ServiceMaster Ozone Test

Re: Hydroxyl Generators

There has been some concern raised about the generation of ozone with the Hydroxyl generator. As discussed in the presentation on Training Tuesday, when using the hydroxyl generator such as Boss XL-3, a unique characteristic ozone smell or odor can be detected. The presence of such a smell can be a cause for concern due to the safety issues with ozone. OSHA and the EPA have set limits for human exposure to ozone.

The maximum TLV (threshold limit value) for a time weighed 8 hour period is 0.1 ppm, and the maximum STEL (short term exposure limit) for "instantaneous" exposure is 0.3 ppm. The lowest detectible level of ozone by the human nose is 0.007 ppm.

The Hydroxyl generators sold by ServiceMaster are manufactured by HGI Industries. Columbia Analytical Services, an independent testing lab, evaluated the presence and quantity of ozone generated by a hydroxyl generator made by HGI. The unit employed in this series of tests was HGI's Mobile Disinfecting Unit, a generator very similar to the Boss XL-3, only roughly 2½ times smaller. The test was run for three hours and ozone measurements averaged each hour. The maximum level of ozone measured was 0.0139 ppm in a room of approximately 1200 cubic feet. Assuming the larger output of the Boss XL-3, this would still be a level of 0.0348 ppm, well below the TLV for ozone.

ServiceMaster has conducted some additional testing on the hydroxyl generators to refine the safety and use procedures.

1. The Boss XL-3 was set up in the Flood House at the Training Center (8,600 cu. ft.) and run overnight with continuous monitoring. At no time did the ozone values exceed 0.008 ppm, well below the TLV for ozone. This represented a "real life" use of the unit.

2. The Boss XL-3 was then placed in a confined area measuring about 800 cu. ft. (8X10X10 ft.) with the door closed. The unit ran for 5 hours and ozone measurements were taken every 20 minutes. The ozone level "leveled out" at a maximum concentration of 0.348 ppm. This shows that in a small confined area with the door closed, ozone levels can exceed the safe level.

3. As a matter of reference, the Boss XL-3 was compared to the Active O ozone generator in this same room--confined area. The Active O unit

was run for 15 minutes but never allowed to reach its maximum level. Even within this short time of 15 minutes, the Active O generated an ozone concentration of 45.26 ppm, or 130 times the amount generated by the Boss XL-3 in 1/8 the time. As expected, this was far in excess of the safe level of ozone.

4. The Boss XL-3 was placed in a room measuring about 3,500 cu. ft. (19X18X10 ft.). The unit ran for 8 hours and ozone measurements were taken. The ozone level "leveled out" at a maximum concentration of 0.039 ppm, significantly below the TLV for ozone. This again showed that in a normal situation, the Hydroxyl generator did not produce levels of ozone that was of any concern.

Based on this data, we can recommend the following safe use protocol for Hydroxyl generators:

1. Boss XL-3 and Boss are safe to use in any room with a volume of 2,900 cu. ft. or greater. This is equivalent to an enclosed room measuring about 19X19X8 ft or 17X17X10 ft. In most commercial applications, for which we recommended this unit, you will be dealing with areas that result in the air space being much greater 2,900 cu. ft. and the unit can be used without any concern.

2. If Boss XL-3 and Boss are used in a confined area measuring less that 2,900 cu. ft., you have two options:
a. Open the door such that the volume of air space exposed to the hydroxyl generator becomes greater than 2,900 cu. ft.
b. If the door cannot be opened, we do not recommend using the Hydroxyl generator.

Questions also arose concerning residual ozone odors left behind from the Boss XL-3. The half life of ozone at 70°F is around 40 minutes. This means the level of ozone drops 50% in the first 40 minutes, then an additional 50% each 40 minutes thereafter. Conservatively speaking, in less than 2 hours, the dissipation of ozone would easily reach the safe level even in the confined area discussed above. Often after using this unit, there is an odor that lingers—this is the odor of "absence of odor" as odor molecules have been neutralized.

It should be pointed out that the mechanism of odor control with the Hydroxyl generator is not ozone, it is hydroxyl molecules. Ozone is just a by-product of the process of generating hydroxyls much like a copier generates ozone while making copies in an office setting. Further, the amount of ozone generated as a by-product is not, on its own,

adequate for serving the purpose of odor remediation. As shown by our testing, when compared to an actual ozone generator, the levels of ozone produced by the Hydroxyl are 100 fold less or lesser.

There was also a question related to hydroxyl free radicals. The manufacturer has informed us that the hydroxyl free radicals that Wikipedia references are biological hydroxyls, or 'in-vivo' hydroxyls. They are formed by the body through chemical reactions. The body constantly produces radicals in-vivo for a variety of reasons. Biological hydroxyls can only travel a few angstroms from where they are formed. The Hydroxyl generator does not produce these types of hydroxyls. Instead, it produces atmospheric hydroxyls. There are no known adverse effects to humans, animals or plants from atmospheric hydroxyls. These are the same, naturally occurring hydroxyls that are formed when the sun's ultraviolet rays react with water vapor. These hydroxyl radicals are abundant in the outdoors during daylight hours. There is a constant concentration of about 10 million hydroxyl radicals per cubic centimeter of air at ground level. Specific hydroxyl concentrations vary across the Earth based on the location's latitude and the local relative humidity. Hydroxyls do not pass into human, animal or plant cells. Therefore, they can not affect internal cells in the way that biological hydroxyls could.

In conclusion, it is our recommendation that you use the Hydroxyl generator in applications where the volume of air exposed to the generator is over 2,900 cu. ft.

Product Development Team