Foreword

This document follows a format based on Test Methods published by the American Society for Testing and Materials (ASTM). It is noted, however that this document is produced independently of ASTM and ASTM International.

Contents

Abstract

This document covers classification and test methods for the materials used in the construction of textile face masks used to prevent community transmission of diseases borne by respiratory drops. Face mask material performance is based on testing for droplet filtration efficiency and differential pressure. This Test Method does not address all aspects of face mask design and performance. The Test Method does not address aspects of mask performance due to fitment, mask design, or material safety and/or compatibility, nor does it provide a specification for textile face masks or materials.

1 Scope

1.1 This Test Method describes the testing requirements for materials used in the construction of textile face masks that are used to combat transmission of disease borne by respiratory drops.

1.2 This Test Method provides for the quantitative classification of face mask material performance. Face mask material performance is based on testing for exhaled droplet filtration efficiency and differential pressure.

1.3 This Test Method does not address all aspects of face mask design and performance. The specification does not address aspects of mask performance due to fitment, mask design, or material safety and/or compatibility.

1.4 This Test Method does not specifically evaluate the effectiveness of face mask designs as related to leakage due to improper design, fitment, and/or use by the wearer.

1.5 This Test Method does not apply to evaluations of mask materials for safety, flammability, or biological compatibility.

1.6 This Test Method does not apply to respiratory protection against airborne disease.

1.7 The values stated in SI units are to be regarded as standard.

1.8 This Test Method does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

2 Referenced Documents

2.1 ASTM Standards:

2.2 ISO Standards:

2.3 NIOSH Standards:

2.4 Federal Standards

3 Terminology

3.1 Definitions of terms used in this document:

Respiratory drop/droplet: a liquid drop such as produced during respiration, speech (including singing), coughing or sneezing equal to or larger than 2 microns.

OPC: Optical Particle Counter

4 Summary of Test Method

4.1 The filtering efficiency of a textile material, as a function of droplet size in the range 0.3-10 microns, is determined by measuring the flux of droplets in discrete size ranges of a droplet laden flow with and without the filter material in place.

4.2 Droplet flux measurements are obtained at 0.3, 0.5, 1.0, 3, 5, and 10 microns by use of a 6-channel optical particle counter inserted into the flow.

4.3 Additionally, the differential pressure across the filter material is reported as a measure of respiratory effort required when wearing the mask.

4.4 Measurements are conducted on an area of samples measuring at least 51 mm in diameter at a gas superficial velocity of 0.33 m/s.

5 Purpose and Use

5.1 This Test Method describes a method for evaluating and classifying materials for use in the construction of textile face masks, on the basis of filtration efficiency of respiratory drops (≥ 2 microns) and differential pressure across the material at a flow rate corresponding closely to moderate respiration (85 l/min) through an effective area equivalent to half of that of a adult disposable medical mask (75mm × 125mm when laid flat).

6 Interferences

6.1 There are no known significant interferences.

7 Apparatus

7.1 The test apparatus shall meet the following requirements:

1. Adjustable air flow up to 2 lpm/cm^2 of textile sample.
2. Nebulizer/atomizer producing statistically significant quantities of propylene glycol/glycerin (50/50% v/v) droplets in the range 0.1 µm < d < 10 µm.
3. Instrumentation:
   a) Differential pressure (0.01 in H_2O precision) across the sample chamber.
   b) Inlet temperature and relative humidity.
   c) Barometric pressure.
   d) Gas flow (0.05 lpm/cm^2 precision).
   e) 6-channel optical particle counter (0.3, 0.5, 1.0, 2.5, 5, 10 µm) and isokinetic sample probe.

8 Materials

8.1 The spray fluid shall consist of a mixture of 50% propylene glycol and 50% glycerin (by volume).

9 Hazards

9.1 Operation of the apparatus requires a compressed gas source. Appropriate safety precautions and adherence to safety regulations regarding use of compressed gas is required.

9.2 Safety glasses are recommended when handling glycerin, propylene glycol, or a prepared mixture of spray fluid.

9.3 Glycerin is a flammable substance in pure form. Preparing mixtures of spray fluid should be conducted away from sources of heat or flame.

9.4 The spray fluid may cause skin or eye irritation. Flush with water if contact with skin or eyes occurs.

9.5 The spray fluid, and its constituents, pose a slip hazard. Clean spills immediately.

9.6 Both propylene glycol and glycerin are used as food additives. Accidental consumption of small quantities of spray fluid, or either pure substance, is unlikely to be harmful.

10 Sampling, Test Specimens, and Test Units

10.1 Test specimens can be any shape, provided that a continuous circular sampling area of at least 50mm diameter can be described upon it. Specimens can be trimmed to fit in a particular apparatus, provided the sampling area is maintained.

10.2 Test specimens must be clean and completely dry prior to use.

10.3 A test unit shall consist of a number of specimens required for the uncertainty in efficiency at 2 microns and at 5 microns to converge to a value less than 0.01.

10.4 A test unit shall consist of a number of specimens required for the uncertainty in differential pressure to converge to a value less than 20 Pa (2 mm H_2O).

10.5 Notwithstanding sections 10.3 and 10.4, a test unit shall consist of no fewer than three (3) separate specimens.

11 Calibration and Standardization

11.1 The following instruments must have valid calibration certificates:

1. Differential pressure transducer
2. Gas flow meter
3. Optical particle counter

12 Conditioning

12.1 Textile samples used in testing must be clean and dry.

12.2 Testing shall be conducted in an indoor laboratory environment at an ambient temperature between 15 degrees C and 30 degrees C, and a relative humidity between 30% and 70%.

12.3 A sterile or clean-room environment is not required. However, the apparatus must be located in a reasonably clean environment free of excessive dust, such that fouling of the apparatus or samples does not occur during the test.

13 Procedure

13.1 The following procedure applies to the measurement of a single test specimen.

13.2 Test Preparation:

1. Ensure that the apparatus is clean, and free of liquid residue and dust.
2. Fill fluid reservoir (if necessary, see Section 8). Note: if this is the first test performed of the day, new fluid must be used.
3. Record the following information:
   a) Sample ID
   b) Date/time
   c) Operator
   d) Instrument serial #
   e) temperature
   f) RH
   g) barometric pressure

13.3 Recording Baseline Data:

4. Close the test section.
5. Start an air flow through the apparatus equivalent to 0.88 lpm/cm^2
6. Record the differential pressure across the empty test chamber for a minimum of 30 seconds.
7. Start mist flow
8. Record baseline droplet count distribution (time/samples TBD)
9. Stop mist and airflow

13.4 Recording Test Data:

10. Clamp or otherwise secure the sample in the test section such that air cannot leak around the sample. It should be wrinkle-free, but not stretched tight.
11. Turn on air flow (0.88 lpm/cm^2)
12. Record the differential pressure across the test chamber containing the sample for a minimum of 30 seconds.
13. Start mist flow
14. Record filtered droplet count distribution (time/samples TBD)
15. Stop the mist flow. Continue to flow air for 30 s.
16. Stop air flow.

13.5 Test Completion:

17. Remove sample from test section.
18. Wipe any excess liquid from the test section.
19. Open drain valve to drain excess liquid from the system.

13.6 Maintenance:

20. Daily: components of the apparatus exposed to spray fluid must be thoroughly cleaned and dried when in use.

13.7 Storage:

21. If stored for more than 7 days, the apparatus should be thoroughly cleaned and covered, with all valves closed and the air outlet capped, to prevent accumulation of dust.

14 Calculation or Interpretation of Results

14.1 The filtering efficiency η of a specimen, as a function of droplet size d, is defined by measuring the flux of droplets of a given size, $\phi(d)$, with and without the filter material in place.

$$\eta(d) = 1 - \frac{\phi_f(d)}{\phi_0(d)} \quad (1)$$

14.2 where $\phi_f(d)$ is the flux of liquid drops of size d passing through the filter, and $\phi_0(d)$ is the flux of liquid drops of size d without the filter in place.

14.3 Calculating efficiency from OPC histogram data is performed as follows:

$$\eta(d) = 1 - \frac{N_f(d)/t_f}{N_0(d)/t_0} \quad (2)$$

where $N_f(d)$ is the number of droplets of size d passing through the filter during the data acquisition time interval t_f, and $N_0(d)$ is the number of droplets of size d detected with no filter in place during the data acquisition time interval t_0.

14.4 The data acquisition duration can be obtained from file timestamp data or manually recorded.

14.5 The filtration efficiency and pressure differential of a test unit is calculated as the arithmetic average of quantities obtained for the test specimens.

14.6 It is helpful to evaluate test results in the context of existing classifications, standards and/or recommendations. Examples include the NIOSH N95 classification [1], which requires a minimum

filtration efficiency of 95% of particles or droplets of 0.3 μm size. Filtration of particles in this size range is required for a mask to be effective at preventing airborne transmission of disease.

14.7 To prevent transmission of disease carried by respiratory droplets, filtration in the 3μm size range is required. CWA 17553:2020 [2] implies that a minimum acceptable filtration performance is in the range of 70% of 3μm drops at a flow rate corresponding to 60 l/s/m^2 (60 l/s per square meter of fabric).

14.8 CWA 17553:2020 further stipulates that the air permeability of a face covering shall be greater than or equal to 96 l/s/m^2 for a vacuum pressure of 100 Pa. Alternatively, for a respiratory effort of 100 Pa, the minimum acceptable flow rate is 96 l/s/m^2.

14.9 It is suggested that the recommendations in CWA 17553:2020 should constitute the minimum standards for filtration and breathability of facial coverings.

15 Reporting

15.1 The following results are reported:

1. Section 1: Laboratory ID, Sample ID, date/time of test, operator ID, Instrument serial #, temperature, RH, barometric pressure
2. Section 2: Pressure drop
3. Section 3: Filtration efficiency at 0.3, 0.5, 1.0, 3, 5, and 10 μm and corresponding measurement uncertainty (Section 17).
4. Section 4: Operator notes.

15.2 An example test report is provided in an appendix.

15.3 Laboratory ID identifies the laboratory where measurements were performed.

15.4 Sample ID is a unique alphanumeric identifier for the sample.

15.5 Date and time: The date and time must be recorded at the beginning and conclusion of a sample test.

15.6 Operator ID is a unique alphanumeric identifier for the personnel conducting the test.

15.7 Instrument serial number is a unique alphanumeric identifier for the apparatus used.

15.8 Temperature and relative humidity refer to the conditions at the apparatus inlet.

15.9 Barometric pressure refers to the ambient condition in the laboratory where the test is conducted.

15.10 Pressure drop refers to the difference in differential pressures measured the sample test section with the textile sample present and not present. Values reported should be positive.

15.11 Filtration efficiency can be tabulated or presented in a figure (or both). Numerical values of efficiency must be provided at 2 microns and 5 microns minimally. Filtration efficiency can be

reported as either fractional (0-1) or in terms of percentage (0-100), provided that the method is clearly identified.

16 Precision and Bias

16.1 Required instrument measurement precisions are provided in Section 7.

16.2 Filtration efficiency results shall be reported with a precision of 0.001 (0.1%).

16.3 Differential pressure measurements shall be reported with a precision of ±10 Pa (±1mm H_2O)

17 Measurement Uncertainty

17.1 At the extremes of the droplet size distribution, count rates are often statistically less significant. It is therefore important to select a nozzle or mist-generator that generates statistically significant numbers of droplets in the range of interest (0.3-10 microns) to minimize efficiency measurement uncertainty.

17.2 A test unit efficiency measurement uncertainty shall be calculated based on the standard deviation of the test sample measurements and a 95% confidence interval (i.e. mean ± 2 standard deviations).

17.3 A test unit pressure differential measurement shall be calculated based on the standard deviation of the test sample measurements and a 95% confidence interval (i.e. mean ± 2 standard deviations).

18 Keywords

18.1 Textile mask, respiratory drops

19 Annexes and Appendices

19.1 A Sample Test Report appears on the following page.

Coanda	***Coanda Research & Development Corporation*** 101-5140 North Fraser Way Burnaby, BC, Canada V5J 0J4 604 420 0367 www.coanda.ca	Report #: PO #: Received: Report Date: Issued by: Approved by:	2020-001 N/A 2020-01-01 2020-01-02 J. Doe A. Nother

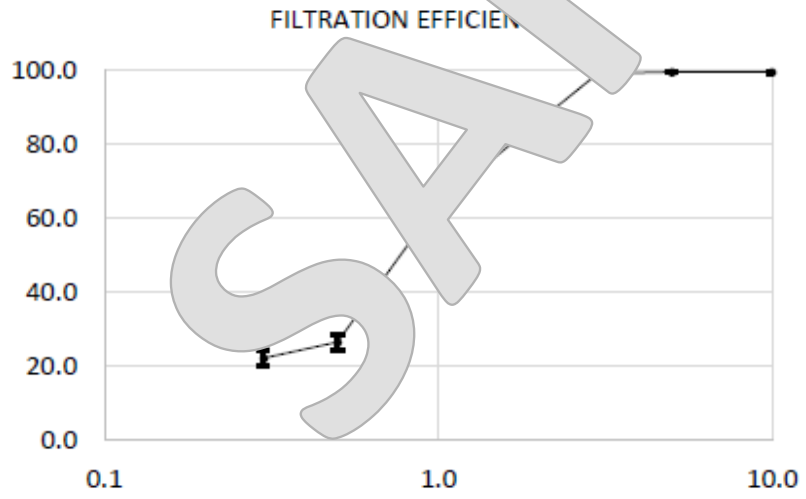
Customer:	***Acme Corp.*** 123 Main St. Anytown, Prov. Canada 800-555-1212	**Contact:** A.N.Other ANOther@email.com 800-555-5555 x. 123

Sample details:	**Date Received:**	2020-01-01	**Cust. ID:**	1234
	Inv. Num.:	2020-	**Description:**	yer covering. 100% poly.
	# Samples:			inner (80 gsm), 100% cotton
	Weight:	N/A		(flannel) outer, (220 gsm)

TEST DATA:

Lab ID:	CRDC-BBY	**Apparatus ID:**	RDC-0	**Location:**	Burnaby, BC, Canada
Test Date:	2020-12-15	**Temperature (C):**		**Time zone:**	PST (UTC-8)
Start Time:	12:10:08 PM	**Bar. Press (mm**		**Operator:**	Roberts, Stephen
End Time:	12:40:11 PM	**DP (C):**		**Protocol:**	CRDC SOP 0067.3

Test Notes:



PRESSURE DROP (dP)		
Test air flow	7.3	l/min
Test liq. flow	5.0	cc/hr
dP	0.505	in H2O
STD. dP	322.5	Pa (@ Qref)

DIA (µm)	**FILTRATION: EFFICIENCY (%)**	**+/- (%)**
0.3	22.1	2.2
0.5	26.5	2.1
1.0	64.1	1.0
3.0	99.0	0.0
5.0	99.6	0.0
10.0	99.7	0.5

INDEX SCORES:

INDEX	RANGE	SCORE	PASS/FAIL	NOTES
BREATHABILITY	MIN: 1, MAX: 5	1	F	
FILTRATION	MIN: 1, MAX: 5	4	P	

20 References

[1] National Institute for Occupational Health and Safety, *42 CFR pt. 84 Approval of Respiratory Protective Devices*, 1995.

[2] European Committee for Standardization, *CWA 17553 Community face coverings - Guide to minimum requirements, methods of testing and use*, 2020.

21 Summary of Changes

2020-10-22: Original Release.

2020-12-15: Revised test report. Added passing standards.