

Evaluation of Acetic Acid and Hydrogen Peroxide Exposures during Sanitizing and Disinfecting Practices at a Child Care Center in San Francisco, California

**California Department of Public Health
Occupational Health Branch, Work-Related Asthma Prevention Program**

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Background

The San Francisco Department of Public Health (SFDPH), Children's Environmental Health Promotion, Environmental Health Section, contacted the California Department of Public Health, Occupational Health Branch (OHB), Work-Related Asthma Prevention Program, for assistance in assessing potential exposures to the ingredients in a sanitizer product they had recommended.

There are requirements for child care providers to sanitize food-contact surfaces and sanitizer products must state on the label that they can be used for this purpose. In addition, SFDPH was attempting to avoid products that contained ingredients that were identified as asthmagens, such as bleach (sodium hypochlorite) and quaternary ammonium compounds. As part of an ongoing project with the San Francisco Asthma Task Force to reduce the use of bleach in child care, SFDPH found only one viable alternative for use as a sanitizer on food-contact surfaces.

The most acceptable product they found that is registered in California for use on food-contact surfaces was SaniDate® Ready to Use, United States Environmental Protection Agency (USEPA) registration number 70299-9. This product contains 0.108% hydrogen peroxide as the active ingredient, and no other ingredients are specified on either the material safety data sheet or the label. SFDPH purchased a supply of this product to be used in the child care centers they had partnered with for the bleach reduction project. Subsequently, because of child care workers noting a vinegar odor coming from the stored bottles, SFDPH found out from the manufacturer that a small amount (0.02%) of acetic acid is added to the product as a stabilizer. In the product, acetic acid reacts with hydrogen peroxide to form peracetic acid. According to the manufacturer, when in equilibrium, the levels of ingredients are:

Hydrogen peroxide: 0.108%
Acetic acid: 0.012%
Peracetic acid: 0.008%

Acetic acid is a primary ingredient in vinegar (at roughly 5-8%) and has been designated as an asthmagen by the Association of Occupational and Environmental Clinicians (AOEC). Peracetic acid is also an asthmagen as designated by AOEC and is often used in higher concentrations as an active ingredient in disinfectants. Because these ingredients are present at extremely low levels in the SaniDate® product, there is no requirement to list them on the material safety data sheet. Inert ingredients (per USEPA regulations, those ingredients that are not the active, or antimicrobial, agents) are seldom listed on pesticide labels. (Disinfectants and sanitizers are regulated as antimicrobial pesticides.)

The California Division of Occupational Safety and Health (Cal/OSHA) 8-hour time-weighted average permissible exposure limit (PEL) for hydrogen peroxide is 1.0 parts per million (ppm) and for acetic acid is 10 ppm. There is not currently a Cal/OSHA or federal OSHA permissible exposure limit for peracetic acid, although there are EPA Acute Exposure Guideline Levels (AEGLs) for peracetic acid. The AEGL-1 is 0.17 ppm for exposures ranging from 10 minutes to 8 hours.

Because other sanitizer options that SFDPH had examined either included higher levels of asthmagens or had other health concerns (e.g., thymol - skin sensitization, developmental toxicity, lack of data) this product still appeared to be the best product available to sanitize surfaces such as meal tables in the child care setting.

Methods

SFDPH requested OHB's assistance in assessing potential exposures to peracetic acid and acetic acid. After reviewing several options such as chamber testing, detector tubes, and direct reading instruments, OHB determined that the most appropriate method would be to assess actual worker exposures during the use of the product using passive sampling badges. Active sampling using media (such as impingers and glass tubes) connected with tubing to personal sampling pumps was determined to be problematic for use around small children, both because of the tendency for infants and toddlers to grab objects and because the pumps could interfere with the ability of workers to lift and carry children.

There is currently no National Institute for Occupational Safety and Health (NIOSH) or Occupational Safety and Health Administration (OSHA) method for analysis of peracetic acid. Measurement of acetic acid was therefore used as a surrogate for peracetic acid, since they

have similar vapor pressures and acetic acid is present at a similar (although slightly higher) concentration as peracetic acid in the liquid sanitizer.

In addition, airborne hydrogen peroxide was monitored to determine exposures to the active ingredient of SaniDate® as well as to the active ingredient of Oxivir TB® (USEPA registration # 70627-56), a disinfectant product used by the child care center to disinfect the diapering area and other locations such as sinks and on plastic toys. Oxivir TB® contains 0.5% hydrogen peroxide. Oxivir TB® cannot be used on food-contact surfaces.

Air monitoring and worker observations were conducted September 10, 2012, at Associated Students Incorporated Early Childhood Education Center (ASI-ECEC) in San Francisco, California. ASI-ECEC was chosen by SFDPH because this center had fully switched to the SaniDate® and Oxivir TB® products and workers had recently received training in the use of these products. This center is located on the San Francisco State University campus and consists of nine classrooms: two infant classrooms, two toddler classrooms, two transitional classrooms (for two-year-olds), and three preschool classrooms. Each classroom is staffed with at least two workers at any given time, and workers include head teachers as well as associate teachers. The center accommodates 100 children on a daily basis. Infant and toddler classrooms are paired in “pods” with each pair measuring 1250 square feet and including 2 classrooms, 2 nap rooms, and a central area which is where the diaper changing area is located. The paired classrooms are open to each other with only low walls or gates separating them. The transitional classrooms are each 830 square feet, and the preschool classrooms are 998 square feet. All classrooms are open to the central outdoor play area in the back and open onto a common hallway that runs along the perimeter at the front of the center.

Where possible, employees wore passive sampling badges during their entire shift. Most of the staff monitored worked less than 8-hour shifts. In two cases the sampling badge was shared by workers who had to leave early due to either illness or needing to attend a meeting outside of the classroom. The workers who were leaving shifted the badges to a worker who was staying in order to simulate the exposure expected for a longer shift.

Child care workers’ tasks are varied and include preparing food, feeding children, diapering, cleaning, tidying, and interacting with the children through teaching and play. A portion of the day is spent outdoors in the play area. In the infant classrooms each child has an individual feeding schedule with bottle feeding in the morning for breakfast, and no sanitizing is performed unless needed. Lunchtime for individual infants varies and sanitizing is performed as infants finish eating. In the other classrooms there are several eating times throughout the day,

including breakfast, lunch, and snack. Sanitizing of meal tables takes place before and after meals and at the end of the day. Wooden toys that children may mouth and chairs are also sanitized at least once a day at the end of the day. In addition, in some rooms, SaniDate® is used on mirrors, windows, mats, beds, doors, shelves, and countertops. Disinfection of the diaper changing areas takes place after each diapering. Because the preschool-age children are no longer in diapers, no diaper changing disinfection takes place in these rooms although Oxivir TB® is used in case of toilet training “accidents.”

During the site visit the doors to the outdoor play area were open for part of the day. Ventilation rates were not measured, but subjectively the air in the classrooms did not appear still or stuffy. No product odors were noted by the OHB investigator.

Both the sanitizer and the disinfectant are ready-to-use products that are sprayed from a pump-style spray bottle. Products are sprayed on surfaces and either wiped with paper towels after the appropriate dwell time has passed or allowed to dry on the surface.

Badges were purchased from Assay Technologies. The ChemDisk™ Monitor for Hydrogen Peroxide uses a chemically activated silica gel adsorbent with a functional range of 15 minutes to 8 hours. The ChemDisk™ Monitor for Acetic Acid uses a coconut charcoal media in a proprietary binder and has a functional range of 15 minutes to 12 hours. According to Assay Technologies, the badges can capture both vapor and mist and meet or exceed OSHA requirements for accuracy with a maximum total error of $\leq 19\%$ for hydrogen peroxide and $\leq 25\%$ for acetic acid at their respective permissible exposure limits.

Exposures in eight classrooms were monitored. Hydrogen peroxide was monitored in one classroom at each child care age level - Infant, Toddler, Transitional, and Preschool, and acetic acid was also monitored in one classroom at each of these four child care age levels. Badges were placed in the personal breathing zone – generally in the lapel area of each staff member monitored – at the beginning of the shift. One worker shifted the badge to her waist level and wore it this way for part of her shift, but was asked to move it back to the lapel area. This badge could possibly have received direct overspray or spray bouncing back from a table and may not be representative of exposure.

Findings and Results

The results listed below are the time-weighted average concentrations for the duration of the time period monitored. Concentrations are listed in parts per million (ppm), meaning parts of the chemical being measured per million parts of air.

Table 1. Acetic Acid Monitoring Results					
Job Title	Location	Result in parts per million (ppm)	Cal/OSHA* Permissible Exposure Limit (ppm)	Detection Limit (ppm)	Comment
Associate Teacher & Teacher Assistant (two employees shared this badge)	Room 2 (Toddler Room)	None Detected	10	0.12	Sampling time 471 minutes. Badge shifted to Teacher Assistant after about 5 hours because Teacher Assistant sanitized while the Assoc. Teacher was at lunch.
Teacher Aide	Room 6 (Transitional Room)	None Detected	10	0.19	Sampling time 304 minutes.
Associate Teacher	Room 4 (Infant Room)	0.5**	10	0.19	Sampling time 299 minutes. Wore badge low, near waist for about 1.5 hours at beginning of shift.
Teacher Assistant	Room 7 (Preschool Room)	None Detected	10	0.17	Sampling time 331 minutes.

*California Division of Occupational Safety and Health.

** This result is suspected to be erroneously high since badge was worn at the waist (instead of on the lapel in the breathing zone) for a portion of the shift and may have been sprayed directly or received bounce back spray from surfaces being sanitized. According to Assay Technologies, if a badge or the badge cap received spray droplets directly it could register a “false positive.” Because this is the only sample that registered any detectible acetic acid this may have been the case.

Job Title	Location	Result in parts per million (ppm)	Cal/OSHA Permissible Exposure Limit (ppm)	Detection Limit (ppm)	Comment
Associate Teacher	Room 8 (Preschool Room)	0.13	1.0	0.031	Sampling time 297 minutes.
Associate Teacher	Room 1 (Infant Room) and Room 9 (Preschool Room)	0.07	1.0	0.019	Sampling time 472 minutes. After ~ 5.5 hours moved to Room 9 (Preschool Room)
Associate Teacher	Room 3 (Toddler Room)	0.12	1.0	0.031	Sampling time 293 minutes.
Two Associate Teachers and Head Teacher (three employees shared this badge)	Room 5 (Transitional Room)	0.08	1.0	0.019	Sampling time 472 minutes. First badge wearer became ill and left after about 1.75 hours. Second wearer (Head Teacher) went to a meeting after wearing the badge for 3.5 hours and shifted it to third wearer.

Usage measurements – SFDPH personnel weighed product bottles before and after the work shift and at the end of the week to determine usage. Results are included below:

Table 3. Weight in Ounces of SaniDate® Used

		Room 1 (Infant) open MWF	Room 2 (Toddler)	Room 3 (Toddler)	Room 4 (Infant)	Room 5 (Transitional)	Room 6 (Transitional)	Room 7 (Pre-K)	Room 8 (Pre-K)	Room 9 (Pre-K)
SaniDate	Day 1	1.5	2	5	3	4	2	3	11	11
	Total for Week	6	23	19	12	21	23	11	41	22

Table 4. Weight in Ounces of Oxivir TB® Used

		Room 1 (Infant) open MWF	Room 2 (Toddler)	Room 3 (Toddler) bottle 2 (play area)	Room 3 (Toddler)	Room 4 (Infant)	Room 5 (Trans- itional)	Room 6 (Trans- itional)	Room 7 (Pre-K)	Room 8 (Pre-K)	Room 9 (Pre-K)
Oxivir TB	Day 1	5		2		7	3	4	1	2	1
	Total for Week	22		19		28	9	11	5	8	4

Workers were observed using disposable powder-free latex gloves for diapering.

The use of an air freshener was observed in one of the offices. The reason given for its use was that the ventilation in this area was poor – that the air was stagnant and there was a problem with odors.

Discussion

Exposure levels of hydrogen peroxide and acetic acid were extremely low during this survey. It would be expected that peracetic acid results would be lower than those for acetic acid because the amount of peracetic acid in the liquid product is 33% lower than the amount of acetic acid and they have similar vapor pressures: the vapor pressure of acetic acid is 2.0 kPa at 25°C and the vapor pressure of peracetic acid is 1.93 kPa at 25°C.

There is not currently a Cal/OSHA or OSHA permissible exposure limit for peracetic acid, although there are EPA Acute Exposure Guideline Levels (AEGLs) for peracetic acid. The AEGL-1 is 0.17 ppm for exposures ranging from 10 minutes to 8 hours. The AEGL-1 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort or irritation. However, the effects at this level are not expected to be disabling and are transient and reversible once exposure has ceased. The AEGL-2 is 0.52 ppm for exposures ranging from 10 minutes to 8 hours. The AEGL-2 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

The Cal/OSHA PEL for acetic acid is the same as the American Conference of Industrial Hygienist (ACGIH's) Threshold Limit Value – Time-Weighted Average (TLV-TWA) of 10 ppm. In a

discussion of chronic respiratory health effects, including asthma, the ACGIH Documentation of the Threshold Limit Values for acetic acid states “the expectation is that the existing TLV-TWA of 10 ppm...would reduce the risk of the development of chronic respiratory symptoms.” Although it is not known what the threshold is for asthma causation for either acetic acid or peracetic acid, exposure levels would be expected to be extremely low during regular use of SaniDate[®], as demonstrated by the findings in this report. Therefore, use of SaniDate[®] would be expected to pose a lower asthma risk, compared to sanitizer and disinfectant products containing bleach or quaternary ammonium compounds, which are generally known to contain greater amounts of active ingredients and would be expected to result in higher exposure levels.

According to SFPD personnel who have worked with child care centers and have trained workers, and based on statements made by workers during the survey, child care center staff have had no complaints of irritation when using these products, which they did have when they used bleach.

When child care centers in San Francisco first switched to SaniDate[®] there were reports of employees noticing a “vinegar” odor. The original bulk 1-gallon bottles were shipped without a seal under the cap and it was thought that the acetic acid was offgassing during storage. Since then the manufacturer has shipped these bottles with a seal and these reports have subsided. One staff member in one of the infant rooms said she could smell vinegar when she first opens a bottle, but not when she sprays the product. The odor threshold range for acetic acid is reported as 0.037 to 0.15 ppm so it is possible to smell acetic acid at very low levels, far below the permissible exposure limit. Odor is not a reliable indicator of exposure, however, because individuals vary in their ability to detect smells.

Usage rates in some rooms appear to be uneven from day to day (see Tables 3 and 4). For example, the use of both products in Room 3 and the use of SaniDate[®] in Rooms 8 and 9 were disproportionately high on the day of the survey compared to the total for the week for those rooms and compared to usage in other rooms. The hydrogen peroxide results for the Room 3 and Room 8 surveys were slightly higher than the results in the other rooms and the higher usage may account for this. In both Rooms 8 and 9, 11 ounces of SaniDate[®] were used, which is more than a third of the 32 oz. spray bottle and appears excessive compared to the amounts used in other rooms. The next highest level was in Room 3, which used 5 ounces.

Recommendations

1. Conduct an employee training to share the results of this investigation.
2. For all chemicals used in the workplace, make sure that Hazard Communication Training is conducted. Emphasize that employees should report to their supervisors any symptoms such as irritation, wheezing, coughing, etc., that they attribute to the products they use.
3. In general, the use of all pesticides, including sanitizers and disinfectants, should be minimized. They should be reserved for use only when it is required by code or Quality Assessment rules. For cleaning non-regulated areas or non-Quality Assessment required areas, such as cubbyholes, shelves, the upper portion of doors and windows, etc., a third-party certified environmentally preferable cleaner (such as those certified under the Ecologo CCD-146 Hard Surface Cleaners Standard) should be used.
4. Where sanitizers or disinfectants are necessary, use good work practices such as spraying the products as far from nose and mouth as possible (i.e., at arm's length) and then leaving the area during the required dwell time.
5. Review practices to ensure that overuse of products is not occurring.
6. Conduct a regular review of new products coming into the market to search for safer alternatives. The Center can work with the SFDPH to help determine if a product is preferable.
7. Latex is a well-known allergen and asthmagen and should be avoided whenever possible. Switching to non-latex gloves, such as nitrile, would be a simple way to avoid this exposure.
8. Air fresheners can contain chemicals that cause or trigger asthma and lead to other health problems. Prohibit the use of air fresheners and have the ventilation system evaluated in offices where there are complaints about stagnant air or about odors to ensure there is adequate fresh air being delivered.

To summarize, the results from this survey show that the use of SaniDate® and Oxivir TB® on the day of the survey resulted in exposure levels to hydrogen peroxide that were low and resulted in exposure levels to acetic acid that were non-detectable.

OHB appreciates the cooperation ASI-ECEC provided to us during this evaluation and the assistance provided by SFDPH.

References and Links

Association of Occupational and Environmental Clinics (AOEC) Exposure Code Online Lookup and Asthmagen Criteria: <http://www.aoec.org/tools.htm>

Odor Thresholds for Chemicals with Established Occupational Health Standards, American Industrial Hygiene Association, 1989.

US Environmental Protection Agency: Acute Exposure Guideline Levels
<http://www.epa.gov/opptintr/aegl/index.htm>

Documentation of the Threshold Limit Values and Biological Exposure Indices, 7th Edition, American Conference of Governmental Industrial Hygienists, 2001.

Ecologo CCD-146: Hardsurface Cleaners:
http://www.ecologo.org/en/seeourcriteria/details.asp?ccd_id=371