



## An Overview on Polychlorinated Biphenyls Pollutants

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### Abstract

Our environment has become a major reservoir of non-biodegradable wastages. Such wastages have been constantly accumulating in the soil, waters, and living organisms causing acute and long-term toxicity. Among such wastages, Polychlorinated Biphenyls (PCBs) have become a major contaminant. This review article focuses on sources, toxic effects, routes of exposure, and remediation methods of PCBs. These compounds are man-made and were mostly used in electrical appliances like transmitters, capacitors, and paint industries during the period between 1930s to 1940s. They revolutionized the industrial age, but their highpersistence and long-term transport made them problematic compounds. Solid waste disposal, soil contamination, and runoff water have made freshwater the biggest reservoirs of PCBs. These PCBs accumulates in the food chain through planktons and ultimately to human through fishes. They revolutionized the industrial age, but their highpersistence and long-term transport made them problematic compounds. To cope with bio-accumulative and toxicity, caused by PCBs, several studies have been carried out for the remediation of these wastages. Major remediation process includes chemical remediation, photo remediation, electrokinetic remediation, and bio-remediation. Several researches are ongoing to counteract PCBs cost-effectively and sustainably. Collaborative and global elimination strategies could only help to resolve the problem of PCBs, making the environment healthier once again.

**Keywords:** Bioaccumulation; Persistence; Remediation; Solid wastages; Toxicity

### Introduction

Polychlorinated Biphenyls (PCBs) are a group of man-made chemicals either in solid or liquid form, which are yellow in color with no smell or taste. They are highly stable, persistent, lipophilic aromatic compounds in which two benzene rings are substituted by chlorine. In commercial scale they are produced by catalytic chlorination of biphenyls producing complex multiple isomers. They are organic compounds, having similar chemical characteristics like that of DDT. The high production and consumption of PCBs was recorded during the period of 1930s to 1940s. PCBs were widely used in manufacturing electrical equipment such as transformers, transistors, capacitors in solid state and as liquid form they are used in transfer fluids and lubricants. They have been widely used in the trade name of Arochlor in USA, Kanechlor in Japan, Pyralene in France, and Chopin in West Germany. The popularity of PCBs gained having multiple uses, because of its widespread use; PCBs have entered in the environment through legal and illegal disposal resulting persistency and contaminating environment. The toxic effect of PCBs was mostly seen in aquatic and soil biota for their inability to metabolize the compounds at considerable rate. Various studies were done after 1950s in bio-accumulation and toxicity of PCBs, concerning their detrimental effects on environment; PCBs were banned in Sweden in 1970 and in Japan in 1972. More recently, The Chemical Treaty on Persistent Organic Pollutants (POPs) list PCBs as one of the priority chemical for eventual elimination by 2025.

### Materials and Methods

Several secondary data were reviewed regarding the pollutants. Information from journal, websites, books, newspaper were meticulously reviewed to delve deeper into the PCBs.

### Results

#### Sources of PCBs

These are man-made chemicals which tend to persist long distance. The major sources of PCBs are transport, electrical and paint industries,

or vapor they are transported to the liver, muscles and accumulate in adipose tissues through bloodstream. In the environment, the key root of exposure is abandoning electrical equipment transformers, paints, industrial and municipal wastages. After they are exposed to the water sources, it is absorbed by the planktons, through which PCBs enters into the food chain and accumulates in the environment (Figure 1).

Medical disposals and municipal waste combustions. It is estimated that more than half of the produced PCBs produced have been released in the environment, these chemical tends to transmit long distance and remain strongly bonded with the soil sediments. (Polychlorinated Biphenyls (PCBs), n.d.). The PCBs concentration in water bodies is generally higher mostly in the form of sediments. These concentrations

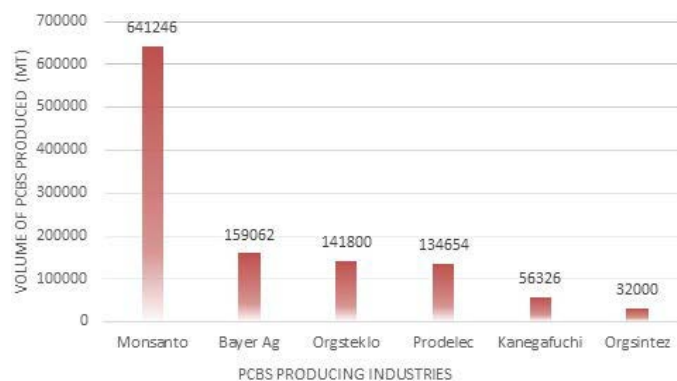


Figure 1: Top PCBs Producing Industries between 1930s-1980s

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of PCBs are the result of environmental cycling from land, soil, and air. PCBs concentrations are generally higher in fish and aquatic bodies than in water sources, which is mainly due to bioaccumulation properties of PCBs. PCBs can also release to the environment from the workshops of transformers, accidents, fires, and spills during repair and maintenance. The chances of these chemicals to accumulate in the environment can also occur through the disposal of unused electrical equipment

### Routes of PCBs exposure

PCBs can be exposed to human and environment causing deterioration of environment and animal health. Ingestion can be considered as the primary source of exposure in humans. Mostly, PCBs are fat soluble compounds exposed to human through ingesting animal fats, inhalation or dermal contact. The tissues of freshwater fishes mostly salmon contain a higher concentration of PCBs, which can enter into human bodies through ingestions. Likewise, human can also get exposed to PCBs in vapor form through disposal sites. Once, PCBs enters into the body through ingestion

### Toxic effects of PCBs

Exposure to PCBs can produce long-term and acute health problems due to their toxicity. The acute toxicity ranges from headache, irritation of nose, lungs, skins severe acne or chloracne, rashes, and eye problems. PCBs are found to be carcinogenic. Long-term exposure can cause breast cancer, brain cancer, liver cancer, gall bladder cancer, and gastro-intestinal cancers. Women exposing to PCBs during her pregnancy causes developmental failure in children and can give to birth to children having neurological or motor control problem with low IQ. A group of children in Michigan whose mothers have been exposed to PCBs during her pregnancy were found to have small head size, decreased birth weight, lower performance on standardized memory, psychomotor and behavioral tests, which lasted for 7 years. PCBs are also found to be mimic with the body's natural hormone, especially estrogen. Long exposure to PCBs causes reduced sperm count, altered sexual behaviors, delayed puberty, and genital malformations. Likewise, PCBs are also found to bind with receptors that control the immune system of the body. It is found to disturb some of the elements of immune system such as thyroid, lymphocytes, and T-cells. Children who are exposed to PCBs are found to be more susceptible to allergic disease, chicken-pox, ear infection, and lower immune system functions.

### Means of remediation of contaminated sites

Contamination of environment by PCBs have been a matter of great deal, though it was banned from 1970s. They are still in use through legal and illegal ways, which has posed serious problem due to bio-accumulation in food chain and environment. Several researches have been conducted for remediation of PCBs, which includes bioremediation, chemical remediation, photoremediation, electrokinetic remediation, thermal remediation etc. Chemical bioremediation process includes photocatalytic dechlorination of PCBs by using solvents like hexane, acetone, dimethyl ether, and isopropyl alcohol. In addition to this, PCBs can be remediated by reductive dechlorination using Iron (Fe<sup>0</sup>). These Nano based technologies were used during past decades for remediation of contaminated soil and groundwater. Likewise, electrokinetic remediation involves applying low-level direct current on electrodes to induce specific transport phenomena such as electro-migration, electro-osmosis, and electrophoresis. Electrokinetic remediation can also be coupled with chemical oxidation, nanotechnology, and microbial for their greater

efficiency. Thermal desorption is also widely used for remediation of contaminated soil as it is an efficient and cost-effective method of remediation. A PCB removal efficiency of 98% was attained after 1 hour of thermal treatment at 600°C. The catalytic decomposition of PCBs using sunlight in an aqueous solution, clay suspension, and sediments have been reported., it was found that 80% of PCBs were destroyed by using titanium dioxide photolytic process in an aqueous solution and clay suspension after 4hrs of radiation treatment and 50% of total PCBs were destroyed in sediment suspension after 6 hrs. Bioremediation is another sustainable and cost-effective means of remediation for PCBs. Different bioremediation processes have been developed to mitigate the accumulation of PCBs. Several transgenic plants, earthworms, microbes have been employed as bio remedial agents for the removal of PCBs from contaminated soil. found that bioaccumulated soil containing earthworm (*Pheritima hawayana*) achieved 55% removal of soil PCBs compared to 39% removal in identical soil without earthworm. suggests that moringa seed powders could possibly serves as an excellent means of remediation for the soil contaminated with PCBs. Several researches are undergoing on bioremediation as it seems a cost effective which determines its ultimate acceptability.

### Conclusion

Polychlorinated Biphenyls are one of the major sources of environmental and soil contamination, which has troubled humans and the environment due to their acute and long-term toxicity. Through they are banned immediately after the discovery of their bio-accumulation and toxic properties, their use have been recorded till today due to this cost-effectiveness and multiple uses. Special measures in global and regional should be taken to control the movement and transport of these hazardous chemicals. Their uses in past decades have been proved to be a boon for growing economy in industrialized and mechanized counties but currently, their remediation should be prioritized to eliminate them from the environment and food chains. Adaptive, collaborative, cost-effective, and sustainable measures should be studied to save the environment and mankind from bioaccumulation of PCBs.

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### Competing Interests

All authors declare no competing interests

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