Canadian Ecological Screening Assessment of Chlorinated Naphthalenes

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Introduction

Chlorinated naphthalenes (CNs) are a category of compounds that includes 75 congeners having one to eight chlorine atoms and that have similar physical and chemical properties as PCBs. CNs can be divided into eight homologue groups, based on the number of chlorine atoms in their structure (e.g. mono-CNs to octa-CNs). In the past, they were used in cable insulation, capacitor fluids, wood preservation, engine oil additives, electroplating masking compounds, feedstocks for dyes, dye carriers, and refracting index testing oils.

An ecological screening assessment of CNs has been undertaken by Environment Canada because of increasing evidence and international concern that CNs are persistent, bioaccumulative and inherently toxic. Recent scientific studies have found CNs in Arctic and Antarctic regions, suggesting that CNs are persistent in air and are subject to long-range atmospheric transport. Polychlorinated naphthalenes may be considered as candidate substance for inclusion in the UNECE POPs Protocol to the Convention on Long-Range Transboundary Air Pollution.

Materials and Methods

Data relevant to the ecological screening assessment of CNs were identified in original literature and review documents. On-line literature database searches were conducted. As well, researchers, academics, and industry were contacted to obtain relevant information on CNs. A voluntary industry survey on CNs was conducted by Environment Canada for the 2000-2002 calendar years. This survey collected data on the Canadian manufacture, import and export of CNs.

The ecological risk assessment of CNs considers ecotoxicity data, current and potential environmental exposures, and data on persistence and bioaccumulation.

Results and Discussion

CNs are not currently in commercial use in Canada, but there are other sources to the Canadian environment, such as evaporative emissions from PCBs, in which CNs are a trace contaminant, and from on-going generation and releases as by-products from a variety of thermal sources involving chlorine such as waste incineration, metal smelting, the chlor-alkali process, and cement kilns. Knowledge of the amounts, composition and sources of CNs produced via thermal and other processes in the presence of chlorine is very limited. Other sources of CNs to the environment include losses from old equipment/products in which CNs were deliberately incorporated, and discharges and losses from old industrial sites where CNs were used.

Reviews indicate the major sources of CNs to the environment are likely to be from waste incineration and leakage from landfills containing electrical equipment and other items containing CNs[1,2]

Fugacity modeling indicates that tri- through octa-CNs will partition primarily to soil when released to the environment. Mono- and di-CNs will partition significantly to water, or will remain in the air, if released to air. Tri-, tetra-, and hexa-CNs will also partition significantly to air, if released primarily to air.

With the exception of mono-CNs, all CNs have predicted atmospheric half-lives greater than 2 days. In addition, CNs have been detected in air and biota in the Arctic[3,4,5,6], Antarctic[7] and other regions lacking significant local sources of CNs[8], which suggests that long-range atmospheric transport of CNs is occurring. CNs have been detected in lake sediments and soils dating back over 18 years[9,10], suggesting that the half-lives of CNs in sediments and soils are greater than 1 year and 6 months, respectively.

Bioconcentration factors (BCFs) greater than 5000 have been measured for most CNs in aquatic biota[11]. Furthermore, most CNs were found to have biomagnification factors (BMFs) greater than 1 in several aquatic food chains, including in the St. Clair River, Michigan[12], and in the Baltic Sea, including in food chains involving piscivorous birds[13]. The half-lives of hexaCN congeners in rats and humans were found to be similar to those of recalcitrant compounds that are known to accumulate in organisms and magnify in food chains[14,15].

CNs have been detected in the following biota samples from Canada: in fish, birds and humans from the Great Lakes region[16,17,18], in Pacific killer whales[19], in birds, seals and whales[5,6,20] from the Canadian Arctic and in Vancouver Island marmot[21]. The database of environmental concentrations of CNs in Canadian biota is limited compared to the available database from Europe.

The ecotoxicity database for CNs is limited. Most toxicity studies were conducted with the Halowax commercial CN products, rather than with individual isomers or homologue groups. Many of the available mammalian studies date prior to 1960. Aquatic toxicity studies indicate that CNs are of moderate to high toxicity to aquatic organisms[11]. The higher chlorinated CNs are more toxic to mammals than lower chlorinated CNs. No toxicity studies with sediment or soil organisms were identified. Few long-term toxicity studies have been conducted with aquatic organisms and none are available for mammals.

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