Final Laboratory Report: Mold

Customer Name	AIR, Alpine Innovative Research
Customer Address	3855 64th Ave SE, Calgary, Alberta T2C 2V5, Canada
Test Requested	*Aspergillus Niger removal*
Sample Description	Air Sniper Pro air cleaners
Number of Samples	3
Date of Receipt	18 August 2016
ASC Code	ASC003339
Report Number	ASCR092180
Report Date	25 October 2016

Contents

1. Purpose

The purpose of this study was to evaluate the forced decay of formaldehyde by the Air Sniper Pro Air Cleaner in a 30 m³ environmental test chamber in comparison to natural decay of formaldehyde in the absence of the air cleaner.

As previously reported in Interim Report ASCR092177, the purpose of the study was also to determine the performance of the Air Sniper air cleaner at removing airborne Aspergillus niger mold spores from within a sealed indoor space. The results reported in Interim Report ASCR092177 (removal of airborne *Aspergillus niger* mold spores and by the Air Sniper Pro Air Cleaner) are also presented here to complete this final report.

2. Background

Following discussions between Alpine Innovative Research (AIR) and airmid healthgroup it was agreed that testing would be performed on the Air Sniper Pro air cleaner to study the effect of the air cleaner on a number of airborne contaminants. The selected contaminants were *Aspergillus niger* mold spores. Testing was performed in airmid healthgroup's environmental test chambers.

3. Abbreviations used in this report

A/C: air cleaner

CFU/m³: colony forming units per cubic meter (in this report, the level of airborne mold)

CFU: colony forming units

HCHO: formaldehyde

Inf A: Influenza A

N/a: Not applicable

PDA: potato dextrose agar

ppm: parts per million

RD: room disturbance

4. Test Item Description

4.1. Air Sniper Pro Air Cleaner

Three Air Sniper Pro air cleaners were received in airmid healthgroup on August

18th 2016 for testing in the environmental testing chamber.

Figure 4.1. Air Sniper Pro air cleaner photographed at airmid healthgroup

5. Materials and Methods

5.1. Environmental Testing Chamber

The ATSM Environmental Testing Chamber maintains selected temperature and humidity levels over a range of 0.38 to 30.0 air changes per hour. It is constructed from stainless steel with all materials complying with low VOC (Volatile Organic

Compounds) emission requirements.

Figure 5.1. Environmental Testing Chamber

6.2. *A. niger* Mold

10 g of dust spiked with 1×10^7 of *A. niger* mold spores was introduced into the environmental testing chamber. A ceiling fan operating at full speed dispersed the dust and allowed it to homogenise throughout the chamber over a 10-minute period. Five minutes before the air cleaner was turned on (t = –5) triplicate 5-minute air samples were collected onto Potato Dextrose Agar (PDA) plates using SKC Bio-Impactors.

The procedure was as follows (Table 6.1). At t = 0 the Air Sniper Pro air cleaner was turned on, and operated at the highest fan speed. The air cleaner was operating for the remaining duration of the experiment. Triplicate airborne samples were taken at t = 10, t = 25, t = 40, and t = 55. A room disturbance was conducted in conjunction with the airborne sampling at t = 25. The room disturbance consisted of walking systematically around the inside of the chamber and bouncing a ball to disturb as much of the settled dust as possible.

Table 6.1. Testing outline for *A. niger* mold study		
Time (*t =x mins*)	**Testing Phase**	**Duration (minutes)**
t = –15	Introduce mold spores and allow to disperse	10
t = – 5	Air sampling	5
t = 0	Air cleaner on and wait 10 minutes	10
t = 10	Air sampling	5
t = 15	Wait 10 minutes	10
t = 25	Room Disturbance & Air sampling	5
t = 30	Wait 10 minutes	10
t = 40	Air sampling	5
t = 45	Wait 10 minutes	10
t = 55	Air sampling	5
END		

The PDA plates were collected at the end of the experiment and incubated at 25 °C for 72 hours. The plates were then examined for mold, and any mold colonies present were counted. A particle counter was set up inside the chamber to monitor airborne particle counts during each experiment. This device monitors airborne particles across six different size channels 0.3 – 0.5 µm, 0.5 – 1.0 µm, 1.0 – 3.0 µm, 3.0 – 5.0 µm, 5.0 – 10.0 µm and >10.0 µm.

The chamber was cleaned and sterilized using UV-C light before the next run. Each test run was conducted in triplicate. The control runs consisted of the same protocol as the test except the Air Sniper Pro air cleaner was absent.

7. Results

7.2. Mold Results

7.2.1. Quantification of Aspergillus *niger*

Three air samples were taken at each time point during each experimental run. Test and control runs were performed in triplicate.

Sample no.	Time (t = x minutes)	CFU/m^3		% reduction (Test vs Control)
		Control	**Test**	
	t = -15	Introduction/Mixing		
1	t = - 5	2268	2571	N/a
	t = 0	N/a	A/C turned on	N/a
2	t = 10	833	335	59.7
3	t = 25 (RD)	747	221	70.5
4	t = 40	547	35	93.5
5	t = 55	423	22	94.9

Table 7.3 Quantification of *A. niger* colony forming units from air samples taken in the presence (Test) and absence (Control) of the Air Sniper Pro

Figure 7.2 Graphical representing the results from Table 7.1 of the total number of *A. niger* CFUs measured in the environmental chamber during the test and control runs. y axis is a logarithmic scale
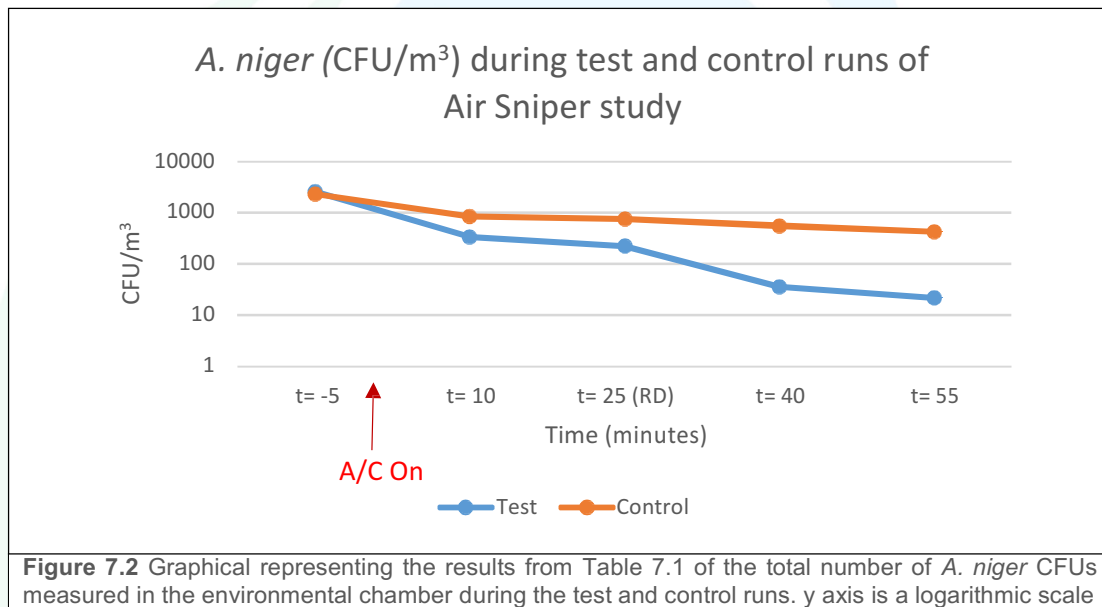
Table 7.3 and Figure 7.2 represent the average number of *A. niger* Colony Forming Units (CFUs) per cubic meter of air from the triplicate runs. During the last sampling point (55 – 60 minutes) of the control runs (no air cleaner) the concentration of airborne mold was 423 CFU/m^3. In contrast, during the same sampling point of the test runs (air cleaner in operation) the concentration of airborne mold was 22 CFU/m^3, a 94.9% reduction in airborne *A. niger* spores.

7.2.2 Particle Counts

Particle counts measured during the test and control runs are presented in Figures 7.3 to 7.8. In each of the figures: BkGd = Background, Mx = Mixing, S-1 = Sample 1, S-2 = Sample 2, RD/S-3 = Room Disturbance and Sample 3, S-4= Sample 4, S-5 = Sample 5
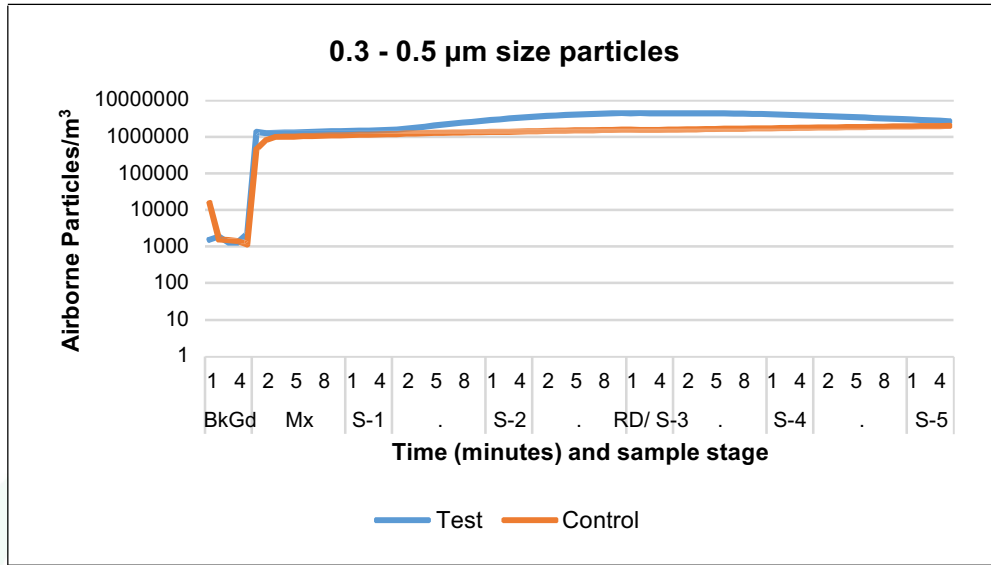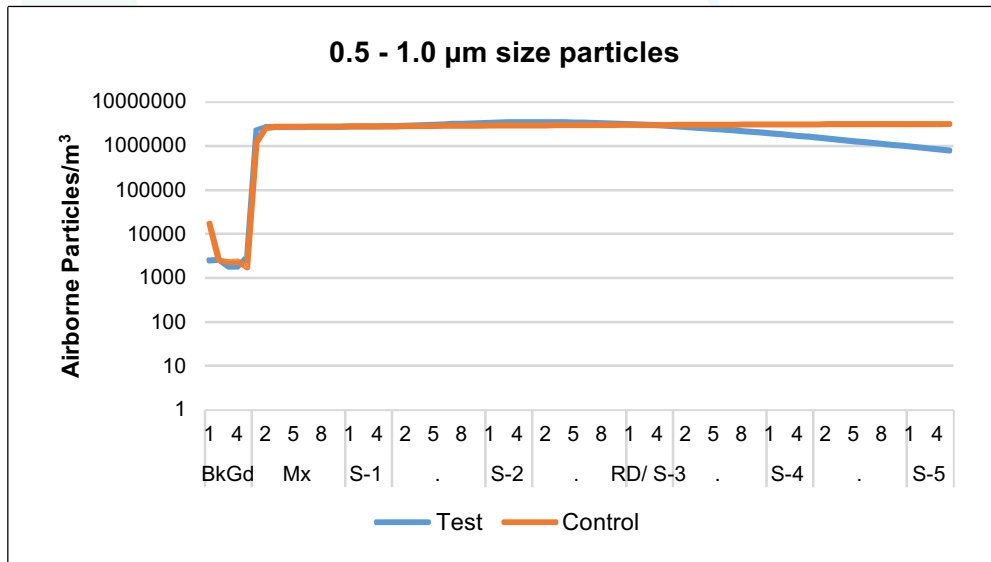

Figure 7.3. Graph representing the number of 0.3 – 0.5 µm size airborne particles recorded from inside the environmental test chamber during the test and control runs of the Air Sniper Pro *A. niger* mold study. y axis is a logarithmic scale.
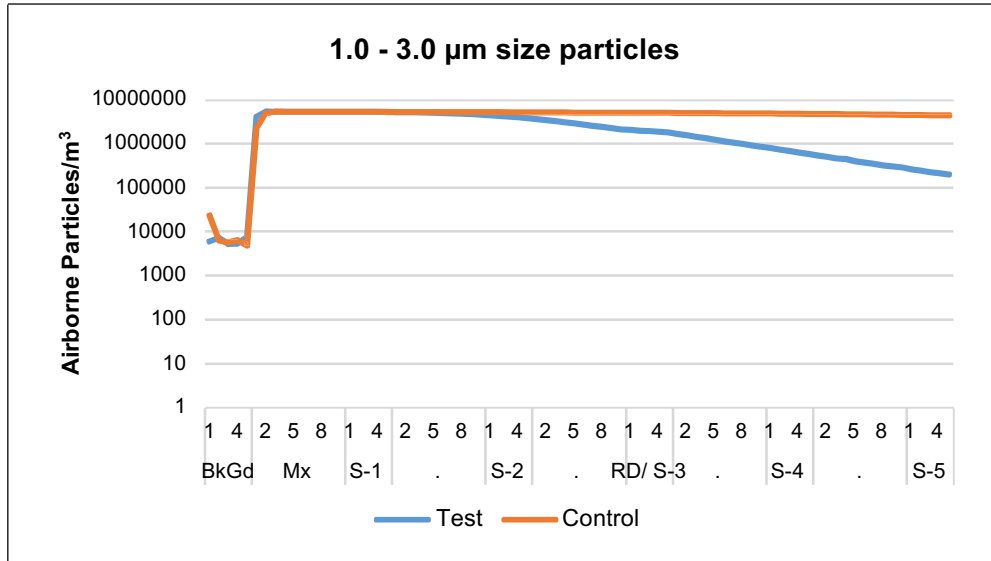

Figure 7.4. Graph representing the number of 0.5 – 1.0 µm size airborne particles recorded from inside the environmental test chamber during the test and control runs of the Air Sniper Pro *A. niger* mold study. y axis is a logarithmic scale.
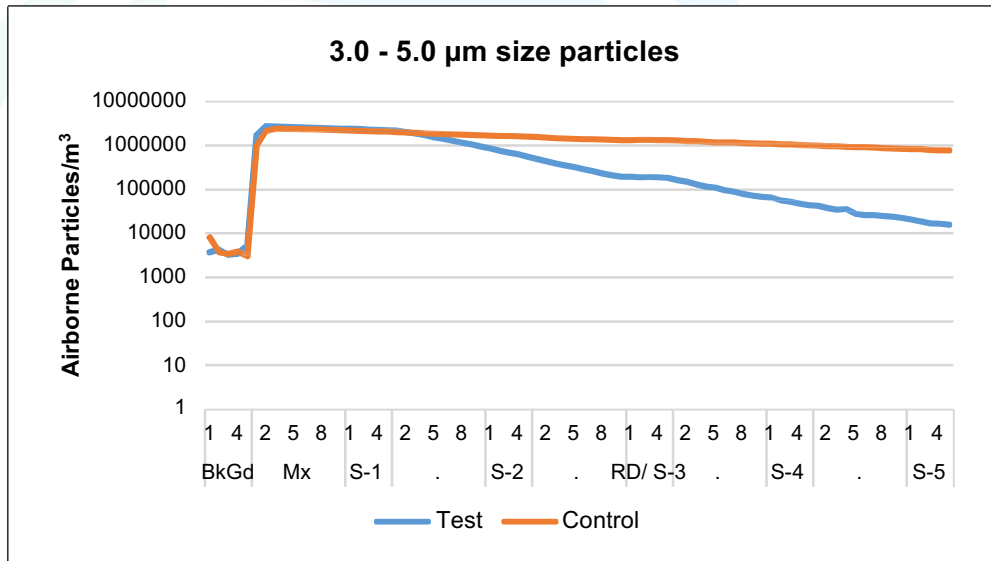
Figure 7.5. Graph representing the number of 1.0 – 3.0 μm size airborne particles recorded from inside the environmental test chamber during the test and control runs of the Air Sniper Pro *A. niger* mold study. y axis is a logarithmic scale.
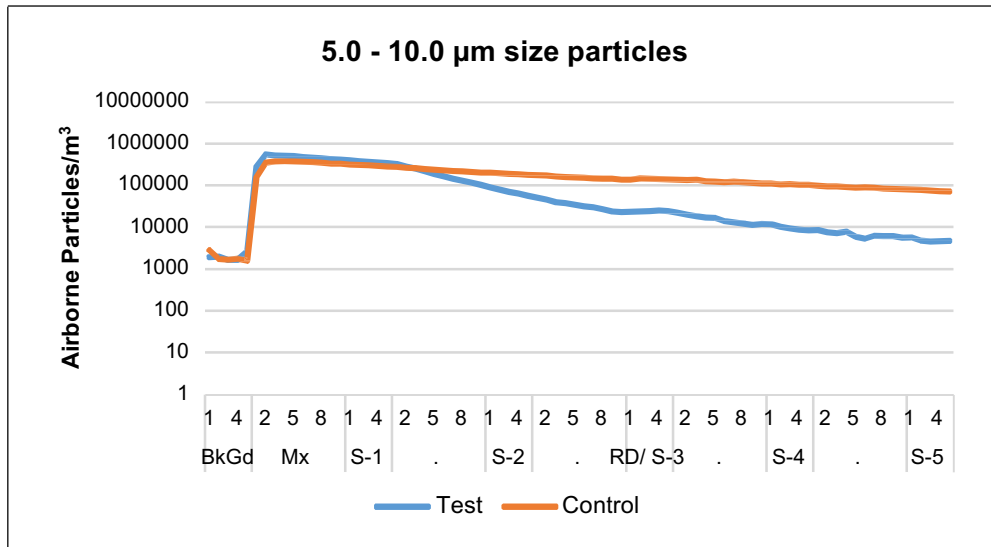

Figure 7.6. Graph representing the number of 3.0 – 5.0 μm size airborne particles recorded from inside the environmental test chamber during the test and control runs of the Air Sniper Pro *A. niger* mold study. y axis is a logarithmic scale.

Figure 7.7. Graph representing the number of 5.0 µm size airborne particles recorded from inside the environmental test chamber during the test and control runs of the Air Sniper Pro *A. niger* mold study. y axis is a logarithmic scale.
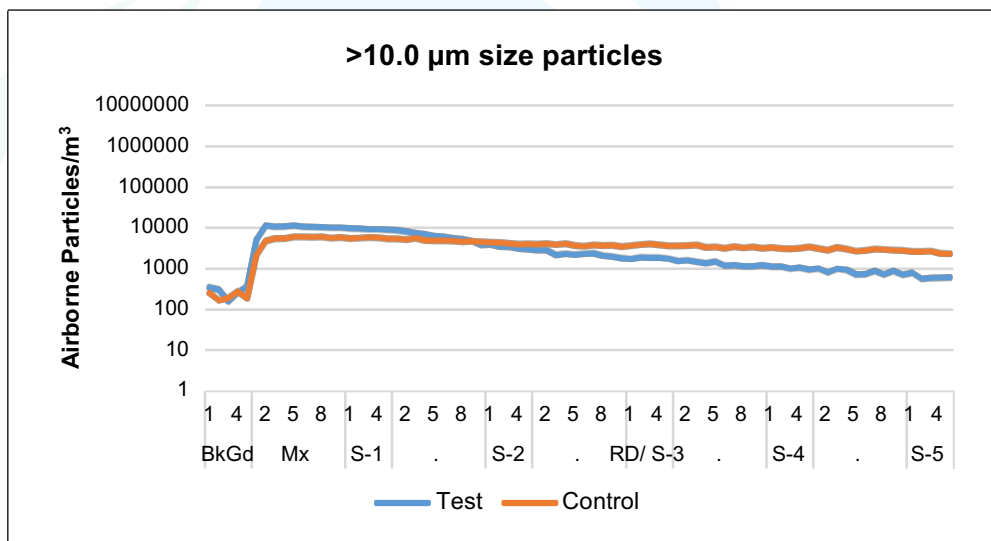

Figure 7.8. Graph representing the number of >10.0 µm size airborne particles recorded from inside the environmental test chamber during the test and control runs of the Air Sniper Pro *A. niger* mold study. y axis is a logarithmic scale.

Other than for the 0.3 – 0.5 µm size particles (Figure 7.3) there is a reduction in airborne particles across all other size ranges. *A. niger* mold spores are around 2 – 3.5 µm size. Therefore, the reduction of *A. niger* mold spores, as a result of the Air Sniper Pro, is best represented by Figures 7.5 and 7.6.

For the 0.3 – 0.5 µm size particles (Figure 7.3) there was an increase in airborne particles after the Air Sniper Pro was turned on. We speculate that this could be due to larger particles being degraded into smaller size fragments by the operation of the air cleaner.

8. Conclusions

The results presented for formaldehyde removal from the air in the environmental test chamber, demonstrate that after 52 min of operation the Air Sniper Pro was only capable of increasing the rate of formaldehyde decay by an additional 20% of that which occurred by natural decay. Formaldehyde levels remained at about five times greater than the 0.1 ppm upper limit recommended for residences by the EPA[1]. In addition, the World Health Organization (WHO) gives a reference concentration of 0.081 ppm for formaldhyde[2]. A considerably longer operation time for the Air Sniper Pro may be required to effectively reduce formaldehyde to safe levels in the environmental chamber. Further tests are recommended to verify this.

The Air Sniper Pro was demonstrated to be capable of reducing the levels of *Aspergillus Niger* mold spores by 94.9% after 55 – 60 minutes of air cleaner operation when compared to the control runs.

The Air Sniper Pro air cleaner was demonstrated to be effective in reducing airborne Influenza A aerosols in the test chamber, reaching 99.9% airborne virus reduction within the first 50 - 60 minutes of operation. Influenza A was not detectable by ELISA in any of the samples collected after 60 minutes of Air Sniper Pro operation. These results indicate that in the presence of an operational unit the Influenza A concentration in the test chamber was reduced to levels below the 1.28 ng/m^3, detection limit of the assay performed to quantify the collected airborne virus.

9. References

1) **United States Environmental Protection Agency**. EPA-454/B-13-001. Technical Assistance Document for the reporting of Daily Air Quality – The Air Quality Index (AQI). 2013.
2) **World Health Organisation**. WHO Indoor Air Quality Guidelines: Formaldehyde, Chapter 5.8. WHO Regional Office for Europe, Copenhagen, Denmark. 2001

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End of Report