AEROBIOTIX™
BETTER AIR FOR HEALTHCARE

White Paper:

Elimination of Aerosolized Virus in Single-Pass Testing using Aerobiotix Ultraviolet Air Handling System

Introduction

The Research Triangle Institute (RTI) Center for Microbial Community Systems and Health Research conducted a series of tests to determine the efficiency of viral inactivation by the Aerobiotix in –room recirculating air cleaner. The unit provided by Aerobiotix was installed in RTI's high-flow test rig. **MS2 virus** test organisms were utilized. The airflow was a constant 450 cubic feet per minute (cfm).

The MS2 virus is an Escherichia coli (E. coli) bacteriophage that roughly approximates the aerosol-related physical characteristics of human viruses. Individual virus particles of health-threatening agents may be somewhat smaller or larger than MS2.

Single Pass In-duct Test Method

The testing was performed in a test duct similar to that illustrated in Figure 1. The test duct provides steady air flow and aerosol drying and neutralization along with sampling ports for bioaerosol sample collection. The cross section of the duct is 0.61 m by 0.61 m (24 in. by 24 in.). The locations of the major components, including the sampling probes, device section, the bioaerosol generator (site of aerosol injection) and samplers are shown.

The unit was installed as shown in Figure 2. There is a 24 x 18 inch air intake at the lower front of the unit and a 24 x 12 inch clean air exhaust at the top of the unit. Transitions were manufactured to connect the air intake and clean air exhaust to the rig. The unit was mounted with the air intake facing upstream so that all the incoming challenge bioaerosol was required to pass through the air intake of the unit and exit through the clean air exhaust.

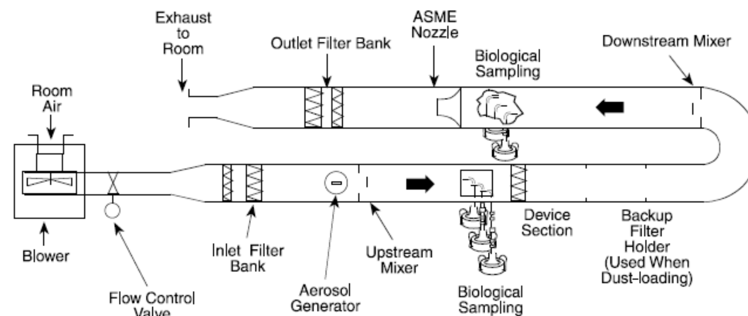

Figure 1. Schematic of a test apparatus. The unit is placed in the device section.

Figure 2. View of the ESP unit installed in the test duct. Air flow in the test duct is from left to right.

The device tested consisted of a MERV 11 prefilter, a blower unit, a UV reactor which combines UVC lamps with a UV transmissible solid filtration media (glass cylinders), and a HEPA post filter. The blower was on for all of the test runs. For testing purposes, the unit was operated in the following modes:

- “full on” (MERV 11 filter, UV, glass cylinders, and HEPA filter),
- “UV only” (MERV 11 and HEPA filters removed),
- “no device” control test mode (MERV 11 and HEPA filters removed, UV off, and glass cylinders removed).

Fresh cultures of MS2 virus were prepared and checked for quality before each run. The challenge bioaerosol suspensions were aerosolized using a Collison modified MRE-type six jet nebulizer (BGI, Waltham, MA). The output of the nebulizer was mixed with clean, dry air prior to its entry into the test duct to create the dry bioaerosol challenge. The organisms were aerosolized in water and tests were conducted at room temperature.

For each round of sampling, six upstream and six downstream bioaerosol samples were taken. A standard sampling time was determined and used for all organisms to facilitate direct comparisons.
Bioaerosol samples were collected from the air stream with sampling probes positioned within the test duct at both the upstream and downstream sampling sites.

The MS2 virus was aerosolized in water and sampling was accomplished using all-glass impingers (AGI’s) containing impinger fluid. After sampling, the impinger fluid was analyzed for viable virions by a standard plaque assay.

For each run, the challenge bioaerosol was injected upstream of the device. A “device off” transmission test was performed for the organism, to determine the microorganism loss that would occur simply as a result of deposition or inactivation in the test duct. To obtain an accurate understanding of potential

organism loss naturally occurring in the air flow through the device, both the MERV 11, HEPA filters, and cylinders were removed for the “device off” tests conducted. The performance of the device is reported as the efficiency of the device in inactivating the organism, corrected to account for the loss of organisms observed with the “device off”.

Test Protocol:

1) Turn on the test duct blower and adjust flow to 450 CFM.
2) Turn ON the Collison nebulizer and drying air and run for at least 5 minutes.
3) Supply power to the air cleaner unit.
4) Collect upstream and downstream bioaerosol samples.
5) Turn OFF Collison and air cleaner.

For the “device off” test, the unit was completely shut off, MERV 11 and HEPA filters (as well as the glass cylinders) were removed and step 3 was omitted.

Single Pass In-duct Test Results

Table 1 presents the efficiency results for the air cleaner. The inactivation efficiencies were calculated as shown in the equation2 below:

Airborne Inactivation Efficiency (%) = 100 (1- Corrected Survival Rate)

The calculation of the test organism survival rate (culturable transmission) was based on the ratio of the downstream to upstream culturable organism counts. To remove system bias, the Survival Rate was corrected by the results of the “device off” transmission test. The “device off” transmission rate was calculated in the same manner as the survival rate. The “device off” value was 1.07 for MS2.

Table 1. Inactivation efficiencies for bioaerosols

Test Organism	Test Condition	Inactivation Efficiency (%)
MS2	Full-on	100
	UV Only	81.37

All samples were collected for 10 seconds upstream and 1 minute downstream. Three samples were collected simultaneously from up and down stream ports followed by another three within 5 minutes of the first set. The difference indicates the time needed to change out impingers and the device and rig continue to run during this time. The average of the 6 upstream samples and the average of the 6 downstream samples for each run was generally used in the calculations (outliers were not included).

Results tabulated above indicate that the MS2 virus inactivation efficiency of the Aerobiotix air cleaner was 100% observed when the unit was operated in “full on” mode.

References

1. Macher, J.M. 1989. Positive Hole Correction of Multiple-jet Impactors for Collecting Viable Microorganisms, American Industrial Hygiene Association Journal. 50: 561-568.

2. Foarde, K.K., Myers, Eric A., Hanley, James T., Ensor, David S., and Roessler, Peter F, 1999. “Methodology to Perform Clean Air Delivery Rate Type Determinations with Microbiological Aerosols”, Aerosol Science and Technology, 30:235-245.