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MOLEKULE INC.
TEST REPORT

SCOPE OF WORK
VOC Emissions on Part C Test 1

REPORT NUMBER
103658037GRR-002

ISSUE DATE
18-October-2018

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TEST REPORT FOR MOLEKULE INC.

Report No.: 103658037GRR-002
Date: 18-October-2018
P.O.: 199E

SECTION 1
CLIENT INFORMATION

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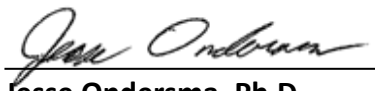

Jesse Ondersma, Ph.D.
Project Reviewer

SECTION 2
SUMMARY AND CONCLUSION

Date Received:	17-August-2018
Dates Tested:	21-September-2018 to 25-September-2018

DESCRIPTION OF SAMPLES

Part Name:	Part C Test 1
Filter Batch Code:	2078D
Model ID:	MH1M-LHA180525-001974
Manufacturer / Location:	Not Specified
Date of Manufacture:	Not Specified
Materials Submitted:	One (1) Filter Unit
Condition of Samples:	Not Specified
Shipping Condition:	Good Condition
Sample ID:	GRR1808170004

WORK REQUESTED/APPLICABLE DOCUMENTS

VOC Reduction Testing:	ISO 16000-3, ISO 16000-6 Referencing NRCC-54013
Intertek Quote:	Qu-00920629

SAMPLE DISPOSITION

At the completion of testing, samples were returned to Molekule Inc.

SECTION 3
VOC EMISSIONS ANALYSIS

Date Received:	17-August-2018
Dates Tested:	21-September-2018 to 25-September-2018

DESCRIPTION OF SAMPLES:

Part Name:	Part C Test 1
Filter Batch Code:	2078D
Model ID:	MH1M-LHA180525-001974
Manufacturer / Location:	Not Specified
Date of Manufacture:	Not Specified
Materials Submitted:	One (1) Filter Unit
Condition of Samples:	Not Specified
Shipping Condition:	Good Condition

TEST PROCEDURE:

Test Method:	Modified NRCC-54013 (04-2011)
Number of Samples:	One (1)

TEST SUMMARY:

The emissions testing were performed according to modified NRCC-54013 “Method for testing portable air cleaners”. The unit was turned off and placed in the testing chamber. The chamber was sealed and purged for a minimum of 6 air exchanges to remove lab air. A photograph of the tested sample is included herein. Air samples were collected prior to the sample being placed in the chamber (Blank), with the sample turned off within the chamber (OFF). The challenge chemicals (formaldehyde, toluene, and d-limonene) were injected and allowed to circulate for 2 hours during which an air sample was taken, time 0 h. Once the device was turned on air samples were taken at (0 h), and at 4, 6, 24, 26, 28, 48, 50, and 52 h after turning the unit on.

Samples analyzed for toluene, d-limonene, individual VOCs, and TVOC were collected on multi-sorbent tubes containing glass wool, Tenax TA 35/60 and Carbograph 5 TD 40/60 with an air flow rate of 200 mL/min. These VOC samples were analyzed by thermal desorption-gas chromatography/mass-spectrometry, TD-GC/MS. $TVOC_{Toluene}$ represents the total of all identified and unidentified VOCs between n-C6 and n-C16 as measured by the GC/MS TIC method with an integration cutoff of 0.2 µg/m3 and expressed as a toluene equivalent value as defined in ISO 16000-6. Individual VOCs were calculated using calibration curves based on pure standards or based on toluene equivalent.

Samples analyzed for analyzed for low molecular weight carbonyls were collected on cartridges treated with 2,4-di-nitrophenylhydrazine (DNPH) and were analyzed using high performance liquid chromatography, HPLC. Individual VOCs were calculated using calibration curves based on pure standards.

TEST NOTES OR DEVIATIONS:

Testing performed without deviation unless noted below.

TEST PARAMETERS:

Table 1: Sample and Chamber Conditions During Test Period

PARAMETER	SYMBOL	VALUE	UNITS
Sample Loading	A	1	Unit
Chamber Volume	V	8.3	m^3
Inlet Air Flow Rate	Q	0.15	$m^3 h^{-1}$
Air Change Rate	ACH	0.018	h^{-1}
Testing Duration	t	52	h
Average Temperature (Range)	T	24.2 (23.4-24.4)	°C
Average Humidity (Range)	RH	53.7 (47.7-59.0)	% RH

TEST RESULTS:

Table 2: Carbonyl Emissions Determined by HPLC (µg/m³)

CHEMICAL	CAS #	BLANK	OFF	MDL	MQL
Formaldehyde	50-00-0	BDL	1.4	**0.6**	**1.7**
Propanal	123-38-6	1.0	0.4	**0.3**	**0.9**
Butanal	123-72-8	BDL	BDL	**0.3**	**1.0**
Pentanal	110-62-3	BDL	BDL	**1.2**	**3.5**
Hexanal	66-25-1	BDL	BDL	**0.1**	**0.4**

1 – Blank and DUT off blank collected 30L air sample

Table 3: Continued Carbonyl Emissions Determined by HPLC (µg/m³)

CHEMICAL	CAS #	0 H	0.25 H	0.5 H	0.75 H	1 H	2 H	3 HR	4 HR
Formaldehyde	50-00-0	167.1	118.9	100.9	88.2	76.8	47.4	30.8	25.8
Propanal	123-38-6	BDL	BDL	BDL	BQL	BQL	BDL	BDL	BDL
Butanal	123-72-8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Pentanal	110-62-3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Hexanal	66-25-1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Table 4: Continued Carbonyl Emissions Determined by HPLC (µg/m³)

CHEMICAL	CAS #	24 HR	26 HR	28 HR	48 HR	50 HR	52 HR	MDL	MQL
Formaldehyde	50-00-0	BQL	BQL	BQL	BQL	BQL	BQL	**5.7**	**17.2**
Propanal	123-38-6	BDL	BDL	BDL	BDL	BDL	BDL	**2.9**	**8.6**
Butanal	123-72-8	BDL	BDL	BDL	BDL	BDL	BDL	**3.4**	**10.3**
Pentanal	110-62-3	BDL	BDL	BDL	BDL	BDL	BDL	**11.7**	**35.2**
Hexanal	66-25-1	BDL	BDL	BDL	BDL	BDL	BDL	**0.1**	**0.4**

Table 5: VOC Emissions Determined by GCMS (µg/m³)

CHEMICAL	CAS #	BLANK	OFF	MDL	MQL
Toluene	108-88-3	BDL	BDL	**0.4**	**1.1**
D-Limonene	5989-27-5	BDL	BDL	**0.9**	**2.7**
Tetradecane	629-59-4	3.4	3.4	-	-
Pentadecane	629-62-9	2.5	3.0	-	-
$TVOC_{Toluene}$	-	7.5	7.5	**6.7**	**20.1**

Table 6: Continued VOC Emissions Determined by GCMS (µg/m³)

CHEMICAL	CAS #	0 H	0.25 H	0.5 H	0.75 H	1 H	2 H	3 HR	4 HR
Toluene	108-88-3	730.4	274.8	142.6	73.1	42.4	< 9.5	< 9.5	< 3.2
D-Limonene	5989-27-5	414	135	56.2	25.9	BQL	BDL	BDL	BDL
Tetradecane	629-59-4	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Pentadecane	629-62-9	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
$TVOC_{Toluene}$	N/A	1481	519.9	250.6	104.9	BDL	BDL	BDL	BDL

Table 7: Continued VOC Emissions Determined by GCMS (µg/m³)

CHEMICAL	CAS #	24 HR	26 HR	28 HR	48 HR	50 HR	52 HR	MDL	MQL
Toluene	108-88-3	BDL	BDL	BDL	BDL	BDL	BDL	**3.2**	**9.5**
D-Limonene	5989-27-5	BDL	BDL	BDL	BDL	BDL	BDL	**7.4**	**22.3**
Tetradecane	629-59-4	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	-	-
Pentadecane	629-62-9	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	-	-
$TVOC_{Toluene}$	N/A	BDL	BDL	BDL	BDL	BDL	BDL	**56**	**168**

PHOTOGRAPHS:

Figure 1: Photograph of Molekule air cleaner as loaded in the test chamber.

SECTION 4

FACILITIES AND EQUIPMENT:

TD-GCMS	
INSTRUMENTATION USED:	Markes TD-100 Thermal Desorption Agilent 7890A GC Agilent 5975C MS
COLUMN USED:	Agilent HP-Ultra 2
HPLC	
INSTRUMENTATION USED:	Agilent 1260
COLUMN USED:	Poroshell 120 EC-C18