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

I. Overview

Nickel aluminate 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. The catalysts used are usually composed of transition metal oxides such as Mo (Molybdenum), W (Tungsten) and Co (Cobalt) or Ni (Nickel) 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):	12004-35-2
CAS Name:	nickel aluminate
EC Number:	234-454-8
Molecular Formula:	Al2NiO4
Molecular Weight:	176.6541

Synonyms: dialuminum nickel tetraoxide, aluminum nickel oxide

Physical-chemical properties:

- Nickel aluminate is an odorless solid in the form of a green powder
- Density: 3.44 kg/m³ at 19.4°C (OECD 109)
- Melting Point: > 400 °C (OECD 102)
- Solubility (28d at 1 mg/L): < 1µg/L at 20.0-23.0 °C and pH = 6 (OECD 29)

III. Applications

Nickel aluminate manufactured by Grace is used solely as a chemical intermediate for catalyst purposes (e.g. for nickel containing hydroprocessing catalysts).

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 employed 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 transition metal oxides like molybdenum together with elements of the iron-platinum group such as nickel is used in combination with other forms of hydroprocessing catalysts.

IV. Manufacturing Processes

Hydroprocessing catalysts are prepared by Grace by supporting necessary elements (e.g. Molybdenum, Tungsten, Cobalt, or Nickel) in their oxide stage on a carrier material. This process is known as either pre or post impregnation. Nickel is typically obtained by Grace from suppliers as nickel carbonate. 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. Hydroprocessing catalysts as 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 is expected to be 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. Exposure to nickel occurs through inhalation, ingestion, and dermal contact. Nickel aluminate has comparable physical-chemical properties compared to nickel oxide and therefore data obtained on nickel oxide can be used to predict effects of nickel aluminate. Based on its similarity to nickel oxide it can be concluded that nickel aluminate is considered carcinogenic to humans. The health effects of nickel aluminate are seen primarily where nickel aluminate comes in direct contact with living tissue such as in the lungs. Inhalation of nickel aluminate dust can irritate the nose, throat, and lungs, and may cause difficulty breathing or an allergenic respiratory reaction. When nickel aluminate 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 oxide which is forced into the lungs of animals, the greater is this inflammatory reaction. It is not acutely toxic in animal tests on rats following the OECD 423 protocol

(LD50 oral > 5000 mg/kg bw) but may cause skin sensitization, an allergic reaction, upon repeated or prolonged contact.

VI. Environmental Effects

Nickel is ubiquitous in the environment and is introduced from both natural occurring nickel in the earth's crust and from human sources. Nickel mining, processing, scrap metal reclamation, and burning of fossil fuels, account for most of the nickel 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. Nickel aluminate is sparingly soluble in water however; controls should be established to prevent the substance from entering waterways.

VII. Conclusion

The primary risk of worker exposure to nickel aluminate is by dust inhalation and by dermal contact. Occupational exposure potential is controlled in industrial settings 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. The primary risk for environmental impact from nickel aluminate would be if the substance comes into contact with water. Because Grace hydroprocessing catalysts containing nickel aluminate are manufactured, transported and used in closed systems in industrial settings the risk of exposure to the general public and the environment is low.

V. 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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VI. References, Literature and Other Sources of Information

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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