26 July 2024

Chemical profile

Polychlorinated Biphenyls (PCBs) and Polychlorinated Terphenyls (PCTs)

Summary

- Polychlorinated biphenyls (PCBs) are chemicals that are internationally recognised as environmental pollutants. Polychlorinated biphenyls were listed on the Stockholm Convention on Persistent Organic Pollutants (POPs) to globally eliminate production and use.
- Polychlorinated biphenyls are high concern chemicals due to being persistent in the environment, bioaccumulative, having toxic and adverse effects on humans and animal life, and undergoing long-range transport far from their place of release.
- Polychlorinated terphenyls (PCTs) have similar properties to PCBs and are considered to be comparable in hazard and risk to human health and the environment. Polychlorinated terphenyls, however, are not listed on the Stockholm Convention.
- Polychlorinated biphenyls and PCTs were mainly used in electrical equipment such as capacitors and transformers but also had uses in carbonless copy paper and as a plasticiser in paints. Use of PCBs and PCTs has declined in Australia since the 1970s, but they may still be present in legacy equipment or in waste stockpiles.
- Australia ratified the listing for PCBs under the Stockholm Convention when Australia became party to the convention in 2004. In Australia, management of PCBs are guided by the Polychlorinated Biphenyls Management Plan and regulated under state, territory and Commonwealth laws.
- Due to severe restrictions and/or bans internationally, PCBs and PCTs are also subject to other global treaties to regulate international trade (the Rotterdam Convention) and waste disposal (the Basel Convention).
- Polychlorinated biphenyls and PCTs are a priority for scheduling under the Industrial Chemicals Environmental Management Standard (IChEMS) to improve management of their long-term risks to the environment and to fulfill Australia's international obligations.

Introduction and use of polychlorinated biphenyls and polychlorinated terphenyls in Australia

Polychlorinated biphenyls (PCBs) and polychlorinated terphenyls (PCTs) are produced from the chlorination of biphenyls (for PCBs) or terphenyls (for PCTs) starting materials. The resulting product is a mixture of different chemicals marketed on their physical properties, rather than their chemical composition. The properties of PCBs and PCTs are very similar, and consequently they were used for similar applications.

Polychlorinated biphenyls and PCTs are water insoluble, have very low electrical conductivity and high resistance to thermal and chemical breakdown. These physical properties made PCBs and PCTs ideal for use in electrical equipment, as insulating material or dielectrics in capacitors and electric transformers, in hydraulic systems, and as heat transfer liquids in heating systems.

The size of transformers and capacitors that contain PCBs or PCTs may range from very large, containing thousands of litres of insulating fluid, to small capacitors containing only millilitres of fluid. Smaller capacitors may be found in farming equipment or on commercial premises. Prior to the 1980s, electrical equipment that may have contained PCBs included fluorescent light fittings, ceiling fans, electric motors, vacuum pumps, air conditioners, dishwashers, washing machines and clothes dryers.

Internationally, PCBs were also used in applications such as lubrication and cutting oils, and as plasticisers in paint, adhesives, sealants, plastics, as well as in inks and carbonless copy paper. It is expected that these applications were once also used in Australia. Other identified uses may include cable insulation, thermal insulation material (fibreglass, felt, foam and cork), tape and adhesives, caulking, slide mounting for microscopes and floor finishes.

Polychlorinated biphenyls were in mass production for commercial use from the late-1920s to mid-1980s, with approximately 1.5 million tonnes generated globally over this period. The production of PCTs has been reported as only 5% of PCB volumes. Commercial manufacture of PCBs and PCTs is not known to have occurred in Australia.

Goods and substances containing PCBs or PCTs have been prohibited from import into Australia since the mid-1970s under the *Customs (Prohibited Imports) Regulations 1956*. As a result, the use of PCBs and PCTs has declined in Australia since this time, although they may still be present in legacy equipment or in waste stockpiles.

Controls under international conventions

Chemicals listed on the Stockholm Convention of Persistent Organic Pollutants (POPs) are persistent, toxic, bioaccumulative, and undergo long-range transport in the environment.

Polychlorinated biphenyls were listed on the Stockholm Convention when the convention entered into force in 2004. They are listed in Annex A of the convention, with the aim to globally eliminate intentional production, phase out the use of PCB-containing equipment by 2025, and make determined efforts for the environmentally-sound waste management of certain PCB-containing materials no later than 2028.

Australia is a party to the convention and must implement measures to restrict import and export, as well as meet standards for managing PCB-containing stockpiles and wastes.

Australia is also a party to two other international conventions relevant to chemicals management; the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. Together with the Stockholm Convention, these conventions

provide an international framework for the environmentally sound management of hazardous chemicals and wastes, including PCBs and PCTs, throughout their life cycles.

Chemical identity

Polychlorinated biphenyls (PCBs) and polychlorinated terphenyls (PCTs) are man-made chlorinated aromatic hydrocarbons. Polychlorinated biphenyls have between 1-10 chlorine atoms attached to a biphenyl giving 209 possible different combinations (congeners), and PCTs have 1-14 chlorine atoms attached to a terphenyl giving 8857 possible congeners.

When manufactured commercially, progressive chlorination of the either biphenyl or terphenyl yields a mixture of different congeners and compounds. Commercial PCBs and PCTs were categorised and marketed based on their physical properties, which depended on the degree of chlorination instead of their chemical composition. Most PCB and PCT mixtures were known by their trade names, the most common being 'Arochlor'.

Impurities present in commercial PCBs include polychlorinated naphthalenes and polychlorinated dibenzofurans, both of which are also recognised as persistent organic pollutants. Polychlorinated terphenyls may also contain residues of polychlorinated dibenzofurans and PCBs.

Polychlorinated biphenyls

- **CAS name:** 1,1'-Biphenyl, chloro derivatives
- **CAS registry number:** 1336-36-3
- **Synonyms:** PCB; biphenyl, chlorinated; chlorinated diphenyl;
- **Trade names:** Aroclor; Aroclor 12 series (E.g. Arochlor 1254); Aroclor 10 series; Clophen, Fenclor, Kaneclor, Pyralene

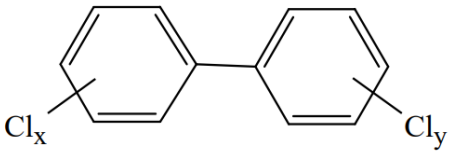

Figure 1. General chemical structure of PCBs, $C_{12}H_{10-n}Cl_n$, where n = x + y = 1-10 (Source: UNEP 2017)

Polychlorinated terphenyls

- **CAS name:** Terphenyl, chlorinated
- **CAS registry number**: 61788-33-8
- **Synonyms:** PCTs; polychlorinated triphenyls;
- **Trade names:** Aroclor 54 series (e.g. Aroclor 5460), Clophen Harz (W), Cloresil (A, B. 100), Electrophenyl T-50 and T60, Kanechlor KC-C, Leromoll; Phenoclor, Pydraul.

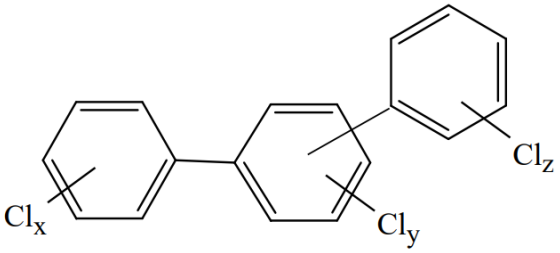

Figure 2. General chemical structure of PCT; $C_{18}H_{14-n}Cl_n$, where n = x + y + z = 1 - 14 (Source: UNEP 2017)

Hazards and risks to the environment

Polychlorinated biphenyls pose a long-term risk to the environment because they are persistent and can be transported long distances. They means they can be found throughout the environment including in remote regions, far from their origin of use. They bioaccumulate and biomagnify in higher trophic levels of the food chain. As a result, PCBs are globally recognised by the Stockholm Convention as having significant adverse human health and/or environmental effects.

Although PCTs are not listed on the Stockholm Convention, they have similar properties to PCBs and pose similar hazards and risk to human health and the environment (IPSC 1992, 1993; Jensen and Jorgensen 1983).

Polychlorinated biphenyls were first detected in wildlife samples in the mid-1960s and were further shown to be widely distributed in most compartments of the environment; they have been detected in air, soil, sediments, biota, foodstuffs and in remote locations such as the Arctic. They have also been detected in human fat and breastmilk. Studies conducted in the 1970s detected PCT in oysters, eels, white tailed eagles, fish, seals and birds as well as human fat.

Despite the cessation of manufacture and global phase-outs of use, PCBs and PCTs are still detected in wildlife and the environment. This is likely from redistribution of these chemicals from previous releases into the environment. In water, the chemicals are drawn to sediments and organic matter. Aquatic sediments are an environmental sink and work as a reservoir for redistribution in the environment.

Polychlorinated biphenyls and PCTs are highly bioaccumulative. They have also been found to biomagnify with preferential accumulation of higher-chlorinated congeners in animals towards the top of the food chain.

Polychlorinated biphenyls and PCTs are toxic to human health and environmental organisms. Very high exposure may lead to liver damage, damage to the nervous system or have immunosuppressive effects in mammals. Experimentally, PCBs have been demonstrated to have short- and long-term adverse effects on aquatic organisms. Polychlorinated biphenyls were implicated in the population decline of several bird species in the world, and population declines of seals and sea lions, although it can be difficult to demonstrate that the effects were solely due to PCBs, as opposed to other pollutants.

In general, PCB levels are low in the Australian environment and foodstuffs. Any emissions are most likely to occur from leaking equipment that is still in use, or through incorrect disposal of legacy materials and waste containing PCB or PCT.

Additional information: regulation of PCBs and PCTs in Australia

The import of PCBs and PCTs in goods and substances is prohibited under the *Customs (Prohibited Imports) Regulations 1956*.

Polychlorinated biphenyls resist degradation at low temperatures of incineration, and dioxin-like PCBs may form under certain combustion conditions. Consequently, disposal of PCBs must be carried out under appropriate conditions, in accordance with the Polychlorinated Biphenyls Management Plan (Revised Edition 2003).

The plan sets out the requirements for the management of PCB-containing materials and waste in Australia, although it does not cover unintentional production of PCBs. It is given effect under Commonwealth, state and territory laws. The plan is generally regarded, in most cases, to be more stringent than control measures for PCBs as set out in the Stockholm Convention.

Polychlorinated biphenyls are required to be reported on the National Pollutant Inventory if a facility exceeds the reporting threshold of 10 tonnes/year.

Both PCBs and PCTs are listed on Annex III of the Rotterdam Convention, and consequently are listed in Section 73 of the *Industrial Chemicals (General) Rules 2019*, which prohibits the export of Rotterdam Convention-listed chemicals without prior authorisation.

References

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More information

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