Filtration Efficacy of the Easy Flow Personal Air Filtration Device against Multiple Microorganisms

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Jamie Balarashti [a], Weston Schaper, M.S. [a]

[a] Aerosol Research and Engineering Laboratories Inc. Olathe KS

Background: This in-vitro study characterized the filtration efficacy of the Easy Flow Personal Air Filtration System. The primary component of this system is the battery-charged device with a replaceable HEPA-13 filter element and fan to move air. It can be combined with a mask or respirator using an air hose through one of two ways. When the device is connected to the air hose, the outlet end of the air hose can be inserted into the inner side at the bottom of the mask and secured with a magnet. It can also be attached to a mask or respirator by cutting a small hole on the mask and slipping the air hose outlet into the hole. The Easy Flow device is designed to be worn for every day, mobile use. It provides positive pressure air which helps maintain mask effectiveness and makes it more comfortable to breathe. Easy Flow uses a 3M HEPA 13 Filter that filters particulates down to 0.3 microns. This filtration system can reduce airborne pathogens and thus mitigate disease transfer. By testing the device using multiple species across multiple classifications of microorganisms, a strong characterization of its performance can be achieved.

Methods: Our study tested Easy Flow's filtration efficacy with six (6) different aerosolized microorganisms: MS2 bacteriophage, *Escherichia coli, Staphylococcus epidermidis*, PhiX174 bacteriophage*, Bacillus subtilis*, and *Aspergillus niger*. Each microorganism was tested in a series of three (3) trials in the following manner: A selected microbe was continuously aerosolized into a sealed 300 L chamber containing the Easy Flow device running on the "high" fan setting. Two impinger sampling ports were used to collect samples from the chamber air and the Easy Flow filtered air. The Easy Flow's air outlet connected to a sample port through the supplied air duct tubing. These two samples were then collected, serially diluted, and plated onto tryptic soy agar plates. The plates were incubated for 24 to 48 hours, then enumerated, recorded, and prepared for data analysis. Microorganism counts are expressed in terms of either colony-forming units per liter (cfu/L) for bacteria and fungi or plaque-forming units per liter (pfu/L) for viruses.

Results: For MS2 bacteriophage, the Easy Flow showed an average of 1.65 LOG reduction at the low speed setting and 2.57 LOG at the high speed setting. For PhiX174 bacteriophage, the Easy Flow showed an average of 2.60 LOG reduction. The Easy Flow air filtration unit demonstrated an average of just over 2 LOG reduction for both *S. epidermidis* and *E. coli*. For the spore-forming organisms, *B. subtilis* and *A. niger*, the Easy Flow achieved a LOG reduction of 2.00 and 3.10, respectively. These results are displayed in the graph below.
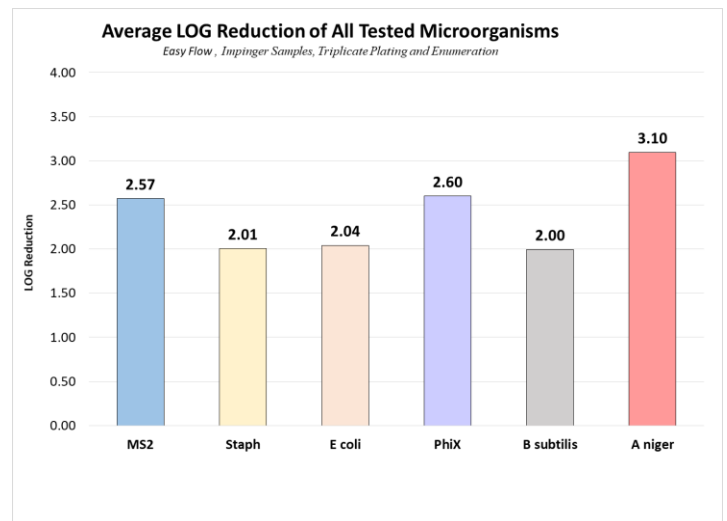
Summary: Overall, the Easy Flow device performed well, achieving a 2 LOG or more reduction for all tested microorganisms. It achieved comparable LOG reductions for the three (3) bacteria that were tested and performed the best on *A. niger* fungal spores, achieving a 3.10 LOG reduction of fungal bioaerosol. A summary table is displayed below.

Average % and LOG Reduction of Bioaerosol by Easy Flow

Bioaerosol Type	Species	Number of Trials	Reduction	Trial Time (minutes)			
				Trial 1	Trial 2	Trial 3	Average
Bacterial	*MS2 bacteriophage (RNA E. coli phage)*	3	*Log Reduction* *% Reduction*	2.57 99.730%	2.50 99.683%	2.65 99.775%	2.57 +/- 0.07 99.729% +/- 0.046%
Bacterial	*Staphylococcus epidermidis (Gram +, vegetative)*	3	*Log Reduction* *% Reduction*	2.01 99.029%	2.02 99.037%	1.99 98.967%	2.01 +/- 0.02 99.011% +/- 0.038%
Virus	*Escherichia coli (Gram -, vegetative)*	3	*Log Reduction* *% Reduction*	1.99 98.981%	2.09 99.178%	2.05 99.112%	2.04 +/- 0.05 99.09% +/- 0.1%
Virus	*PhiX174 (E. coli phage)*	3	*Log Reduction* *% Reduction*	2.80 99.842%	2.50 99.686%	2.49 99.678%	2.6 +/- 0.18 99.736% +/- 0.092%
Bacterial spore	*Bacillus subtilis*	3	*Log Reduction* *% Reduction*	2.01 99.020%	2.02 99.035%	1.96 98.909%	2 +/- 0.03 98.988% +/- 0.069%
Fungal spore	*Aspergillus niger*	3	*Log Reduction* *% Reduction*	3.14 99.928%	3.11 99.923%	3.03 99.908%	3.1 +/- 0.05 99.919% +/- 0.01%
							2.39 +/- 0.41 **99.412% +/- 0.426%**