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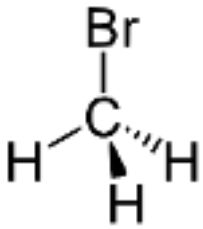
Methyl Bromide

Overview

Methyl bromide is a broad-spectrum pesticide used in the control of pest insects, nematodes, weeds, pathogens, and rodents. In the U.S., methyl bromide has been used in agriculture, primarily for soil fumigation, as well as for commodity and quarantine treatment, and structural fumigation (EPA).

Because MeBr depletes the stratospheric ozone layer, the amount of MeBr produced and imported in the U.S. was reduced incrementally until it was phased out in January 1, 2005, pursuant to obligations under the Montreal Protocol on Substances that Deplete the Ozone Layer and the Clean Air Act (CAA) (EPA). However, there are some exemptions that still allow the use of methyl bromide.

Chemical Description



The chemical name (IUPAC, CAS) for methyl bromide is bromomethane, and it is classified as an alkyl bromide. It is a colorless and odorless gas at normal temperatures and pressures, but the liquefied gas can be handled as a liquid (14.4 lb/gal) under moderate pressure. At very high concentrations it has a sweet, fruity odor.

Methyl bromide is readily soluble in lower alcohols, ethers, esters, ketones, halogenated hydrocarbons, aromatic hydrocarbons, and carbon disulfide. It reacts with strong oxidizers, magnesium, aluminum, tin, zinc, and alloys. It attacks aluminum to form aluminum trimethyl, which is spontaneously flammable (Methyl Bromide).

Uses

- The primary use of methyl bromide is as a fumigant in soil to control fungi, nematodes, and weeds; in space fumigation of food commodities (e.g., grains); and in storage facilities (such as mills, warehouses, vaults, ships, and freight cars) to control insects and rodents.
- Methyl bromide is also used as a chemical intermediate as a methylating agent, as a refrigerant, as a herbicide, as a fire extinguishing agent, and as a solvent in aniline dye manufacture; for degreasing wool; for extracting oils from nuts, seeds, and flowers; and in ionization chambers (EPA).

There have been both chemical and non-chemical alternatives to methyl bromide. EPA is trying to prioritize the registration of alternatives to methyl bromide.

Routes of Exposure and Metabolism

Methyl bromide can enter the body through inhalation by breathing air contaminated with methyl bromides, through skin or through eyes (PANNA).

Methyl bromide undergoes initial metabolism primarily by nucleophilic displacement of the bromide ion. When the attacking species is water, the products are methanol and bromide ion (ATSDR-Toxicological Profile for Bromomethane).

Also, the conjugation with glutathione appears to be an important part of metabolism and the toxification/detoxification process for methyl bromide (CA.gov).

Human Health Effects

Acute Health Effects

The symptoms of inhalation of methyl bromide are abdominal pain, convulsions, dizziness, headache, labored breathing, vomiting, weakness, hallucinations, loss of speech and incoordination. When exposed to skin, it can cause tingling and itching. It can also be absorbed in the skin: symptoms of absorption are redness, burning sensation, pain and blisters. Redness, pain, blurred vision and temporary loss of vision are the symptoms which occur when methyl bromide comes in the contact with eyes (PANNA).

EPA lists methyl bromide as "highly acute toxic".

Chronic Health Effects

It is listed as an endocrine disrupting chemical by the EU. According to the California Proposition 65 List, methyl bromide has effects on reproduction and development.

Environmental Health Effects

While methyl bromide is a natural substance (natural sources are ocean, plants, and soil), the additional methyl bromide added to the atmosphere by humans contributes to the thinning of the ozone layer, allowing increased UV radiation to reach the earth's surface, with potential impact not only to human health and the environment, but to agricultural crops as well.

Since methyl bromide is highly volatile, nearly all environmental releases of methyl bromide are into the-air. The most important anthropogenic releases are from fumigation activities, since methyl bromide is simply dispersed into the air after fumigation is completed. Gas-phase methyl bromide will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is about one year. If released to soil, methyl bromide has very high mobility. Volatilization from moist soil surfaces is expected to be an important fate process. Volatilization is relatively rapid, with half-lives ranging from 0.2 to 0.5 days, depending on depth. Methyl bromide volatilizes from dry soil surfaces based upon its vapor pressure. Chemical reactions, likely nucleophilic substitutions on soil organic matter, are the predominant pathway through which methyl bromide degrades in soil.

If released into water, methyl bromide is not expected to adsorb to suspended solids and sediment. Volatilization from water surfaces is expected to be an important fate process based upon this compound's Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 1.0 hrs and 3.9 days, respectively. Chemical hydrolysis is the primary degradation mechanism for methyl bromide in water. The potential for bioconcentration in aquatic organisms is low (National Library of Medicine, ATSDR).

Toxicity to organisms
Methyl bromide is moderately toxic to aquatic organisms. Acute toxicity in freshwater fish (bluegill sunfish) occurs at concentrations of 11 mg/L and in saltwater fish (tidewater silversides) at about 12 mg/L (EXTOXNET).

Precautions

Under the law, methyl bromide may only be applied by licensed applicators or those under their direct supervision. Licensed applicators must meet strict criteria governing safe handling, storage and use of the compound, which helps to reduce exposure potential.

Workers involved in methyl bromide application or the removal of containment after fumigation are likely to have the highest risk of exposure, followed by those workers who first re-enter the area after fumigation. To reduce this risk, regulations restrict re-entry to application sites and require personal protective clothing and equipment for people who handle the product.

Because methyl bromide is absorbed by the soil and readily dissipates in the atmosphere, bystanders such as farm workers in adjacent fields and those who live or work nearby are likely less at risk. Even so, depending on soil and weather conditions and proximity to the application site, bystanders may come into contact with residues as the compound disperses (Albemarle).

Regulation

In the U.S. the use of methyl bromide is regulated by:

- **Montreal Protocol**
  The Montreal Protocol is an international treaty developed to protect the earth from the detrimental effects of ozone stratospheric depletion. Since its initial signing by the United States and 26 other countries in 1987, virtually the whole world has signed on to the treaty (191 countries are now Parties to the treaty). The Parties to the Montreal Protocol agreed to specific reduction steps that lead to the phase-out of production and import of ozone-depleting substances, including methyl bromide.
  The Montreal Protocol required phase out in industrialized countries by the year 2005, and a future freeze in developing country use.

- **Clean Air Act**
  The Clean Air Act defines EPA's responsibilities for protecting and improving the nation's air quality and the stratospheric ozone layer (Clean Air Act).
  A 1998 amendment (P.L. 105-178, Title VI) conformed the Clean Air Act phase-out date with that of the Montreal Protocol (CRS Report for Congress).

There are allowable exemptions to the phase-out which include:
1) the Quarantine and Preshipment (QPS) exemption, to eliminate quarantine pests, and
2) the Critical Use Exemption (CUE), designed for agricultural users with no technically or economically feasible alternatives (EPA).

The 2011 nomination for exemptions from the phase-out of methyl bromide covers 15 crops and their uses, including tomatoes, strawberries, peppers, cucurbits, orchard replants, and post-harvest uses (EPA-2011 Critical Use Exemption Nominations from the Phase-out of Methyl Bromide).

External Links

- Int'l Chemical Safety Card
- NIOSH Pocket Guide to Chemical Hazards

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