UltraPure Water Quality Inc.
Accelerated Testing of UPS 350 and Del Spa Ozone Generators
Laboratory Manager: Deborah Kon
Date: December 2004 – June 2005

Purpose

The purpose of this testing was to determine whether the ozone output of spa units changes over run time. Specifically, the ozone output of UltraPure Water Quality's UPS 350 spa ozone generator was compared to the ozone output of Del's CDS-16 DR ozone generator.

Experimental Design

In order to properly simulate the operation of the ozone generators in the field, all units were running for a certain period of time per day. Untreated ambient air was drawn through the units.

Manifold Design

For this experiment, a manifold was constructed which allowed 12 units to be run at the same time (see figure 1). This ensured that all units connected to the manifold were receiving the same amount of air. The manifold was connected to the suction side of an air compressor which pulled the air through all units. The exhaust of the compressor was connected to an exhaust fan to allow sufficient ozone off gassing. The units and the compressor were connected to a timer, allowing the units and the compressor to turn on and off at the same time.

Number of Units Tested

For this experiment, six UPS 350 (120 V) and six Del-CDS-16DR (120 V) ozone generators were tested.

Running Time

The units and the compressor were set to be on for 3 hours at a time, then off for 1 hour, and then on for 3 hours. This cycle was continued for the period of 24 hours. If we are to assume that the spa units are running for 6 hours in the field (typically the spa units are running for 4-6 hours in the field), one day run at our test facility approximates 3 running days in the field. This testing was conducted for a period of 6 months. This approximated 18 months of running time in the field.

Data Collection

The initial ozone output of all units was determined before the units were connected to the manifold. After the units were connected to the manifold and the running cycle has started, the ozone output was determined every 7-8 days.

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Relative humidity of air and air temperature around the manifold were recorded at least once per week.

Experimental Conditions

Air Flow Through Each Unit During Run Time: 3 CFH
Air Temperature During Run Time: Ambient Air Temperature (16 – 24 °C)
Relative Humidity of Air During Run Time: Ambient Relative Humidity (24 – 50%)

Air Flow Used for Determination of Ozone Output: 2 CFH
Instrument Used for Determination of Ozone Output: Hankin OzoMeter™ HA-100GTP Ozone Gas Analyzer

Test Results

The test results are shown in a separate graph (see figure 2).

The ozone output results for all UPS 350 units and Del-CDS-16DR units were averaged at each month. The averaging of all units has corrected for variation in the ozone output between individual units.

In addition, all ozone output values were corrected to a standard relative humidity value of 30%. This was done in order to make all the results more comparable to each other and to eliminate the natural variations in the ozone output resulting from variations in relative humidity of the air.

Furthermore, there are three different time scales on the graph. The first time scale measuring from 0 – 18 months shows the ozone output over time when the units were running for 6 hours per day. The second time scale was added to show the ozone output over time if units were running for 4 hours per day. The third time scale was added to show the ozone output over time if the units were on for 24 hours per day. These two additional time scales were added since the ozone generators are on for 4 hours on some spas, while some ozone generators are on for 24 hours on other spas. The three scales on the graph cover the running time of most ozone generators in the field, ranging from 4-24 hours.

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Table 1 shows the average ozone output of UPS 350 units with running time of 6 hours per day. All values were corrected to 30% relative humidity.

Table 1.

Running Time at Test Facility (months)	Running Time in Field (months)	Ozone Output (ppm)
0 (Initial Ozone Output)	0 (Initial Ozone Output)	147.3097
1	3	138.9487
2	6	130.2034
3	9	119.4926
4	12	107.9162
5	15	97.0055
6	18	86.4026

Table2 shows the average ozone output of Del-CDS-16DR units with running time of 6 hours per day. All values were corrected to 30% relative humidity.

Table 2.

Running Time at Test Facility (months)	Running Time in Field (months)	Ozone Output (ppm)
0 (Initial Ozone Output)	0 (Initial Ozone Output)	266.0518
1	3	260.0280
2	6	37.4092
3	9	6.0238
4	12	0.0000
5	15	0.0000
6	18	0.0000

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Discussion and Conclusions

The test results obtained from this experiment indicate the following:

For the Del-CDS-16DR units, the largest drop in ozone output occurs at 6 months. After 6 months, the ozone output of this generator is very low and almost nonexistent.
If the units are running for 6 hours per day, the Del-CDS-16DR ozone generator completely stops producing ozone after 9 months.

In contrast, the UPS 350 ozone generator continues to produce ozone well after 12 months. At 18 months, this ozone generator is still producing ozone and based on shape of the graph curve, it will continue to do so for an extended period of time.

If the units are running for 4 hours per day, it can be seen that the Del-CDS-16DR unit will stop producing ozone after 12 months. At this point in time, the ozone output of the UPS 350 unit is above 100 ppm.

If the units are running for 24 hours per day, it can be predicted that the Del-CDS-16DR unit will stop producing ozone after 2 months. At this point in time, the ozone output of the UPS 350 unit is above 100 ppm.

Based on the results from this experiment, it can be concluded that depending on the running time, the Del-CDS-16DR unit stops producing ozone between 2-9 months, while the UPS 350 unit continues to make ozone well beyond 18 months.