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|---|---|
| **Customer Name** | MedicAir DentAir Ltd |
| **Customer Address** | The Barns, Hilltop Farm, Lyne Lane, Chertsey, Surrey, KT16 0AW |
| **Contact** | Alex Hallwood |
| **Sample Description** | MedicAir FOZKYGB-04 Air Purifier |
| **Number of Samples** | 1 |
| **Date of Receipt** | 17 June 2021 |
| **ASC Code** | ASC004167 |
| **Report Number** | ASCR092499 |
| **Report Date** | 12 August 2021 |

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## 1. Purpose

To assess the MedicAir FOZKYGB-04 air purifier in removing airborne *Escherichia* virus MS2 in a 28.5 $m^3$ environmental test chamber.

## 2. Test Item Description

One MedicAir FOZKYGB-04 air purifier was received by airmid healthgroup on 17 June 2021 in good condition (Figure 2.1).


**Figure 2.1.** MedicAir FOZKYGB-04 air purifier

## 3. Materials and Methods

### 3.1. 28.5 $m^3$ Environmental Test Chamber

Testing was conducted in a state-of-the-art 28.5 $m^3$ test chamber purpose-built to comply with the American Society for Testing and Materials (ASTM) standard. The chamber features include HEPA filtered supply air and an ability to maintain selected temperature and humidity levels at a wide range of air change rates. The chamber was constructed using powder-coated stainless steel with all materials complying with low volatile organic compound (VOC) emission requirements.

The chamber is sealable from the exterior environment with access via an anteroom with interlocking doors and complies with cleanroom standards. The air change rate within the chamber can be controlled within a range of 0.06 to 20 air changes per hour.

### 3.2. Bacteriophage MS2 (MS2)

Bacteriophage MS2 (MS2) is a non-enveloped positive-sense single stranded RNA virus that infects *Escherichia coli* and some other closely related bacteria but has not been shown to infect eukaryotes. However, several steps of MS2 replication, including viral gene expression and genome replication, share many similarities with positive-sense RNA viruses that infect eukaryotes. Thus, MS2 is often used as a surrogate for other viruses such as Norovirus, including studies where MS2 has been aerosolised [1] and where viral inactivation by ultraviolet light has been assessed [2,3]. Based on the requirements for aerosolisation, the use of ultraviolet light as the antiviral technology and its suitability as a surrogate for some human viral pathogens, MS2 was used as the challenge microorganism in this study.

## 4. Protocol

### 4.1. Part One: Test Preparation

4.1.1. The environmental test chamber is operated at 20 air changes per hour.

4.1.2. The walls, floor and ceiling of the environmental test chamber are washed.

4.1.3. Once dry, they are wiped with an isopropanol-based wipe.

4.1.4. A UV-C light sterilises the surface for 1 hour before testing.

### 4.2. Part Two: Equipment setup and chamber conditioning

4.2.1. The UV light is turned off. Sterile sampling equipment filled with virus collection media is set up on retort stands.

4.2.2. Sampling pumps located outside the chamber are calibrated to a specified flow rate for virus sampling.

4.2.3. Virus nebulisation equipment is set up in four locations in the test chamber.

4.2.4. The test chamber is conditioned to 20°C (± 3°C) and 50 % relative humidity (± 5 %).

### 4.3. Part Three: Testing

4.3.1. The ventilation system on the environmental test chamber is shut down to minimise the number of air changes during the test.

4.3.2. Background air samples are taken in duplicate for 10 minutes.

4.3.3. MS2 virus is loaded into the four nebulisers.

4.3.4. A ceiling fan and floor fan is operated. The ceiling fan is turned off after nebulisation.

4.3.5. The virus is nebulised into the test chamber over 20 minutes.

4.3.6. When nebulisation is complete, triplicate air samples are taken for 10 min (t= -10 to 0 minutes).

4.3.7. After the air samples have been taken, the air purifier is operated remotely in MAX mode with UV on and remains operating for the duration of the test. In the control runs, no air purifier is operated.

4.3.8. Additional air samples are taken in triplicate at the following time points:

- t = + 5 to 15 minutes
- t = + 20 to 30 minutes
- t = + 50 to 60 minutes

### 4.4. Part Four: Post-study

4.4.1. The floor fan is stopped.

4.4.2. Air samples are collected and transferred to the laboratory for plaque assay analysis.

4.4.3. Sampling equipment is removed and bagged for autoclave sterilisation.

4.4.4. The UV light is operated inside the test chamber to decontaminate all surfaces.

4.4.5. After UV sterilisation the chamber is operated at 20 air changes per hour.

All testing to the above method is conducted in triplicate for both active test and inactive controls

## 5. Results

Table 5.1 summarises the $Log_{10}$ values of the MS2 plaque-forming units per cubic meter of air ($PFU/m^3$) measured inside the environmental test chamber at each time point. The results of three inactive control runs (no air purifier) and three active test runs (air purifier operating) are presented, the average of which is graphed in Figure 5.1.

Table 5.1. Average Plaque Forming Units/$m^3$ for MedicAir active test and inactive control runs ($Log_{10}$)

| *Time (minute)* | ***Control*** | | | | ***Test*** | | | |
|---|---|---|---|---|---|---|---|---|
| | *Run 1* | *Run 2* | *Run 3* | ***Average (n=3)*** | *Run 1* | *Run 2* | *Run 3* | ***Average (n=3)*** |
| -10 to 0 | 8.0 | 10.2 | 8.2 | ***9.7*** | 8.1 | 8.4 | 8.1 | ***8.2*** |
| + 5 to 15 | 8.0 | 10.1 | 8.0 | ***9.7*** | 6.7 | 6.3 | 6.6 | ***6.5*** |
| +20 to 30 | 7.6 | 10.0 | 7.6 | ***9.5*** | 4.8 | 4.3 | 4.8 | ***4.7*** |
| +50 to 60 | 7.6 | 10.0 | 7.6 | ***9.5*** | 3.6 | 4.3 | 3.7 | ***4.0*** |

<LOD: Less than Limit of detection: 3.66 $PFU/m^3$ (Log10)

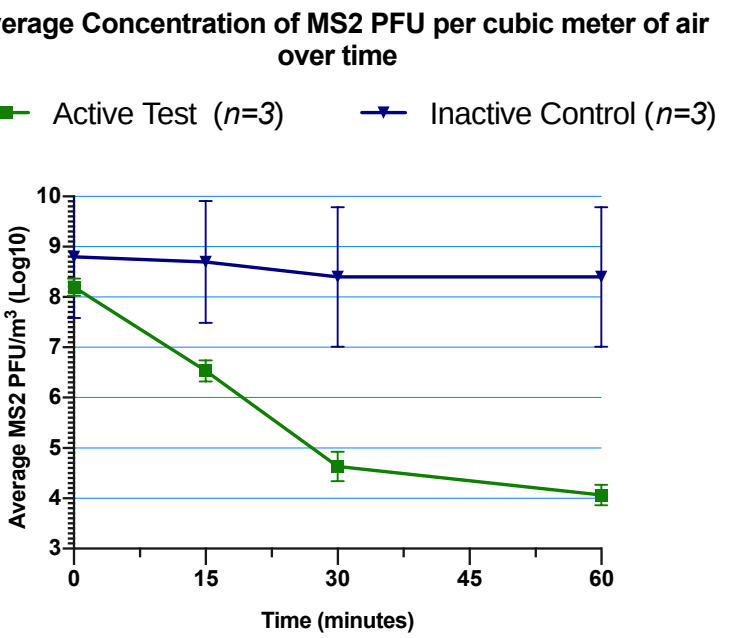


**Figure 5.1.** Average $Log_{10}$ MS2 $PFU/m^3$ of air over time. Error bars = standard deviation.

The measured starting concentration of MS2 was similar between each of the active test and inactive control runs. In the inactive control (no air purifier), there was a 0.2 log reduction due to natural decay after 60 minutes.

In the active test runs, the concentration of airborne MS 2 reduced by on average 8.2 log to 4.0 $Log_{10}$ MS2 $PFU/m^3$.

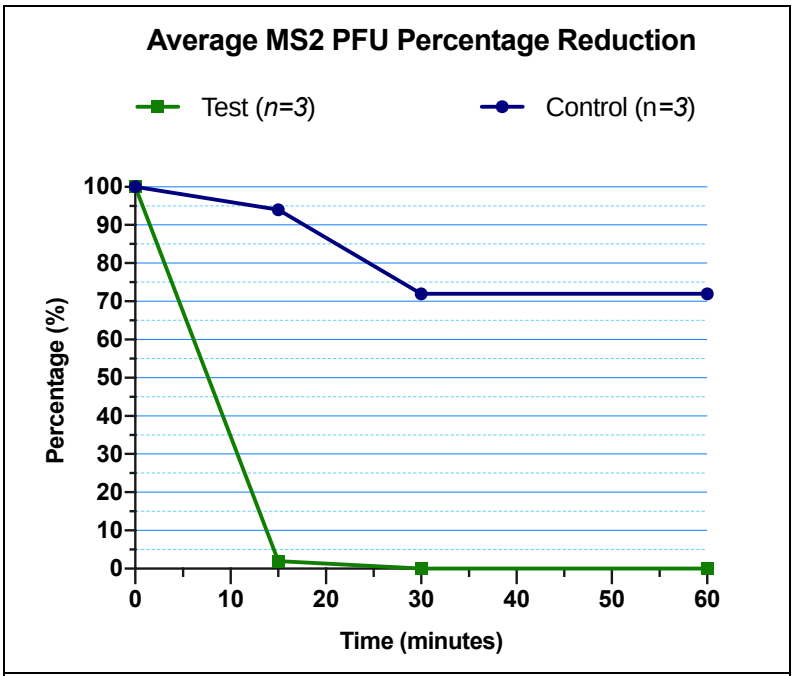


**Figure 5.2.** Average percentage reduction of MS2 PFU/m$^3$ of air over time. Graph is calculated from data points in appendix Tables 8.1 and 8.2

## 6. Discussion

Our environmental test chamber assessment demonstrated that, when challenged with MS2, the MedicAir FOZKYGB-04 air purifier could reduce the average airborne concentration of the virus from 8.2 to 4.0 $Log_{10}$ PFU/m$^3$ after 60 minutes of operation. A reduction was observed in each of the triplicate active test runs.

The triplicate inactive control runs (no air purifier) did not show the same scale of reduction, the average concentration of MS2 decreased from 9.7 to 9.5 $Log_{10}$ PFU/m$^3$.

Calculating the percentage reduction based on the PFU/m$^3$ results there was a greater than 99.9% reduction of airborne MS2 within 20 - 30 minutes of the air purifier operating.

## 7. References


1) Tung-Thompson G, Libera DA, Koch KL, de los Reyes FL III, Jaykus L-A (2015) Aerosolization of a Human Norovirus Surrogate, Bacteriophage MS2, during Simulated Vomiting. PLoS ONE 10(8): e0134277. hiips://doi.org/10.1371/journal.pone.0134277

2) G.W. Park, K.G. Linden, M.D. Sobsey (2010) Inactivation of murine norovirus, feline calicivirus and echovirus 12 as surrogates for human norovirus (NoV) and coliphage (F+) MS2 by ultraviolet light (254 nm) and the effect of cell association on UV inactivation. Letters in Applied Microbiology (Volume 52, Issue 2, Pages 162-167). hiips://doi.org/10.1111/j.1472-765X.2010.02982.x

3) Jung Eun Lee, GwangPo Ko (2013) Norovirus and MS2 inactivation kinetics of UV-A and UV-B with and without TiO2. Water Research (Volume 47, Issue 15, Pages 5607-5613). hiips://doi.org/10.1016/j.watres.2013.06.035


## 8. Appendix

| *Time (minute)* | Table 8.1. Average PFU/m$^3$ recovered from test run samples | | | | |
|---|---|---|---|---|---|
| | Test 1 | Test 2 | Test 3 | Average | % Reduction |
| 0 | 115,151,515 | 224,242,424 | 113,787,879 | **115,151,515** | N/A |
| 15 | 4,469,697 | 2,060,606 | 3,681,818 | **4,469,697** | 97.7 |
| 30 | 66,667 | 21,212 | 65,152 | **66,667** | >99.9 |
| 60 | 1,515 | 18,182 | 4,545 | **1,515** | >99.9 |

| *Time (minute)* | Table 8.2. Average PFU/m$^3$ recovered from control run samples | | | | |
|---|---|---|---|---|---|
| | Control 1 | Control 2 | Control 3 | Average | % Reduction |
| 0 | 90,117,994 | 14,132,475,194 | 160,766,962 | **4,794,453,383** | N/A |
| 15 | 91,445,428 | 13,301,153,124 | 90,265,487 | **4,494,288,013** | 6.3 |
| 30 | 39,233,038 | 10,297,666,935 | 37,463,127 | **3,458,121,033** | 27.9 |
| 60 | 35,840,708 | 10,351,300,617 | 36,725,664 | **3,474,622,329** | 27.5 |

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***End of Report***