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Study of ClO₂ Levels in Room Treated with KennelSol[®] APS Room “Shock” Deodorizer

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Executive Summary

Common indoor odors vary greatly in type and source. Many products currently on the market can successfully remediate a narrow range of odor sources at best, or simply mask the scents with fragrances. Alpha Tech Pet, Inc. has designed a product that addresses this problem: **KennelSol[®] APS** (air purification system) **Room “Shock” Deodorizer**. Air quality improvement is accomplished by the controlled release of **ClO₂**, a compound with demonstrated effectiveness in destroying a wide range of common facility odors as well as their microbial sources.

A number of adverse health effects may result from exposure to high levels of ClO₂. OSHA has set safe exposure limits of 0.3 ppm for 15 minutes and a time-weighted average of 0.1 ppm for 8 hours of contact with ClO₂ gas. To ensure compliance with OSHA standards, treatment tests were conducted and air samples analyzed for ClO₂ levels.

Results from air sample analysis show that, at all dosage levels applied in this experiment, the concentration of ClO₂ in the room was well below 0.1 ppm for the 4-hour treatment duration. ClO₂ levels declined rather than accumulated over time—indication of the consumption and degradation of this compound. This experiment demonstrates that the Room “Shock” Deodorizer is safe for human exposure.

Background

Alpha Tech Pet, Inc. has developed **KennelSol[®] APS Room “Shock” Deodorizer**, a ClO₂-releasing product that destroys common facility malodors, such as those caused by fouled air conditioning, smoke, spills and pets. Excessive exposure to ClO₂ gas can cause irritation of the eyes and respiratory tract. In severe cases, pulmonary edema or chronic bronchitis may result. The Occupational Health & Safety Administration (OSHA) has established ClO₂ exposure limits of 0.3 ppm (0.83 mg/m³) for 15 minutes and the time-weighted average of 0.1 ppm (0.28 mg/m³) for 8 hours of exposure.

Experiments were conducted to determine, at varied dosage levels, the ClO₂ concentrations in a treated room, and to ensure that this product, when used as prescribed, complies with OSHA standards.

Ion chromatography is the standard method used by OSHA in the detection and quantification of ClO₂; however, when ClO₂ is present in samples at visibly detectable levels, titrimetry serves as an effective analytical tool.

Materials/Procedures

SKC 224XR Series flow pump, **KennelSol[®] APS Room “Shock” Deodorizer** ClO₂ gas-phase sachets, 10 wt % potassium iodide solution (KI), distilled water, standard laboratory glassware

For each experiment, 10 mL of potassium iodide solution (KI) was placed in each impinger. The air sample collection apparatus (see Figure 1) and sachets were placed in the closed-off treatment room. ClO₂ gas-phase sachets were activated by unfolding and shaking vigorously for a few seconds for the thorough mixing of materials, followed by suspension of the sachets from ceiling vents. The flow pump power button was

immediately switched to ON, and the air flow rate recorded. The flow pump rate through the impingers was 2.3 L/min for all experiments.

Figure 3: KennelSol® APS ClO₂ sachets suspended from ceiling vent



Results

Twenty-one treatment experiments with **KennelSol® APS Room “Shock” Deodorizer** were conducted in a two-month span. The individual data points are referenced in the Appendix (see Table 2). Average ClO₂ levels in the room air space, presented as parts-per-million-by-volume (ppmv), are displayed in Table 1. This data is presented in graphical form in Figure 4.

The theoretical ClO₂ levels were calculated assuming all ClO₂ produced by the sachets accumulate in the room air and is not consumed. The ClO₂ generation expected of one sachet was determined by suspending a sachet over 10% KI solution in an enclosed glass container, placing the container in an unlit cabinet and analyzing via titration at 1-hour intervals for four hours. Theoretical and actual ClO₂ levels are presented in Figure 5.

Table 1: Average ClO₂ levels (ppmv)

No. Sachets	Time (hr)			
	1	2	3	4
1	0.07 ± 0.02	0.05 ± 0.01	0.03 ± 0.02	0.02 ± 0.01
2	0.11 ± 0.08	0.10 ± 0.08	0.05 ± 0.04	0.04 ± 0.02
3	0.11 ± 0.07	0.10 ± 0.07	0.05 ± 0.03	0.04 ± 0.02
4	0.16 ± 0.05	0.08 ± 0.04	0.03 ± 0.03	0.03 ± 0.03

Figure 4

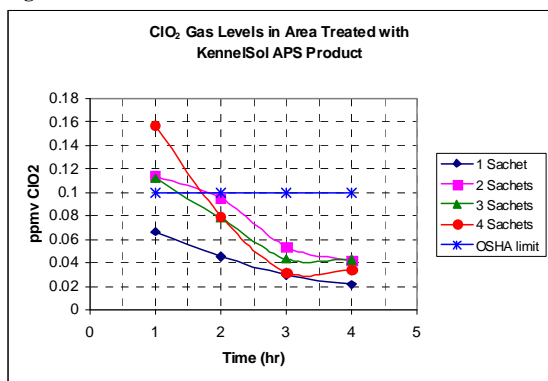
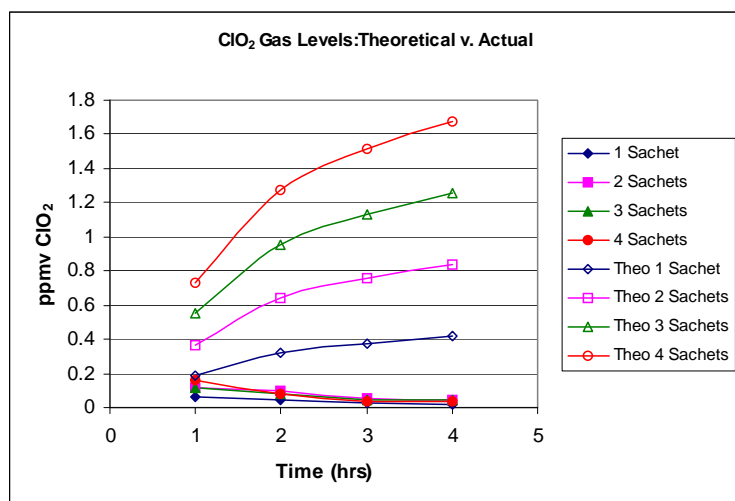


Figure 5



Discussion

Figure 5 shows that the actual ClO₂ levels are well below theoretical values—a phenomenon that can be attributed to the oxidant demand in the treated room as well as decomposition due to the inherent instability of this species and exposure to light.

While Figure 4 suggests that ClO₂ concentration in the room is directly proportional to the number of sachets used, the standard deviation of the data indicates otherwise. The data overlap within the confidence interval of one standard deviation demonstrates that the number of sachets used has no considerable impact on ClO₂ concentration. The variation in the data can be attributed to fluctuating oxidant demand in the room, inherent degradation factors remaining constant. The change in oxidant demand over time and at different treatment dosages is perhaps an indication that the oxidant demand in the room, although varying, remained at high levels, such that the more ClO₂ generated by the sachets, the more consumed.

Conclusions

Multiple air sample analyses of a room treated with KennelSol® APS Room “Shock” Deodorizer have demonstrated that this product, in compliance with OSHA’s standards, is safe for use and human exposure. ClO₂ is a compound that decomposes readily in gaseous form and when exposed to light. This, along with the oxidant demand normally found indoors, results in a decline in ClO₂ levels over time.

Appendix

Table 2: Compilation of data from all experiments: ppmv ClO₂

Exp. No.	Time (hr)			
	1	2	3	4
1-a	0.047	0.042	0.028	0.013
1-b	0.089	0.063	0.031	0.022
1-c	0.057	0.039	0.020	0.020
1-d	--	--	0.059	0.044
1-e	0.073	0.038	0.013	0.009
2-a	0.184	0.101	--	0.061
2-b	--	0.024	0.119	0.061
2-c	--	0.039	0.018	0.033
2-d	0.132	0.048	0.044	0.035
2-e	0.026	0.048	0.035	0.018
3-a	1.057	0.235	0.054	0.053
3-b	0.118	0.038	0.011	--
3-c	0.079	0.047	0.026	0.017
3-d	0.219	0.105	0.057	0.053
3-e	0.118	0.118	0.097	0.061
3-f	0.026	0.083	0.026	0.041
4-a	0.097	0.039	0.012	0.007
4-b	0.228	0.083	0.016	0.057
4-c	0.123	0.041	0.015	0.005
4-d	0.158	0.097	0.051	0.032
4-e	0.180	0.140	0.067	0.070