MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

INTEROFFICE COMMUNICATION

TO: File for Diammonium Phosphate (CAS No. 7783-28-0)

FROM: Michael Depa, Toxicologist, Air Quality Division

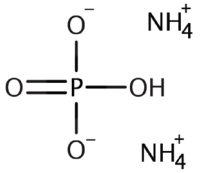
SUBJECT: Screening Level Derivation

DATE: July 30, 2024

In lieu of setting an Initial Threshold Screening Level (ITSL) for diammonium phosphate, use the National Ambient Air Quality Standard (NAAQS) for Particulate Matter (PM) to evaluate emissions and impacts. See footnote No. 26 of the Toxics Screening Level Query Notes.

A literature review was conducted to determine an ITSL for diammonium phosphate. The following references and databases were searched to derive the screening level: European Chemical Agency (ECHA) Registration, Evaluation, Authorisation *[sic]* and Restriction of Chemicals (REACH), United States Environmental Protection Agency (EPA) Integrated Risk Information System (IRIS), National Institute for Occupational Safety and Health (NIOSH®), American Conference of Governmental Industrial Hygienists (ACGIH®) Threshold Limit Values and Biological Exposure Indices (TLV/BEI) 2022 Guide, National Toxicology Program (NTP) Study Database, International Agency for Research on Cancer (IARC), Registry of Toxic Effects of Chemical Substances (RTECS®), Chemical Abstract Service (CAS) SciFinder®, PubMed®, EPA Computational Toxicology (CompTox) Database, EPA Provisional Peer-Reviewed Toxicity Values (PPRTVs), National Technical Information Service (NTIS), Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Level (MRL) database, and California Office of Environmental Health Hazard Assessment (OEHHA). NIOSH, ACGIH, EPA, ATSDR, and OEHHA have not derived health benchmarks for diammonium phosphate. Diammonium phosphate has a molecular formula of H9N2O4P, and a molecular weight of 132.056 g/mol.

Molecular Structure of Diammonium Phosphate



Background Information on Diammonium Phosphate

Excerpts for Wikipedia (Wiki, 2024)

> DAP is used as a fertilizer. When applied as plant food, it temporarily increases the soil pH, but over a long term the treated ground becomes more acidic than before, upon nitrification of the ammonium. It is incompatible with alkaline chemicals because its ammonium ion is more likely to convert to ammonia in a high-pH environment. The average pH in solution is 7.5–8. The typical formulation is 18-46-0 (18% N, 46% P2O5, 0% K2O). DAP can be used as a fire retardant. It lowers the combustion temperature of the material, decreases maximum weight loss rates, and causes an increase in the production of residue or char. These are important effects in fighting wildfires as lowering the pyrolysis temperature and increasing the amount of char formed reduces that amount of available fuel and can lead to the formation of a firebreak. It is the largest component of some popular commercial firefighting products.

In the manufacture of cigarettes, diammonium phosphate is added to tobacco at 0.5 to 1% (Stavanja et al., 2008).

Exposure Limits Derived from Unknown Toxicological Data

- Military Exposure Guideline (MEG) Negligible: 30 mg/m³ (TEEL-1) (CompTox, 2024)
- Protective Action Criteria (PAC) PAC1: 20 mg/m³ (CompTox, 2024)
- Occupational Exposure Limit (RUSSIA) Short-term exposure limit: 10 mg/m^3 (RTECS, 2024)

Inhalation Toxicity Study

In a 4-hour lethal concentration limit test, five male and five female Wistar rats (Crl:WI(Han)) were exposed to a concentration of 5.5 mg/L diammonium phosphate by nose-only inhalation (ECHA, 2024). There were no control animals. Animals were subjected to daily observations and determination of body weight on Days 1, 2, 4, 8 and 15. Macroscopic examination was performed after terminal sacrifice (Day 15). The mean actual time-weighed concentration was 4.84 ± 0.28 mg/L. The Mass Median Aerodynamic Diameter (MMAD) and geometric standard deviation (gsd) were determined twice. The MMAD was 6.0 mm and 5.6 mm, respectively, and the gsd was 1.8 in both cases. Agglomeration of aerosol particles at this high concentration resulted in MMAD values to exceed the recommended range of 1 to 4 µm. Additional efforts to reduce the MMAD were unsuccessful and the MMAD remained significantly larger than 4 µm (i.e., use of a micronizing jet-mill and two cyclones, lowering the concentration down to 1 mg/L). Since the geometric standard deviation of 1.8 determined during the actual exposure indicated that the aerosol was polydisperse, and since approximately 20% of the particles were smaller than 4 µm, it can be assumed that test substance deposition in the lower respiratory tract occurred during the exposure. It was therefore considered that the outcome of this study is valid for the limit concentration of 5 mg/L.

No mortality occurred and no clinical signs were noted during the study. The authors stated that overall body weight gain in males and females were within the range expected for rats of this strain and age used in this type of study. No abnormalities were reported at macroscopic post-mortem examination of the animals. Since no mortality occurred at the limit concentration, no full study using lower concentrations was conducted.

The 4-hour LC50 value of diammonium phosphate in Wistar rats was considered to exceed 5 mg/L (5000 mg/m³) under the conditions in this study.

Derivation of Candidate ITSL

A lethal dose limit test was the only toxicity study available to assess the inhalation toxicity of diammonium phosphate. Since there were no deaths after exposing male and female Wistar rats to 4 hours of diammonium phosphate at a concentration of 4840 mg/m³, the limit test can be considered to be a lethal concentration zero percent (LD0). This limit test can be considered as a lethal dose 50% test. Although over-estimating the inhalation risk of diammonium phosphate, the algorithm used to calculate an ITSL based on an LD50 (i.e., Rule 232(f)) can be used to derive a candidate ITSL as follows:

Candidate ITSL = LC50/(500 × 100) × unit conversion
Candidate ITSL = (4840 mg/m³)/(50,000) × 1000 µg/mg
Candidate ITSL = 96.8 µg/m³

Discussion

At >5 mg/l, the LC50 of diammonium phosphate dust is categorized as Category 4 and can be characterized a low acute toxicity (UNECE, 2014). In fact, since no animals died during the LC50 test, the 5 mg/l dose level should be assumed to be a lethal concentration 0%, or LC0. Using the 5 mg/l (5000 mg/m³) as an LC50 in the equation from Rule 232(f) to derive an ITSL is an over-estimate of inhalation risk. The inhalation health risk of diammonium phosphate dust is likely similar to generic dust. Because of the low acute toxicity of diammonium phosphate and that the candidate ITSL of 96.8 is greater than the NAAQS for PM, it is recommended that the NAAQS for PM be used to evaluate exposures to diammonium phosphate dust. The screening level footnote 26 should be used to evaluate exposures to diammonium phosphate:

> 26. This toxic air contaminant (TAC) is reasonably anticipated to exist as a particle in the ambient air. A toxicological review has determined that, in lieu of setting a screening level, the primary NAAQS for particulate matter (PM2.5, PM10) are reasonable and appropriate health protective levels for the particulate. The combined ambient impact of all particulate TAC emissions from the process must be below the applicable PM primary NAAQS (PM2.5, PM10). The PM primary NAAQS for particulate matter may be used in permit to install exemption determinations for this TAC under Rule 290(2)(a)(iii) or Rule 291.

References

ECHA. 2024. Dossier for Diammonium hydrogenorthophosphate. European Chemical Agency. Accessed 21 March, 2024. https://www.echa.europa.eu/web/guest/registration-dossier/-/registered-dossier/15555

Stavanja, Mari S., Curtin, Geoffrey M., Ayres, Paul H., Bombick, Elizabeth R., Borgerding, Michael F. et al. 2008. Safety assessment of diammonium phosphate and urea used in the manufacture of cigarettes. Experimental and Toxicologic Pathology 59 (2008) 339–353.

RTECS. 2024. Registry of Toxic Effects of Chemical Substances. Database. Canadian Centre for Occupational Health and Safety. Accessed 21 March, 2024. https://www.ccohs.ca/products/rtecs

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