TEST REPORT

Measurement of Ozone (O_3) Leakage of Multi-Purpose Personal Home Sterilizer in Each Use

January 2005

Air Resources Research Center
Korea Institute of Science and Technology (KIST)

KLENZ CO. LTD.

The Letter of the Presentation

Name of Applicant: Representative of KLENZ CO. LTD

We submit this information as the result of required service. (Measurement of Ozone (O_3) Leakage of the Multi-Purpose Personal Home Sterilizer in Each Use)

January 2005

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Organization Performed: Air Resources Research Center, KIST

Contents

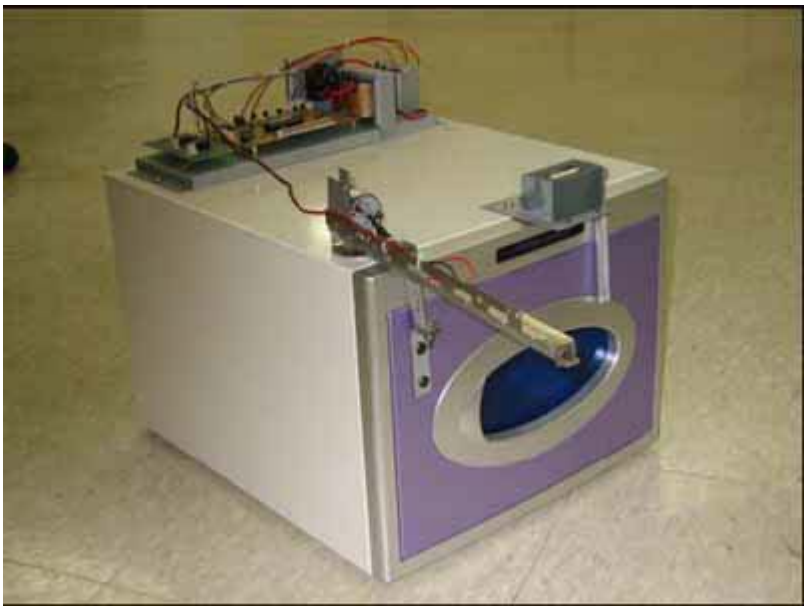
1. Survey

This experiment was performed to measure ozone leakage in each use of the **M**ulti-**P**urpose **P**ersonal **H**ome **S**terilizer (MPPHS) submitted by KLENZ CO., LTD. The objective of the experiment is to see whether ozone leakage from the door and the exhaust port of MPPHS meets the regulation leakage of the ozone density of air purifiers or ozonizers. We made MPPHS operated for 2 hours in $4m^3$ acrylic chamber with nothing affected.

2. Test Installation and Method

a. Test Object.

We selected each of zero-time (no-used), 450-time used, 1,350-time used, 2,000-time used MPPHSs to gauge ozone leakage in each use. We assumed that each MPPHS would be used 10 times a day and that each test object had been used for first day (new), 1.5 months, 4.5 months, and 6.5 months. First, we found frequency of use of MPPHS with a counter attached and then measured ozone leakage of the MPPHSs. Each MPPHS appears in Picture 1. We equipped zero-time used (new) MPPHS with ozone resolution catalyst only. While the door closed for four minutes, it operated to generate ozone for four minutes, and then to automatically open its door over again. On the other hand, we equipped the rest objects (450-time used, 1,350-time used, 2,000-time used MPPHSs) with an active carbon filter as well as an ozone resolution catalyst. While the door closed for eight minutes, the rest objects operated to generate ozone for seven minutes, to let the ozone gas go out of the machines with a fan moving for one minute, and then to automatically open each door repeatedly.

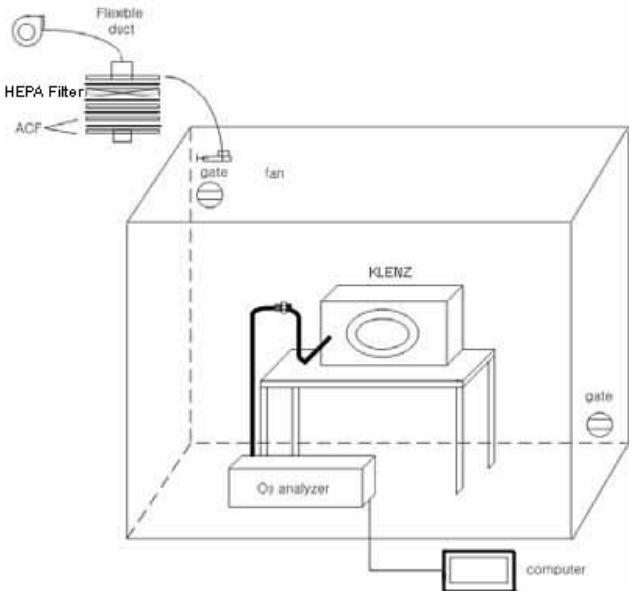


Picture 1. The Multi-Purpose Personal Home Sterilizer

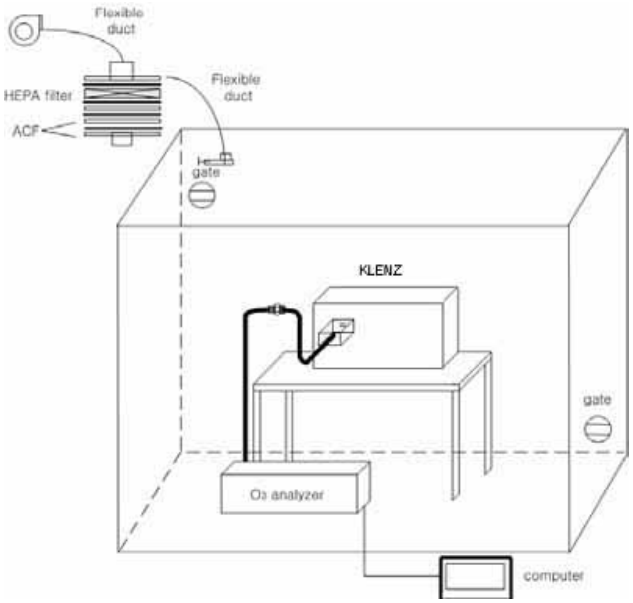
b. Test Installation

As appeared in Picture 2, the test installation consists of a chamber, one set of clear air supply device and an ozone analyzer etc. The chamber is made of acryl and its volume is $4m^3$ (1.4 x 1.4 x 2.0 meters = 55 x 55 x 79 inches)

The clear air supply device provides clean air to the chamber through a fan after removing dirt and particulate using HEPA (High Efficiency Particulate Air) filter and ACF (Activated Carbon Fiber) filter. We measured ozone density coming from a tube of MPPHS after installing the Ozone Analyzer (U.V. Photometric Ambient O_3 Analyzer, Thermo Environmental Instruments Inc., model 401) outside the wall of the chamber. The scope of the ozone analyzer is 0~100 ppb. In addition, Ozone Calibrator (Advanced Pollution Instrumentation, model 401) adjusted the Ozone Analyzer before every use. We made and attached a square duct, which is width 7cm (2.75 inches) and height 5cm (1.96 inches), to the exhaust port in order to measure ozone density. As appeared in Picture 3, we conducted the experiment putting a MPPHS on a table 80cm (31.5 inches) high.



(a) Door



(b) Exhaust Port

Picture 2. Illustration of the Test Installation

(a) Door

(b) Exhaust Port

Picture 3. Actual Description of Test Installation

c. Test method

The experiment of ozone leakage was conducted with the following orders in each use.

① Place a MPPHS at the best position in the chamber.

② Fill the chamber with clean air using the clear air supply device for 30 minutes.

③ Adjust ozone analyzer at the density of 0, 50, 75, 100 ppb three times using ozone calibrator.

④ Check ozone density every 10 seconds inside the chamber for 20 minutes in order to make sure the background density of ozone in the chamber before a MPPHS operates.

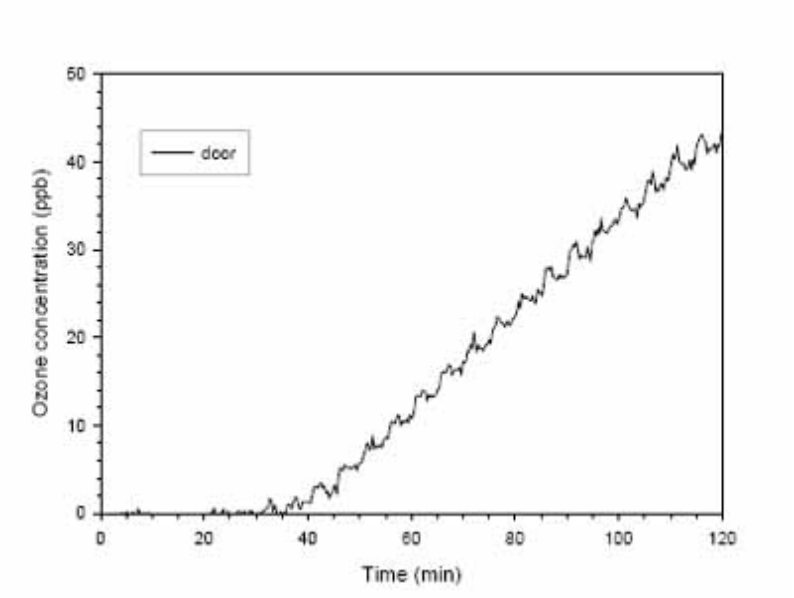
⑤ Measure each ozone density for 2 hours after a MPPHS operates.

3. Test result

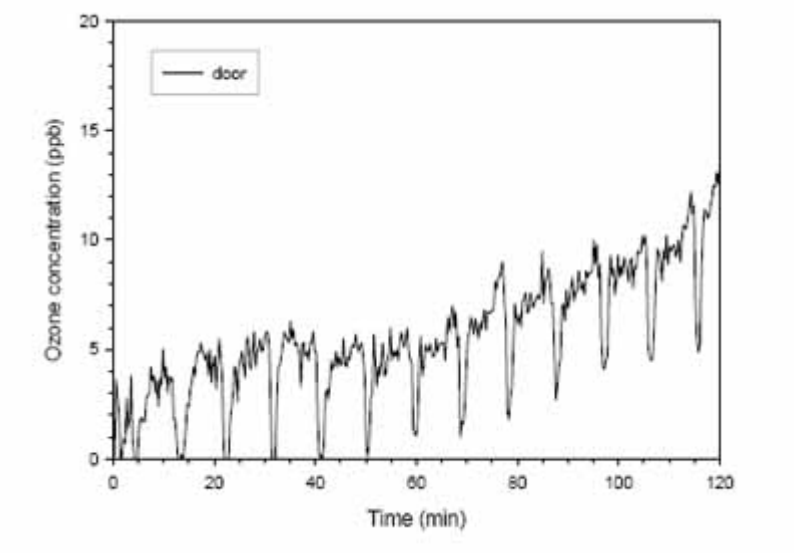
a. Door

After MPPHSs were installed inside the chamber, we measured the change of the ozone density at around the door of the MPPHSs for 2 hours. It appears in Picture 4. Picture 4(a) shows the change of the ozone density of zero-used (new) MPPHS. From the beginning up to 20 minutes, the ozone density indicates the inner density of the chamber when the MPPHS does not operate. As shown in the Picture 4(a), the density is very low under 1 ppb. After 20 minutes, when the new MPPHS operates, ozone begins to be a little bit detected. From the point of 30 minutes, the state of ozone leakage is more remarkable. Since the chamber is shut and the leaked ozone is accumulated, the ozone density increases continuously. After 2 hours, the whole ozone density in the chamber increases over 40 ppb. However, the leaked ozone density was very low, under 5 ppb when the door opened.

Picture 4(b) appears the change of the ozone density of when the 2,000-time used MPPHS operates. We operated the MPPHS from the beginning and the state of the ozone leakage is more remarkable according to operation cycle. In comparison with zero-used MPPHS, the term that ozone leaks increases and the leakage density also a little increases, 5 ppb or so. However, the whole ozone density in the chamber is 5 ppb or so, lower than zero-used MPPHS. That is why 2,000-time used MPPHS is equipped with an active carbon filter as well as an ozone resolution catalyst, whereas new MPPHS is equipped with an ozone resolution catalyst only. It proves that the active carbon filter enhances the power of removing ozone. There is a slight difference in the state of the ozone leakage coming from each door between new and 2,000-used MPPHSs but general ozone leakage is less than 5 ppb that is 1/10 of the regulation (50 ppb) of the ozone leakage of air purifiers or ozonizers.



(a) Zero-Used (New) MPPHS



(b) 2,000-time used MPPHS

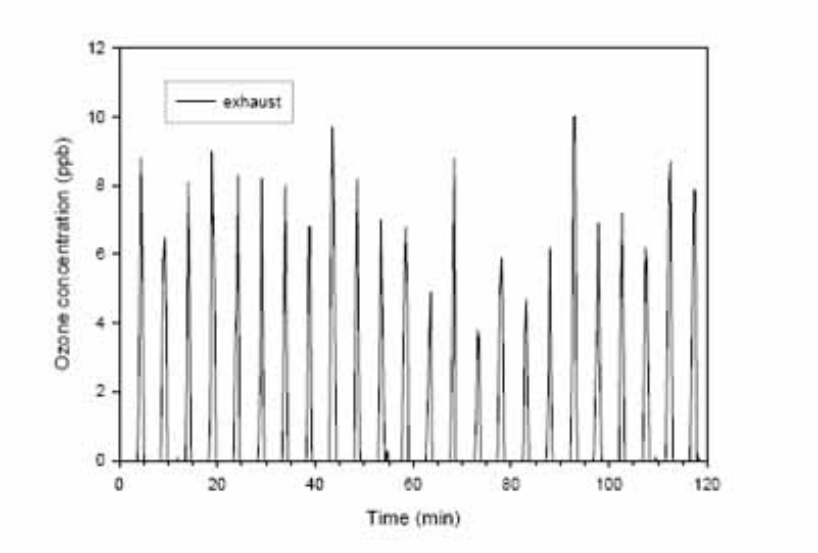
Picture 4. The change of the ozone in the chamber density as time goes on

b. Exhaust port

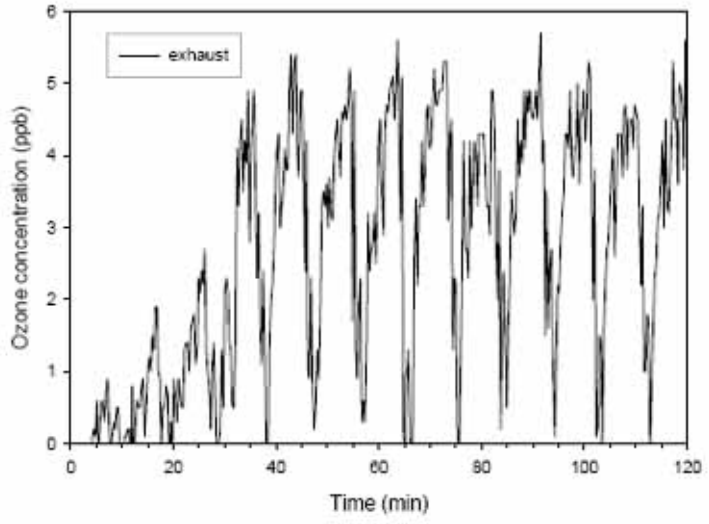
After MPPHSs were installed inside the chamber, we measured the change of the ozone density at around the exhaust port of the MPPHSs for 2 hours. It appeared in Picture 5. Picture 5(a) shows the change of the ozone density of zero-used (new) MPPHS. Ozone is detected regularly less than 10 ppb. Picture 5(b) shows the change of ozone density of 450-time used MPPHS. At the beginning, it leaks low-density ozone and gradually increases, and from the point of 30 minutes, its ozone leakage gets similar with increase. The term that ozone leaks is longer than zero-used (new) MPPHS but leakage density of ozone a little bit decreases less than 6 ppb. That is why 450-time used MPPHS was equipped with an active carbon filter as well as an ozone resolution catalyst, whereas new (no-used) MPPHS was equipped with an ozone resolution catalyst only. It proves that the active carbon filter enhances the power of removing ozone.

Picture 5(c) shows the change of ozone density of 1,350-time used MPPHS. Its state of ozone leakage is less distinct than zero-used (new) and 450-time used MPPHSs. Leakage density of ozone is also lower than 4 ppb. Picture 5(d) shows the change of ozone density coming from 2,000-time used MPPHS. The state of ozone leakage is similar to that of the 1,350-time used MPPHS and ozone density of leakage is also lower than 4 ppb.

There is a slight difference in the state of the ozone density leaked from the exhaust port according to the frequency of use among the 4 kinds of MPPHS. When an MPPHS is equipped with an ozone resolution catalyst only, ozone leakage is less than 10 ppb that is 1/5 of the regulation (50 ppb) of ozone leakage. When a MPPHS is equipped with an active carbon filter as well as an ozone resolution catalyst, the ozone leakage is less than 5 ppb that was 1/10 of the regulation (50 ppb) of ozone leakage.

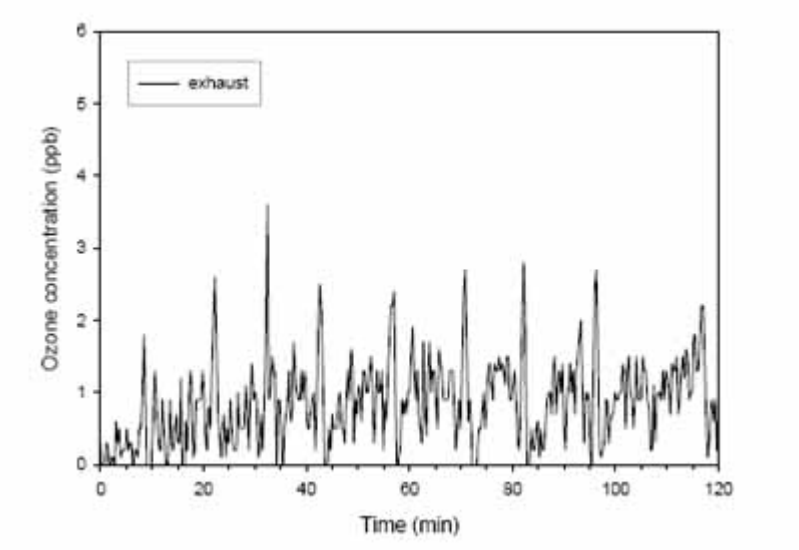


(a) Zero-Used MPPHS

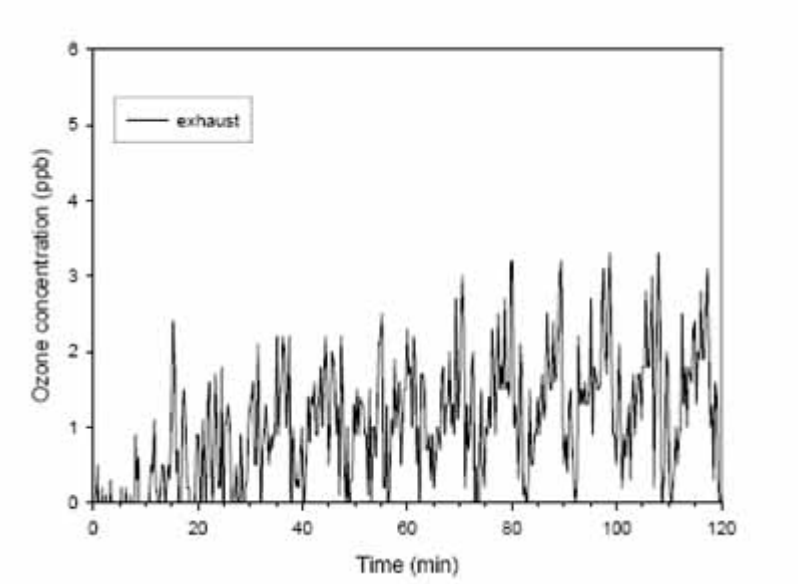


(b) 450-time used MPPHS

Picture 5. The change of the ozone in the chamber density as time goes on



(c) 1,350-time used MPPHS



(d) 2,000-time used MPPHS

Picture 5. (Continued)

4. Summary

After we installed 4 kinds of MPPHS (zero-used, 450-time used, 1,350-time used, 2,000-time used) submitted by KLENZ CO. LTD in the acrylic chamber that was $4m^3$, and measured the change of ozone density for 2 hours, we obtained the following results.

① In case that the door opened while operating, the ozone density leaked from the front side was less than 5 ppb.

② Ozone leakage density was less than 5 ppb coming from the exhaust port of the 2,000-time used MPPHS equipped with an active carbon filter and an ozone resolution catalyst.

Regulation leakage of ozone density is less than 50 ppb in case of electric air purifiers or ozonizers. Since ozone leakage density is less than 5 ppb from the door and the exhaust port of the 2,000-time used MPPHS equipped with an active carbon filter and an ozone resolution catalyst, we assess that this MPPHS may be used indoors.