

Bacterial Filtration Efficiency (BFE) and Differential Pressure (Delta P) Final Report

Test Article: Face Mask
Purchase Order: 20-201A
Study Number: 1291693-S01
Study Received Date: 22 Apr 2020
Testing Facility: Nelson Laboratories, LLC
6280 S. Redwood Rd.
Salt Lake City, UT 84123 U.S.A.
Test Procedure(s): Standard Test Protocol (STP) Number: STP0004 Rev 18
Deviation(s): None

Summary: The BFE test is performed to determine the filtration efficiency of test articles by comparing the bacterial control counts upstream of the test article to the bacterial counts downstream. A suspension of *Staphylococcus aureus* was aerosolized using a nebulizer and delivered to the test article at a constant flow rate and fixed air pressure. The challenge delivery was maintained at $1.7 - 3.0 \times 10^3$ colony forming units (CFU) with a mean particle size (MPS) of $3.0 \pm 0.3 \mu\text{m}$. The aerosols were drawn through a six-stage, viable particle, Andersen sampler for collection. This test method complies with ASTM F2101-19 and EN 14683:2019, Annex B.

The Delta P test is performed to determine the breathability of test articles by measuring the differential air pressure on either side of the test article using a manometer, at a constant flow rate. The Delta P test complies with EN 14683:2019, Annex C and ASTM F2100-19.

All test method acceptance criteria were met. Testing was performed in compliance with US FDA good manufacturing practice (GMP) regulations 21 CFR Parts 210, 211 and 820.

Test Side: Inside
BFE Test Area: $\sim 40 \text{ cm}^2$
BFE Flow Rate: 28.3 Liters per minute (L/min)
Delta P Flow Rate: 8 L/min
Conditioning Parameters: $85 \pm 5\%$ relative humidity (RH) and $21 \pm 5^\circ\text{C}$ for a minimum of 4 hours
Test Article Dimensions: $\sim 172 \text{ mm} \times \sim 171 \text{ mm}$
Positive Control Average: 2.7×10^3 CFU
Negative Monitor Count: < 1 CFU
MPS: $2.8 \mu\text{m}$



Sarah Smit electronically approved for
Study Director

Janelle Bentz

31 May 2020 17:03 (+00:00)
Study Completion Date and Time

Results:

Test Article Number	Percent BFE (%)
1	99.7
2	99.5
3	99.9
4	99.9
5	99.9

Test Article Number	Delta P (mm H ₂ O/cm ²)	Delta P (Pa/cm ²)
1	4.1	40.1
2	4.5	43.7
3	4.1	40.5
4	3.9	38.3
5	4.3	41.9

The filtration efficiency percentages were calculated using the following equation:

$$\% BFE = \frac{C - T}{C} \times 100$$

C = Positive control average

T = Plate count total recovered downstream of the test article

Note: The plate count total is available upon request

Microbial Cleanliness (Bioburden) of Medical Masks Final Report

Test Article: Face Mask
 Purchase Order: 20-201A
 Study Number: 1291696-S01
 Study Received Date: 22 Apr 2020
 Testing Facility: Nelson Laboratories, LLC
 6280 S. Redwood Rd.
 Salt Lake City, UT 84123 U.S.A.
 Test Procedure(s): Standard Test Protocol (STP) Number: STP0036 Rev 15
 Customer Specification Sheet (CSS) Number: 202001516 Rev 02
 Deviation(s): None

Summary: The testing was conducted in accordance with EN 14683:2019, with the exception of approximate volumes of eluent used when performing the extraction procedure and a temperature range of 30-35°C used for aerobic incubation.

When bioburden results are calculated using a software program, manual calculations may differ slightly due to rounding. The counts determined on products are colony forming units and may not always reflect individual microorganisms. The sponsor performs any statistical analysis and determines the acceptable limits. Testing was performed in compliance with US FDA good manufacturing practice (GMP) regulations 21 CFR Parts 210, 211 and 820.

Results:

Unit Number	Weight (g)	Aerobic	Fungal	Total Bioburden (CFU/mask)	Total Bioburden (CFU/g)
1	2.8	<3	<3	<6.0	<2.2
2	2.7	<3	<3	<6.1	<2.3
3	2.7	<3	<3	<5.8	<2.2
4	2.8	<3	<3	<5.9	<2.1
5	2.7	<3	<3	<6.0	<2.2
Recovery Efficiency	UTD ^a				

< = No Organisms Detected

UTD = Unable to Determine

Note: The results are reported as colony forming units (CFU) per mask.

^a UTD due to zero count on the first rinse. An alternative method or inoculated product recovery efficiency is recommended.



Matthew Shepherd electronically approved for
Study Director

Robert Putnam

07 May 2020 17:02 (+00:00)

Study Completion Date and Time

Method Suitability:

Organism	Percentage
<i>Bacillus atrophaeus</i>	96%

Test Method Acceptance Criteria: If applicable, anaerobic controls are acceptable for the bioburden test results. The number of masks to be tested shall be a minimum of 5 or more to meet an acceptable quality level of 4%. The bioburden of the medical mask shall be < 30 CFU/g tested.

Procedure:

- Positive Controls/Monitors: *Bacillus atrophaeus*
- Extract Fluid: Peptone Tween[®]
- Extract Fluid Volume: ~300 mL
- Extract Method: Orbital Shaking for 15 minutes at 250 rpm
- Plating Method: Membrane Filtration
- Agar Medium: Potato Dextrose Agar
Tryptic Soy Agar
- Recovery Efficiency: Exhaustive Rinse Method
 - Aerobic Bacteria: Plates were incubated 3 days at 30-35°C, then enumerated.
 - Fungal: Plates were incubated 7 days at 20-25°C, then enumerated.