W. R. Grace & Co.-Conn.
Nickel Molybdate Product Stewardship Summary

I. Overview

Nickel molybdate 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 are usually composed of oxides/mixed metal oxides of Mo (Molybdenum), Co (Cobalt), Ni (Nickel), and W (Tungsten) on a matrix or carrier of alumina, silica or silica and alumina. Grace does not manufacture or supply pure nickel aluminate and all uses of this substance as supplied by Grace are limited to industrial applications.

II. Chemical Identity – Physical and Chemical Properties

Chemical Identity:

CAS# (EC inventory):	14177-55-0
CAS Name:	nickel molybdate
EC Number:	238-034-5
Molecular Formula:	MoNiO4
Molecular Weight:	218.63

Synonyms: molybdenum nickel tetraoxide, dioxido(dioxo)molybdenum; nickel(2+)

Physical-chemical properties:

- Nickel molybdate is an odorless solid in the form of a green powder
- Density: 3.3723 g/cm³ at 20.0°C (OECD 109)
- Melting Point: > 1000 °C (OECD 102)
- Solubility: 4652 mg/L at 20.0 °C and pH = 7 (OECD 105)

III. Applications

Nickel and molybdenum have many uses, the primary of which is in steel and alloy manufacturing. They are also used extensively as a chemical intermediate for catalytic purposes (e.g. for nickel molybdenum containing hydroprocessing catalysts). Hydroprocessing catalysts are used in the refining industry within process reactors at industrial locations to crack heavy oils into lighter, more useful products and to remove impurities such as nitrogen, sulfur and (heavy) metals, allowing less expensive feedstock to be used in the petroleum refining process. 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.

IV. Manufacturing Processes

Hydroprocessing catalysts are prepared by Grace by supporting necessary elements (e.g. Molybdenum, Tungsten, Cobalt, or Nickel) in their oxide state on a carrier material. This process is known as either pre or post impregnation. Nickel is obtained by Grace from suppliers as nickel carbonate or acetate. During the impregnation step it is converted into a soluble form. A second conversion takes place that occurs in the presence of oxygen. 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. The hydroprocessing catalysts supplied by Grace are not highly reactive, flammable or explosive. The manufacture, distribution and use of hydroprocessing catalysts supplied by Grace is performed under controlled and regulated conditions therefore, the potential exposure to the public and the environment is expected to be very low.

V. Health Effects

Nickel and nickel compounds are abundant in the earth's crust. They occur naturally from weathering rocks, soils, and windblown dusts. Nickel in the environment is also a result of fossil fuel consumption, nickel mining, processing and scrap metal reclamation. Molybdenum does not occur naturally as a free metal on earth, but rather in various oxidation states in minerals. Molybdenum may be released to the environment by the combustion of fossil fuels, waste waters from industrial processes, the transportation of ores, and distribution of sewage. Exposure to nickel molybdate occurs through inhalation, ingestion, and dermal contact. Nickel molybdate has comparable physical-chemical properties compared to nickel chloride or sulfate and therefore, data obtained on nickel chloride or sulfate can be used to help predict effects of nickel molybdate. Based on the similarity to water soluble nickel salts nickel molybdate is considered

carcinogenic to humans, is harmful if swallowed or inhaled, has been classified as a possible mutagen and reproductive hazard, and it may cause sensitization. Inhalation of nickel molybdate dust can irritate the nose, throat, and lungs, and may cause difficulty breathing or an allergenic respiratory reaction. The health effects of nickel molybdate are seen primarily where nickel molybdate comes in direct contact with living tissue such as in the lungs. When nickel molybdate is inhaled in large quantities in experimental laboratory animals, it has been shown to cause inflammation and injury to the lung tissues. This is noted to be a cumulative effect over time and is dose related. This means that the greater amount of nickel molybdate which is forced into the lungs of animals, the greater is this inflammatory reaction.

The potential for occupational exposure during the manufacture, distribution and use of Grace hydroprocessing catalysts containing nickel molybdate is controlled by the use of a combination of engineering controls, personal protective equipment and administrative controls. Workplace exposure limits exist for nickel compounds to help ensure exposure to personnel is limited. Many of the same controls help ensure exposure to the public is minimal.

VI. Environmental Effects

Nickel and molybdenum both are ubiquitous in the environment and are introduced from both natural occurrence in the earth's crust and from human sources. Elemental mining and burning of fossil fuels account for most of the nickel and molybdenum in the environment related to human activity. Nickel in sufficient amounts in both fresh water and marine environments have been shown to be toxic to a variety of life forms including plant species. While nickel is an essential nutrient for a variety of mammals including humans and non-mammals, the concentration of nickel in the environment must be controlled to protect marine organisms, plants and higher animals. Due to the fact that nickel molybdate is soluble in water and is both an acute and chronic toxin to aquatic life there is the need that proper controls be established to prevent the substance from entering waterways.

VII. Conclusion

The hydroprocessing catalysts in which the nickel molybdate supplied by Grace are important to refining industry because they are necessary to remove pollutants like sulfur, nitrogen and heavy metals from fuel oils. The primary risk of worker exposure to nickel molybdate is by dust inhalation and by dermal contact. Exposure potential is controlled in industrial settings by use process enclosures, ventilation and other strictly controlled conditions along with the use of personal protective equipment and administrative controls. The primary risk for environmental impact from nickel molybdate would be if the substance comes into contact with water. The risk of exposure for the general public and to the environment from Grace hydroprocessing catalysts containing nickel aluminate is largely limited to that which may occur in accidental situations due to the fact that these products are manufactured, transported and used in closed systems in industrial settings.

VIII. W. R. Grace Contacts

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

Brett Jurd Brett.Jurd@grace.com
Juergen Nolde Juergen.Nolde@grace.com

IX. References, Literature and Other Sources of Information

The International Agency for Research on Cancer **(**IARC) Nickel Oxide Monograph
http://monographs.iarc.fr/ENG/Monographs/vol100C/mono100C-10.pdf

ATSDR. 2005. ToxFAQs™ for Nickel. Agency for Toxic Substances and Disease Registry. [http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=244&tid=44]

Centers for Disease Control and Prevention, NIOSH Pocket Guide to Chemical Hazards Nickel metal and other compounds (as Ni)
http://www.cdc.gov/niosh/npg/npgd0445.html

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