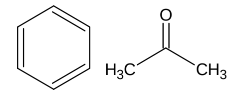
Recognition
Evaluation
Control



General Casualty
Environmental Health Newsletter March 2009

This is the first edition of a quarterly EH related newsletter designed to provide technical information to Loss Control staff. Each quarter there will be three or four articles on various topics. Some may be related to things I have encountered in the field while others may be things in the news or related to OSHA or other regulatory activity. If you encounter any unusual exposures in the field or have ideas for topics, please let me know.

Erik Goplin CIH, CSP
Environmental Health Specialist

Swimming Pool Chemicals

Swimming pools are encountered from time to time during Loss Control surveys and we write a number of risks that have swimming pools on the property. Besides the general liability issues regarding slips, falls, accidental drowning, attractive nuisance, etc.; pools also pose a risk for potential Work Comp related losses due to chemical exposures.

As we all know, swimming pools are prone to growth of algae, bacteria and other microbial organisms and chemicals are used to control these organisms. Swimming pool chemicals include disinfectants and sanitizers and most are based on chlorine as the active agent.

Swimming pool water treatment chemicals can become hazards when they become wet or if they are mixed improperly. These chemicals can also be self reactive over time. Each year there are numerous incidents relating to exposure to toxic chemicals and fire caused by pool chemicals. I know of at least one claim at GC relating to exposure to pool chemicals. We need to be aware of these hazards as well as controls when we look at swimming pools.

There are two types of chlorinators. The first class are the inorganics. These include:

- Calcium hypochlorite (Cal Hypo)
- Lithium hypochlorite
- Sodium hypochlorite
- Chlorine gas

The most common pool disinfectant is calcium hypochlorite or Cal Hypo. Sodium hypochlorite in diluted form is common household bleach. Chlorine gas is sometimes used at large swimming pools. The organic chlorinators include:

- Trichloroisocyanuric acid (Trichlor)
- Potassium dichloroisocyanurate (Dichlor)
- Sodium dichloroisocyanurate (Dichlor)
- Sodium dichloroisocyanurate dihydrate (Dichlor)
- Brominated Hydantoin

Isocyanurates form cyanuric and hypochlorous acid in water solutions. Trichloroisocyanuric acid (Trichlor) is the most common isocyanurate disinfectant.

These chemicals are all oxidizers which release the chlorine ions that kill algae, bacteria and fungi. Organic and inorganic chlorinators are completely incompatible with each other. Many incidents occur because they are mixed either accidentally or intentionally. One product might be scooped into another or added together in a pail or in the pool chlorination equipment. They might be mixed when spilled material are swept up together and mixed in a disposal container. When Cal Hypo is mixed with an isocyanurate like Trichlor they react explosively and highly toxic chlorine gas is produced. These chemicals are also incompatible with many other chemicals such as ammonia, gasoline, paints, solvents and pesticides. They are water reactive. Under normal circumstances, these chemicals are intended to be added to very large volumes of water. If instead, a small amount of water is added to the chemical, an unwanted chemical reaction can occur. Even a small amount of water can trigger a strong reaction. Accidental mixing with incompatibles or water can generate temperatures high enough to ignite nearby combustibles so they should also be stored away from combustible materials.

Swimming pool chemicals need to be stored in a secure area with access limited to authorized employees who are properly trained to use the materials. The storage area should be cool and dry and well ventilated and preferably in a detached location. Areas should be posted with signs identifying the major hazards of the chemicals stored in the area. Smoking should be prohibited in the storage area and the area should be clean and good housekeeping practices should be in place. Other chemicals like paints, solvents soaps, oils, etc. should not be stored in the same area as pool chemicals. If chlorine gas is used, cylinders should be upright and secure to prevent tipping and with valve caps in place. Pool chemicals should not be stored in basements or near elevator shafts, ventilation systems or other openings that might spread gases through the building if a leak occurs. Spilled chemicals should never be returned to the original container. Employees who apply pool chemicals should be properly trained so that they know how to apply the chemicals safely, use the proper mixing and application techniques, know the proper dosage, and how to use personal protective equipment.

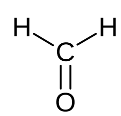
Special emergency plans should be in place. Employees should not attempt to cleanup large spills, fight fires or deal with runaway chemical reactions. Outside help will be required. Emergency responders may need to wear SCBAs (self contained breathing apparatus) and special fire fighting procedures need to be employed.

When evaluating pools and pool chemical storage here are few things to check into:

- Where are the chemicals stored?
- How are they secured?
- What are the specific types of chemicals used?
- What are the quantities of chemicals on site?
- Is there any evidence of water leaks or water entry into the storage area?
- Are there combustible materials in the storage area?
- Are there warning sings posted at the storage area?
- How are incompatibles chemicals segregated?
- Is the storage area clean or is there evidence of spills?
- What are the procedures for cleaning up spills?
- What training is conducted?
- Are minors involved in any way with the pool chemicals?
- What PPE is used when handling the chemicals?
- How are chemicals dispensed and transported?
- What are the procedures for emergency situations?

Keep in mind that these same issues apply to hot tubs, spas, wading pools and whirlpools since the same chemicals may be used at these applications as well.

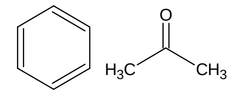
Chemical Awareness-Formaldehyde



Our chemical focus this quarter is formaldehyde. Formaldehyde is one of the most import industrial chemicals with widespread use in many products and operations. It's a colorless gas with a pungent, irritating odor. The odor threshold is reported as 0.83 ppm with a range of 0.05 to 1.0 ppm. It is commonly sold as formalin which is a methanol stabilized water solution containing 37% to 50% formaldehyde. It is sold in this form since formaldehyde readily polymerizes when in the gas phase. The major use of formaldehyde includes urea-formaldehyde and phenol-formaldehyde resins, as well as melamine and polyacetal resins. Other uses include production of many other chemicals, fertilizer, dyes, disinfectants and germicides. The germicidal properties of formaldehyde have lead to widespread use as a preservative in shampoos, conditioners and water based paints as well as disinfecting treatments for grain and agricultural products.

Formaldehyde is a skin, eye and respiratory tract irritant. Eye irritation is reported at levels as low as 0.1 ppm while respiratory irritation is reported at levels of 0.3 to 0.5 ppm. Employees can become acclimated to formaldehyde with symptoms disappearing at these levels. Formaldehyde exposure can also lead to allergic-type skin and respiratory effects. Some individuals can become highly responsive to low doses leading to dermatitis, rhinitis and asthma. Formaldehyde is classified as a suspected human carcinogen. The ACGIH has established a TLV of 0.3 ppm as a ceiling level to prevent irritative effects and to minimize the cancer threat. OSHA has a specific formaldehyde standard (29 CFR 1910.1048) with a PEL of 0.75 ppm and a STEL of 2 ppm. The standard includes air monitoring, medical evaluation, personal protective equipment and training requirements.

Since formaldehyde containing resins and adhesives are so common, it has been a common indoor air quality issue. In the indoor environment, formaldehyde is produced by off-gassing of fabrics, building materials and insulation. That new carpet or



vehicle odor is a complex mixture of organic chemicals that may include formaldehyde that off gases from the product. As the product ages, these emissions gradual dissipate. One of the major emission sources is fiberboard, particle board and plywood adhesives. Studies have shown that formaldehyde concentrations typically range form 0.06 to 2 ppm in homes where pressed wood products are used. The Department of Housing and Urban Development (HUD) has standards for product emission of formaldehyde which are designed to maintain levels in homes below 0.4 ppm. During the past few years, manufacturers have been able to drastically reduce formaldehyde off-gassing in these products. ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) recommends that formaldehyde levels be maintained below 0.06 ppm in indoor environments based upon World Health Organization (WHO) studies. Formaldehyde is one of the contaminants I typically monitor when doing indoor air quality investigations.

At General Casualty we are most likely to see formaldehyde in three main areas. These include:

- In association with adhesives and resins
- Germicidal and disinfectant applications
- In certain plastics

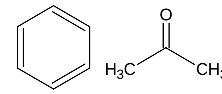
Many adhesive systems are based on formaldehyde-urea, formaldehyde-phenol or formaldehyde-melamine formulations. Look for this application where gluing, lamination processes or paper coatings are applied. At General Casualty we insure companies where a flame retardant coating is applied to fabric and various photo finishing films are applied to paper. These coatings contain formaldehyde resins. Companies that do extensive gluing or laminating of wood products may use formaldehyde based resins. Formaldehyde-melamine resins are used for laminate floorings and countertops. Formica® is a trade for a common formaldehyde-melamine composite.

These formaldehyde based resins and adhesives are thermosets. Thermosets are cured by heating which causes an irreversible chemical reaction. Reheating results in decomposition before the melting point is reached so thermosets cannot be re-melted and reshaped. Be alert for processes where heat is to cure resins. This may ne an indicator that a formaldehyde based resin is being used.

One interesting case comes to mind from years ago when I did some formaldehyde monitoring at a facility that made door jams and frames. Large amounts of particle board were cut at gang saws in the operation and the saw operator was overexposed to formaldehyde. Testing revealed that when the saw's blades were sharp at the beginning of the shift there were no overexposures. By mid day however, the saw blades were getting dull which caused more frictional heating of the particle board. This heating caused the adhesives in the particle board to thermally decompose creating the formaldehyde exposure. The issue was addressed by changing out the blades half-way through the shift each day with freshly sharpened blades.

Plastic injection molding is another common place we might run into formaldehyde. The first commercial synthetic polymer was invented by Leo Bakeland and is know as Bakelite. Since that time other polymers containing formaldehyde were developed. These include a melamine based polymer known as Melmac. Bakelite and Melmac aren't used much today since many other polymers with superior qualities have been developed, but we still may run into them. The most likely polymers containing formaldehyde that we run into are a class called polyacetal polymers also called acetal polymers. The most common one I encounter is Delrin® made by DuPont. During thermal processing these acetal polymers are easily decomposed into the starting chemicals (monomers). In this case its formaldehyde. Overexposure to formaldehyde is common when acetyl polymers are overheated during processing. Generally, local exhaust ventilation including canopy hoods should be in place over plastic injection molding machines where acetyl polymers are processed.

The last area where we commonly encounter formaldehyde is when it is used as a germicide or preservative. Some of these applications include metal workers where water based metal working fluids are used and spray painting with water based paints and stains. Formaldehyde is in these types of materials at a low level to



prevent microbial growth. Exposures are usually low I have found overexposures at spray finishing operations.

If you have any questions about formaldehyde, resins, polymers, thermal decomposition products of certain plastics, I have much more information.

Nanoparticles and Nanotechnology- Hazards of the Future?

Nanotechnology is a term that you may have heard of recently. It has been a hot topic at safety and health conferences. General Casualty probably does not have any accounts that are directly involved with this new technology at this point but the National Science Foundation estimates that there will be a $1 trillion impact globally by 2015 with as many as 1 million workers in the United States working in industries involved with nanotechnology.

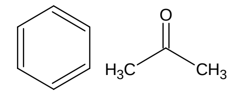
What is nanotechnology and a nanoparticle? According to the U.S. National Nanotechnology Council, a nanoparticle is a structure with at least one dimension that is 1-100 nanometers (nm). A nanometer is extremely small. 1 nm is 10^{-9} m or one millionth of a millimeter. For a sense of scale, the diameter of a human hair is 10,000 to 50,000 nm and the diameter of a red blood cell is about 5,000 nm. The term nanotechnology can be misleading since it is not a single technology but rather a multidisciplinary grouping of physical, chemical, biological, engineering and electronic processes, materials or applications in which the defining characteristic is size. Much of the hype involved with nanotechnology stems from novel and unpredictable characteristics that are exhibited by materials when they are at the micro scale. These include extraordinary strength, chemical reactivity, electrical conductivity, or other characteristics. For instance, nanotubes are a particularly novel form of nanoparticle. They are elongate carbon tubes 1-2 nm in diameter that can be made to more than 1 mm in length that are 100 times stronger than steel and only one sixth the weight making them the strongest fiber known. They also exhibit high conductivity and unique electronic properties. Applications include polymers, construction composites, electromagnetic shielding, super capacitors, batteries, and hydrogen storage. Other nanoparticles include nanowires, nanocrystals and quantum dots which have applications for nanoelectronic devices and microchips. Other products that currently incorporate nanoparticles include cosmetics, self cleaning windows, stain and wrinkle free fabrics, polymer films and coatings and butyl rubber/nanoclay composites.

As with any new form of technology, the health and safety research lags behind the research associated with the application of the new technology and this is a major concern. It was decades after asbestos, lead and many other highly toxic materials were incorporated into everyday products that the health hazards of these materials were identified. By then there were large numbers of workers as well as the public whose health was impacted by these materials. This is one of the concerns with nanotechnology. Ongoing research is being conducted to investigate potential health hazards to prevent widespread problems down the road. Some of the issues arising from a review of the studies include:

- Nanoparticle nomenclature in not sufficiently well described or agreed upon
- There are no convenient methods for measuring or assessing nanoparticles in the workplace
- There is insufficient knowledge concerning nanoparticle exposure
- The effectiveness of control approaches has not been evaluated
- There is not enough knowledge to adequately perform risk assessments

Initial research with laboratory animals has demonstrated increased biological activity of nanoparticles compared to larger particles of the same material. The properties of nanoparticles including size, surface area, surface coating, shape, solubility, charge and other factors influence their biological activity and potential toxicity. The small size allows nanoparticles to enter cells and organs within the cells where they can disrupt cellular processes. The animal studies have also shown that nanoparticles avoid engulfment by macrophages, which are a clearance mechanism for particles in the respiratory system. They also cause inflammation and

Recognition
Evaluation
Control



General Casualty
Environmental Health Newsletter March 2009

fibrosis and are translocated into the blood stream. Nanoparticles have been shown to translocate from the nasal passage to the olfactory lobe of the brain in rats. One of the basic tenants of toxicology is the principle of dose response. This is where a specific dose (mass) of a substance elicits some sort of an effect. In the case of nanoparticles, it appears that surface area rather than mass of a substance becomes more important. Nanoparticles have very high surface areas so they have more active sites where chemical reactions can take place and this seems to be the cause of the increased biological activity. More research is needed in this area.

Another potential concern with nanoparticles is fire and explosions. Although there has been little research in this area, nanoscale particles could pose a higher risk than larger particles because of the increased surface area as well as increased dispersion in the air.

Control of hazards associated with nanoparticles involves:

- Identifying hazards
- Assessing risk
- Preventing or controlling the risk
- Evaluation of effectiveness

This is the same approach used for any potential hazard. Assessment of risk should be made based upon the best available information. Strategies to control nanoparticles may include:

- Total process enclosure
- Partial enclosure with local exhaust ventilation
- General ventilation
- Limiting the number of workers in an exposure area
- Reduction in period of exposure
- Regular cleaning of surfaces
- Use of PPE
- Prohibition of eating and drinking in exposure areas

Filtration plays an important role in control of particulate matter regardless of the size. Filtration of nanoparticles with HEPA (High Efficiency Particulate) filter media should be effective. This is because very small particles under 100 nm in size are governed by Brownian diffusion. Brownian diffusion is caused by collisions between particles and the air molecules and creates random paths which the particles follow. Particle momentum plays no part in the movement of nanoparticles like it does with larger particles, for instance from a grinder or saw blade where the larger particles are thrown in the direction of the revolving grinder or saw blade. In this respect, nanoparticles behave more like vapors than particles. When particles governed by Brownian motion enter a HEPA filter, the random motion increases the probability that the particle will contact a filter element. Electrostatic charges on the particles cause them to adhere to the filter media. There has not been much work done at this point to quantify filter performance but it is widely accepted that with diffusion being the dominant mechanism for particle movement efficiency of filters will be high.