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3AC., LTD.

TEST REPORT

SCOPE OF WORKS
EVALUATION OF AIR FILTER ANTIVIRAL EFFICIENCY PERFORMANCE TEST IN A CONTINUOUS AIR CONDITION

REPORT NUMBER
RT20E-S0004

ISSUE DATE
18-MAR-2020

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TEST REPORT FOR 3AC CO., LTD.

Report No.: RT20E-S0004
Date: 18-MAR-2020

OBJECTIVE

The purpose of the testing is:
To evaluate the antibacterial efficacy of air filter in a continuous airflow condition.

HYPOTHESIS

The antiviral air filter can remove more than 99.9 % of the viruses in a continuous airflow condition.

CONCLUSION

Based on the data collected the Hypothesis is accepted:

The antiviral air filter can remove more than 99.9 % of the viruses in a continuous airflow condition.

Suyeon Park		Bo Park	
ENGINEER		**REVIEWER**	

CONDUCTED BY	3AC CO., LTD.
WITNESSED BY	INTERTEK TESTING SERVICES KOREA LTD.
PERIOD OF TEST	24 FEB 2020 ~ 28 FEB 2020
DATE OF ISSUE	18 MAR 2020

PRODUCT INFORMATION :

PRODUCT : TRI CARE FILTER

LABORATORY INFORMATION

NAME	YONSEI UNIVERSITY
ADDRESS	A487, 1st Engineering Building, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul , Korea
TECHNITION	Dae Hoon Park

WITNESS INFORMATION

NAME	INTERTEK TESTING SERVICES KOREA LTD.
ADDRESS	Intertek Testing Services Korea Ltd. 4/F, A-JU Digital Tower, 7, Achasan-ro 5 –gil, Seongdong-gu, Seoul, Korea
TECHNICAL MANAGER	Suyeon Park
LABORATORY DIRECTOR	Bo Park

SECTION 1
INDEX

SECTION 2
OBJECTIVE

The purpose of the testing is:

To evaluate the antiviral efficiency of air filter in a continuous airflow condition.

SECTION 3
PARAMETERS

The following parameters are controlled

VALUE	DESCRIPTION	UNITS	METHOD	MU
23±5	Test room temperature	°C	Thermo-hygrometer	± 0.5 °C (Approx. 95 %, k=2)
50±30	Test room humidity	% R.H.	Thermo-hygrometer	± 2.3 % R.H. (Approx. 95 %, k=2)
37±5	Test incubated Temperature	°C	Thermo-hygrometer	± 0.8 °C (Approx. 95 %, k=2)
24	Test incubated time	hrs	Timer	± 1% (Approx. 95%, k=2)
37±5	Shaking incubated Temperature	°C	Thermo-hygrometer	± 0.8 °C (Approx. 95 %, k=2)
24	Shaking incubated Time	hrs	Timer	± 1% (Approx. 95%, k=2)
ϕ 1cm pieces	Dimension	cm	Ruler	± 0.007 mm (Approx. 95%, k=2)

The following parameters are monitored

VALUE	DESCRIPTION	UNITS	METHOD	MU
23±5	Test room temperature	°C	Thermo-hygrometer	± 0.5 °C (Approx. 95 %, k=2)
50±30	Test room humidity	% R.H.	Thermo-hygrometer	± 2.3 % R.H. (Approx. 95 %, k=2)
37±5	Test incubated Temperature	°C	Thermo-hygrometer	± 0.8 °C (Approx. 95 %, k=2)
24	Test incubated time	hrs	Timer	± 1% (Approx. 95%, k=2)
37±5	Shaking incubated Temperature	°C	Thermo-hygrometer	± 0.8 °C (Approx. 95 %, k=2)
24	Shaking incubated Time	hrs	Timer	± 1% (Approx. 95%, k=2)
ϕ 1cm pieces	Dimension	cm	Ruler	± 0.007 mm (Approx. 95%, k=2)

SECTION 4
SAMPLE ACQUISITION

Samples prepared by 3AC Co., Ltd.:

Sample #	Description	Serial #	Purchase Location	Date	Condition
1	Tri Care Filter	-	prepared by 3AC	-	Packaged and undamaged

SECTION 5
HYPOTHESIS

The antiviral air filter can remove more than 99.9 % of the viruses in a continuous airflow condition.

SECTION 6
EQUIPMENT LIST

#	EQUIPMENT DESCRIPTION	MANUFACTURER'S NAME / MODEL # / SERIAL #	CALIBRATION DATE	CALIBRATION DUE	RANGE USED
1	Auto clave	Coretech / CT-DAC 60	-	-	-
2	Incubator	VISION SCIENTIFIC / VS-1203P4S	2020-02-17	2021-02-16	(15 ~ 45) °C
3	Shaking Incubator	SEJONG Plus	2020-02-17	2021-02-16	(15 ~ 45) °C
4	Biological Safety Cabinet #1	KUMKANGENG Inc. / Class Ⅱ, Type A	2019-12-13	2020-12-12	-
5	Biological Safety Cabinet #2	Customized / Class Ⅱ, Type A	2019-12-13	2020-12-12	-
6	Thermometer	Testo/435	-	-	(-50 ~ +150) °C
7	Hydrometer	Testo/435	-	-	(0 ~ 100) % R.H.
8	Pipet (1000)	AXYGEN	2020-02-21	2021-02-20	(100 ~ 1000) µL
9	Pipet (200)	AXYGEN	2020-02-21	2021-02-20	(20 ~ 200) µL
10	Deep-freezer	NIHON FREEZER CO.,LTD.	-	-	(-70 ~ -30) °C
11	Water bath	Coretech / HQ-DW11	-	-	-
12	Clean air supply system	CSI Tech	-	-	-
13	Atomizer	TSI/9302	-	-	-
14	Diffusion dryer	CSI Tech	-	-	-

Note: The equipment measurement uncertainty is stated in the Test Procedure.

SECTION 7
TECHNICAL STAFF

#	Staff Name	Area of Expertise
1	Dae Hoon Park	Engineer / Yonsei University.
2	Suyeon Park	Technical Manager / Intertek Testing Korea Ltd.
3	Rody Ju	Technical Manager / Intertek Testing Korea Ltd.
4	Bo Park	Laboratory Director / Intertek Testing Korea Ltd.
Note: Complete training records for staff are available upon request		

Testing was conducted at:

YONSEI UNIVERSITY
A487, 1ST Engineering Building, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 120-749, Korea
Maetan 3-dong, Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea

Witnessed by : Rody Ju, Suyeon Park

SECTION 8
TEST PROCEDURE

1. Preparation of host bacterial solution**:**

1.1 The bacteriophage MS2 virus (ATCC 15597-B1), and *Escherichia coli* strain C3000 (ATCC 15597) were used as test virus and host bacteria, respectively.

1.2 In order to restore the bacterial cells from the deep-freezer, 10 mL of tryptic soy broth (TSB) was injected into the freeze-dried cells and the mixture was shaken and incubated for 24 h at 37°C in the shaking incubator. (150-200 rpm)

1.3 0.1 mL of incubated bacterial solution was injected into the 10 mL of TSB, and the mixture was used as a host bacterial solution after additional shaking incubation for 6 h at 37°C

*** Before experiments, all equipment/sample/solution should be auto-claved for 15 min at 121°C.

2. Preparation of virus solution:

2.1 0.1 mL of the freeze-dried MS2 virus was diluted with 50 mL deionized water (DI water), and the solution was used as a virus solution.

3. Filtration of virus particles:

3.1 The virus solution was aerosolized by an atomizer in 2 LPM of compressed clean air from a clean air supply system.

3.2 Aerosolized virus particles entered the test duct, in which a fabricated filter was installed, through a diffusion dryer in order to remove any moisture.

3.3 The aerosolized virus particles were deposited onto an air filter sample for 15 ~ 30 minutes at standard atmospheric conditions and relative humidity.

4. Elution of virus particles:

4.1 Urea-arginine phosphate buffer (U-APB) solution was prepared by adding 0.9 g of urea, 0.4 mL of 0.2 M NaH_2PO_4, and 0.5 M L-arginine into 10 mL of DI water.

4.2 The filter sample was placed into the solution for 10 minutes.

5. Incubation of viruses :

5.1 Then 0.1 mL of the solution was dissolved in 0.9 mL of DI water, and the number of plaques in the solution was counted with a single agar layer method.

5.2 0.1 ml of the solution was mixed with 0.3 mL of host bacterial solution and 29 mL of soft tryptic soy agar (TSA) which was maintained at 48 ~ 50 °C in a water bath. Then the mixture was poured into the petri-dish and incubated overnight at 37 °C.

*** Before experiments, all equipment/sample/solution should be auto-claved for 15 min at 121°C.

6. Calculation

6.1 Plaque forming unit (PFU) counting: After overnight incubation at 37°C, the number of plaques was counted. Finally, the overall anti-viral efficiency was calculated using the following equation;

Percent reduction = [(a-b)/a] x 100

Where:
a = the plaque number of virus detected after passing through the untreated filter(PFU/ml)
b = the plaque number of virus detected after passing through the tri care filter(PFU/ml)

** The preferable counting range on a Soft TSA is 30-300 colonies.*

SECTION 9

TEST RESULT

Repeat #1	PFU/mL			
	1st	2nd	3rd	Average
Untreated Filter	1660	1700	1770	1710
Tri Care Filter	0	0	0	0
% reduction	99.9			

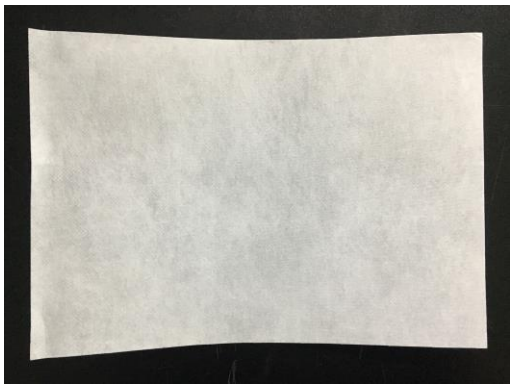
SECTION 10

Conclusion

Based on the data collected the Hypothesis are accepted:

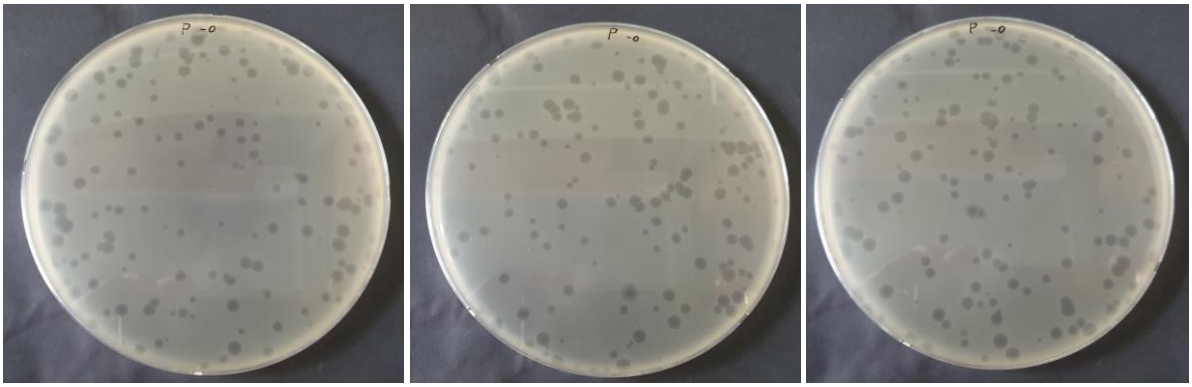
The antiviral air filter can remove more than 99.9 % of the viruses in a continuous airflow condition.

Appendix I. Photo of sample



<Tri Care Filter>

Appendix II. Test image



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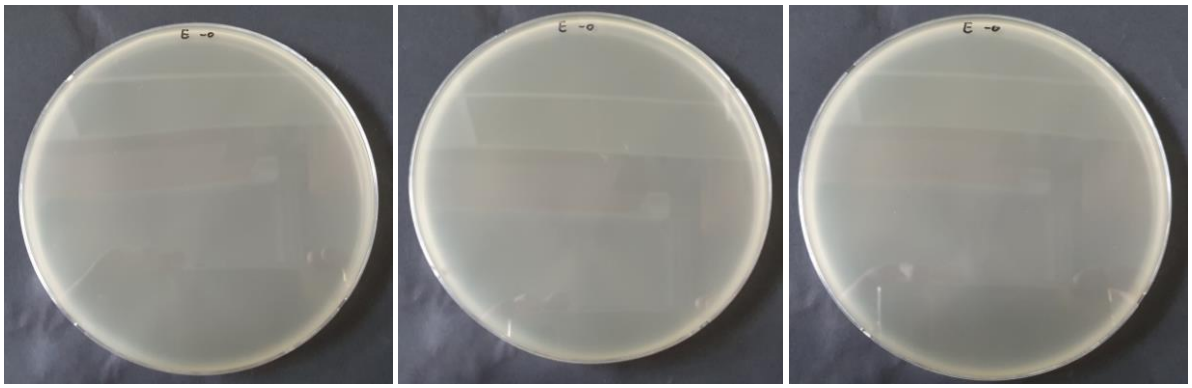

< Tri Care Filter >