October, 2021

PRODUCT STEWARDSHIP SUMMARY: CARBON NANOSTRUCTURES (CNS)

Overview

This Product Stewardship Summary provides a general overview of Cabot Corporation's carbon nanostructures (CNS), which include all ATHLOS™ CNS grades. CNS is used as a conductive additive in various applications.

Chemical Identity

CNS is composed of cross linked and branched multi-walled carbon nanotubes in which internal carbon nanotube walls are shared between adjacent tubes and can be considered a highly structurally entangled polymer of multi-walled carbon nanotubes. CNS is produced using a proprietary roll-to-roll chemical vapor deposition (CVD) process. It is then post-coated or encapsulated with polymer to form pellets.

The Chemical Abstracts Service (CAS) Inventory Expert Service (IES) does not presently have nomenclature rules or conventions with which to develop Chemical Abstracts (CA) Index Names or Numbers that are chemically complete or specific for this type of nanoscale chemical substance. CNS is listed in US EPA's Toxic Substances Control Act (TSCA) Inventory with the PMN number of P-12-576 (with the name "Infused carbon nanostructures"). CNS is registered under EU REACH as EC 951-407-3 with the name "Branched and cross-linked multi-walled carbon nanotubes".

Physical and Chemical Properties

CNS in general consists of at least 95% elemental carbon with low concentrations of hydrogen and oxygen. CNS is insoluble in water and organic solvents. Its vapor pressure is negligible. CNS is a highly entangled crosslinked polymer of multi-walled carbon nanotubes with a high molecular weight of up to 90,000. Therefore, the potential for bioaccumulation is negligible. CNS is an inorganic carbon substance and will not be degraded to carbon dioxide, or hydrolyze in water.

Uses

CNS products are intended to impart key performance features to the final product in which they are incorporated including:

- High electrical conductivity at low loadings, enabling light weighting
- EMI shielding performance
- Improvement of mechanical properties

Health Effects

Short-term CNS toxicity studies have shown that CNS does not cause acute oral toxicity, skin or eye irritation, or skin sensitization. It did not cause mutagenicity in an *in vitro* mammalian cell gene mutation test. It is noted that there is a specific type of long, rigid multi-walled carbon nanotube called MWCNT-7 that has been classified by the International Agency for Research on Cancer (IARC) as possibly carcinogenic to humans (Group 2B). Multi-walled carbon nanotubes other than MWCNT-7 are not

classifiable as to their carcinogenicity to humans (Group 3) (IARC 2017). CNS is not physically similar to MWCNT-7.

For its facilities, Cabot has adopted the National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL) for Carbon Nanotubes and Nanofibers as elemental carbon of 1 µg/m^3 (as respirable fraction), 8-hour time-weighted average (TWA) (NIOSH, 2013).

Environmental Effects

Based on its physical/chemical properties (insolubility, no vapor pressure), CNS released into the environment will be distributed mainly in soil or sediments. A dispersion stability test with CNS demonstrated that it cannot form a stable dispersion in water, and is completely insoluble. Thus, it is not possible to carry out many standard ecotoxicity tests for this substance. Since CNS is an inert solid, it does not have adverse biodegradability and is not bioaccumulative.

Exposure Potential

Once CNS pellets are incorporated into a polymer or other compounds, there is no observable release of free CNS even after mechanical processing such as sanding and grinding. This is shown by a study conducted by the National Institute of Occupational Safety and Health (NIOSH) on CNS (Bishop et al. 2017) and also Cabot internal studies using microscopy of collected debris and fracture surfaces.

Potential exposure to CNS could occur in the workplace when the CNS pellets are handled during compounding operations or during its production. However, workplace exposures can be managed appropriately with engineering controls and personal protective equipment. Cabot manages to the NIOSH REL of 1 µg/m^3 (as respirable fraction), 8-hour TWA. This value is the most stringent occupational exposure limit for the countries in which Cabot operates.

Risk Management

Risk is measured as a function of both hazard and exposure. If the hazard and/or exposure are low, the potential for risk is low. CNS exposure to workers is controlled through engineering controls and personal protective equipment as listed below.

- Cabot Corporation manages worker exposure to CNS in all its facilities to the NIOSH REL of 1 µg/m^3 (as respirable fraction), 8-hour TWA.
- Inhalation exposure is reduced by a combination of NIOSH certified respirators and engineering controls. The effectiveness of exposure controls may be verified via personal exposure monitoring using NIOSH Method 5040.
- Appropriate engineering controls will be used to capture at least 99% of CNS particulates from being released from the facility in fugitive or stack air.
- Any waste generated containing CNS is disposed of via incineration, or in accordance with local regulations.

Consumer exposure to CNS is negligible. Therefore, CNS is considered to pose a low risk to humans and the environment.

Cabot Corporation Contacts

We appreciate your interest in CNS. If you need additional information, please feel free to contact Cabot's Product Support and Toxicology Group at regulatory.inquiries@cabotcorp.com.

Disclaimer

This Product Stewardship Summary is intended to provide the general public with an overview of this chemical substance. It is not intended to provide emergency response, medical or treatment information. In-depth safety and health information can be found on the current Safety Data Sheet (SDS) for the product.

References

Bishop, L., et al. 2017. In Vivo Toxicity Assessment of Occupational Components of the Carbon Nanotube Life Cycle To Provide Context to Potential Health Effects. ACS Nano **11**(9): 8849-8863.

IARC, 2017. IARC monographs on the evaluation of carcinogenic risks to humans; volume 111. "Some nanomaterials and some fibres". International Agency for Research on Cancer, Lyons, France. https://monographs.iarc.who.int/wp-content/uploads/2018/06/mono111.pdf.

NIOSH, 2013. Current Intelligence Bulletin 65: Occupational Exposure to Carbon Nanotubes and Nanofibers. https://www.cdc.gov/niosh/docs/2013-145/default.html.

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