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Characterization of a Hydrogen Peroxide Photocatalytic Active Pathogen Scavenging Device in Deactivation of Aerosolized SARS-CoV-2

Summary of Report

FOR

Hi-Tech Air and Water Purification Systems, LLC

Independent Testing Oversight and Review
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Research Subject Matter Expert

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Preface

This Report was prepared at MRIGlobal for the work performed under MRIGlobal Task No. 311737.01.001, "Characterization of a Hydrogen Peroxide Photocatalytic air infusion Active Pathogen Scavenging Device in Deactivation of Aerosolized SARS-CoV-2."

The experimental phase of this task was initiated by MRIGlobal on April 1, 2021 and ended on April 8, 2021.

All operations pertaining to this study, unless specifically defined in this protocol, were performed according to the Standard Operating Procedures of MRIGlobal, and any deviations were documented.

In preparation of this summary of the final report, no data has been altered and no conclusions have been altered or omitted. Changes were made only for brevity and clarity.

Final testing report can be requested through our web page at www.cimrtech.com.

All testing records are stored at MRIGlobal.

Executive Summary

Background:

The objective of this project was to measure the efficiency of an innovative air infusion Hydrogen Peroxide photocatalytic converter to generate an Active Pathogen Scavenging air purification system known as "Continuous Infectious Microbial Reduction" (CIMR). The CIMR Technology was developed and refined by Alton Holt, Founder of Hi-Tech Air & Water Purification Systems (2004). The CIMR Technology incorporates a design that utilizes a photocatalytic process for the deactivation of biological aerosols (in the air) and against surface risks (surface deactivation was not tested in this test). The ultra-low level of Hydrogen Peroxide produced by the CIMR device is self-regulating at .02 ppm replicating the real application of CIMR use indoors for the deactivation of a wide range of pathogens. CIMR is designed to be effective for air and surface disinfection from small rooms to very large auditoriums/stadiums by using in CIMR devices integrated into existing duct work in existing HVAC and/or CIMR portable units.

CIMR's Active Pathogen Scavenging Technology Test Device challenges were conducted in a primary aerosol containment system with a Class III biological safety cabinet. The CIMR Test Device is designed to be effective for air disinfection in room environments using an internal blower to deliver hydrogen peroxide at 0.02 ppm into the treated space. MRIGlobal tested the CIMR Test Device (without the aid of any ionization nor using or producing any ozone) to evaluate the effectiveness in inactivating and eliminating an envelope virus (SARS-CoV-2 Washington State Isolate Strain). ALL TEST measurements are relative to CONTROL, i.e., all reported effectiveness takes no credit for decay in live virus that occurs naturally that was observed on the CONTROL testing and only measures the virus inactivation impact of the CIMR device.

Objectives

The objective of this project was to measure the efficacy of Hi-Tech's CIMR's Active Pathogen Scavenging Technology in the deactivation of aerosolized SARS-CoV-2 replicating REAL WORLD CONDITIONS

- During interval 1, our objective was to measure CIMR effectiveness of eliminating viral load in real time while in close proximity to highly infected individuals. During Interval 1 test, virus was injected at heavy concentration throughout the measurement interval while CIMR was producing .02 PPM hydrogen peroxide (There was no over H2O2 concentration, no ionization device, and without using nor creating any ozone).

- During Intervals 2 and 3 we stopped nebulization/injection of SARS-CoV-2 and continued to measure CIMR effectiveness (at .02 PPM) in clearing the virus. Our objective was to measure CIMR's efficacy and speed of deactivating and eliminating virus in a room.

Test Units

The CIMR device tested is an air infusion photocatalytic low level hydrogen peroxide generator. Continuous Infectious Microbial Reduction (CIMR) Active Pathogen Scavenging Technology cells developed by Alton Holt, Hi-Tech Air and Water Purification Systems, LLC.

Study Design

Aerosol testing was performed using an aerosol test system fabricated out of Plexiglas. The test system was housed in the Class III Biosafety Cabinet for all conducted tests. The aerosol containment system has internal dimensions of 2.5ft high × 3.5ft wide × 1.5ft deep, with a displacement volume of approximately 370 liters or 13.1 cubic feet. The bio-aerosol test system is fabricated for nebulizer adaptation, aerosol and sample dilution air displacement filtration, air supply regulation and control, exhaust flow regulation, aerosol sampling, particle size measurement, and temperature and humidity monitoring. Aerosol generation and sampling system pressures and flow rates were monitored and controlled for maintaining reproducible test conditions using calibrated digital mass flow meters and controllers. Additional equipment included a system humidification with remote control operation. SARS-CoV-2 aerosol nebulizer generation was provided with flow and pressure regulated tank supplied breathing grade air. A diagram of the aerosol test system is shown in Figure 1. Three Control runs and three separate Test runs were undertaken over two consecutive days.

The test chamber was pre-treated with CIMR generated hydrogen peroxide plasma at .02 PPM for 10 minutes stabilizing at .02 PPM, and then tested over 3 intervals in order to evaluate the following:

- For the period zero (0) to ten (10) minute interval, both CIMR Test Device and active nebulization injection of high concentration of virus were active, this period is intended to test CIMR effectiveness, relative to control, against high levels of virus continuing to be nebulized into the air

- During eleven (11) to twenty-one (21) minute interval, with nebulization stopped and the CIMR Test Device continuing to be active, the objective was to measure CIMR effectiveness to inactivate and eliminate the virus after virus was no longer actively spread

- During the twenty-two (22) to thirty-two (32) minute period interval, virus nebulization still stopped and the CIMR Test Device active to measure CIMR continued ability to inactivate virus relative to Control measurements

ALL Test results are reported relative to Control runs and deactivation was solely attributable to CIMR technologies impact.

Results

First Interval – Continuous Heavy Nebulization of Virus - CIMR Active

The result relative to control indicates that CIMR is deactivating and eliminating 90.98% of active virus in real time during continuous virus introduction throughout the period

Second Interval – Nebulization stopped - CIMR Active

The result relative to control indicates that CIMR is deactivating and eliminating active virus at 99.81% after the virus injection has stopped

Third Interval – Nebulization stopped - CIMR Active

The result relative to control indicates that CIMR continues deactivating and eliminating virus at 96.67% even when virus levels are very low

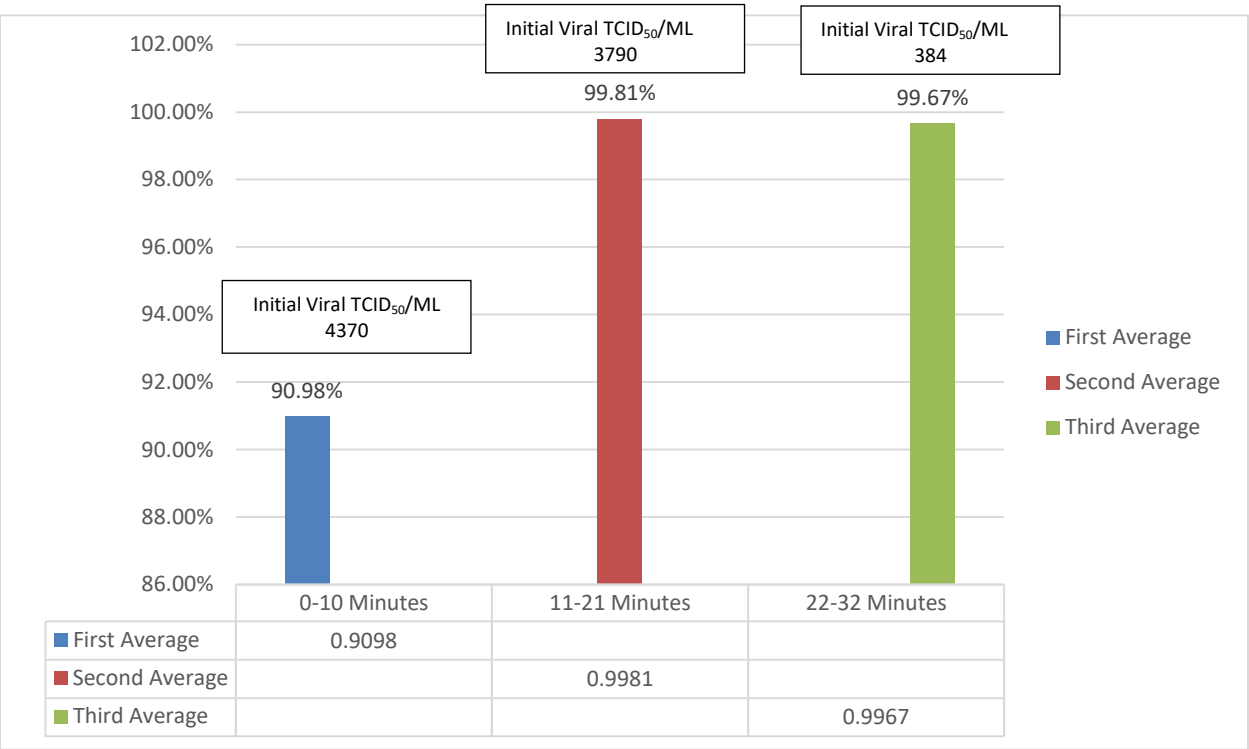
Aerosol plates were read four days after testing. The Test Device reduced viral infectivity by 1.04 log (90.98%), 2.71 log (99.81%) and 2.48 log (99.67%) for the 0-to-10 minute (during ongoing nebulization of virus continuously with CIMR on), 11-to-21-minute (with CIMR on and nebulization off), and 22-to-32-minute (with CIMR on and nebulization off) Test Device exposure time periods respectively compared to baseline control standard tests. Table 1 and Figure 1 summarize these findings.

Table 1. $TCID_{50}$/ml Calculations for aerosol testing

Sample Name	Test Description	Test Replicate	Sample Interval	Samples Interval Time (min)	TCID50/ml	Log10 TCID50/ml	Avg TCID50/ml	Avg Log10 TCID50/ml	Log10 Reduction	Percent Reduction
C1-1	Control	1	1	0-10	4.32E+03	3.64	4.37E+03	3.58	N/A	
C2-1		2			7.01E+03	3.85				
C3-1		3			1.76E+03	3.25				
C1-2		1	2	11-21	5.16E+02	2.71	3.79E+03	3.34		
C2-2		2			8.47E+03	3.93				
C3-2		3			2.39E+03	3.38				
C1-3		1	3	22-32	5.16E+02	2.71	3.84E+02	2.57		
C2-3		2			2.85E+02	2.46				
C3-3		3			3.51E+02	2.55				
T1-1	Test	1	1	0-10	5.16E+02	2.71	3.61E+02	2.53	1.04	90.98%
T2-1		2			2.16E+02	2.34				
T3-1		3			3.51E+02	2.55				
T1-2		1	2	11-21	5.16E+00	0.71	4.27E+00	0.63	2.71	99.81%
T2-2		2			4.14E+00	0.62				
T3-2		3			3.51E+00	0.55				
T1-3		1	3	22-32	1.11E+00	0.05	1.40E+00	0.09	2.48	99.67%
T2-3		2			2.39E+00	0.38				
T3-3		3			7.01E-01	-0.15				

Figure 1 – CIMR Percent Deactivation vs Control

[$TCID_{50}$/ML Initial Values]

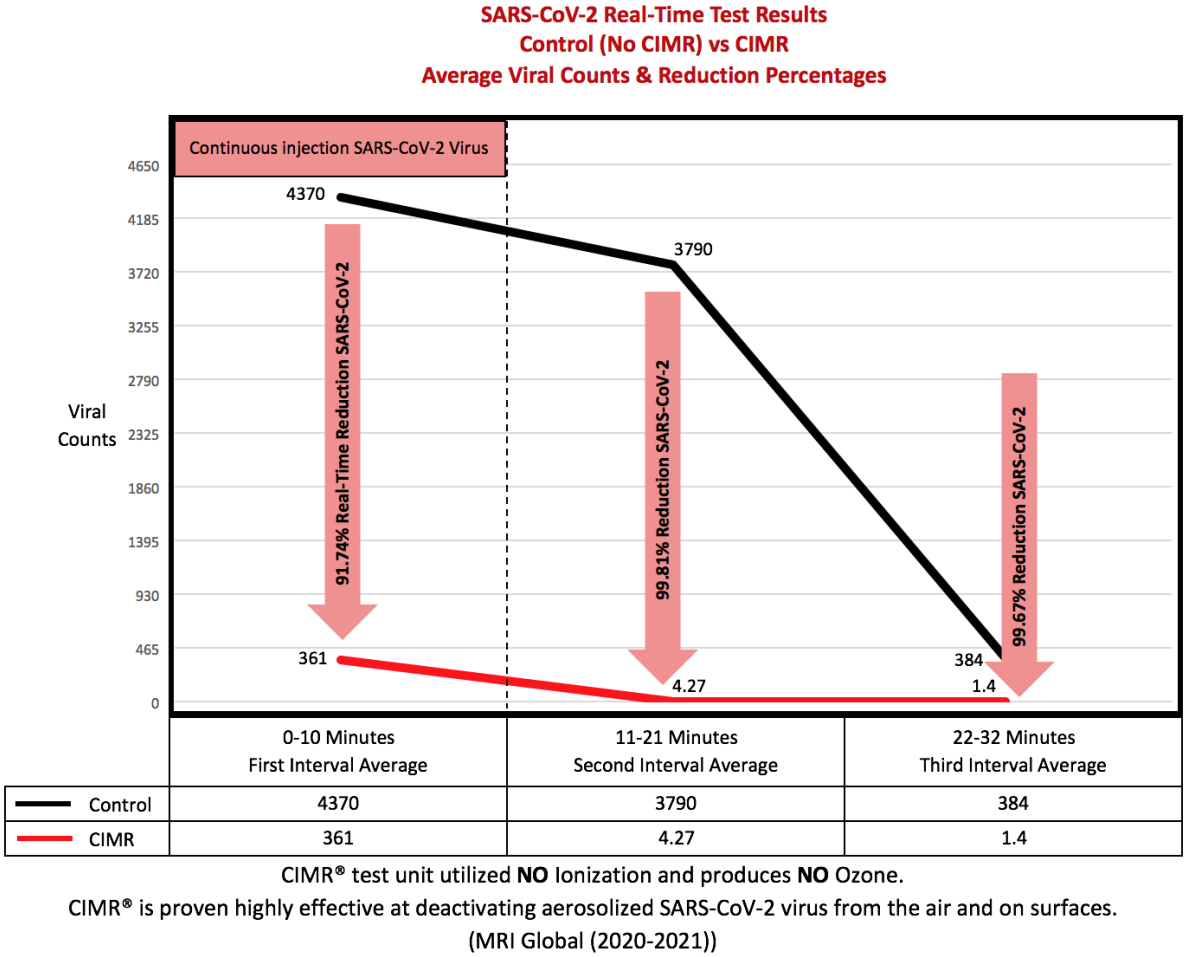


Conclusions

Based on this testing protocol, that the CIMR Device is very effective at deactivating and eliminating aerosolized SARS-CoV-2 virus from the air. The CIMR technology reduced viral infectivity relative to control by (Figure 2):

- 90.98% virus elimination during the first interval of zero (0) to ten (10) minutes, the period when both CIMR Test Device and active nebulization injection of high concentration of virus were active
- 99.81% virus elimination during the eleven (11) to twenty-one (21) minute interval during the second interval, with nebulization off and the CIMR Test Device active, and
- 99.67% virus elimination during the twenty-two (22) to thirty-two (32) minute sample times respectively with the CIMR Test Device active

Figure 2 - CIMR reduced viral infectivity relative to control



CIMR® test unit utilized **NO** Ionization and produces **NO** Ozone.
CIMR® is proven highly effective at deactivating aerosolized SARS-CoV-2 virus from the air and on surfaces.
(MRI Global (2020-2021))

The test result percent log reduction values are calculated based on comparative analysis of viral sample concentrations at each sample time point for Control vs CIMR Test Device trials. The CIMR Test Device showed similar viral deactivation results at the eleven (11) to twenty-one (21) minutes, and twenty-two (22) to thirty-two (32) minute test time points. This can be attributed to a reduction of control sample natural decay viability and a limitation in sample concentration yield at the later test collection time points of the baseline control standard results as seen on Figure 1.

Theoretically, it can be inferred that the technology would have a greater reduction with increased viral aerosol exposure time which could not be precisely quantified based on experimental limitations.