

A Closer Look at the Size of the Coronavirus Disease 2019

Andrea Capra

May 9, 2020

1 Filtration Efficiency

Three main mechanisms are responsible for the filtration of aerosol particles by fibrous filters. For submicron particles the dominant process is collection by Brownian diffusion. For larger particles interception and inertial impaction mechanisms are active. It results that there exists a region where none of the above effects predominates over the others, yielding a maximum in the particle penetration, and consequently a minimum in the filtration efficiency. While the location of said minimum depends on the type of filter and the flow velocity, it generally occurs around $0.3\text{ }\mu\text{m}$. In addition it's worth noting that the most penetrating particle size will decrease with increasing filtration velocity and increase with increasing filter fiber size. Further, it predicts that increasing the filter solid volume fraction. For explicit calculation see Lee and Liu (1980) and references therein.

2 Dust Mask and Filter Cartridge Ratings

See Table 1 for a classification of filtering respirators by the U.S. National Institute for Occupational Safety and Health (NIOSH).

Table 1: NIOSH Particulate Respirator Class Minimum Efficiency Levels. The diameter refers to the *mass-median-diameter*, identified by the symbol D_{50} , and is considered to be the average particle diameter by mass

Respirator Rating			
Letter Class		Number Class	
N	Not oil resistant	95	Removes 95% of all particles that are at least $0.3\text{ }\mu\text{m}$ in diameter
R	Resistant to oil	99	Removes 99% of particles that are at least $0.3\text{ }\mu\text{m}$ in diameter
P	Oil Proof	100	Removes 99.97% of all particles that are $0.3\text{ }\mu\text{m}$ in diameter or larger

3 Example Particle Sizes

See Table 2.

Source: <https://www.envirosafetyproducts.com/resources/dust-masks-whats-the-difference.html>

Table 2: Example Particle Sizes

Particle	Min Diamteter	Max Diamteter
	μm	
Anthrax	1	5
Asbestos	0.7	90
Atmospheric Dust	0.001	40
Bacteria	0.3	60
Beach Sand	100	10 000
Bone Dust	3	300
Bromine	0.1	0.7
Carbon Dioxide		0.000 65
Copier Toner	0.5	15
Corn Starch	0.1	0.8
Fiberglass Insulation	1	1000
Lead	0.1	0.7
Metallurgical Dust	0.1	1000
Mold Spores	10	30
Oil Smoke	0.03	1
One inch	25 400	
Oxygen		0.0005
Pesticides & Herbicides		0.001
Radioactive Fallout	0.1	10
Red Blood Cells	5	10
Saw Dust	30	600
Smoke from Natural Materials	0.01	0.1
Smoke from Synthetic Materials	1	50
Spores	3	40
Sugars	0.0008	0.005
Tobacco Smoke	0.01	4
Typical Atmospheric Dust	0.001	30

4 Size of the SARS-CoV-2

Diameter varied from about 60 to 140 nm. Virus particles had quite distinctive spikes, about 9 to 12 nm, and gave virions the appearance of a solar corona. Zhu *et al.* (2020)

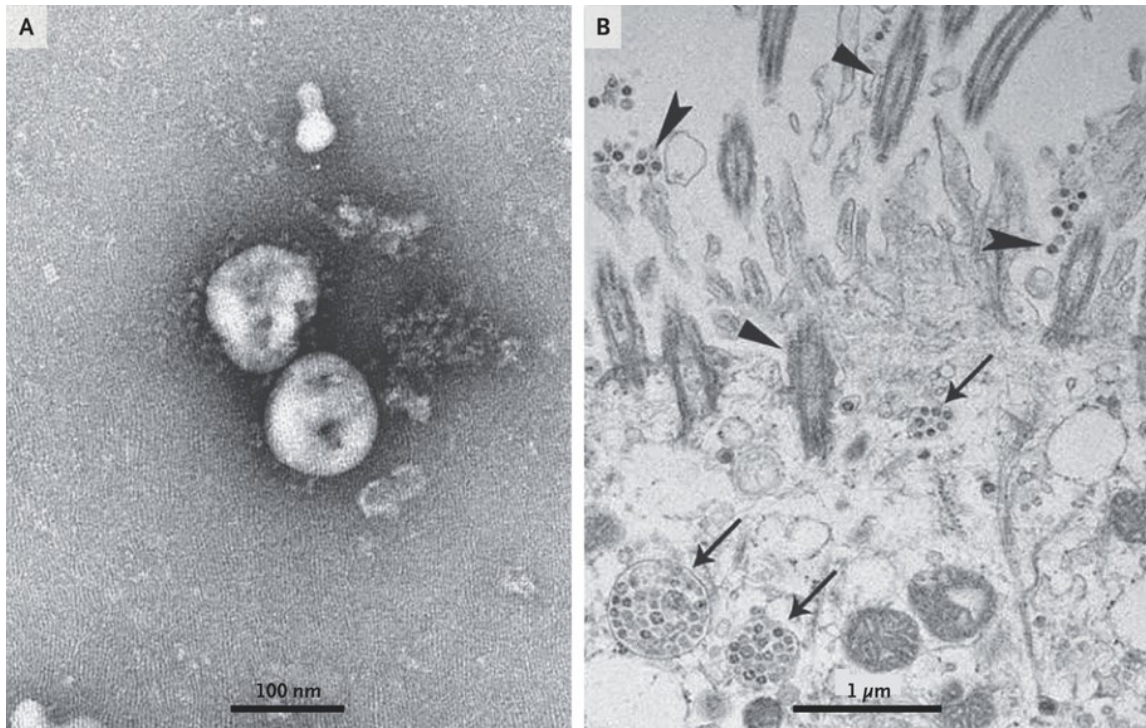


Figure 1: Visualization of 2019-nCoV with Transmission Electron Microscopy Zhu *et al.* (2020).

References

- Lee, KW and Liu, BYH, *On the minimum efficiency and the most penetrating particle size for fibrous filters*, Journal of the Air Pollution Control Association, **30** 4 (1980)
- Zhu, Na and Zhang, Dingyu and Wang, Wenling and Li, Xingwang and Yang, Bo and Song, Jingdong and Zhao, Xiang and Huang, Baoying and Shi, Weifeng and Lu, Roujian and Niu, Peihua and Zhan, Faxian and Ma, Xuejun and Wang, Dayan and Xu, Wenbo and Wu, Guizhen and Gao, George F. and Tan, Wenjie, *A Novel Coronavirus from Patients with Pneumonia in China, 2019*, New England Journal of Medicine, **382** 8 (2020) 10.1056/NEJMoa2001017