Technical Report

Date: **04/15/2020**
Subject: **Antimicrobial Efficacy of PuraShield Air Filtration Unit**

Scope

Information in this report is intended to communicate the antimicrobial efficacy of Purafil's PuraShield filtration equipment. Viral and bacterial kill rates were assessed on a completed PuraShield-500 (CPUM-500) unit. Standardized third-party testing revealed significant microbial reduction in as little as one hour by the PuraShield unit in a test space representative of residential and commercial rooms and offices.

Experimental Method

All testing was performed by the Guangdong Detection Center of Microbiology (Guangzhou, CN). Measurements were collected in accordance with the Technical Standard for Disinfection (2002 Ministry of Health P.R. China)-2.1.3.[1] General testing conditions specified by the standard are outlined in the below table for convenience.

Conditions of Antimicrobial Efficacy Evaluation on PuraShield	
Microbial Contaminants	H1N1 Influenza A; *Staphylococcus albus* 8032
Air Circulation?	Yes
Room Volume	1059ft3 / 30m^3
Duration	1hr
Temperature	Ambient
Relative Humidity	50-70%

Two separate tests were conducted using the Influenza A subtype H1N1 virus and *Staphylococcus albus (*also called *Staphylococcus epidermis*). After placing one Purashield 500 unit in a sealed 30m^3 room, the aerosolized contaminant was introduced into the test chamber and circulated throughout the space for one hour. Initial control and final sampling measurements over three independent trials for each contaminant were used to ascertain CPUM 500 sterilization rates.

Described test results on Purafil SP media were carried out in accordance to the same general test method. 500g of Purafil SP media was placed in a 1m^3 test chamber, and exposed to the same aerosolized microbial agents over a 2hr measurement period.

Results and Discussion

Overview of Test Conditions

Commonly-used HEPA filtration measurements are based non-biological components, such as DOP/PAO (0.3µm particles) and sodium flame challenge evaluations (0.58µm particles)[2,3] HEPA filters typically claim 99.97% removal efficiencies on 0.3µm particle sizes from uniform, unidirectional flow tests.[3] Conversely, chamber tests like the one implemented here with the Purashield 500 unit also account for natural non-uniformities in air mixing in a realistic end-use environments for air purifiers, which would likely foster lower measurable particulate removal efficiencies. Furthermore, differences in the size, shape, and other physical characteristics of aerosolized viruses and bacteria can generate disparate transport behavior from relatively invariable and inert filtrates. Additionally, HEPA filters themselves do not have the capacity to kill microbial contaminants, which poses the risk of leakage overtime. This is not the case with antimicrobial media within Purashield , where Puraward and Purafil SP media both enact antimicrobial capability on

their own. Accordingly, testing on actual microbial agents in realistic use environments, as performed here with PuraShield, provide a more accurate reflection of pathogenic removal efficacy for filtration products.

Antimicrobial Efficacy of PuraShield Filtration Unit

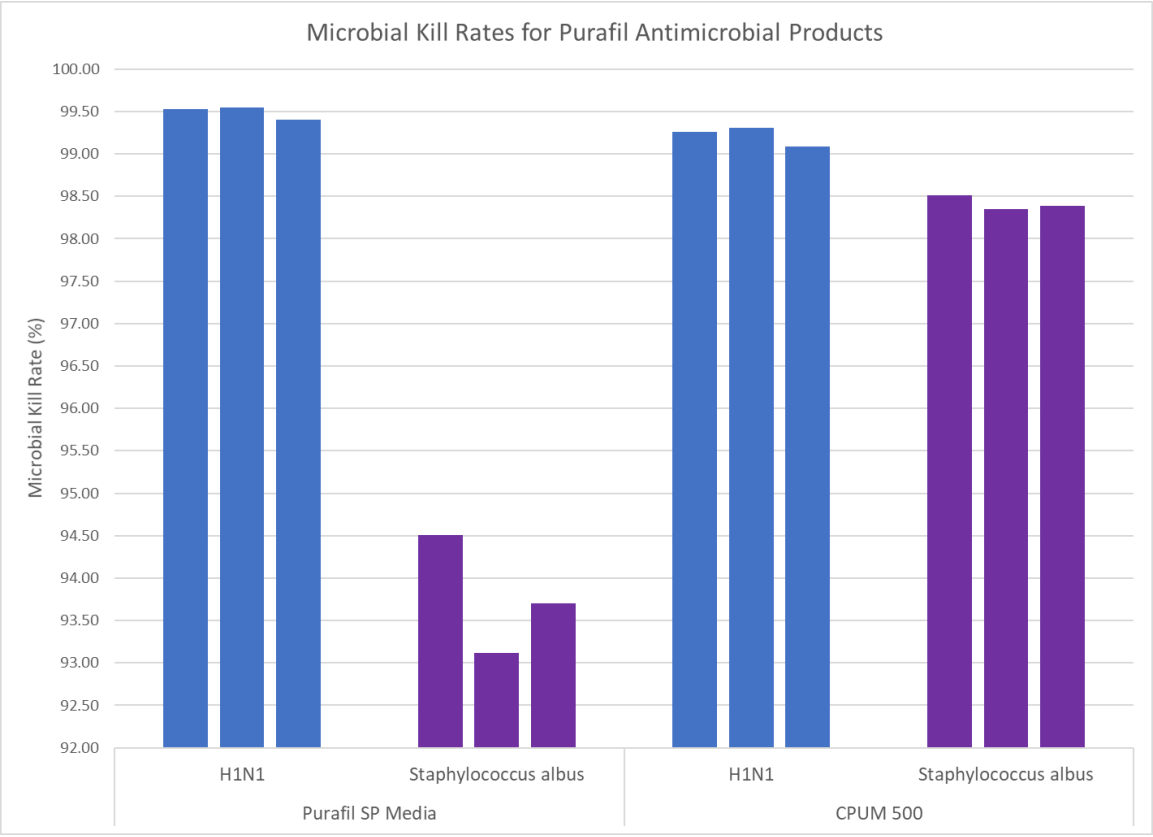
Laboratory test data for viral and bacterial disinfection efficacy are outlined in Table 1. Measurements with CPUM 500 reveal average kill rates of **99.22%** against viruses and **98.42%** against bacteria over just one hour of operation. Longer time periods of operation would likely enhance overall room sterilzation through enhanced filter contact time with airborne contaminants. Test measurements show the capacity of PuraShield to significantly and permanently reduce the concentration of airborne pathogens over relatively short operational periods.

Table 1. Antimicrobial Efficacy Measurements on PuraShield (CPUM 500) Unit

Contaminant	Trial (#)	Airborne Microbial Content ($TCID_{50}/m^3$)		Kill Rate (%)
		Initial	After 1hr	
Staphylococcus albus 8032	1	5.7×10^4	5.5×10^2	98.51
	2	5.8×10^4	6.2×10^2	98.35
	3	5.9×10^4	6.4×10^2	98.39
Influenza A subtype H1N1	1	6.11×10^5	1.06×10^3	99.26
	2	7.65×10^5	1.34×10^3	99.31
	3	9.04×10^5	1.80×10^3	99.09

Comparison to Purafil SP Media Testing

Antimicrobial testing on Purafil SP media, one of the antimicrobial components of PuraShield, was also evaluated. Calculated kill rates of both the CPUM 500 unit and Purafil SP are displayed together in figure to facilitate comparson.



The significantly higher bacterial reduction of the CPUM 500 unit in comparison to Purafil SP-alone is enacted by combinatorial microbial filtration from Puraward, Purafil SP, and HEPA filtration in the PuraShield unit. It is important to note that the tests conducted on Purafil SP media alone were performed for twice as long (2hr vs. 1hr) and with a magnitude higher microbial concentration (Intial $TCID_{50}/m^3 \approx 10^6$ vs 10^5) than measurements acquired with PuraShield 500. These conditions would enhance contact time and adsorptive forces in the media-only test evaluations as compared to described test conditions for the PuraShield unit, and likely account for ~0.1% differences in antimicrobial activity between Purafil SP-only and CPUM 500 tests against H1N1.

Conclusions

Test data on actual microbial contaminants show PuraShield can effectively disinfect spaces with airborne pathogenic contaminants. Measurements using the CPUM 500 unit against H1N1 and *Staphylococcus albus* suggest the PuraShield removes >**99.2%** of viruses and >**98.4%** of bacteria within only 1hr of operation. The complete PuraShield unit, which utilizes several microbial filtration platforms, generates enhanced bacterial removal and comparable viral filtration to antimicrobial media alone, but impressively in half the exposure time and a magnitude lower initial contaminant concentration. As such, PuraShield filtration devices enact effective removal capability for airborne microbial contaminants.

References

1) Antibacterial and Cleaning Functions of Household and Similar Electrical Appliances. From *Methods for the Determination of Inhalable Particles in Air in Public Places "Technical Standard for Disinfection*. Ministry of Public Health. 2002 ed. Peoples Republic of China.

2) Meek J.; Milholland D.; Litauszki L. Alternative Methods for HEPA Filter Leak Detection. *Pharm. Eng.* **2011**, 2 (31), 22-32

3) Comparison of High Efficiency Particulate Filter Testing Methods. International Atomic Energy Agency. Vienna, AT. **1985**.