W. R. Grace & Co.-Conn.
Aluminum Molybdenum Oxide Product Stewardship Summary

I. Overview

Aluminum Molybdenum Oxide is a component in Grace hydroprocessing catalysts used by the petroleum industry for the refining of crude oil fractions like naphtha, kerosene and diesel under elevated pressure and temperature. These catalysts used are usually composed of oxides of Mo (Molybdenum), Co (Cobalt), Ni (Nickel), and W (Tungsten) on a matrix or carrier of alumina, silica or silica and alumina. Aluminum Molybdenum Oxide, as used by Grace, is generated and used in situ in closed industrial processes. The substance is incorporated into extrudates with other substances. Grace is not a commercial supplier of Aluminum Molybdenum Oxide.

II. Chemical Identity - Physical and Chemical Properties

Substance Name: Aluminum Molybdenum Oxide
CAS RN: 15123-80-5
EINECS No: 239-183-9
MF: Al2Mo3O12[7]
MW: 389.84[8]
Alternate Names: Aluminum molybdate; Dodecaaluminium trimolybdenum dodecaoxide
Alternate CAS RNs: N/A

Physical Chemical Properties

Melting Point: >1100 °C [9]
Boiling Point: N/A
Vapor Pressure: Non-volatile
Density: 3.7165 g/cm^3 [10]
pH: 4.34-4.78[12]
Physical State: solid[11]
Solubility: 23 to 264 mg/L; based on nominal concentration.[12]

III. Applications

Hydroprocessing catalysts are used in the refining industry within process reactors at industrial locations to upgrade heavy oils into lighter, more useful products by removing impurities such as nitrogen, sulfur and heavy metals, allowing less expensive feedstock to be used in the petroleum refining process. Hydroprocessing is an important process necessary to remove pollutants like sulfur, nitrogen and heavy metals from fuel oils. The purpose of removing sulfur (hydrodesulfurization) is to reduce the sulfur dioxide (SO_2) emissions that result from using those fuels in vehicles, aircraft, ships, gas and oil burning power plants, furnaces and other forms of fuel combustion. The level of allowed sulfur content in fuels is regulated and can only be achieved by using such hydroprocessing catalysts. The desulfurization reaction takes place in a closed fixed-bed reactor at elevated pressure and temperature. Typically, a combination of nickel and molybdenum is used in combination with other forms of hydroprocessing catalysts.

IV. Manufacturing Processes

Hydroprocessing catalysts are prepared by Grace by supporting molybdenum in combination with other metals on a carrier material. This process is known as impregnation. Hydroprocessing catalysts are typically supplied as extrudates or structured shapes such as asymmetric quadrilobes and spheres. Hydroprocessing catalysts supplied by Grace can be termed pre-catalysts because they must be sulfided to become active. Hydroprocessing pre-catalysts as supplied by Grace are not highly reactive, flammable or explosive.

V. Health Effects

Aluminum molybdenum oxide has low acute toxicity and minimal systemic toxicity. It is not corrosive and is neither a skin irritant nor eye irritant. Based on negative Ames assay it is not mutagenic, is not known to cause endocrine disruption and is not sensitizing. No studies related to carcinogenicity were located on aluminum molybdenum oxide and molybdenum is classified by the IARC as A3 – Confirmed Animal Carcinogen with Unknown Relevance to Humans. There are no reproductive assays available; however, based on aluminum citrate, there may be some potential for reproductive toxicity at high doses.

Although an essential dietary element, molybdenum may have health concerns at high doses, including lack of appetite, join and muscle pain, and altered blood chemistry; based on observations in humans, the chronic oral Reference Dose (RfD) for molybdenum and molybdenum compounds is 0.005 mg/kg/day and the subchronic RfD is also 0.005 mg/kg/day. High levels of aluminum exposure can also cause altered blood chemistry and neurological sequelae. Inhalation exposure is especially likely to lead to pulmonary fibrosis.

Aluminum and Molybdenum ions are rapidly absorbed from the gastrointestinal system. Adsorption after inhalation is likely compared to other soluble molybdenum species,

whereas an adsorption after dermal contact is low to negligible. The mechanism of absorption of Aluminum is fairly complex and not fully understood. Acute oral uptake or by dermal contact tests indicate a low toxicological profile. The substance is not sensitizing and not irritating to eyes and skin. In-vitro genetic toxicity assays with and without metabolic activation were negative.

Acute Toxicity:
Oral: > 2000 mg/kg bw (rat)
Dermal: >2000 mg/kg (rat)
Inhalation: > greater than 2.3 mg/L based on analogue substance.

Exposure Limit Data:
Molybdenum (as Mo):
Permissible Exposure Limit (PEL) - General Industry: 15 mg/m3
OSHA PEL - Construction Industry 15 mg/m3
OSHA PEL - Shipyard Employment 15 mg/m3
American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV): 10 mg/m3 (inhalable), 3 mg/m3 (respirable)
CAL/OSHA PELs: 10 mg/m3 TWA (total dust) 3 mg/m3 TWA (respirable)
NIOSH Immediately Dangerous to Life or Health (IDLH) concentration: 5000 mg/m3 (as Mo)

Exposure Limit Data:
Aluminum (Al):
OSHA Permissible Exposure Limit (PEL) - General Industry: 15 mg/m3 T
OSHA PEL - Shipyard Employment - 15 mg/m3 TWA
National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL)- 10 mg/m3 TWA
CAL/OSHA PEL: 10 mg/m3 TWA

VI. Environmental Effects

Based on acute aquatic tests Aluminium Molybdenum Oxide is not harmful in the aquatic compartment long-term studies however long term studies showed a reduction in the mean weight of fish, but no effects to aquatic invertebrates. As an inorganic salt it is not subject to biodegradation and bioaccumulation potential is low. Studies on macroorganisms (earthworm) indicated no acute effect in soil. In general the ecotoxicological concern can be expected to be low.

VII. Conclusion

Aluminum Molybdenum Oxide, as used by Grace, is generated in situ and used in a closed industrial process. The substance is incorporated in extrudates with other substances. The potential for exposure to humans or the environment of these extrudates with a diameter of more than 1 mm during manufacture is minimal. There were no identified exposures to consumers or children of this substance. Some potential concerns cannot be excluded for both human and aquatic toxicity; however, the use

pattern suggests negligible exposure potential. Therefore, the overall risk concerns would be low. Proper PPE should be used when handling the material to avoid potential dermal exposure.

VIII. W. R. Grace Contacts

Please feel free to contact one of the following Grace representatives should you desire additional information or have questions.

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IX. References, Literature and Other Sources of Information

Gordon Haxel, et al. US Geological Survey. *Rare Earth Elements – Critical Resources for High Technology* (USGS Fact Sheet 087-02). 2002. Page 4.

C. K. Gupta and Nagaiyar Krishnamurthy. *Extractive Metallurgy of Rare Earths.* CRC Press, 2004. Pages 43-44, 53.

Centers for Disease Control and Prevention, Registry of Toxic Effects of Chemical Substances (RTECS): OE5330000

European Chemicals Agency registered substances webpage: http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances