Respiratory Effectiveness of Cloth Masks

Behnam Pourdeyhimi NC State University
Simon Schick North Carolina State University
Robert Groten HOCHSCHULE NIEDERRHEIN University of Applied Sciences, Germany and North Carolina State University
Hooman Vahedi Tafreshi North Carolina State University

The shortage of medical masks and respirators led to an explosion of cloth mask offerings. In the absence of any regulatory requirements, and appropriate guidance, the medical masks vary greatly in their performance and have become more of a fashion item.

We review the filtration mechanisms and test methods and show data on common offerings. Almost exclusively, the data suggest that cloth masks do not offer much of a protection, and many are poorly designed with only the pressure drop and fogging in mind; these compromise the performance of the entire mask. While cloth masks do not offer significant respiratory protection, it is still critical that masks are worn during pandemics regardless in that they do reduce the number of aerosols expelled by the wearer.

Citation

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Introduction

Prior to the development of the current respirators and medical masks, cloth masks were worn by healthcare providers and others.

The introduction of various forms of mouth and nose coverage can be followed back to the turn-of-the-20th-century. In 1897, Carl Friedrich Flügge (1847–1923) discussed the possibility of droplet infections while coughing, and interestingly, the importance of social distancing was already recognized[1,2]. In the same year, 1897, Another publication appeared that discussed the airborne transmission of cholera, plague, and cerebrospinal meningitis and discussed the importance of wearing a “mouth bandage”. Their mouth covering was a single layer cotton gauze.

The current respirators and facemasks are built on two key developments: 1) meltblowing technology for the creation of fine fibers and 2) electrostatic charge. These technologies date back to the early 1960’s.

The meltblowing technology extends back to 1941 when the process was invented. The meltblowing technology was capable of producing very fine fibers compared to other processes. Two structure attributes are critical for filtration. These are solidity (1 – porosity) and fiber size. Meltblowing is a very economical, large-scale process that creates fibers that can be sub-micron.

The second critical technology was the development of electrostatic charging which enhances the particle capture efficiency of filters at a significantly lower pressure drops. Other critical technologies that were developed focused on ensuring that the charge density is high and more importantly, stable.

The first key patent was due to 3M in 1980 when a meltblown structure was electrostatically charged to form a high efficiency, electric filter. And, in 1985, 3M developed the first molded respirator. The key timeline is outlined below:

Year	Event
1941	Meltblowing invented
1951	Key Patent by Naval Research Laboratory
1965	First 10-inch Melt Blowing line (Exxon) – the so-called Exxon Die
1971	First Commercial Line – U.S.
1972	First US Manufacturing (Accurate Products)
1973-5	First Seven Practitioners – U.S.
1974	First Japanese Practitioner (Tonen)
1989	First REICOFIL Turnkey Meltblown Line
1993	REICOFIL 2 SM and SMS Turnkey Lines
1997	REICOFIL 3 SMS Turnkey Lines
2002	REICOFIL 4 SMS Turnkey Lines
2004	Hills' First Commercial Meltblown System for Elastomeric Materials
2004	REICOFIL Meltblown with Stabilized Air Flow
2007	Hills' First Commercial Meltblown System for Nanofibers (~ median diameter < 0.5 micron)
2008	REICOFIL Bico-Meltblown
2008	Hills' First Commercial Meltblown System for High Temperature and Corrosion Resistant Polymers
2012	Turnkey Meltblown Line Single or Multi-Row
2017	REICOFIL 5 SMS Turnkey Lines

Table 1. *Critical timelines in the development of current meltblowing technology*

The first "modern" mask was introduced in 1967, while the first respirator was patented in 1976. A key development was the application of electrostatic charge to meltblown webs in 1980. The key patents leading to the current charged N95 respirators soon followed. Some of the early key inventions are listed below:

Patent No.	Year	Details
3,333,585	1967	Robert J Barghini, Walter M Westberg, Patrick H Carey Jr, "Cold weather face mask", assigned to 3M
3,971,373A	1976	David L. Braun, "Particle-loaded microfiber sheet product and respirators made therefrom", assigned to 3M Co
4,215,682A	1980	Donald A. Kubik & Charles I. Davis, "Melt-blown fibrous electrets", assigned to 3M Co
4,536,440A	1985	Harvey J. Berg, "Molded fibrous filtration products", published 1985-08-20, issued 1985-08-20, assigned to 3M
4,807,619	1989	James F. Dyrud, Harvey J. Berg, Alice C. Murray, "Resilient shape-retaining fibrous filtration face mask", assigned to 3M
4,850,347	1989	Martin R. Skov, "Face mask", assigned to Moldex Metric Inc

4,856,509	1989	Jerome H. Lemelson, “Face mask and method”
5,307,796A	1994	Joseph P. Kronzer, Roger J. Stumo, James F. Dyrud, Harvey J. Berg, “Methods of forming fibrous filtration face masks”, assigned to 3M

Table 2. *Critical timelines in the development of current respirators & masks*

During the COVID-19 coronavirus crisis, the shortage of personal protective equipment (PPE) has been severe and continues to date especially regarding the availability of N95 and surgical (medical) masks.

Consequently, cloth masks have been used in both healthcare and community settings. A simple search on Amazon will lead to thousands of offerings. Many have no data on the performance of the mask and the ones that do, often, misguide the consumer.

There have been extensive studies on the filtration performance, and the fit of cloth masks[3-9]. The overwhelming conclusion is that cloth masks offer little or no respiratory protection. However, none of these studies used the current established test methods by CDC/NIOSH, FDA and ASTM.

There are essentially two classes of masks/respirators used by healthcare providers. These are the so called N95 respirators and Medical Masks.

N95 respirators are considered as personal protective equipment (PPE) that are used to protect the wearer from airborne particles and from liquid contaminating in the case of surgical masks. The N95 and N99 respirators are regulated by the Centers for Disease Control and Prevention (CDC) National Institute for Occupational Safety and Health (NIOSH) and Occupational Safety and Health Administration (OSHA) and must adhere to the strict performance guideline established by these organizations.

An **N95 respirator** is a respiratory protective device designed to achieve a **close facial fit** and very efficient filtration of airborne particles if fitted properly.

Surgical N95 Respirators are commonly used in healthcare settings and are a subset of N95 Filtering Facepiece Respirators (FFRs), often referred to as N95s.

The similarities among surgical masks and surgical N95s are:

1. They are tested for fluid resistance, filtration efficiency (particulate filtration efficiency and bacterial filtration efficiency), flammability and biocompatibility.
2. They should not be shared or reused.

N95 surgical masks are single-use, disposable respiratory protective devices used and worn by health care personnel during procedures to protect both the patient and health care personnel from the transfer of microorganisms, body fluids (blood splatter), and particulate material. These surgical N95 respirators are class II devices regulated by the FDA, under 21 CFR 878.4040, and CDC NIOSH under 42 CFR Part 84.

N95s respirators regulated under product code MSH are intended to prevent specific diseases or infections or filtering surgical smoke or plumes.

N95 Respirator filters must meet stringent certification tests (42 CFR Part 84) established by NIOSH. The NIOSH tests use what are considered “worst case” parameters, including:

1. A sodium chloride (for N-series filters) or a dioctyl phthalate oil (for R- and P-series filters)

test aerosol with a mass median aerodynamic diameter particle of **~ 0.3 µm**, which is in the **MPPS-range** for most filters
2. Airflow rate of **85 L/min**, which represents a moderately-high work rate
3. Conditioning at **85% relative humidity** and **38°C** for 24 hours prior to testing
4. An initial breathing resistance (resistance to airflow) not exceeding **35 mm water column (~343 Pa)** pressure and initial exhalation resistance not exceeding **25 mm water column (~245 Pa)** pressure
5. A **charge-neutralized** aerosol
6. **Aerosol loading** conducted to a minimum of **200 mg**, which represents a **very high workplace exposure**
7. The filter **efficiency cannot fall below the certification class level** at any time during the NIOSH certification tests

NIOSH uses a specific instrument (TSI 8130 or TSI 8130A). The procedures and testing modes (**42 CFR PART 84**) are well documents and easy to follow. Note that regardless of the size of the filter or the mask, the flow rate is fixed. Thus, there is little room for the manufacturer or the testing facility to manipulate or influence the data. The only avenue for the mask manufacturer to alter the performance for the given filter is to adjust the total size of the respirator to impact its total face velocity.

A **surgical mask** (also referred to as a medical mask) is a loose-fitting, disposable device that creates a physical barrier between the mouth and nose of the wearer and potential contaminants in the immediate environment. These are often referred to as face masks, although not all face masks are regulated as surgical masks. Unlike the N95 respirators, the edges of the mask are not designed to form a good seal around the nose and mouth.

Collectively, there are a number of standards that apply to surgical masks. These are shown below in Table 3.

ASTM F2101-19	Standard Test Method for Evaluating the Bacterial Filtration Efficiency (BFE) of Medical Face Mask Materials, Using a Biological Aerosol of Staphylococcus aureus
ASTM F2100-19	Standard Specification for Performance of Materials Used in Medical Face Masks
ASTM F1862/F1862M-17	Standard Test Method for Resistance of Medical Face Masks to Penetration by Synthetic Blood (Horizontal Projection of Fixed Volume at a Known Velocity)
ASTM F1494-14	Standard Terminology Relating to Protective Clothing
ASTM F3387-19	Standard Practice for Respiratory Protection
FDA Guidelines	FDA Guidance Document

Table 3. *Various Standards and Guidelines for Surgical Masks*

Surgical masks are classified as Levels 1 to 3. See Table 4 below

		Level 1	Level 2	Level 3
Barrier testing	BFE%ASTM F2101, EN 14683	≥ 95	≥ 98	
	PFE%ASTM F2299	≥ 95	≥ 98	
	Synthetic Blood ASTM F1862, ISO 22609	Pass at80 mmHg	Pass at120 mmHg	Pass at160 mmHg
Physical Testing	Differential PressureEN 14683	< 5.0 mmH2O/cm2	< 6.0 mmH2O/cm2	
Safety Testing	Flammability16 CFR Part 1610	Class 1 (≥3.5 seconds)		
	Microbial	Not Required		

	CleanlinessISO 11737-1	
	BiocompatibilityISO 10993	510 K Guidance recommends testing to ISO 10993
Sampling: ANSI/ASQC Z1.4 ISO 2859-1		AQL 4% for BFE, PFE, Delta P32 masks for Synthetic Blood(Pass= ≥29 passing, Fail= ≤28 passing)14 masks for Flammability

Table 4. *ASTM F2100-19 Standard Specification For Performance Of Materials Used In Medical Face Masks*

These standards have been used for many years. The PFE Standard Test Protocols are inadequate in that it is possible to attain different classifications depending on how the test is performed. This is described fully below.

Particle Filtration Efficiency (PFE) for Surgical Masks

The ASTM F2299 (reapproved in 2017) establishes the procedures for the measurement of the initial efficiency of materials used in medical facemasks (surgical masks) by using monodispersed latex spheres.

The test method recommends utilizing a light scattering particle counter to measure particles in the size range of **0.1 to 5.0** micron and the airflow test velocity of **0.5 to 25 cm/s**.

The test procedure measures filtration efficiency by comparing the particle count feed stream (upstream) to that in the filtrate (downstream). It is further recommended that the particles are **charge neutralized.**

The challenge with this test method lies in the fact that the specimen size is not specified, and the face velocity is not fixed. The face velocity is defined as:

$V=Q/A$

where V is the face velocity (cm/s), Q is the flow rate (cm^3/s), and A is the area (cm^2).

The NIOSH Standard Test Protocol for N95 respirators specifies the flow rate (85 L/min) for the device to be tested. The only avenue for a manufacturer of the device to impact the face velocity is to use a larger mask. The total area of current N95 masks range from 140 cm^2 (small molded) to ~250 cm^2 (duckbill and folded). This translates to a face velocity of 10 cm/s for small masks and 5.7 for larger masks. The procedures and testing modes (**42 CFR PART 84**) are well documents and easy to follow. Note that regardless of the size of the filter or the mask, the flow rate is fixed. For a given sample size, the flow rate has a profound impact on the face velocity which in turn impacts particle capture efficiency and pressure drop. In Figure 1 and Figure 2, we show the pressure drop and the efficiency for a classical N95 meltblown filter medium tested as a flat sheet. Note that the particle efficiency (measured on TSI 8130) drops quickly with face velocity and the pressure drop increases rapidly. The meltblown media are designed for the face velocities of 7 to 10 cm/s and work well under these conditions.

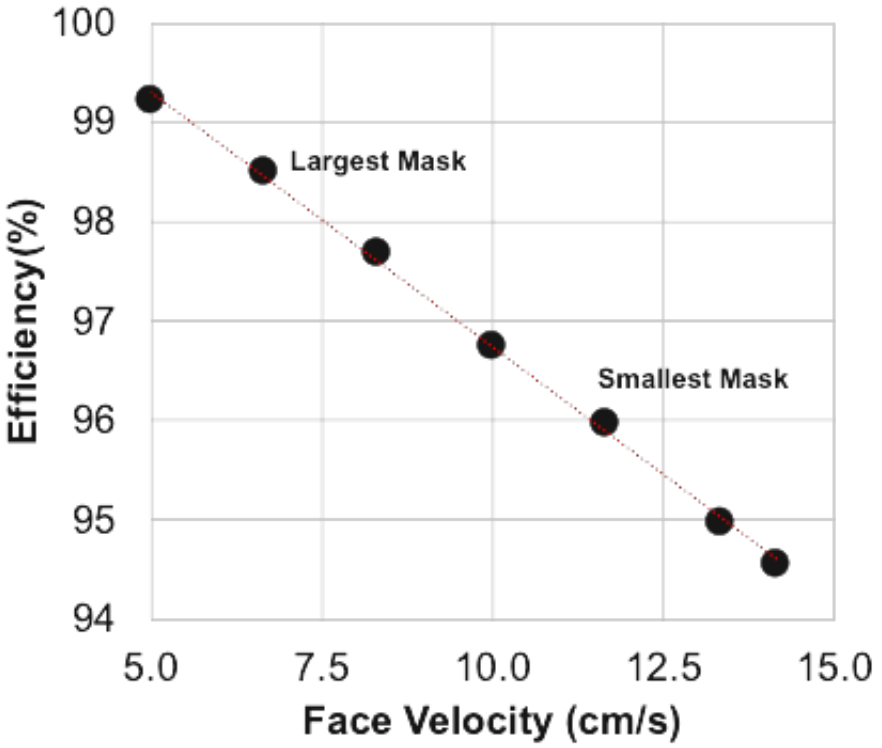

Figure 1. ***Efficiency as a function of face velocity – Flow rate ranging from 30 to 85 L/min for a sample size of 100 cm^2 – TSI 8130***

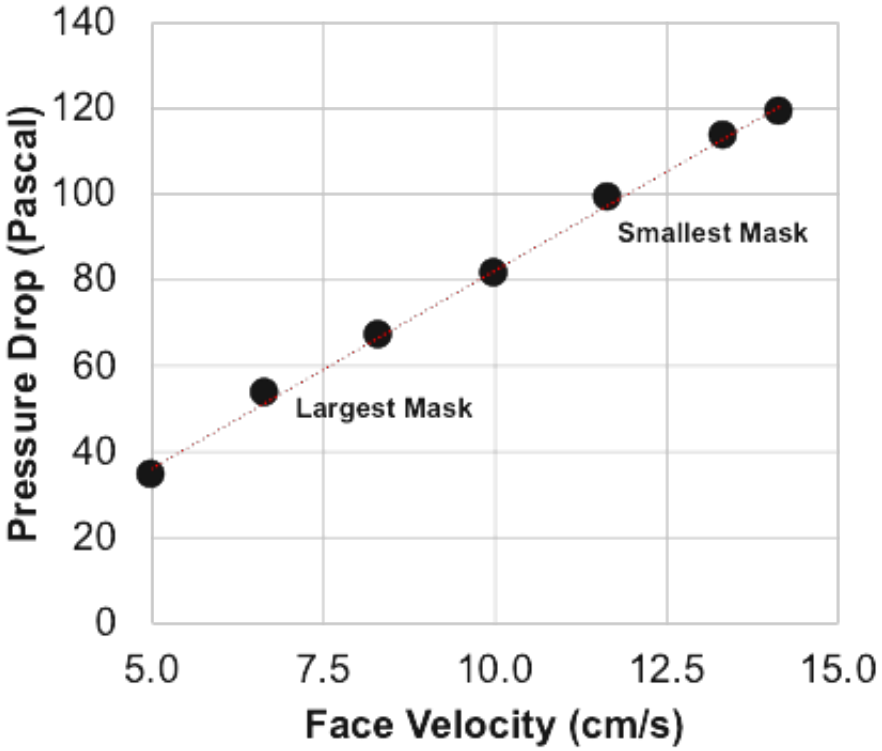

Figure 2. ***Pressure drop as a function of face velocity***

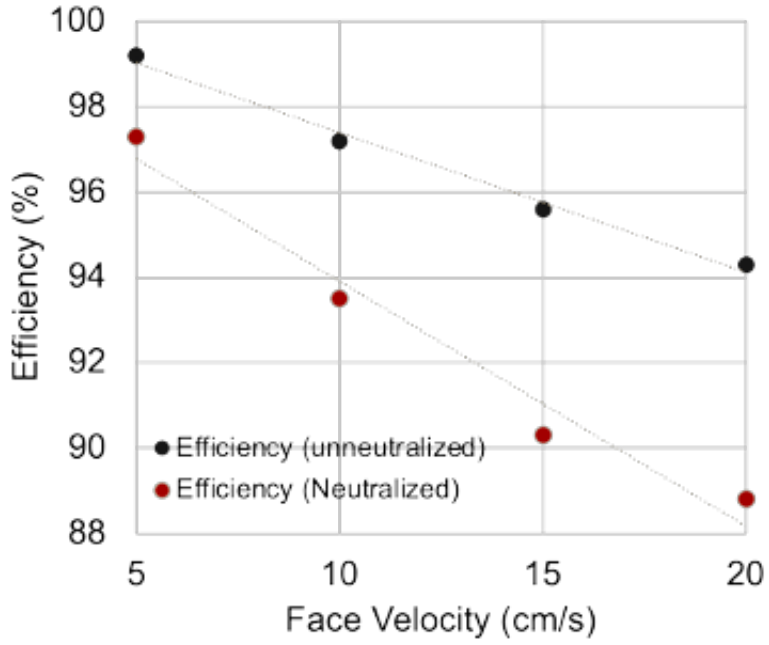

Figure 3. ***Particle filtration efficiency at 0.1 micron at different face velocities for charged and uncharged particles – TSI 3160 equipped with latex monodisperse particles***

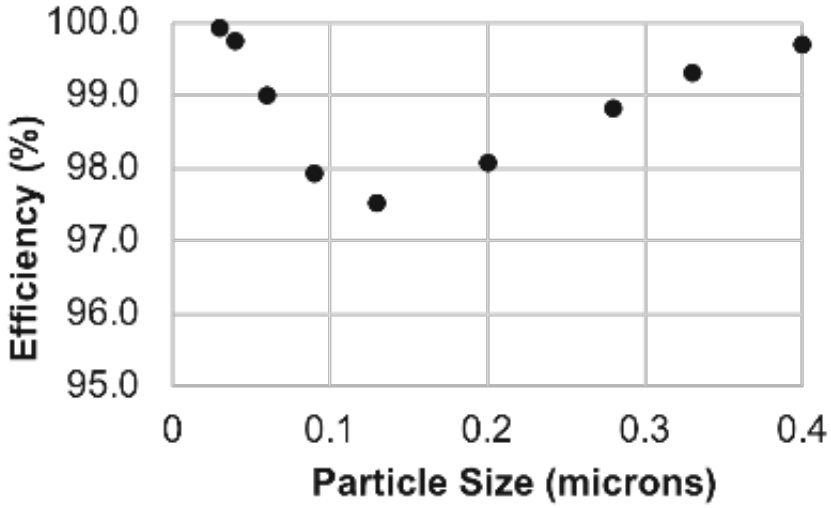

Figure 4. ***Fractional efficiency at 30 L/min for a sample size of 100 cm^2 – TSI 3160***

There is a misconception that ay 0.1 micron particle size, the face velocity does not impact the penetration significantly; note that the ASTM standard specifies a face velocity of 0.5 to 25 cm/s.

Figure 3 shows the particle penetration (0.1 micron latex) at various face velocities for neutralized and unneutralized particles. It is clear that the face velocity impacts the efficiency as does the particle charge. The other challenge is that particle size matters very greatly. The filter behavior at 0.1 micron is not the same as 0.3 or 3 or 5 microns. Figure 4 shows the fractional efficiency for the same meltblown medium at a flow rate of 30 L/min. Note that particles at 0.1 micron and smaller are easier to capture since the main mechanism is due to Brownian diffusion.

The FDA guidance Document however, “fixes” the particle size at 0.1 micron. ASTM F2100 also specifies a particle size of 0.1 microns and refers back to F2299 for the test procedure. However, FDA recommends the use of unneutralized latex particles, but falls short of specifying the flow rate

and the sample size or the face velocity. Charge neutralized aerosol is known to produce maximum penetration (low efficiency), but the current FDA guidelines lowers the bar to the use of unneutralized latex particles.

Nelson Labs is a certified lab that can perform pre-certification for both FDA and NIOSH. They indicate that ASTM F2100 specifies a challenge particle size of 0.1µm. Nelson labs uses an optical laser based particle counter and operates at a flow rate of 1 cubic foot per minute (CFM) or 28.3 L/min. The sample size is set at 91.5 cm^2. This translates to a face velocity of 5.2 cm/s. They specify that they use unneutralized particles also to be consistent with the FDA guidelines. The test protocol is summarized below in Table 5.

	(PFE) ASTM	(PFE) FDA Guidelines	(PFE) Nelson Labs	(PFE) Other Labs
Particle Charge	Neutralized	Unneutralized	Unneutralized	Neutralized
Particle Size (mm)	0.1 to 5	0.1	0.10	0.10
Flow Rate (L/min)	Not specified	Not specified	28.3	28.3
Test area (cm 2)	Not specified	Not specified	91.5	45.2
Face Velocity (cm/s)	0.5 to 25	Not specified	5.2	10.4

Table 5. *Summary of the particle filtration efficiency testing for medical masks*

Cloth Masks

Cloth masks are not regulated. Often, it is stated that the main purpose of the cloth (community) masks is to prevent the spread of the virus. That is, it is implied that cloth masks can trap and slow down exhaled droplets due to talking, coughing and sneezing. However, no guidelines are available to the manufacturer in terms of material properties that are important in performing said tasks. And, the basic protection mechanisms and benefits of these masks remain controversial.

A new ASTM working group is developing standards for “barrier masks” - ASTM WK73471. This specification is primarily intended to help ensure barrier face coverings meeting the stated requirements provide

1. a means of source control for individual wearers by reducing the number of expelled droplets and aerosols from the wearer’s nose and mouth into the air and,
2. to potentially offer a degree of particulate filtration and to reduce the amount of inhaled particulate matter by the wearer.

This specification will establish minimum design, performance (testing), labeling, user information, and conformity assessment requirements for barrier face coverings. Details are slowly emerging about the levels that will be established. At the moment, the group is contemplating two classifications within the new standards – one for face coverings that filter out between 20 and 50 percent of sub-micron particles and another for face coverings that are shown to filter out more than 50%[10,11].

Filtration Mechanisms and Why Cloth Masks Do Not Offer Respiratory Protection

Aerosols are a suspension of solid or liquid particles in a gas ranging in size from 2 nm to 100 µm. Bioaerosols are aerosols of biological origin, including viruses, bacteria and fungi. An ideal filter removes only the unwanted aerosol particles from the air and does it without creating a large pressure drop. There are 4 primary aerosol filtration mechanisms (see Figure 4).

The air stream bends as it moves around the fibers. Large particles are trapped by **Inertial impaction**. Large particles have a high probability of impacting with a fiber because inertia causes them to deviate from the streamline. Inertial impaction is for large micro particles and becomes important at high and medium velocities. Very small particles also have a high probability of hitting

a fiber due to Brownian motion. Brownian motion comes about as the particles collide with gas (air) molecules that are much smaller than the particles. This leads to a chaotic movement that is disordered and abrupt leads to **diffusion**. The capture mechanism for particles less than 100 nm is mainly due to diffusion. However, larger sized particles (100 nm to ~ 400 nm with ~ 300 nm representing the most challenging particle size to capture) normally follow the airflow streamlines and are the most difficult to capture, and the capture mechanisms is due to interception as the particles may be intercepted by a fiber. This is where the electrostatic attraction becomes important. Oppositely charged particles are attracted to a charged fiber. This collection mechanism does not favor a certain particle size particularly but is more significant for the most difficult particles to capture.

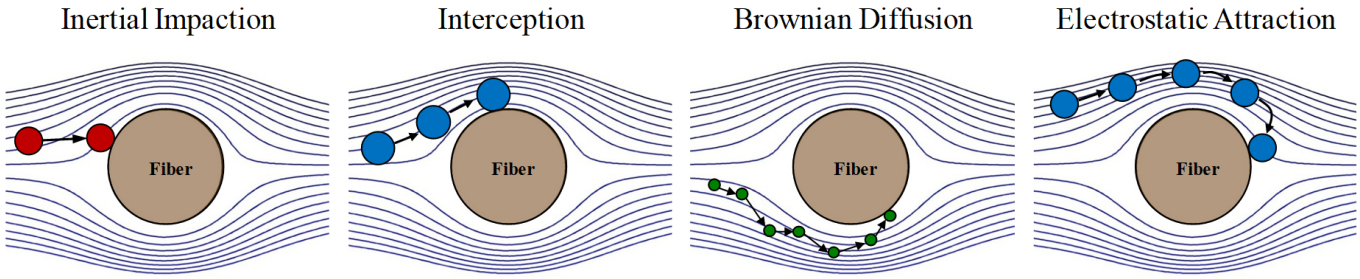

Figure 5. ***Filtration mechanisms***

Fiber size becomes critical for the interception capture mechanism. If the fibers are of the same size or smaller, they have a tendency to be more effective in intercepting the particles. This together with high electrostatic attraction leads to high filtration collection efficiency in today's respirators and medical masks that reply upon charged meltblown structures. While meltblown structures show a wide fiber diameter distribution, the majority of the fibers are below 1 micron and together with their high charge density, they are able to capture particles effectively.

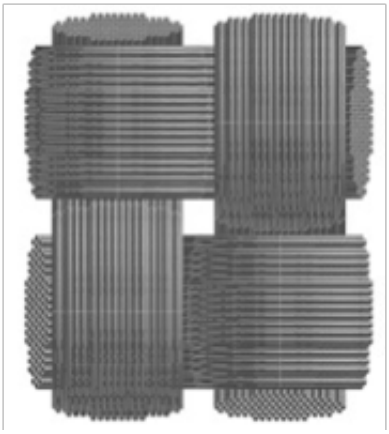

Figure 6. ***A typical woven structure Note that regardless of the number of ends and pick, there will always be interstices present***

Cloth masks produced from regular textile fibers employ much larger fibers (greater than 15 microns in most cases), lack electrostatic charge and the structures create large gaps or holes. These lead to localized areas that have a much lower pressure drop and therefore, the air stream will flow naturally to these areas, carrying the aerosol particles through the structure – see Figure 6.

Note also that nonwovens are essentially, multi-layered structures with significant pore tortuosity. This together with the fine fibers used and electrostatic charge leads to very efficient filters.

Experimental Methods

A number of “sports” masks were purchased. Almost all could not be mounted on the TSI 8130 to perform a full mask test. Therefore, samples were cut from the front of the mask where presumably the structure had better filtration efficiency. Therefore, the results are limited to the base material in front of the nose and the mouth and not the entire mask itself.

As indicated earlier, there are 3 key features that are critical in any mask. These are filtration efficiency, pressure drop and the degree of fit. What can impact the filtration characteristics of a mask is also the design of the mask. A common challenge with many masks is the “fogging”. This is a challenge when one wears glasses or a face shield. The exhaled breadth passing through the filter or escaping from leaks around the nose leads to fogging. Some mask designs have created an area around the nose with a much lower pressure drop commonly made from a stretch knitted structure. While this makes it easier for the exhaled air to escape leading to less fogging, it creates an easier pathway for inhaled air to carry the particles through rendering the rest of the mask ineffective (assuming that the mask did offer some respiratory protection). This will be dealt with separately. Thus, this particular study is limited to evaluating the filtration efficiency and the pressure drop of the base materials used.

The filtration efficiency was measured as follows:

1 – ASTM F2299 – monodisperse 0.1 micron latex spheres on a modified TSI 3160 fractional efficiency tester. The tests were performed with both charge neutralized and unneutralized particles at a face velocity of 5 and 10 cm/s. This would cover what the ASTM F2299 specifies in addition to ASTM F1215-89 (withdrawn in 1998) as well as the FDA guidance document (510 K for premarket notification) that specifies the use of unneutralized particles. This also covers the range of what is currently performed by certified labs such as Nelson Labs (unneutralized particles, at a face velocity of 5.2 cm/s) and Intertek/SGL labs (neutralized particles at a face velocity of 10.4 cm/s).

2 – TEB-APR-STP-0057-0058-0059; 42 CFR PART 84 - this protocol is designed for masks. However, since the masks could not be mounted as a whole, only flat sheets were used for testing, and only the initial efficiency and pressure drops were recorded – the tests were performed at a face velocity of 10 cm/s on a TSI 8130. Since the sample area measures 100 cm^2, the flow rate was set at 60 L/min to achieve a face velocity of 10 cm/s. If the sample size was smaller than 100 cm^2, then the flow rate was adjusted accordingly to maintain the same face velocity at 10 cm/s.

Results and Discussions

The results are arranged for different standards.

ASTM F 2299 – 0.1 Latex Particle size

The results are shown for two of the best-selling spots masks (selling for more than $15 per mask) and two Class III commercial surgical masks.

Several conclusions can be drawn from the data presented in Table 6 and Table 7 for a face velocity of 5 and 10 cm/s respectively. The data are for an average of 5 samples.

Regardless of the type of mask, as expected, the efficiency and pressure drops are impacted by the face velocity used. Similarly, **Unneutralized** particles are much easier to capture since the particle carry a charge. The challenge, however, is that the degree to which the particles may be charged is unknown. Thus, there can be variations in the results obtained from day to day. More significantly, both surgical masks will be classified as class III per FDA guidance documents (**Unneutralized**

particles) and the face velocity used by Nelson labs. These, however, will not be classified as Class III as tested by SGL (**Neutralized particles**) and higher face velocity.

Mask Type	Pressure Drop (Pascal)	Charge Neutralized Efficiency (%)	Unneutralized Efficiency (%)
Sport Mask 1 – knitted	15.3	14.19	24.55
Sport Mask 2 – knitted	20.7	25.97	29.74
Surgical Mask 1 – 3 ply nonwoven	64.7	96.45	99.73
Surgical Mask 2 – 3 ply nonwoven	47.4	88.30	98.95

Table 6. *Latex 0.1 mm Particle efficiency of sports masks and classical surgical masks tested at 5 cm/s*

Mask Type	Pressure Drop (Pascal)	Charge Neutralized Efficiency (%)	Unneutralized Efficiency (%)
Sport Mask 1 – knitted	34.2	8.61	10.89
Sport Mask 2 – knitted	44.5	15.25	26.32
Surgical Mask 1 – 3 ply nonwoven	136.0	92.11	98.53
Surgical Mask 2 – 3 ply nonwoven	99.9	79.74	92.75

Table 7. *Latex 0.1 mm Particle efficiency of sports masks and classical surgical masks tested at 10 cm/s*

It is clear that the sports masks offer little or no respiratory protection. These fall significantly short of the performance of the classical surgical masks, and well below the new proposed standard for barrier masks.

NIOSH TEB-APR-STP-0057-0058-0059; 42 CFR PART 84

Flat sheets were cut out of the various masks and tested at a face velocity of 10 cm/s for initial pressure drop and efficiency by using a TSI 8130. The set tested include the same best-selling sports masks and the two Class III commercial surgical masks as well as a number of “community” masks and two meltblown media used in the production of N95 masks.

Note that only the *initial* pressure drop and efficiency were recorded. The loading behavior however, showed a sharp decrease in efficiency for the sports masks indicating that their efficiency further decreases with use (particle loading). The same will be true as moisture builds up in such masks. The data are summarized in Table 8, and are for an average of 3 measurements.

Mask Type	Pressure Drop (Pascal)	Neutralized Particle Efficiency (%)
Sport Mask 1 – knitted	37.3	15.42
Sport Mask 2 – knitted	56.0	18.60
Community Mask 1 – 1 ply woven	585.5	43.50
Community Mask 2 – 3 ply cotton	75.0	15.00
Community Mask 3 – woven + nonwoven	238	91.01
Community Mask 5 – 3 ply nonwoven	125.8	24.23
Surgical Mask 1 – 3 ply nonwoven	196.9	96.98
Surgical Mask 2 – 3 ply nonwoven	118.5	92.26
Meltblown 1	70.0	98.52
Meltblown 2	100.0	98.98

Table 8. *Particle efficiency of sports masks and classical surgical masks at ~ 0.3 microns tested at a face velocity of 10 cm/s by using a TSI 8130*

These results for the cloth masks indicate their lack of respiratory protection. Most show efficiencies below 20%. The one with 43.5% efficiency has a pressure drop of 585 Pa; this is completely unacceptable and essentially indicates that the mask will be worn only for a few minutes and the wearer will resort to realigning it to force leakage to make it more breathable. Currently, this is almost twice the maximum pressure drop allowed for N95 respirators. The only community mask that shows promise is the one listed as community mask 3. Upon further examination, it was noted that it uses a charged meltblown layer together with a stiffer spunbond sandwiched between two layers of woven cotton fabrics. The initial pressure drop, and efficiency are acceptable and better than the pure cloth masks or layered cotton masks; using a charged meltblown has boosted the performance. However, it is marketed as a washable mask. The meltblown nonwoven is quite fragile and also loses charge due to laundering and exposure to heat, is damaged easily and its performance will deteriorate. This, however, is not communicated or documented and the consumer simply relies upon their advertising. Some of these masks are now worn by our school children and the community at large is being misled in the absence of stringent standards and guidelines.

A recent study[12] discusses fully the protective mechanisms of facemasks against expelled droplets. Their results conclude that only fine dust filters show a comparable or even better filtering effect than commercial particle filtering FFP2/N95/KN95 half masks. They also documented that simple mouth-and-nose covers made of good filter material cannot reliably protect against droplet infection due to the poor fit of such masks, and that only a close-fitting, particle-filtering respirator offer good self-protection against droplet infection.

They conclude however, by stating that wearing simple homemade or surgical face masks in public is highly recommended if no particle filtrating respiratory mask is available not because of the respiratory protection they offer but rather because they protect against habitual contact of the face with the hands. Such masks can offer some protection to other people if they are at a sufficient distance. The challenge is that social distancing cannot be observed for example, in workplaces like grocery stores., and unfortunately, wearing a simple cloth mask perhaps offers a false sense of security that leads to not practicing appropriate social distancing.

The study concludes by stating:

“If these general rules are followed and all people use suitable particle-filtering respirators correctly, the transmission of viruses via droplets/aerosols can be effectively prevented. … , proper face masks can save lives while maintaining social life and securing the economy and the state.”

Similarly, two recent studies outline the degree to which masks can reduce the amount of expelled aerosols[13,14]. The study’s findings are summarized below:

Type of Mask Used	Avg. No. of Sneeze Droplets Passing Through the Mask	Avg. No. of Cough Droplets Passing Through the Mask
No Mask	40,000	3,000
N 95 Mask	0	0
Surgical Mask	23	2
Cloth Mask	1,445	108

Table 9.

They note that the threshold for infection is ~ 1,000 droplets and that the cloth masks are above this threshold for sneezing, but clearly are effective for cough droplets.

Conclusions

There is an urgency in ensuring that there are uniform procedures for the measurement of the performance of cloth masks. While cloth masks may help reduce the spread of expelled aerosols, they do not eliminate the threat. Nor do they offer any significant respiratory protection compared to N95 and medical/procedural masks

In the absence of appropriate guidance from regulatory agencies, the general public is given a false sense of security and safety and this can lead to an increase in activities that may cause further spreading of the virus. The new proposed ASTM standard is a major step in the right direction. We fully agree with the findings[13-15] that wearing simple homemade or cloth masks in public is highly recommended if no particle filtrating respiratory mask is available because they protect against habitual contact of the face with the hands and such masks offer some protection to other people if social distancing is practiced.

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