Michigan Department of Environmental Quality

Interoffice Communication

TO: File for Molybdenum (CAS # 7439-98-7)

FROM: Doreen Lang, Toxics Unit, Air Quality Division

SUBJECT: Screening Level for Molybdenum (CAS # 7439-98-7)

DATE: March 31, 2009

The screening level for the elemental molybdenum and insoluble molybdenum compounds is 30 ug/m^3, while the screening level for soluble molybdenum compounds is 5 ug/m^3 based on an 8 hour averaging time.

A literature review was conducted to determine an initial threshold screening level (ITSL) for molybdenum. The following references and databases were searched to derive the above screening level: EPBCCD, IRIS, NIOSH, ACGIH TLV/BEI 2004 guide, DEQ library, NTP Study Database, IARC, Acute Database, CAS Online, NLM-online, EPA ACToR Database, Kirk-Othmer chemical encyclopedia, and Patty's Industrial Hygiene & Toxicology. The ITSL for molybdenum is dependent on whether the molybdenum is in a soluble or insoluble form. After reviewing all available data, there is evidence which indicates that elemental molybdenum and insoluble molybdenum compounds have a lower toxicity than soluble molybdenum compounds. The ITSL for molybdenum and insoluble molybdenum is greater than for the soluble form due to its relatively less reactive and therefore less toxic form.

Insoluble Molybdenum	Soluble Molybdenum
Molybdenum metal (Mo) [7439-98-7] MW 95.94	Molybdenum trioxide (MoO_3) [1313-27-5] MW 143.94
Molybdenum dioxide (MoO_2) [18868-43-4] MW 127.94	Calcium molybdate ($CaMoO_4$) [7789-82-4] MW 200.02
Molybdenum disulfide (MoS_2) [1317-33-5] MW 160.07	Sodium molybdate (Na_2MoO_4) [7631-95-0] MW 205.92
	Ammonium molybdate ($(NH_4)_6Mo_7O_{24} \cdot 4H_2O$) [12054-85-2] MW 1235.86

Molybdenum has many industrial uses due to its hardness at extremely high temperatures and ease of binding to other elements because of its many oxidation states (Patty's Toxicology – 5th ed. Vol 3 eds Bingham E., Cohrssen B., and Powell C.H. 2001. John Wiley & Sons). Molybdenum is used in the production of steel and other metal alloys, electronic parts, wire, induction heating elements, electrodes for glass melting, pigments, catalysts, lubricants, corrosion inhibitors, flame retardants and smoke suppressants, and

when combined with ammonia is used as a fertilizer (Patty's Toxicology – 5th ed. Vol. 3 eds. Bingham E., Cohrssen B., and Powell C.H. 2001. John Wiley & Sons).

The critical effect of oral exposure is increased uric acid levels in the blood, which may lead to copper deficiency (http://www.epa.gov/NCEA/iris/subst/0425.htm). Molybdenum inhalation causes irritation of the lungs and can cause neuromuscular affects which is not seen with molybdenum ingestion (http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~XgH2fN:2:BODY). Soluble molybdenum compounds are readily taken up through the lungs and GI tract. The highest levels of molybdenum are found in the liver, kidney, spleen, and bone. Molybdenum is excreted through the urine and bile. The biological half-life in the body can be up to several weeks in humans (Friberg, L. and Lener, J. (1986) as cited in ACGIH Documentation of the TLV's and BEI's with other world wide occupational exposure values 2003). Workers chronically exposed to molybdenum indicate incidences of weakness, fatigue, headache, irritability, lack of appetite, epigastric pain, joint and muscle pain, weight loss, red and moist skin, tremor of the hands, sweating, and dizziness (Walravens PA, Moure-Eraso R, Solomons CC, Chappell WR, Bentley G. Biochemical abnormalities in workers exposed to molybdenum dust. Arch Env Health. Sep/Oct, 302-308 (1979)). In another study workers had difficulty breathing, general weakness, dizziness, dry cough, pain in chest, expectoration, pneumoconiosis, and pulmonary hemorrhage (Molgilevskaya O.Y. (1967) as cited in ACGIH Documentation of the TLV's and BEI's with other world wide occupational exposure values 2003).

Since molybdenum effects on an organism are dependent on the route of exposure (http://wwwimoa.info/HSE/environmental_data/experimental/molybdenum_in_animals.html), the ITSL is derived from the ACGIH TLV values, which are based on respiratory exposure, instead of the RfD value listed in the EPA's IRIS database, which is based on oral exposure. In accordance with ACT 451, Part 55, R335.1232 (1) (c) the ITSL is determined as follows:

ITSL = OEL divided by 100

Where the occupational exposure level (OEL) is the lowest value of the NIOSH REL or the ACGIH TLV. Since the RfD value is not relevant to expected ambient exposure the ITSL is based on the ACGIH TLV of 3 mg/m^3 (R) for molybdenum and insoluble molybdenum compounds and the TLV of 0.5 mg/m^3 (R) for soluble molybdenum compounds.

The ITSL values listed above are for all insoluble and soluble molybdenum compounds above. Molybdenum trioxide also has an IRSL value because it has been found to be carcinogenic – see file CAS# 1313-27-5.

Based on the above data, the proposed ITSL for molybdenum metal and insoluble molybdenum compounds is 30 ug/m^3, while the ITSL for soluble molybdenum compounds is 5 ug/m^3 based on an 8 hour averaging time.