

CELIOS TEST REPORT

SCOPE OF WORK

VOC Reduction by Model G200

REPORT NUMBER

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TEST REPORT FOR CELIOS CORPORATION

Report No.: 104240789GRR-001

Date: 03-March-2020

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SECTION 1

CLIENT INFORMATION

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SECTION 2

SUMMARY AND CONCLUSION

Date Received: 05-February-2020
Dates Tested: 14-February-2020 to 20-February-2020

DESCRIPTION OF SAMPLES

Part Name: Model G200
Model Number: Not Specified
Manufacturer / Location: Celios Corporation
Materials Submitted: One (1) Filtration Unit & Two (2) Sets of Replacement Filters
Condition of Samples: Not Specified
Shipping Condition: Good Condition

WORK REQUESTED/APPLICABLE DOCUMENTS

VOC Reduction Testing: ISO 16000-3, ISO 16000-6 Referencing NRCC-54013
Intertek Quote: Qu-01030544-4

TEST SUMMARY

The air purifier was challenged with three VOCs representative of what are found in homes: formaldehyde, toluene, and D-limonene.

SAMPLE DISPOSITION

At the completion of testing, samples were returned to Celios Corporation.

SECTION 3**ISO 16000-3, ISO 16000-6 REFERENCING NRCC-54013**

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Dates Tested: 14-February-2020 to 20-February-2020

DESCRIPTION OF SAMPLES:

Part Name: Model G200
Model Number: Not Specified
Manufacturer / Location: Celios Corporation
Materials Submitted: One (1) Filtration Unit & Two (2) Sets of Replacement Filters
Condition of Samples: Not Specified
Shipping Condition: Good Condition

TEST PROCEDURE:

The purpose of this testing is to determine the efficacy of the Celios Corporation to remove challenge VOCs. VOC removal testing was performed referencing NRCC-54013 (April 2011): Method for Testing Portable Air Cleaners sections 3.2 and 5.1.2.

Natural system decay for the challenge chemicals is performed prior to the test. The unit was placed in the center of a chamber which was sealed and flushed with clean air for a minimum of one night. An additional enclosure fan was operated to ensure air mixing. The challenge chemicals (formaldehyde and toluene) were injected and allowed to circulate for 30 minutes during which an air sample was taken. Each challenge chemical was performed using a fresh filter. The system was then turned on using the highest fan speed beginning the test timing.

VOC samples were collected at 5, 10, 15, 20, 25, 30, 45, 60, 90, 120, 180, 240, 300, 360, 420, and 480 minutes after starting the system. Samples analyzed for toluene were collected on multi-sorbent tubes containing Tenax TA. These VOC samples were analyzed by thermal desorption-gas chromatography/mass-spectroscopy, TD-GC/MS. Samples analyzed for formaldehyde 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 was continued for an additional 4 hours to be a total of 8 hours.

TEST PARAMETERS:**Table 1: Chamber Conditions During Test Period**

| PARAMETER | SYMBOL | VALUE | UNITS |
|------------------|-----------------------------|-------|------------------|
| Chamber Volume | V | 30 | m ³ |
| Testing Duration | t | 8 | h |
| Test Conditions | Average Temperature (Range) | T | 23.6 (23.5-23.8) |
| | Average Humidity (Range) | RH | 49.2 (48.9-49.9) |

TEST RESULTS:**Table 2: Concentration of challenge chemical decay through test.**

| Time (min) | Formaldehyde (µg/m ³) | Toluene (µg/m ³) | D-Limonene (µg/m ³) |
|------------|-----------------------------------|------------------------------|---------------------------------|
| 0 | 180 | 835 | 695 |
| 5 | 171 | 792 | 671 |
| 10 | 163 | 705 | 595 |
| 15 | 161 | 675 | 578 |
| 20 | 153 | 650 | 552 |
| 25 | 151 | 616 | 528 |
| 30 | 148 | 605 | 519 |
| 45 | 140 | 488 | 415 |
| 60 | 129 | 431 | 370 |
| 90 | 118 | 301 | 257 |
| 120 | 108 | 210 | 177 |
| 180 | 90 | 103 | 85 |
| 240 | 83 | 52 | 41 |
| 300 | 73 | 23 | 18 |
| 360 | 67 | 9 | < 8 |
| 420 | 59 | < 8 | < 8 |
| 480 | 51 | < 8 | < 8 |

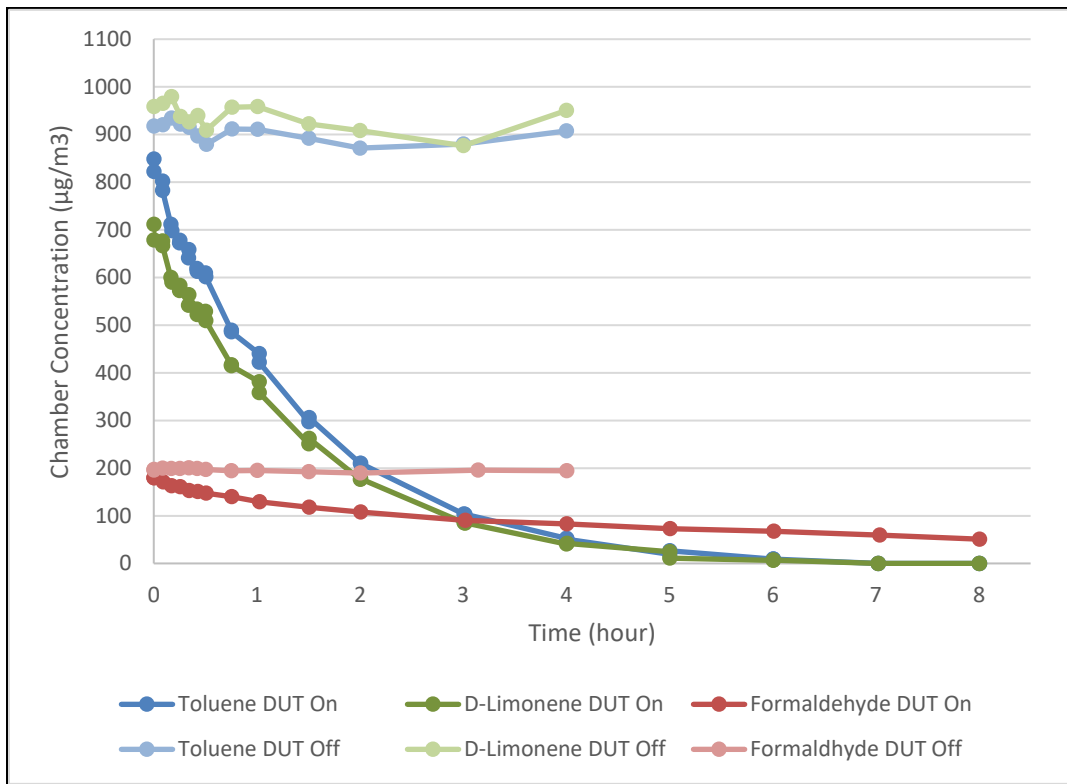


Figure 1: Concentration change throughout test for challenge chemicals

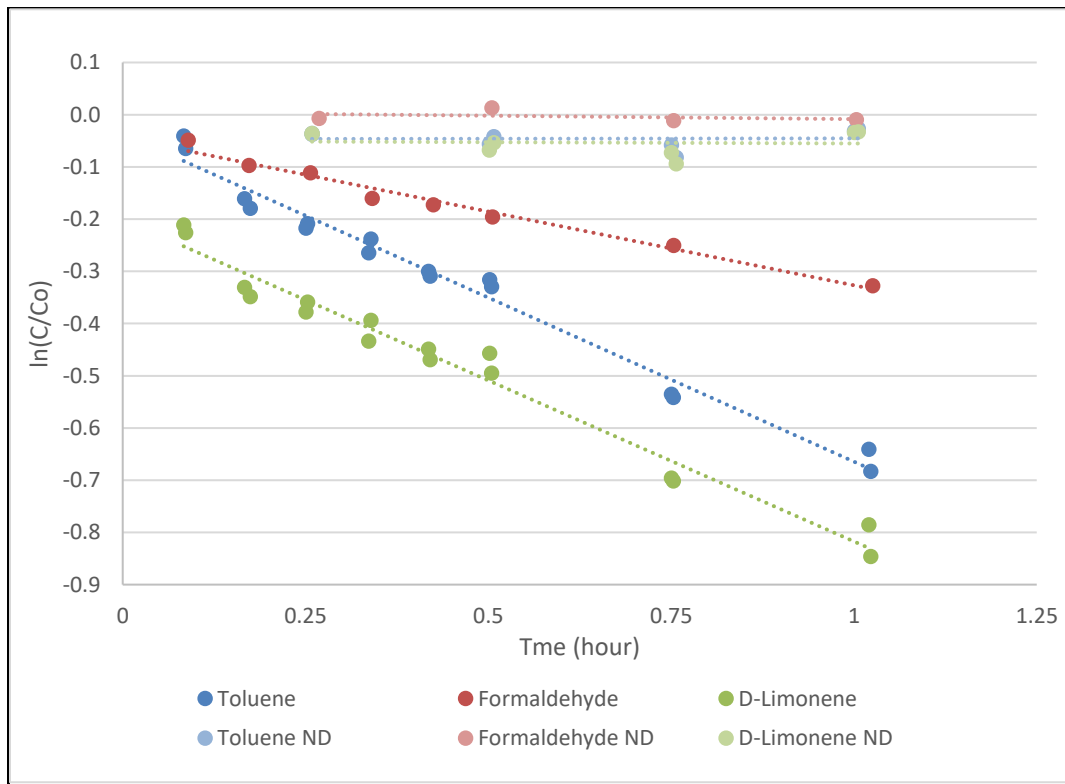


Figure 2: Removal rate of challenge chemicals.

The clean air delivery rate (CADR) is calculated according to equation 1:

$$\ln\left(\frac{C_t}{C_0}\right) = -\left(k_n + \frac{CADR}{V}\right)t \tag{Eq. 1}$$

where:

- C_t : chemical concentration at time t ($\mu\text{g}/\text{m}^3$)
- C_0 : chemical concentration at time t_0 ($\mu\text{g}/\text{m}^3$)
- V : volume of the test chamber (m^3)
- t : time (h)
- $CADR$: Clean Air Delivery Rate (m^3/h)
- k_n : first order decay constant with PAC turned off

The single pass efficiency (SPE) is calculated according to equation 2:

$$SPE = \frac{CADR}{Q} \tag{Eq. 2}$$

where:

- Q : purifier flow rate ($27 \text{ m}^3/\text{h}$).

Table 2: Purifier efficiency – calculation of clean air delivery rate and single pass efficiency.

| VOC | CAS No. | CADR (m^3/h) | SPE (%) |
|--------------|-----------|--------------------------------|---------|
| Formaldehyde | 50-00-0 | 5.6 | 21 |
| Toluene | 108-88-3 | 18.8 | 69 |
| D-Limonene | 5989-27-5 | 18.5 | 68 |

PHOTOGRAPHS:



Figure 3: Photograph of sample as received.

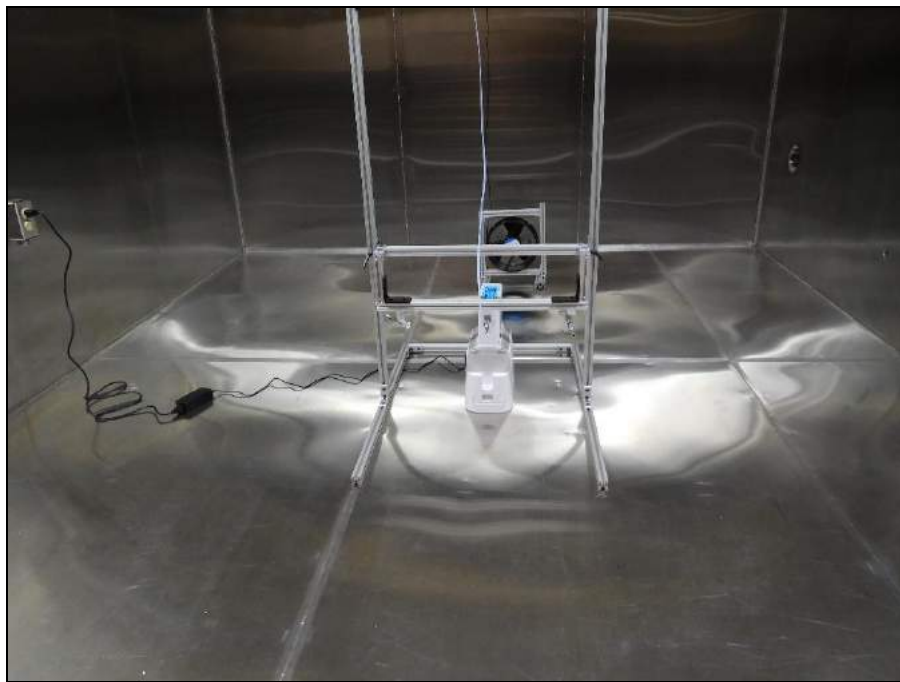


Figure 4: Photograph of sample in testing chamber.

SECTION 4

FACILITIES AND EQUIPMENT:

GCMS

| | |
|-----------------------|---|
| INSTRUMENTATION USED: | Markes TD-100 Thermal Desorption Agilent 7890A GC Agilent 5975C MS |
| COLUMN USED: | Agilent HP-Ultra 2 (GC) |

HPLC

| | |
|-----------------------|------------------------------|
| INSTRUMENTATION USED: | Agilent 1260 Infinity Series |
| COLUMN USED: | Poroshell 120 EC-C18 |