MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

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INTEROFFICE COMMUNICATION

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TO: File for Zinc oxide [CAS # 1314-13-2]

FROM: Doreen Lehner, Toxics Unit, Air Quality Division

DATE: December 1, 2017

SUBJECT: ITSL for Zinc Oxide

The initial threshold screening level for zinc oxide [CAS # 1314-13-2] is 20 µg/m^3 based on an 8-hour averaging time.

Zinc oxide is an inorganic compound with the formula ZnO and has a molecular weight of 81.38 g/mol. Zinc oxide is an odorless, white powder that is insoluble in water and is used as: an additive in rubbers, plastics, ceramics, glass, cement, lubricants, paints, ointments (e.g., sunscreen), adhesives, sealant, pigments, foods, batteries, fire retardants, first-aid tapes; as a wide-bandgap semiconductor in transparent electrodes in liquid crystal displays, energy-saving windows, thin-film transistors, and light-emitting diodes.

Zinc is an essential element in the diet. Zinc is important in cellular metabolism. Zinc is required for the catalytic activity of approximately 100 enzymes including: immune function, protein synthesis, wound healing, DNA synthesis, and cell division. Zinc is essential for growth and development from the fetus through adulthood. Zinc is associated with the ability to taste and smell. The recommended daily allowance for zinc is: 2 mg/day for newborn to 6 months; 3 mg/day for children 7 months to 3 years of age; 5 mg/day for children 4 to 8 years of age; 8 mg/day for children 9 to 13 years of age; 9 mg/day for females 14 to 18 years old; 11 mg/day for males 14 years and up; 8 mg/day for adult females; and 12 mg/day for pregnant and nursing females (NIH, 2016). Insufficient or excessive zinc levels can cause toxicity or disease. “Zinc deficiency has been associated with dermatitis, anorexia, growth retardation, poor wound healing, hypogonadism with impaired reproductive capacity, impaired immune function, and depressed mental function; increased incidence of congenital malformations in infants has also been associated with zinc deficiency in the mothers” (ATSDR, 2005). “Zinc deficiency may also have an impact on carcinogenesis, though the direction of the influence seems to vary with the agent” (ATSDR, 2005). Zinc is readily absorbed orally and via inhalation. No evidence for percutaneous absorption of zinc was found from topical application in healthy skin, but if the skin is damaged zinc absorption can occur.

“There is evidence to suggest that exposure to zinc oxide fumes may impair lung function. Malo et al. (1990, 1993) present case reports of two workers exhibiting symptoms of metal fume fever with evidence of functional lung involvement. In the first case (Malo et al., 1990), a worker exposed to zinc oxide fumes reported chills with muscle aches and dyspnea; a chest radiograph revealed diffuse interstitial shadows. After a 10-day period of non-exposure, the chest radiograph was normal. A lung function test was performed after the worker was away from work for 30 days; forced expiratory volume in one second (FEV_1), forced vital capacity (FVC),

and the FEV_1/FVC ratio were normal. The worker was then exposed to his usual work environment for 1 hour on 2 consecutive days. Significant decreases in FEV_1 (16-20%) and FVC (10-11%) were observed on both days, 4-6 hours after exposure; buccal temperature was also increased and the worker experienced malaise and general muscle ache. In the second case (Malo et al., 1993), lung function tests were performed 3 months after the worker left work and after the worker returned to work for 1 day. A decrease in FEV_1 (24%) was observed after the worker returned to work (lung function was normal prior to returning to work). Total zinc concentration in the work environment were 0.26-0.29 mg/m^3" (EPA, 2005). The EPA (2005) integrated risk information system (IRIS) did not develop a reference concentration (RfC) for chronic inhalation exposure to zinc oxide. The EPA states that, "Available data are not suitable for the derivation of an RfC for zinc. A number of case reports of metal fume fever have been reported in humans; however, exposure levels are not known. The data in animals are limited to a few studies of acute duration; no subchronic or chronic inhalation studies of zinc are available at this time" (EPA, 2005).

ACGIH has a threshold limit value – time weighted average (TLV-TWA) of 2 mg/m^3 for respirable particulate mass to reduce the incidence of metal fume fever. Metal fume fever is characterized by chills, muscular pain, nausea, and vomiting. "…Work from Fine and co-workers (1997) has demonstrated that metal fume fever can occur after a 2-hour exposure at 2.5 mg/m^3 of freshly formed zinc oxide. These investigators also reported that although symptoms abated in all subjects after 3 daily exposures at 5 mg/m^3, pulmonary inflammation and cytokine production remained elevated in some human volunteers. Studies in rats and mice have similarly demonstrated that exposure at 1 or 2.5 mg/m^3 zinc oxide for 3 hours can produce biochemical, cellular, and molecular changes in the mammalian lung. In particular, studies in mice have demonstrated that the pulmonary response to zinc oxide fumes is strain dependent, suggesting a genetic component in the interindividual variability in response" (ACGIH, 2003).

According to Rule 232(1)(c), an ITSL can be derived from an occupational exposure level (OEL) when one is available. ACGIH has a TLV-TWA of 2 mg/m^3.

$$ITSL = \frac{OEL}{100} = \frac{2\ {}^{mg}/_{m^3}}{100} = 0.02\ {}^{mg}/_{m^3} = 20\ {}^{\mu g}/_{m^3}$$

Rule 232(2)(a), the averaging time is 8 hours for an ITSL derived from an occupational exposure level. Therefore, the ITSL for zinc oxide [CAS# 1314-13-2] is 20 µg/m^3 based on an 8-hour averaging time.

References:

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