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TOXIOLOGICAL PROFILE OF TRICHLOROMETHAN

PANKAJ GUPTA & VERSHA GUPTA

[1]Professor, Department of Chemistry, Sunrise University, Alwar, Rajasthan, India

[2]Research Scholar Sunrise University, Alwar, Rajasthan, India

ABSTRACT

This CICAD on Trichloromethane was drafted by Toxicology Advice and Consulting Ltd in light of documentation arranged by Environment Canada and Health Canada as a feature of the Priority Substances Program under the Canadian Environmental Protection Act (CEPA). The goal of appraisals of need substances under CEPA is to evaluate potential impacts of circuitous introduction in the general environment on human wellbeing and additionally natural impacts. Information recognized as of October 1999 were considered in the source record. A far reaching writing inquiry of a few on-line databases and different sources was led in February 2003 to distinguish any key references distributed consequent to those fused in the source report. Data on the way of the associate audit and the accessibility of the source archive is introduced in Appendix 1. Data on the associate audit of this CICAD is exhibited in Appendix 2. This CICAD was endorsed as a global evaluation at a meeting of the Final Review Board, held in Varna, Bulgaria 11 September 2003. Members at the Final Review Board meeting are recorded in Appendix 3. The International Chemical Safety Card (ICSC 0027) for Trichloromethane, created by the International Program on Chemical Safety (IPCS, 2000a), has likewise been recreated in this report. Trichloromethane (CAS No. 67-66-3) is a reasonable, dismal, unpredictable fluid with a charming etheric smell.

KEYWORDS: Trichloromethane, Methane

INTRODUCTION

Trichloromethane—likewise referred to by its formal name as trichloromethane ($CHCl_3$)— was the most as often as possible distinguished unpredictable natural compound (VOC) in the Nation's ground water examined by the U.S. Land Survey's (USGS) National Water-Quality Assessment (NAWQA) Program (Squillace and others, 1999; Moran and others, 2002; Zogorski and others, 2006). Grady (2003) additionally reported Trichloromethane as the most habitually identified VOC in a national investigation of both ground-and surface-water wellsprings of drinking water for group water frameworks (CWSs). Trichloromethane and three other distinguished trihalomethanes (THMs) — bromodichloromethane, dibromochloromethane, and bromoform—are cleansing by-items normally created amid the chlorination of water and wastewater. Entirely talking, "trihalomethanes" applies to trihalogenated methanes containing any of the halogen molecules (chlorine, bromine, iodine, or fluorine), yet this term will be utilized as a part of this report to allude just to those containing either chlorine or bromine in light of the fact that these are the ones most ordinarily recognized, or broke down for, in chlorinated waters. The act of treating a lot of surface and ground water with chlorine for general wellbeing reasons started in the United States in Jersey City, New Jersey, in 1908, and since has turned into a standard strategy for CWSs the country over. The basic role of chlorination of drinking water is to keep the spread of waterborne sicknesses, particularly lethal infections, for example, cholera and typhoid. Despite the fact that chlorination has been utilized to treat drinking

water across the country for right around 100 years, Trichloromethane and different THMs were initially recognized by J.J. Rook in 1974 as being delivered amid the chlorination process.

The vicinity of Trichloromethane in drinking water is a potential human-wellbeing concern. In 1986, the U.S. Ecological Protection Agency (USEPA) characterized Trichloromethane as a likely human cancer-causing agent ("Group B2" cancer-causing agent), taking into account proof of its cancer-causing nature in creatures. In 1998, the USEPA amended the cancer-causing nature hazard evaluation of Trichloromethane, expressing that the compound is prone to be cancer-causing to people by all courses of introduction at fixations sufficiently high to bring about cytotoxicity and development of regenerative knobs in vulnerable tissues. Bromodichloromethane and bromoform likewise are suspected human cancer-causing agents, while lacking information exist to evaluate the human cancer-causing capability of dichlorobromo The aggregate worldwide flux of Trichloromethane through the earth is around 660 000 tons for every year, and around 90% of emanations are characteristic in starting point. In the late 1990s, about 520 000 tons were made every year, essentially in the USA, the European Union, and Japan. A noteworthy use is in the creation of chlorodifluoromethane (HCFC-22), which is utilized (in diminishing amounts) as a refrigerant and (progressively) as a fluoropolymer feedstock. Trichloromethane may be discharged into the earth from HCFC-22 plants. The other principle Trichloromethane discharges to the earth happen as an aftereffect of utilizing chlorine-based chemicals for dying and sterilization purposes at mash and paper factories and water treatment plants.

poisonous quality. On rehashed inward breath introduction, the most reduced reported impact level in a research center creature study was 9.8mg/m3, which brought about cell multiplication in nasal entry tissues of rats and mice. For rehashed oral presentation, most minimal reported impact levels were comparable (10– 17 mg/kg body weight every day) in different species for distinctive end-focuses. A physiologically based pharmacokinetic (PBPK) model and the outcomes from a 7.5-year canine study in which mellow liver poisonous quality (greasy growths suggestive of interruption of hepatic digestion system of fat) was seen were utilized to foresee the rate of Trichloromethane digestion system in the human liver (3.8 mg/liter every hour) that would deliver a tissue measurements rate of lethal metabolites connected with a 5% expansion in danger. This tissue measurements rate would come about because of lifetime drinking of water containing Trichloromethane at 37 mg/liter or lifetime presentation to 9.8 mg Trichloromethane/m3 air. Individual lower 95% certainty cutoff points were 12 mg/liter and 3.4 mg/m3. A middle of the road every day oral admission of 0.015 mg/kg body weight every day and an average convergence of 0.14 mg/m3 air are gotten from these figures. Likewise, the PBPK model and the outcomes from a study in which Trichloromethane actuated kidney tumors in male rats were utilized to determine closely resembling human rates of digestion system prompting a 5% expansion in the rate of tumors and tumor forerunner sores. These were assessed to be 3.9 and 1.7 mg/liter every hour, separately. For the previous, the 95% lower certainty limits for constant presentation by means of drinking-water and by means of air were 2363 mg/liter and 74 mg/m3, separately. For the recent, the metabolic rate was identical to constant introduction at 1477 mg/liter water and 33.3 mg/m3 air (95% lower certainty points of confinement were not given).

Production & Uses

This compound was initially made by the response of ethanol or CH3)2CO with blanching powder calcium hypochlorite. In advanced times, on the other hand, it is produced mechanically by consolidating methane with chlorine. Little measures of the concoction are delivered normally by marine life, for example, kelp, and by the disintegration of plant stays in the dirt. The principle human sources in the earth are from the utilization of chlorine as a blanching operators

in paper plants, and the chlorination of drinking water. The chlorine responds with different natural mixes to create trichloromethane, however the sums present in chlorinated water are minor and are not thought to represent any danger to human wellbeing under ordinary circumstances.

Identity and Physical Properties

Trichloromethane (CAS No. 67-66-3) is also known as trichloromethane, methane trichloride, triTrichloromethane, methyl trichloride

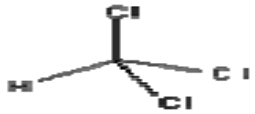

Figure 1: Chemical Structure of Chloroform

and formyl trichloride. Its molecular formula is CHCl3, and its relative molecular mass is 119.4. Trichloromethane's chemical structure is shown in Figure 1.

At room temperature, Trichloromethane is a clear, colourless, volatile liquid with a pleasant etheric odour. The ranges of values reported for selected physical/chemical properties are presented in Table 1. Additional properties are given in the International Chemical Safety Card (ICSC 0027) reproduced in this document.

Table 1: Physical and Chemical Properties of Chloroform

Property	Value[a]
Boiling point (°C) at 101.3 kPa	61.3
Vapour pressure (kPa) at 20 °C	21.3
Water solubility (g/litre) at 25 °C	7.2–9.3
Density (g/cm^3) at 25 °C	1.48
Henry's law constant (Pa·m^3/mol) at 20 °C	304
Log K_{ow}	1.97
Log K_{oc}	1.44–2.79

[a] Data listed in source document (Environment Canada & Health Canada, 2001).

The conversion factors1 for Trichloromethane in air at 20 °C and 101.3 kPa are as follows:

1 ppm = 4.96 mg/m3

1 mg/m3 = 0.202 ppm

In this CICAD, we have followed the convention of the source document, which is to use conversion factors at 25 °C instead of 20 °C:

1 ppm = 4.9 mg/m3

1 mg/m3 = 0.204 ppm

Sources of Human and Environmental Exposure

Trichloromethane is both a manufactured and normally happening compound, albeit anthropogenic sources are in charge of a large portion of the Trichloromethane in the earth. Trichloromethane is discharged into the earth as an aftereffect of its production and utilize; its arrangement in the chlorination of drinking water, civil and modern waste water, and swimming pool and spa water; and from other water treatment procedures including chlorination. Under anaerobic conditions, some microscopic organisms can dehalogenate Tetrachloromethane to discharge Trichloromethane. The vast majority of the Trichloromethane discharged into nature will in the end enter the air. In the climate, Trichloromethane may be transported long separations before eventually being corrupted by roundabout photochemical responses with such free radicals as hydroxyl.

Human Exposure: Environmental

Deterministic evaluations of normal and upperbounding assessments for day by day admission have been created in Canada in view of focuses decided in Canadian air (national overviews), sustenance in Canada and the USA, and drinking-water (commonplace and regional information). These are exhibited in Tables 3 and 4.

Deterministic appraisals were created utilizing the above checking information and reference values for body weight, inward breath volume, and utilization of nourishment and water. Normal admission from sustenance, drinking-water, and air fluctuated from 0.6 to 10 μg/kg body weight every day. Upperbounding assessments were figured utilizing most extreme reported fixations as a part of water, nourishment, and air and

gone from 40 to 95 μg/kg body weight every day (or up to 148 μg/kg body weight every day for newborn children bolstered only on powdered baby recipe arranged with faucet water containing the most extreme reported Trichloromethane fixation). Every day showering expanded evaluated presentation by around 50–100% for a few subgroups. Further subtle elements are given in the source record.

Furthermore, probabilistic evaluations of day by day Trichloromethane admission from air and savoring water Canada were produced for two situations (normal populace presentation and sensible most pessimistic scenario), however information were viewed as deficient to create probabilistic introduction gauges from sustenance utilization or showering. Reenactments of 10 000 trials were run 5 times every utilizing Monte Carlo irregular and Latin Hypercube routines. The two examining strategies gave comparable assessments, and relative.

Table 3: Deterministic Estimates of Average Daily Intake for the General Population.[a]

Exposure medium	Average daily intake (μg/kg body weight per day) for age groups in the general population					
	0–6 months	7 months – 4 years	5–11 years	12–19 years	20–59 years	60+ years
Outdoor air	0.002–0.034	0.004–0.072	0.003–0.056	0.002–0.032	0.001–0.027	0.001–0.024
Indoor air	0.559–0.744	1.197–1.596	0.933–1.244	0.531–0.708	0.456–0.608	0.396–0.528
Food	– (included in water data)	0.150–1.145	0.105–0.899	0.060–0.612	0.043–0.478	0.028–0.349
Drinking-water	1.003–9.536	0.424–4.037	0.334–3.172	0.190–1.806	0.199–1.891	0.209–1.987
Subtotal	1.56–10.31	1.78–6.85	1.38–5.37	0.78–3.16	0.70–3.00	0.63–2.89
Showering[b]	–	–	–	0.43–4.06	0.36–3.40	0.35–3.35

[a] Further details on the basis for estimated figures are given in Environment Canada & Health Canada (2001).
[b] Inhalation and dermal intake from daily showering.

Table 4: Deterministic Upper-Bounding Estimates of Daily Intake for the General Population.[a]

Exposure medium	Upper-bounding estimates of intake (µg/kg body weight per day) for age groups in the general population					
	0–6 months	7 months – 4 years	5–11 years	12–19 years	20–59 years	60+ years
Outdoor air	0.21	0.45	0.35	0.20	0.17	0.15
Indoor air	16.81	36.02	28.08	15.97	13.72	11.92
Food	– (included in water data)	2.87	2.36	1.58	1.25	0.89
Drinking-water	130.6	55.28	43.43	24.73	25.90	27.20
Subtotal	147.6	94.62	74.22	42.48	41.04	40.16
Showering[b]	–	–	–	55.64	46.61	45.90

[a] Further details on the basis for estimated figures are given in Environment Canada & Health Canada (2001).
[b] Inhalation and dermal intake from daily showering.

Standard deviations (for n = 5 reenactments of 10 000 trials each) of the upper-percentile appraisals of admission did not surpass 5%, showing a high level of reproducibility. The normal populace situation depended on the conveyance of Trichloromethane in 8807 open air tests gathered amid the 1990s, the assessed geometric mean and standard deviation of an accepted lognormal appropriation of Trichloromethane in the indoor demeanor of 754 Canadian homes, and examination of Trichloromethane in 6607 drinking-water tests in Canadian regions and regions. The 95th percentiles of the appropriation of admissions from inward breath and ingestion of drinking-water for five age gatherings of the all inclusive community (i.e., 0.5 years to 60+ years old) ran from 4.9 to 12.9 µg/kg body weight every day. The impediments of the information on the every day admission rate of aggregate faucet water by babies (EHD, 1998) kept the improvement of probabilistic evaluations for this subgroup.

EFFECTS ON OTHER ORGANISMS IN THE LABORATORY AND FIELD

Aquatic Environment

The danger of Trichloromethane has been concentrated on in oceanic microscopic organisms, green growth, spineless creatures, fish, and creatures of land and water.

Microorganisms can be entirely touchy to Trichloromethane. Anaerobic absorption of sewage slime was repressed at 0.1 mg Trichloromethane/liter. Others watched restraint of unacclimated societies at 0.5 mg/liter; with acclimation, focuses up to 15 mg/liter were endured. This study inspected methane generation from acetic acid derivation enhanced methanogenic societies presented to slug dosages of Trichloromethane at beginning groupings of 0.5, 1, 2, or 2.5 mg/liter. Seeded societies were set up in sans oxygen serum containers worked in clump or semi-persistent (50, 25, or 12.5 days solids maintenance time [SRT]) mode. Methane generation was restrained at all Trichloromethane focuses. At 0.5 mg/liter, recuperation had happened following 3 days at all SRTs. At 1 mg/liter, recuperation was slower (2.5, 4, 11, and 25 days under clump and semi-persistent 50, 25, and 12.5 days SRT, individually). Trichloromethane parceled (3.1:1) between the fluid and gas stages (68% of the starting Trichloromethane stayed in the fluid stage after balance) and was additionally diminished bit by bit because of fluid washout and stripping by methane creation. In a different test in which Trichloromethane was step by step directed as day by day encourage, methane creation was unaffected at 10 mg/liter, while there was introductory restraint took after by adjustment at 15 mg/liter. At 20 mg/liter, no recuperation was seen inside of 80 days.

Trichloromethane and three other trihalomethanes (THMs) — bromodichloromethane, dibromochloromethane, and bromoform—are disinfection by-products commonly produced during the chlorination of water and wastewater.

As part of the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program, samples of untreated ground water from drinking-water supply wells (1,096 public and 2,400 domestic wells) were analyzed for THMs and other volatile organic compounds (VOCs) during 1986–2001, or compiled from other studies. This report provides a summary of potential sources of THMs and of the occurrence and geographical distribution of THMs in these samples and presents evidence for an anthropogenic source of Trichloromethane and other THMs.

CONCLUSIONS

Implications for future research also are presented. Potential sources of THMs to both public and domestic wells include the use and discharge of chlorinated drinking water and wastewater that may be intentional. These potential sources include the use of municipally supplied chlorinated water to irrigate lawns, golf courses, parks, gardens, and other areas; the use of septic systems; or the regulated discharge of chlorinated wastewater to surface waters or ground-water recharge facilities. Other potential sources of THMs to public and domestic wells also may be inadvertent including leakage of chlorinated water from swimming pools, spas, or distribution systems for drinking water or wastewater sewers.

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