MICROBIOLOGY REPORT

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Test Type: Multi-Pass Efficiency

Scope

Customer provided two units, RM1-16 (1 UVC bulb) and RM2-16-16 (2 UVC bulbs), for multi-pass efficiency testing with MS-2 bacteriophage (ATCC 15597-B1) as the challenge aerosol. These units were tested with UVC lamps on, and the UVC lamps off (Natural Decay). Testing was performed in a large (1000 ft^3) stainless-steel chamber.

Method

The MS-2 bacteriophage was harvested and titrated to 1E9 pfu/ml. Suspensions of the organisms were then aerosolized into the chamber using a nebulizer prior to powering the test device. The test chamber air was sampled at 5 to 15-minute intervals using a SKC BioStage cascade impactor for 1-minute sampling periods. The cascade impactors were calibrated to an airflow rate of 28.3 liters/min and the sampling inlet was situated at the midpoint of the test chambers. The recovered organisms were enumerated after 24-hours of incubation.

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Testing Approval
Al Vatine, CEO

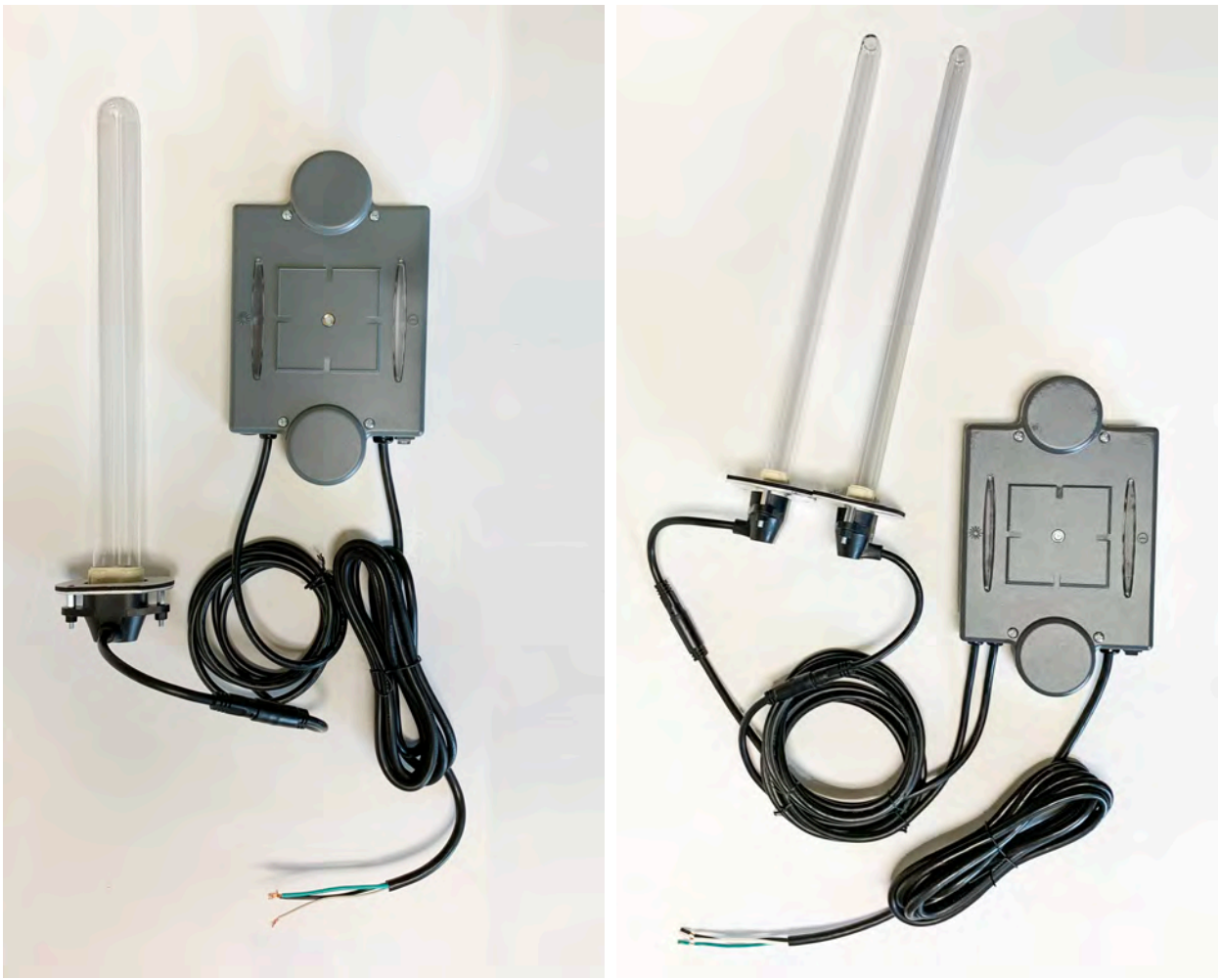

Figure 1. RM1-16 and RM2-16-16

Test Conditions
Environmental Conditions: 72 °F and 50% RH
Test Airflow Rate: 656 CFM

Equipment
1000 ft^3 Stainless-Steel Test Chamber
SKC BioStage Single-Stage Impactors
TSI Scanning Mobility Particle Sizer (SMPS) 3938

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Figure 2. Test chamber

MS-2 Bacteriophage Results

The corrected removal efficiencies for the Brio air cleaner uses the empty chamber data from time=0 as follows:

$$Corrected\ Removal\ Efficiency = 1 - \left(\frac{DevicePFU_{t=x}}{DevicePFU_{t=0}} * \frac{EmptyPFU_{t=0}}{EmptyPFU_{t=x}}\right)$$

Table 1. MS-2 PFU Removal Efficiency Results (Average of 3 Samples)

	Positive-Hole Corrected MS-2 PFU		
Time (min)	Natural Decay	RM1-16	Removal Efficiencies %
0	397.8	356.6	N/A
5	293.6	23.7	91.00
10	255.8	7.1	96.90
15	189.6	0	>99.99
20	157.2	0	>99.99
30	124.5	0	>99.99
45	63.8	0	>99.99
60	52.2	0	>99.99

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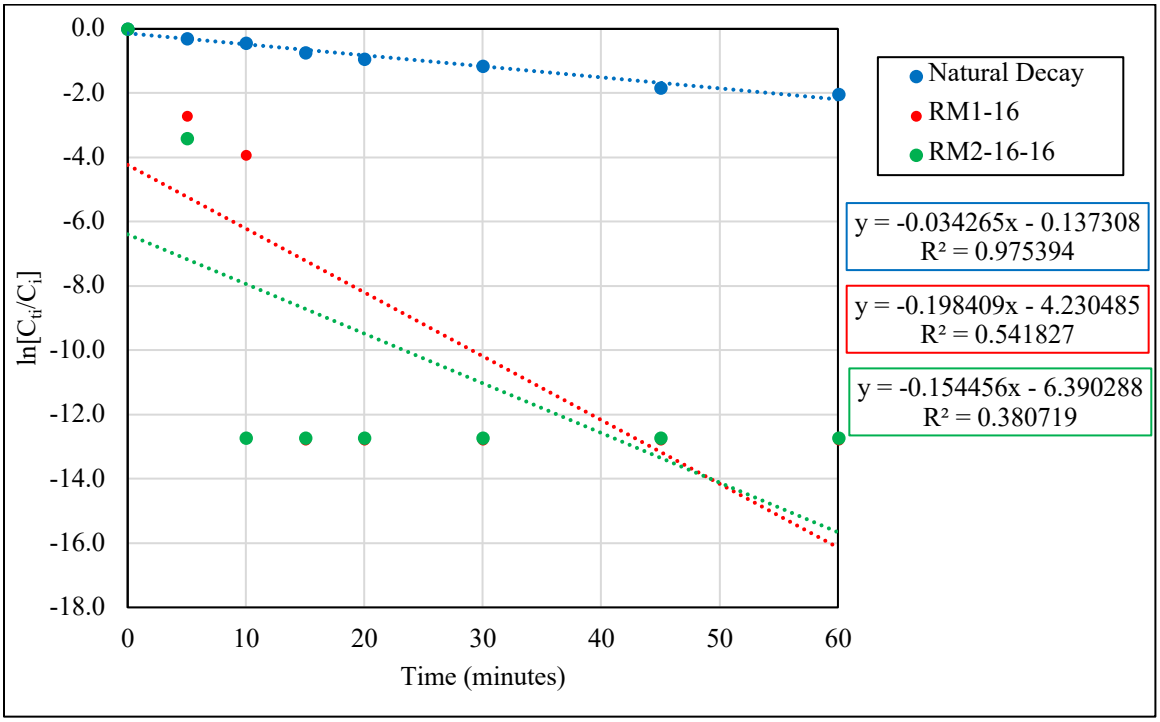
	Positive-Hole Corrected MS-2 PFU		
Time (min)	Natural Decay	RM2-16-16	Removal Efficiencies %
0	397.8	333	N/A
5	293.6	11.1	95.78
10	255.8	0	>99.99
15	189.6	0	>99.99
20	157.2	0	>99.99
30	124.5	0	>99.99
45	63.8	0	>99.99
60	52.2	0	>99.99

These results are plotted in the following graph. MS-2 PFU losses follow the exponential decay function:

$$C_{t_i} = C_i e^{-kt_i} \qquad \text{(Equation 2)}$$

where C_{ti} is the PFU at time t_i, C_i is the PFU at time = 0 minutes, k is the decay rate constant, and t_i is the time. The decay rate constant is then found from the slope of the $\ln[C_{ti}/C_i]$ vs. t_i curve:

$$\ln \frac{C_{t_i}}{C_i} = -kt_i + b \qquad \text{(Equation 3)}$$



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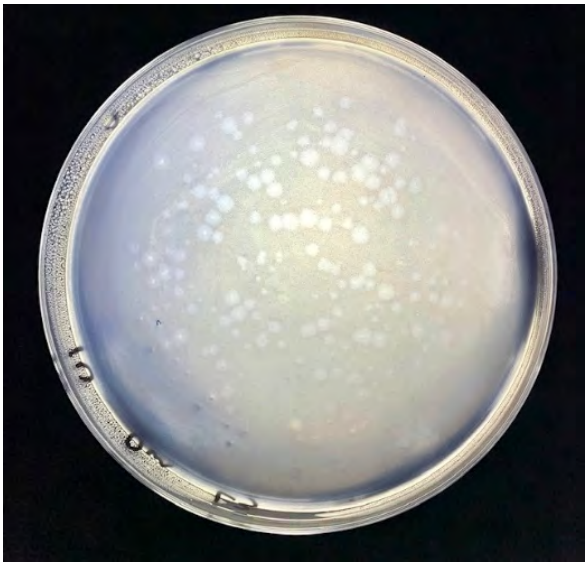
Using Equation 4, the CADR $_{\text{virus}}$ calculation based on cumulative viral particle number concentration is as follows:

$$CADR = V\left(k_{device} - k_{natural\_decay}\right) \qquad \text{(Equation 4)}$$

$$CADR_{viral\ count} = 1000ft^3(0.198409 - 0.034265) = 165.1\ cfm \qquad \text{(RM1-16)}$$

$$CADR_{viral\ count} = 1000ft^3(0.154456 - 0.034265) = 214.7\ cfm \qquad \text{(RM2-16-16)}$$



MS-2 Pfu at 0 time

MS-2 Pfu at 15 minutes

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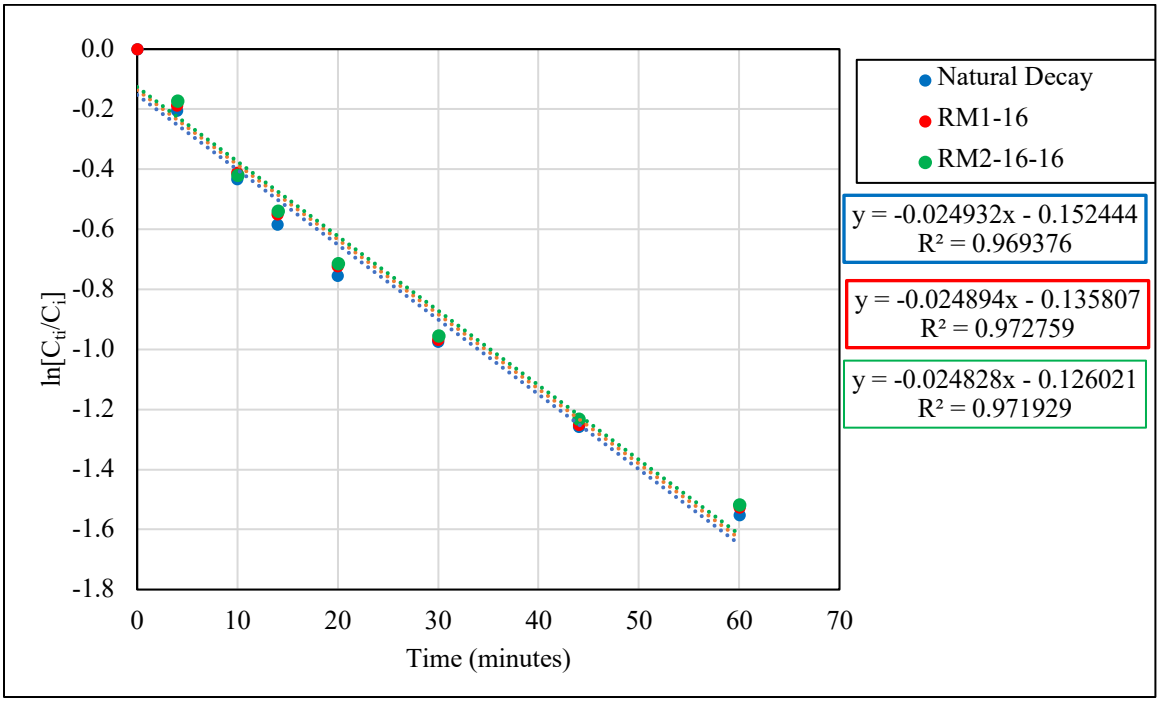
SMPS Results

Cumulative particle number concentrations in the range of 16.5nm-604.3nm were measured with the TSI SMPS for the natural decay test, RM1-16 test and the RM2-16-16 test. As above, particle losses follow the exponential decay function (Equation 2) where C_{ti} is the cumulative particle number concentration at time t_i, C_i is the cumulative particle number concentration at time = 0 minutes, k is the decay rate constant, and t_i is the time.

The curve $\ln[C_{ti}/C_i]$ vs. t_i was plotted to determine the decay rate constants.



$\ln[C_{ti}/C_i]$ versus time for Natural Decay, RM1-16 and RM2-16-16 Tests using TSI SMPS particle number concentration

Using Equation 4, the CADR calculation based on cumulative particle number concentration from the TSI SMPS data is as follows:

$$CADR_{particulate} = 1000ft^3(0.024894 - 0.024932) = -0.04\ cfm \quad \text{(RM1-16)}$$

$$CADR_{particulate} = 1000ft^3(0.024828 - 0.024932) = -0.10\ cfm \quad \text{(RM2-16-16)}$$

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