MICROBIOLOGY REPORT

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Date: June 17, 2021
Test Requested By: Agentis Air
Test Type: Multi-Pass Efficiency

Scope

Customer provided a unit for multi-pass efficiency testing with MS-2 bacteriophage (ATCC 15597-B1) as the challenge aerosol. 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-minute intervals using a SKC Bio-Stage 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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Air Cleaner

Figure 1. Air Cleaner Tested

Test Conditions
Environmental Conditions: 72 °F and 50% RH

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	AirBrio	Removal Efficiencies %
0	103.20	224.80	N/A
5	93.00	25.80	87.26
10	65.00	2.00	98.59
15	46.60	0	>99.99
20	50.00	0	>99.99
30	48.80	0	>99.99

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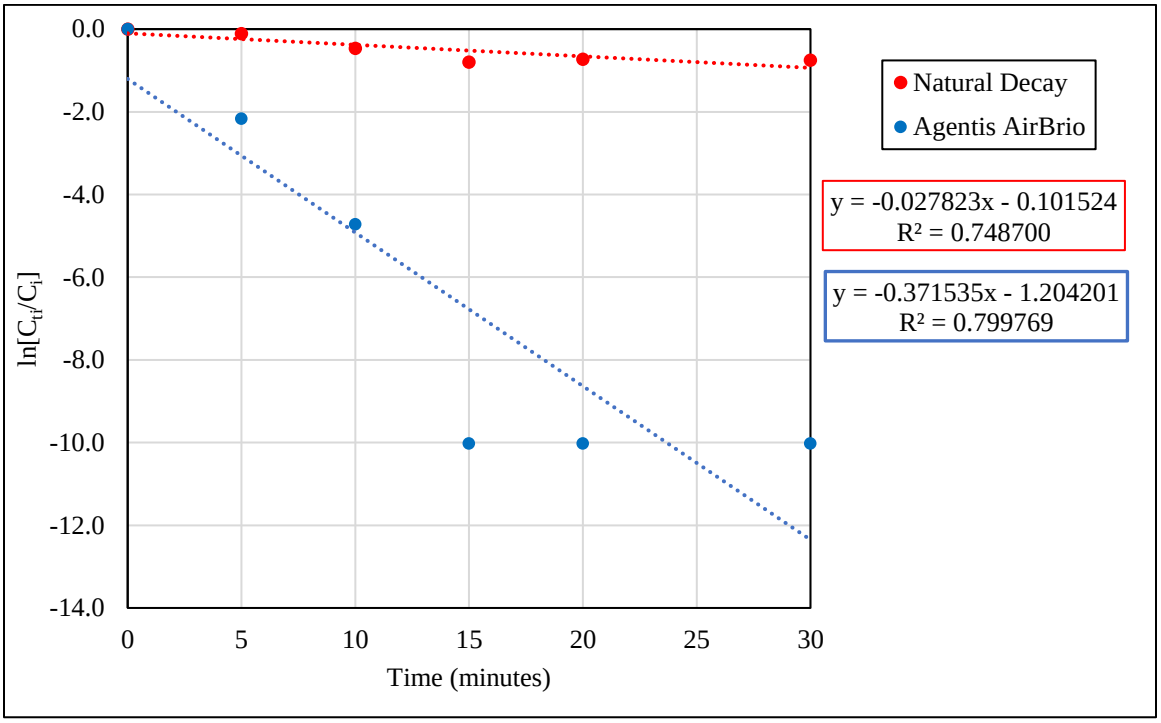
These results are plotted in the following graph. MS-2 PFU losses follow the exponential decay function:

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

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:

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



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

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

$$CADR_{viral\ count} = 1000 ft^3 (0.371535 - 0.027823) = 343.7\ cfm$$

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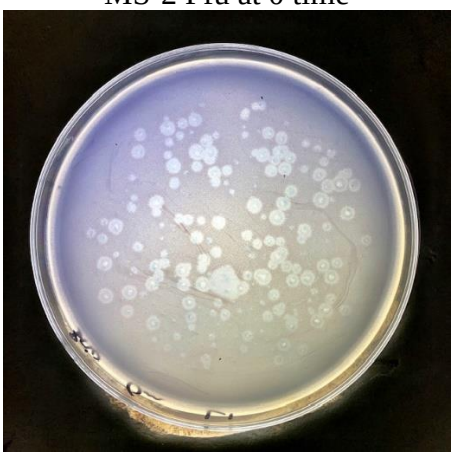
MS-2 Pfu at 0 time



MS-2 Pfu at 15 minutes

SMPS Results

Cumulative viral particle number concentrations in the range of 16.5nm-604.3nm were measured with the TSI SMPS for both the natural decay test and the AirBrio 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.

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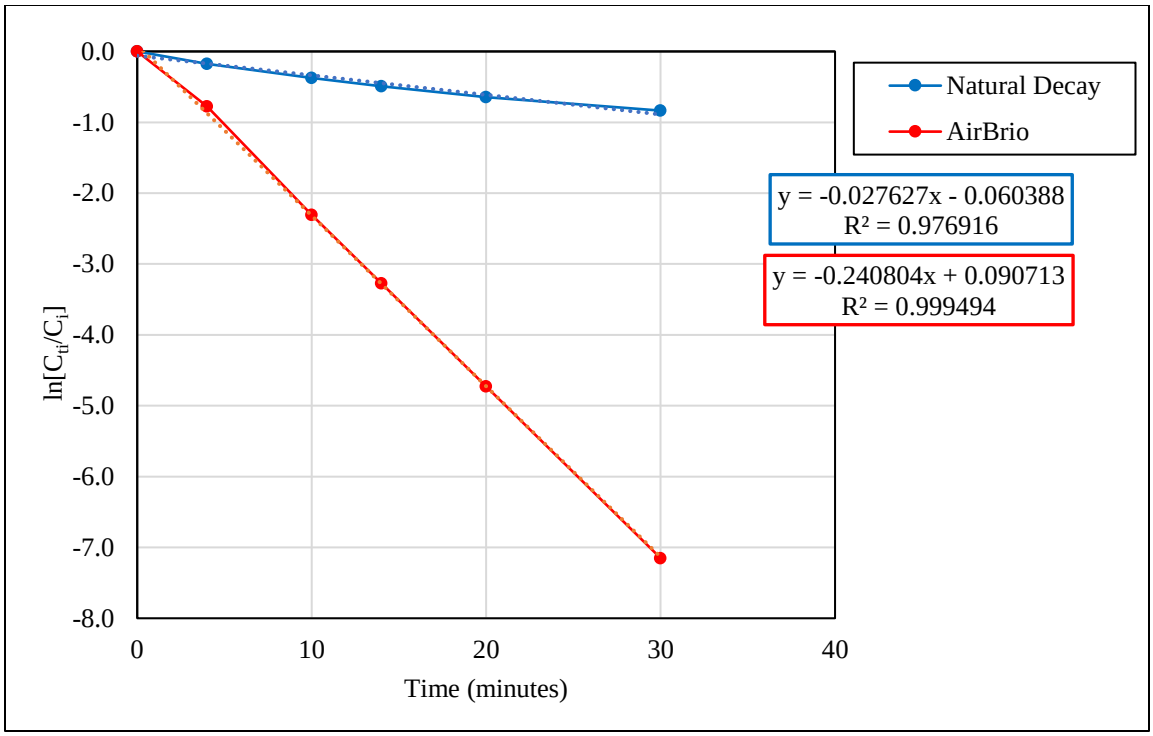

ln[C_{ti}/C_i] versus time for Natural Decay and AirBrio Tests using TSI SMPS particle number concentration

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

$$CADR_{particulate} = 1000ft^3(0.240804 - 0.027627) = 213.2\ cfm$$

This will indicate that besides viral collection, there is possible deactivation.

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