Methane, bromochloro-: Environment tier II assessment

22 November 2013

CAS Registry Number: 74-97-5.

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Preface

This assessment was carried out by staff of the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) using the Inventory Multi-tiered Assessment and Prioritisation (IMAP) framework.

The IMAP framework addresses the human health and environmental impacts of previously unassessed industrial chemicals listed on the Australian Inventory of Chemical Substances (the Inventory).

The framework was developed with significant input from stakeholders and provides a more rapid, flexible and transparent approach for the assessment of chemicals listed on the Inventory.

Stage One of the implementation of this framework, which lasted four years from 1 July 2012, examined 3000 chemicals meeting characteristics identified by stakeholders as needing priority assessment. This included chemicals for which NICNAS already held exposure information, chemicals identified as a concern or for which regulatory action had been taken overseas, and chemicals detected in international studies analysing chemicals present in babies' umbilical cord blood.

Stage Two of IMAP began in July 2016. We are continuing to assess chemicals on the Inventory, including chemicals identified as a concern for which action has been taken overseas and chemicals that can be rapidly identified and assessed by using Stage One information. We are also continuing to publish information for chemicals on the Inventory that pose a low risk to human health or the environment or both. This work provides efficiencies and enables us to identify higher risk chemicals requiring assessment.

The IMAP framework is a science and risk-based model designed to align the assessment effort with the human health and environmental impacts of chemicals. It has three tiers of assessment, with the assessment effort increasing with each tier. The Tier I assessment is a high throughput approach using tabulated electronic data. The Tier II assessment is an evaluation of risk on a substance-by-substance or chemical category-by-category basis. Tier III assessments are conducted to address specific concerns that could not be resolved during the Tier II assessment.

These assessments are carried out by staff employed by the Australian Government Department of Health and the Australian Government Department of the Environment and Energy. The human health and environment risk assessments are conducted and published separately, using information available at the time, and may be undertaken at different tiers.

This chemical or group of chemicals are being assessed at Tier II because the Tier I assessment indicated that it needed further investigation.

For more detail on this program please visit: www.nicnas.gov.au.

Disclaimer

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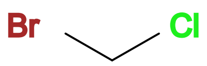
Acronyms & Abbreviations

Chemical Identity

Synonyms	Bromochloromethane BCM Chlorobromomethane Halon 1011
Structural Formula	
Molecular Formula	CH_2BrCl
Molecular Weight	129.38

(g/mol)	
SMILES	C(Cl)Br

Physical and Chemical Properties

The physical and chemical property data for this chemical were retrieved from the databases included in the OECD QSAR Toolbox (LMC, 2013).

Physical Form	Liquid
Melting Point	-87.9°C (exp.)
Boiling Point	68°C (exp.)
Vapour Pressure	19 100 Pa (exp.)
Water Solubility	16 700 mg/L (exp.)
Ionisable in the Environment?	No
log K_{ow}	1.41 (exp.)

Import, Manufacture and Use

Australia

Methane, bromochloro- (or bromochloromethane) is an ozone depleting substance. Ozone depleting substances are controlled under the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* (the Ozone Act) (Cwlth) in Australia.

Under the Ozone Act, bulk imports of the chemical are banned, unless it is for use as a feedstock. Additionally, the import, manufacture and use of any volume of the chemical (except for use as a feedstock) are prohibited by the Ozone Act. However, a licence may be obtained to gain an exemption from these requirements (Australian Government Department of the Environment, 2013a; Commonwealth of Australia, 1989).

Licences may only allow imports of the chemical for uses in accordance with Annex IV of the Seventh Meeting of the Parties to the *Montreal Protocol on Substances that Deplete the Ozone Layer* (the Montreal Protocol). Uses listed under Annex IV include use in research and development, analytical uses and regulated applications (for example, quality control), and laboratory use (Australian Government Department of the Environment, 2013b; UNEP, 1995).

The quantity of the chemical that is imported or manufactured for use as a feedstock must be reported to the Australian Government Department of the Environment on a quarterly basis (Commonwealth of Australia, 1989). There have been no reported imports of the chemical as a feedstock in the last 10 years.

International

In 2012, two companies were registered as manufacturing the chemical in the USA (US EPA, 2013a). A test plan including robust study summaries for this chemical is available under the United States Environmental Protection Agency (US EPA) High Production Volume (HPV) Challenge program. These documents indicate that the largest current use for the chemical is as an intermediate in the synthesis of other organic chemicals (US EPA, 2010).

Bromochloromethane is registered under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation for use as a closed-system industrial intermediate in the European Union (ECHA, 2013).

Under the Montreal Protocol, production and consumption of the chemical were phased out by 1 January 2002 (UNEP, 2012). The quantity of the chemical that is imported or produced for feedstock purposes does not contribute to calculations of the total quantity of chemical that is produced or consumed under the Montreal Protocol.

Historically, bromochloromethane was used as a fire-extinguisher fluid in aircraft and portable fire extinguishers (US NLM, 2011). These emissive uses have been effectively phased out since the chemical was included on the Montreal Protocol in 1999.

Environmental Regulatory Status

Australia

Bromochloromethane is a scheduled substance under the Ozone Act. The Act gives effect to Australia's obligations under the Montreal Protocol by controlling the manufacture, import and export of ozone depleting substances and listing banned applications. Import or manufacture of the chemical is banned, and it can only be used if an exemption licence is obtained from the Australian Government Department of the Environment, or it is used as a feedstock (Commonwealth of Australia, 1989).

United Nations

The chemical is one of the controlled substances listed under Annex C of the Montreal Protocol (UNEP, 2000). The Montreal Protocol calls for the phase-out of use of the chemical. All 197 countries of the United Nations have ratified the Montreal Protocol, including Australia, and only a few countries are yet to ratify the last amendment (UNEP, 2013).

OECD

The chemical has not been sponsored for assessment under the Cooperative Chemicals Assessment Programme (CoCAP) (OECD, 2013).

Canada

The chemical is listed on Schedule 1 of the *Canadian Environmental Protection Act 1999* (the Toxic Substances List). Use is prohibited for any purpose other than essential uses or for an analytical standard (Environment Canada, 2013a).

The chemical has been categorised as Persistent (P), not Bioaccumulative (not B) and not Inherently Toxic to the Environment (not iT_E) by Environment Canada during the Categorization of the Domestic Substances List (DSL) (Environment Canada, 2013b).

European Union

The chemical is identified as an ozone depleting substance and is controlled under *Regulation No 1005/2009 of the European Parliament and of the Council of 16 September 2009 on Substances that Deplete the Ozone Layer*. The production, trade and use of the chemical is prohibited, unless the chemical is to be used as a feedstock, process agent, for an essential laboratory or analytical use, or is destined for destruction or reclamation (European Union, 2009).

United States of America

The chemical is identified as a Class I Substance under Title VI of the *Clean Air Act 1970*. Production and use of the chemical is prohibited except for specified exceptions, including essential uses and feedstock uses (US EPA, 2013b).

Environmental Exposure

The Ozone Act prohibits the use of bromochloromethane in Australia if the use results in discharge of the chemical to the environment (Commonwealth of Australia, 1989).

Additionally, the uses of the chemical that may be allowed under the provision of a licence are generally limited to those listed under Annex IV of the Seventh Meeting of the Parties to the Montreal Protocol. These are low volume, closed system or reactive uses, such as use in research and development, analytical uses and regulated applications (for example, quality control), and laboratory use (Australian Government Department of the Environment, 2013c; UNEP, 1995).

Therefore, the chemical is not expected to be released into the environment as a result of current industrial uses in Australia.

Environmental Fate

Partitioning

The measured Henry's Law constant for partitioning of bromochloromethane from water to air is 148 Pa-m^3/mol at 25°C (LMC, 2013). This large partitioning ratio indicates that the chemical is highly volatile from water and moist soil.

The calculated organic carbon normalized adsorption coefficient (K_{oc}) for the chemical is 21.7 L/kg (US EPA, 2012a). The relatively low magnitude of the water to organic carbon in soil partitioning ratio indicates that the chemical will be very highly mobile in soil.

Calculations with a standard multimedia partitioning (fugacity) model, assuming equal and continuous distributions to air, water and soil compartments (Level III approach), predict that the chemical will mainly partition to air (41%) and water (38%) compartments, with additional partitioning to soil (22%). However, with sole release to the atmosphere, the model predicts that 98.4% of the chemical will remain in the air compartment (US EPA, 2012a). The latter scenario is expected to be the more likely route for release of the chemical into the environment.

The chemical is a highly volatile substance that, if released, will partition primarily into the atmosphere.

Degradation

Bromochloromethane is not rapidly degradable in water or soil under aerobic conditions. The aerobic degradation of the chemical was determined to be 4% after 28 days in a study conducted in accordance with OECD Test Guideline (TG) 301 C

(LMC, 2013). The chemical is also not expected to undergo rapid abiotic degradation in the terrestrial or aquatic environment, with an estimated hydrolysis half life in water of 44 years at 25°C (US NLM, 2011).

There is some evidence to suggest that the chemical may undergo more rapid degradation under anaerobic conditions by both biotic and abiotic processes (US NLM, 2011).

The major environmental degradation processes for bromochloromethane involve indirect photo-oxidation in the lower atmosphere (troposphere) by hydroxyl radicals. Atmospheric modelling indicates that oxidation of the chemical by hydroxyl radicals accounts for approximately 99% of the loss of this substance from the atmosphere (Wuebbles et al., 1998).

The lifetime for the chemical in the troposphere based on reactions with hydroxyl radicals is 137 days (WMO, 2011). This lifetime, although short by comparison with more highly substituted volatile organohalogens, does significantly exceed the domestic criteria for persistence in air ($t_{1/2}$ = 2 days). The chemical is therefore categorised as persistent.

Bioaccumulation

The measured bioconcentration factor (BCF) for the chemical in the fish *Cyprinus carpio* is 3.5 L/kg (LMC, 2013). This low bioconcentration factor indicates a limited potential for bioaccumulation in aquatic organisms.

Transport

The chemical has been detected in remote ocean areas (US NLM, 2011) and in the atmosphere from the marine boundary layer to the upper troposphere (WMO, 2011). However, the interpretation of these data in relation to the long range transport potential of the chemical is complicated by the fact that bromochloromethane is naturally produced by marine algae (Ballschmiter, 2003; WMO, 2011). Nevertheless, the high volatility and persistence of the chemical in the atmosphere suggests that long-range transport in the atmosphere is likely. Additionally, the chemical is expected to be transported to the upper atmosphere (stratosphere) (Wuebbles et al., 1998).

Predicted Environmental Concentration (PEC)

Bromochloromethane is not expected to be released into the environment due to industrial use in Australia, as release of the chemical is prohibited under the Ozone Act. As no environmental release resulting from current industrial uses is expected, the PEC for this chemical has not been calculated.

Although emissions of the chemical to the environment from current industrial activities are not expected, bromochloromethane may still be present at low concentrations in the aquatic and air compartments due to historical industrial uses and emissions from biogenic sources such as marine algae (Ballschmiter, 2003; US NLM, 2011; WMO, 2011).

Environmental Effects

Effects on the Atmosphere

The stratospheric ozone layer protects life on Earth by absorbing ultraviolet (UV) radiation from the sun. This form of radiation can be damaging to most forms of life on Earth (Australian Government Department of the Environment, 2013c). Therefore, the destruction of ozone in the atmosphere is of environmental concern.

Although the majority of the chemical will degrade in the troposphere, approximately 2% of bromochloromethane released to the atmosphere is predicted to migrate through the troposphere into the stratosphere. Photolysis of the chemical in the stratosphere by high-energy UV radiation liberates highly reactive chlorine atoms and bromine atoms. These atoms undergo reactions that destroy ozone and hence deplete the capacity of the ozone layer to absorb harmful UV radiation (Wuebbles et al., 1998).

The impact of ozone depleting chemicals on stratospheric ozone is typically reported in terms of the ozone depletion potential (ODP) metric. The ODP is the ratio of the impact of the substance on ozone compared to the impact of the same mass of the chlorofluorocarbon, trichlorofluoromethane (CFC-11) (US EPA, 2010; WMO, 2011). Bromochloromethane is assigned an ODP of 0.12 under the Ozone Act (Commonwealth of Australia, 1989).

A global warming potential (GWP) has not been calculated for bromochloromethane as the concept is inappropriate for substances with an atmospheric lifetime of less than 0.5 years (WMO, 2011).

Effects on Aquatic Life

Two measured median lethal concentrations (LC50s) were identified and used to characterise the acute effects of the chemical on fish (LMC, 2013). Calculated endpoints (LC50s and median effective concentrations (EC50s)) derived from quantitative structure-activity relationships (QSARs) have been used to fill the gaps in the acute aquatic ecotoxicity data available for the chemical (US EPA, 2012b).

Acute toxicity

The following measured acute ecotoxicity endpoint for fish from a short term test was reported in a database included in the OECD QSAR Toolbox (LMC, 2013). The acute ecotoxicity endpoints for a taxonomic group from all three major aquatic trophic levels (including fish) were also calculated using the respective neutral organic QSAR models that are available in ECOSAR version 1.11 (US EPA, 2012b):

Taxon	End point	Method
Fish	48 h LC50 = 340 mg/L 96 h LC50 = 345.5 mg/L	Experimental (renewal) Calculated (Neutral Organics SAR)
Invertebrates	48 h LC50 = 186.1 mg/L	Calculated (Neutral Organics SAR)
Algae	96 h EC50 = 111.5 mg/L	Calculated (Neutral Organics SAR)

The available measured and calculated acute ecotoxicity endpoints for bromochloromethane indicate that the chemical is not harmful to aquatic organisms in short term exposures.

Chronic toxicity

There are no suitable data available to evaluate the long-term effects of the chemical on aquatic organisms.

Predicted No-Effect Concentration (PNEC)

The PNEC for the chemical in the air compartment was not calculated. The current global consensus is that anthropogenic emissions of this chemical should be minimised in order to maintain the health of the ozone layer.

The PNEC for the chemical in the aquatic compartment is calculated to be 111.5 µg/L, based on the calculated acute toxicity to algae (96 h EC50 of 111.5 mg/L) and an assessment factor of 1000. A conservative assessment factor of 1000 was selected as the acute aquatic toxicity data for the chemical is principally based on calculated endpoints and there are no suitable data available to evaluate the potential for chronic effects of the chemical on aquatic organisms.

Categorisation of Environmental Hazard

Persistence

Persistent (P). The chemical is not rapidly degraded by natural processes in the environment and has a half life of greater than 2 days in the atmosphere. Therefore, the chemical is categorised as Persistent.

Bioaccumulation

Not Bioaccumulative (Not B). The chemical has a low potential for bioaccumulation based on the measured bioconcentration factor which is below the domestic threshold for a bioaccumulation hazard in aquatic organisms (BCF = 2000 L/kg). The chemical is therefore categorised as Not Bioaccumulative.

Toxicity

Not Toxic (Not T). The chemical is not expected to be toxic to aquatic organisms based on the measured and calculated acute toxicity endpoints, which are all greater than 1 mg/L. Therefore, the chemical is categorised as Not Toxic.

Summary

Bromochloromethane is categorised according to domestic environmental hazard thresholds (EPHC, 2009; NICNAS, 2013) as:

- P
- Not B
- Not T

Risk Characterisation

Risk quotients (RQs) have not been calculated for the chemical.

The international consensus is that release of this chemical to the atmosphere poses a risk to the environment. However, as environmental exposure in Australia is controlled under the Ozone Act, the risk to the atmosphere resulting from current industrial use of the chemical is low.

A PEC was not calculated for the aquatic compartment as there is limited potential for release of the chemical to the aquatic environment. The risk to the aquatic environment resulting from current industrial use of the chemical is low.

The risks to the soil and sediment compartments are expected to be low as the chemical is not expected to partition to these compartments.

Key Findings

The release of bromochloromethane to the environment is of concern due to the ozone depleting properties of the chemical. However, the manufacture, import and export of bromochloromethane are controlled in Australia under the Ozone Act and no environmental release of the chemical due to industrial use is expected. Therefore, current industrial use of the chemical is not expected to be of concern to the environment.

The chemical is not a PBT substance according to domestic environmental hazard criteria.

Recommendations

The manufacture, import and export of methane, bromochloro- (bromochloromethane) is controlled in Australia under the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989*. The control measures implemented under the Act are expected to prevent environmental exposures of this chemical from industrial use. Current risk management measures are therefore considered adequate to protect the environment. No further assessment is required.

Environmental Hazard Classification

In addition to the categorisation of environmental hazards according to domestic environmental thresholds presented above, the classification of the environmental hazards of bromochloromethane according to the third edition of the United Nations' Globally Harmonised System of Classification and Labelling of Chemicals (GHS) is presented below (UNECE, 2009):

Hazard	GHS Classification (Code)	Hazard Statement
Ozone Layer	Category 1 (H420)	Harms public health and the environment by destroying ozone in the upper atmosphere

There are insufficient reliable data to classify the short and long-term aquatic hazards of this chemical.

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