# Measuring Air Filter Efficiencies in the Discrete PRRS Virus Range

MIKE OSBORNE PH.D., RAHUL BHARADWAJ PH.D., AND ANGIE WISE M.S


## Abstract

New evaluation procedure using (Optical Particle Sizer/Scanning Mobility Particle Sizer/Condensation Nuclei Counter) particle size measurement allows testing of the effectiveness of filters against PRRS virus in the range where possible individual and agglomerated virus freely exist, the E000 range of 0.01 – 0.03 µm, the E00 range of 0.03 - 0.10 µm and the E0 range of 0.10 - 0.30 µm.


## Background

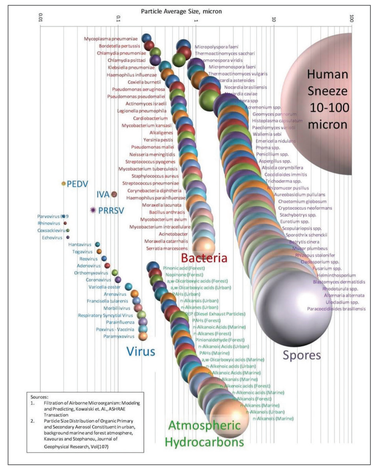
Studies have shown the settling velocities of particles are inversely proportional to particle diameter. A particle 10 – 20 µm in size will take approximately 5 minutes to settle over a distance of 1 meter. A particle below 0.1 µm stay suspended in the air for up to 10 days [1].

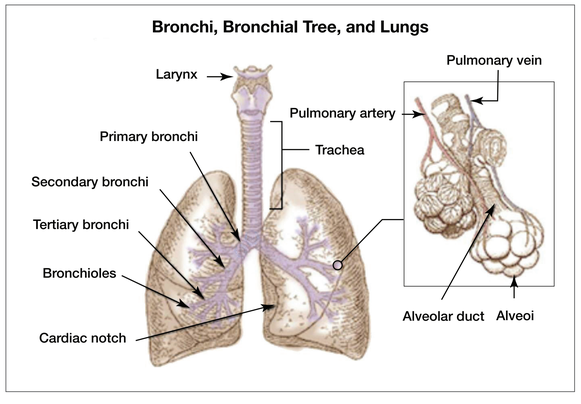
The sizes of critical swine viruses are shown in Figure 1, along with a broad range of typical airborne contaminants.

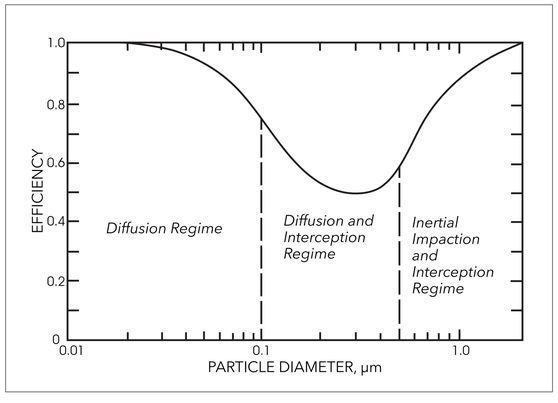
The ASHRAE 52.2 test standard uses the MERV (Minimum efficiency rating value) as the filter classifications with E1= 0.30 - 1.0 µm, E2 = 1.0 - 3.0 µm, E3 = 3.0 – 10 µm. The standard does not consider efficiencies below 0.3 µm, well above the size range of PRRSV, PEDV and IVA particles as shown in Figure 1.

The principles of particle capture mechanisms can be represented by the MPPS (Most Penetrating Particle Size) curve as shown in Figure 2.

Spengler et.al showed smaller particles penetrate to the alveoli where they have access to the bloodstream as shown in Figure 3. Alveolar macrophages are the site of PRRSV infection by individual viral particles known to be 45-90 µm in diameter.



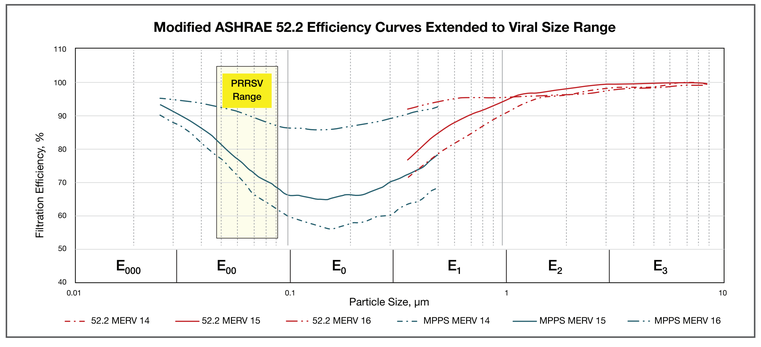

## Testing

Three commercial V-Bank filters (MERV 14, 15 and 16) with microglass media were tested per the ASHRAE 52.2 test method (0.3-10 µm) using an Optical Particle Counter, OPC, Figure 4, along with a Scanning Mobility Particle Sizer and a Condensation Particle Counter, SMPS & CPC, Figure 5, (0.015 µm – 0.5 µm). In this study additional ranges were defined as E0 (0.10-0.30 µm) and E00 (0.03 - 0.10 µm) and E000 (0.01 – 0.03 µm) as an extension to the ASHRAE 52.2 classification of E1, E2, E3. The testing was carried out at the Clean AIR Center in Jeffersonville, Indiana, Efficiency Duct #5 as shown in Figure 6.

## Results

The efficiency curves for all three filters are shown in Figure 7. The efficiency curves, per the 52.2 method, are shown in red on the right side. These data were taken using an OPC (TSI 3330) with KCL as the challenge aerosol. The blue curves on the left side were taken using an SMPS & CPC with DEHS (Di-Ethyl-Hexyl-Sebacat) as the aerosol. The MPPS values of MERV 15 and 16 filters were found to be 0.135 µm, the MERV 14 was found to be 0.122 µm. The efficiencies of the filters at MPPS were 85.7% for the MERV 16 filter, 65.1% for MERV 15, and 57.9% for MERV 14.

The size range of individual PRRSV Particles is highlighted in Figure 7 as 0.045 µm – 0.09 µm, which falls within the E00 range . The average efficiencies, based on number of particles, in this range were found to be ~90% for MERV 16, ~74% for MERV 15, and ~68% for MERV 14.




## Conclusions

- Fine particles in the viral size range stay suspended almost indefinitely. If these particles are present in breathed air, they can penetrate to the alveoli, the site of the infection for PRRSV.
- To properly evaluate filters for swine applications, the size range of particles where viruses are typically found needs to be extended below current ASHRAE 52.2 protocol.
- Field tests using the SMPS and CPC for particles in the submicron viral size ranges are currently underway to determine the particle counts before and after filtration in swine barns.


***REFERENCES:***

*1. J.D Spengler, Harvard public health*

*2. Jessica Sigmon www.prezi.com*

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