Case Study

Proposed Safety Measures for Work after Ozone—Induced Deodorization in a Hotel

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Key words: Ozone, Safety manual, Safety control, Deodorization

There is now a trend in the hotel business to use ozone-generating equipment daily to remove tobacco and body odor from guest rooms, relying on the effects of sterilization^{1–3}, deodorization⁴, and bleaching by ozone.

Ozone can deodorize every corner of a room because it is a gas. Moreover, since it decomposes to oxygen after use, it has been thought to be comparatively safe but, the strong oxidization effect of ozone may cause adverse effects on humans depending on the concentration^{5–7}.

The health effects of ozone have been reported as follows⁸: 0.01 ppm; threshold for keen sense of smell, 0.1–0.3 ppm; irritating to mucous membranes of nose and throat in most individuals, 0.4 ppm; breathing disorder, 0.8–1.7 ppm; upper respiratory irritation, 1.0 ppm; cough and feeling of fatigue, 1.5 ppm; chest pain and depression, under 9.0 ppm; dyspnea and a lung congestion, 1,700 ppm; death within several minutes.

While the ozone-generating equipment is in operation, a sign is put on the door, warning workers not to enter the hotel room. Nevertheless, during busy periods sometimes workers must clean the room while ozone is being generated or immediately after ozone generation has stopped, and some workers have complained of eye and/or throat irritation. In order to compile a health and safety manual, we measured the concentrations of ozone during and after the generation of ozone in several guest rooms and a corridor. The information is used to recommend how long workers should wait before entering a room after ozone generation in a hotel. This is the first report on the safety manual based on the results of ozone measurements.

Subjects and Methods

Measurement of the ozone concentration was performed at three points, i.e. in a single room (45 m³=18 m² × 2.5 m), a twin room (65 m³=26 m² × 2.5 m) and the corridor in front of the single room with its door closed during and after ozone generation. For ozone deodorization, ozone was generated at an amount of more than 500 mg/h for 60 min in the sealed, vacant room, with an ozone generator (Cabin Refresher CR–500T made by ONIT Inc.).

The ozone concentration was measured with an ultraviolet ray absorption system which incorporates ozone monitor model 1150 made by DYLEC Inc.. The indoor temperature was 24°C, the central air conditioning system was on and the bathtub was not filled with water. The ozone sampling was performed at one point near the center of the guest room (less than 30 m²) at a height of 150 cm above the floor (Fig. 1), which was basically in accordance with the Working Environment Measurement Standard⁹. The same experiment was conducted twice.

Results

The concentration of ozone increased for 20 min immediately after ozone generation and reached a plateau for 40 min in the single room, the twin room and the corridor.

The average concentration for the plateau level was 2.2 ppm in the first experiment (Fig. 2) and 2.0 ppm in

Fig. 1. Measuring ozone concentration in a hotel room.

Received Sep 3, 2003; Accepted Dec 22, 2003

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Fig. 2. Ozone concentration in the single room.

Fig. 3. Ozone concentration in the twin room.

Fig. 4. Ozone concentration in the hotel corridor.

the second experiment in the single room. The average concentration for the plateau level was 1.2 ppm in the first experiment (Fig. 3) and 1.1 ppm in the second experiment in the twin room. The highest concentration was about 2.76 ppm in the single room and about 1.78 ppm in the twin room.

The average concentration for the plateau level was 0.06 ppm in the first experiment (Fig. 4) and 0.04 ppm in the second experiment in the corridor. The highest concentration for the plateau level was about 0.14 ppm in the corridor.

The concentration of ozone decreased rapidly after stopping the ozone generation. It was less than 0.2 ppm in 10 min and less than 0.1 ppm in 15 min. It returned to the baseline level (0.002–0.005 ppm) in 20 to 30 min.

Discussion

Ozone is often used to remove odors arising from organic substances. Ozone deodorizes by oxidation. It is used to deodorize laboratory animal cages¹⁰⁾ and hospitals¹¹⁾ as well as hotel rooms.

The Japan Society for Occupational Health has determined the Occupational Exposure Limit (OEL) of ozone to be 0.1 ppm¹²⁾. The Time-Weighted Average (TWA) is determined to be 0.1 ppm for light work and 0.2 ppm for less than 2 h work according to the Threshold Limit Value (TLV) of the American Conference of Governmental Industrial Hygienists¹³⁾ (ACGIH).

In our results, the average concentration (2.1 ppm) in the single room under ozone generation was about 21 times the OEL value in Japan, and about 10.5 times the TWA value for less than 2 h work in America. When working under such an ozone concentration for even a short time, irritation of the upper respiratory tract and/or chest pain may result.

In order to work safely, a worker should ideally enter the guest room 30 min after ozone generation has been stopped. The ozone concentration returned to the baseline level in 30 min under this condition. Even during extremely busy periods workers should wait at least 10 min, until the ozone concentration has returned to 0.2 ppm. This concentration is less than 2 h work at the TLV. As the highest concentration of ozone in the corridor (0.14 ppm) was almost the same as the OEL value (0.1 ppm), guests and workers in the corridor should not suffer any harmful effects of ozone.

“Standard rules for work in hotel rooms deodorized by ozone-generating equipment” was newly compiled as follows, based on the results of our investigation in the hotel.

1. Prior check and correct use of ozone-generating equipment according to the institution manual.
2. Check of the guest room that has been deodorized (ventilation, house keeping, etc.)
3. Refrain from entering a room while ozone-generating equipment is in operation.
4. Work with the door open in emergency cases when the ozone-generating equipment is in operation.
5. Workers should not enter a guest room for at least 10 to 15 minutes after ozone generation has been stopped.
6. General safety practices should be followed to prevent bruising, falling and other injuries and harmful effects. Since our safety manual was provided to the workers, they have never complained of eye and/or throat irritation.

References

- 1) M Oizumi, T Suzuki, M Uchida, J Furuya and Y Okamoto: In vitro testing of a denture cleaning method using ozone. *Journal of Medical and Dental Sciences* 45, 135–139 (1998)
- 2) K Mochitate, K Katagiri and T Miura: Impairment of Microbial Killing and Superoxide—Producing Activities of Alveolar Macrophages by a Low Level of Ozone. *Journal of Health Science* 47, 302–309 (2001)
- 3) H Murakami, M Mizuguchi, M Hattori, Y Ito, T Kawai and J Hasegawa: Effect of Denture Cleaner using Ozone against Methicillin-resistant *Staphylococcus aureus* and *E. coli* T1 phage. *Dental Materials Journal* 21, 53–60 (2002)
- 4) K Nakajima, H Kuno, M Kasegawa, M Suzuki, T Tamura, N Yanagisawa and A Igata: Odor evaluation in use of an odorless portable toilet in the sickroom. *Geriatric Medicine* 39, 1501–1507 (2001) (in Japanese)
- 5) Mckee DJ, Bachman JD: Ozone, Robert L. Harris, Fifth Edition PATTY’S Industrial Hygiene. New York: John Wiley & Sons, Inc, 2000: 2795–2799.
- 6) WF McDonnell, PW Stewart, S Andreoni, E Seal Jr, HR Kehrl, DH Horstman, LJ Folinsbee and MV Smith: Prediction of Ozone—induced FEV1 Changes. *American Journal of Respiratory and Critical Care Medicine* 156, 715–722 (1997).
- 7) Amdur MO, Air Pollutants, Klaassen CD, Amdur MO, Doull J: Casarett and Doull’s Toxicology The Basic Science of Poisons third edition. New York: 1986: 812–813.
- 8) Japan Association of Industrial Health: *Jpn J Ind Health* 14, 48–49 (1963) (in Japanese).
- 9) Japan Association for Working Environment Measurement: Table 3 Overview of Working Environment Measurement Standards, Working Environment Measurement System in Japan. Tokyo: Japan Association for Working Environment Measurement. 1996: 5–7.
- 10) TM Pan, K Shimoda, Y Cai, Y Kiuchi, K Nakama, T Akimoto, Y Nagashima, M Kai, M Ohira, J Saegusa, T Kuhara and K Maejima: Deodorization of Laboratory Animal Facilities by Ozone. *Exp Anim* 44, 255–259 (1995).
- 11) N Tabata: Deodorizing Technology (1) Chemical Oxidization Systems (Ozone, etc.). *Journal of Healthcare Engineering Association of Japan* 39, 591–594 (1997) (in Japanese).
- 12) Japan Society for Occupational Health: *J Occup Health* 44, 271 (2002)
- 13) ACGIH: Adopted Threshold Limit Values, 2003 TLVs and BEIs. Cincinnati: ACGIH, 2003: 45.