Use of Methyl Ethyl Ketone Peroxide in an Assisted Living Facility

In January 2016, the Environmental Epidemiology Program (EEP) at the Utah Department of Health (UDOH) received a request for technical assistance from the Our House Assisted Living of Provo facility in Provo, UT regarding potential health effects of exposure to methyl ethyl ketone peroxide (MEKP).

Methyl ethyl ketone peroxide, also known as 2-butanone peroxide, is a strongly oxidizing (caustic) organic peroxide that is commonly used in the manufacture of acrylic resins and as a room temperature hardening and curing agent for fiberglass-reinforced plastics and unsaturated polyester resins (HCN, 2002; NTP, 1993). At room temperature, it is a colorless to yellow liquid with a characteristic or mint-like odor (NIOSH, 2007; NTP, 2016). As MEKP is shock, sunlight, and heat sensitive, it is typically sold commercially in a solution of 30 – 60% MEKP mixed with diluents like dimethyl phthalate, cyclohexane peroxide, or diallyl phthalate to prevent explosions (HCN, 2002; NIOSH, 2007). It can also undergo spontaneous ignition or explosion if mixed with oxidizable organic, flammable, or chemical materials (HCN, 2002; NOAA, 2015).

When MEKP is used as a hardening or curing agent, the duration of the reaction is dependent on both the type of resin being cured as well as the formulation of the MEKP solution. Typical reactions contain approximately 1 - 2% MEKP. In a series of experiments, the 'time to cure' was roughly 40 - 50 minutes for a commercial MEKP formulation (CI, 1999). The 'time to cure' is the time from the initiation of the reaction to when the peak temperature is reached (often in excess of 350°F), which is not necessarily the end of the reaction. Though it is sometimes incorrectly called a catalyst, MEKP is not a true catalyst as it is consumed in the reaction (Juska & Puckett, 1997).

Studies of the health effects of MEKP are limited and primarily focus on short-term exposures to relatively large amounts of the chemical. Rats and mice exposed to MEKP (45% in dimethyl phthalate) on their skin for two and thirteen weeks developed a spectrum of necrotic, inflammatory, and regenerative lesions at the application site. Increased formation of red and white blood cells in the spleen and bone marrow was also observed (NTP, 1993). Direct exposure to the eyes of rabbits resulted in damage, with severe injury occurring with two drops of 40% MEKP. Three percent MEKP caused a more moderate reaction that improved after two days (Hathaway & Proctor, 2014). Several studies have examined inhalation exposure in mice and rats; the concentration needed to kill 50% of the animals (known as the LC_{50}) in four hours was 170 parts per million (ppm) in mice and 200 ppm in rats (HCN, 2002; NIOSH, 2009).

Very little data exists on human exposures to MEKP. The majority of information is on accidental exposures in the workplace, along with rare intentional exposures. A 1990 study of eye injuries in 19 patients from a single exposure to MEKP vapor or solvent (both full strength and diluted) found that the damage ranged from mild to severe. Delayed onset keratitis (an inflammation of the cornea, the transparent front part of the eye) was observed in some patients, potentially due to an autoimmune response. The length of time between the exposure to MEKP and adequate rinsing of the eyes was identified as a major factor in injury severity (Fraunfelder et al., 1990; NTP, 1993). Case reports show that ingestion of MEKP can cause acute toxic symptoms like nausea, vomiting, gastrointestinal bleeding, perforation of the stomach,

abdominal burns, tightening of the esophagus, severe metabolic acidosis, rapid liver failure, respiratory failure, and in severe cases, death (Hathaway & Proctor, 2014; HCN, 2002; NTP, 1993).

Neither the National Toxicology Program (NTP), the Environmental Protection Agency, nor the International Agency for Research on Cancer have evaluated MEKP for its potential to cause cancer (OSHA, 2012). There is some evidence that MEKP may be carcinogenic, as it showed weak tumor promoting activity when applied to the skin of mice also exposed to ultraviolet light (HCN, 2002; NTP, 1993).

Although inhalation exposure of aerosolized MEKP likely occurs in the workplace (NTP, 1993), the EEP was unable to find studies detailing the health effects of MEKP inhalation. Non-occupational inhalation exposures may occur during the use of fiberglass resin kits that contain MEKP (e.g., for boat or automobile repair) (Galvin & Farr, 1993). As described above, animal studies show that breathing MEKP can result in harm. The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) of 0.2 ppm; similarly, the American Conference of Governmental Industrial Hygienists (ACGIH) also uses 0.2 ppm for their threshold limit value (TLV). Neither are legally enforceable levels, and OSHA has not established a regulatory level for MEKP (OSHA, 2012). However, neither the NTP nor NIOSH list a vapor pressure for MEKP, rendering it difficult to infer how easily the chemical might volatilize into the air (NIOSH, 2007; NTP, 2016). It is also important to note that RELs and TLVs are developed for workplace exposures, and are intended to be used in conjunction with engineering controls, exposure monitoring, and appropriate worker training and personal protective equipment (NIOSH, 2007).

In conclusion, the EEP recommends that great care be practiced with the use of this chemical in an assisted living facility, where residents are likely very sensitive to harm from inhalation exposures due to pre-existing conditions. Workers using this chemical should ensure that proper ventilation is maintained through all phases of work, and that any chemical off-gassing has ended prior to allowing residential access to or near areas, where this chemical was used.

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