisons | 0.00 | 0.20 | 0.74 |
| Fiber diameter, WIRA procedure | | | |
| Single-material comparisons | 0.23 | 0.11 | 0.37 |
| Multi-material comparisons | 0.13 | 0.11 | 0.38 |

**TABLE 2 Critical Differences,[A] µm, For The Conditions Noted**

| Names Of The Properties | Number Of Observations In Each Average | Single-Operator Precision | Within-Laboratory Precision | Between-Laboratory Precision |
|---|---|---|---|---|
| Fiber diameter, Port-Ar procedure | | | | |
| Single-material comparisons | 1 | 0.57 | 0.79 | 2.14 |
| | 2 | 0.41 | 0.68 | 2.10 |
| | 4 | 0.29 | 0.61 | 2.08 |
| | 8 | 0.20 | 0.58 | 2.07 |
| Multi-material comparisons | 1 | 0.57 | 0.79 | 2.20 |
| | 2 | 0.41 | 0.68 | 2.17 |
| | 4 | 0.29 | 0.61 | 2.15 |
| | 8 | 0.20 | 0.58 | 2.14 |
| Fiber diameter, WIRA procedure | | | | |
| Single-material comparisons | 1 | 0.64 | 0.71 | 1.25 |
| | 2 | 0.46 | 0.55 | 1.16 |
| | 4 | 0.32 | 0.44 | 1.11 |
| | 8 | 0.23 | 0.38 | 1.09 |
| Multi-material comparisons | 1 | 0.73 | 0.79 | 1.32 |
| | 2 | 0.57 | 0.65 | 1.24 |
| | 4 | 0.48 | 0.56 | 1.20 |
| | 8 | 0.42 | 0.52 | 1.18 |

[A] The critical differences were calculated using $t = 1.96$, which is based on infinite degrees of freedom.

has been forced into the chamber, close the compression chamber lid, 5, in place. Pull forward on the compression lever, *9*, until it locks in place. Apply air pressure either by the atomizer bulb or by the electric pump to fill the pressure tank (Note 3). Read the diameter in micrometres on the scale as the piston settles. Record the reading and remove the specimen, carefully reopen it by hand to eliminate compact areas, replace the specimen in the chamber and make a second reading.

NOTE 4—In using the electric pump, some operators find continuous operation advantageous. Satisfactory results will be obtained in this case if calibration adjustments are also made with the pump running continuously. A small reservoir tank or "bladder" mounted in the air line between the pump and the instrument will reduce needle vibration.

NOTE 5—Port-Ar instrument described in Fig. 1 is calibrated for wool grade (Top and wool). Port-Ar instrument is also available for measuring mohair fibers.

12.2 *Procedure with the WIRA Fiber Fineness Meter*:

12.2.1 Feed the weighed specimen into the metal container, meanwhile pushing the wool down evenly into the container with the *short* end of the rod provided. It is important to use this rod and nothing else for packing since it prevents tight packing of the fibers. Then push in the metal plunger (avoiding trapping any fibers) until it rests on the lip of the container and screw down the retaining collar to the furthest extent, meanwhile holding the plate attached to the metal plunger to prevent it rotating.

12.2.2 With the control knob in the OFF position switch on the pump then turn the knob slowly until the liquid level in the gage tube falls to the lower mark reading at eye level.

12.2.3 Reading at eye level across the top of the spinner record the scale reading to the nearest millimetre.

12.2.4 Take out the specimen, reverse its direction, repack in the container using the rod and take another reading. Repeat this until 4 readings have been recorded and take the average. Do not repack the specimen with the fingers.

12.2.5 Turn the control knob back to zero.

12.2.6 For wool above 30 micrometres make four readings on each of four weighings and for wool of 30 micrometres or less make four readings on each of three weighings.

## 13. Calculation

13.1 Calculate the average fiber diameter of the lot from all the readings, to the nearest 0.05 µm.

## 14. Report

14.1 State that the specimens were tested as directed in Test Method D 1282. Describe the material or product sampled and the method of sampling used.

14.2 Report the following information:

14.2.1 The average fiber diameter to the nearest 0.05 µm.

14.2.2 The number of test specimens used and the number of readings made on each specimen.

14.2.3 The solvent used if not trichloroethane.

14.2.4 For the Port-Ar, the conditions under which the testing was carried out, if the standard atmosphere for testing was not used, and if the instrument was calibrated using the standard calibration switch plunger, 10, or well-measured wool samples.

## 15. Precision and Bias

15.1 *Summary*—In comparing two averages, the differences should not exceed the following critical differences in 95 cases out

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of 100 when all of the observations are taken by the same well-trained operator using the same piece of test equipment and specimens randomly drawn from the same sample of material.

| | |
|---|---|
| Fiber Diameter, Port-Ar Procedure | 0.40 |
| Fiber Diameter, WIRA Procedure | 0.45 |
| Micrometres For Averages Of | 2 |
| Micrometres For Averages Of | 2 |

The size of an observed difference is likely to be affected adversely by different circumstances. The ~~true~~ values of the properties tested by Test Method D 1282 can be defined only in terms of specific test methods. Within this limitation, the procedures in Test Method D 1282 for determining these properties have no known bias. Sections 14.2.1-14.2.4 explain the basis for this summary and for evaluations made under other conditions.

15.2 *Interlaboratory Test Data*[6]—An interlaboratory test was run in 1976 in which randomly drawn samples of five materials were tested in each of five laboratories using the Micronaire and Port-Ar procedures and in each of three laboratories using the WIRA procedure. Each laboratory used two operators, each of whom tested two specimens of each material. The components of variance expressed as standard deviations were calculated to be the values listed in Table 1.

NOTE 6—Where separate components of variance are shown for multimaterial comparisons, (*1*) the multi-material, single-operator component is due to an operator times material (within-laboratories) interaction and is combined with the single-material, single-operator component in calculating critical differences, and (*2*) any increase in the multimaterial, between-laboratory component over the single-material, between-operator component is due to a material times laboratory interaction.

NOTE 7—Since the Interlaboratory tests using the WIRA procedure included only three laboratories, between-laboratory precision data for that procedure should be used with special caution.

NOTE 8—The tabulated values of the critical differences should be considered to be a general statement, particularly with respect to between-laboratory precision. Before a meaningful statement can be made about two specific laboratories, the amount of statistical bias, if any, between them must be established, with each comparison being based on recent data obtained on randomized specimens from one sample of the material to be tested.

15.3 *Bias*—The microprojector procedure in Test Method D 2130 is the accepted referee method for determining the diameter of wool and other animal fibers.

15.3.1 The values obtained using the procedures in Test Method D 1282 for measuring average fiber diameter have the following estimated biases as compared to the values obtained using Test Method D 2130.

| Instrument | Average Bias, μm |
|---|---|
| Port-Ar | + 0.68 |
| WIRA | – 0.41 |

NOTE 9— *Example*—A wool reported as having a diameter of 26.000 μm when using Method D 2130 would tend to be reported as having a diameter of 26.68 μm when using the Port-Ar procedure of Method D 1282.

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## 16. Keywords

16.1 air-flow; diameter; wool

[6] ASTM Research Report No. RR D-13-1051. A copy is available from ASTM Headquarters.

[6] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: **RR D-13-1051** .