

# STRAINING OF THE ENVIRONMENT BY POLYCHLORINATED BIPHENYLS IN EAST SLOVAKIA

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**Abstract:** *This article focuses on the quality of the environment and effects that polychlorinated biphenyls (PCB) have on it. PCBs are characterized in the historical point of view; they make their way through atmosphere, hydrosphere and lithosphere. Another part of the article focuses on the situation concerning PCB in Slovakia and the effects it has on animals and human being, and also on the current trend in research of these substances.*

**Keywords:** *PCB, environment, atmosphere, hydrosphere, lithosphere, health, quality, pollutants, harmfulness, research*

## Introduction

Ecology is a science about mutual relations and effects of human being onto the environment in global system of Earth that happen in significant competitive interactions of life forms. In a similar way as anthropoecology it observes natural and social (psychosocial, economic and others) relations and society progression. In the age of the beginning of the third millennium human ecology is a philosophy of survival for the human race too (Klein and Bencko, 1997).

The environment is mutually connected complex in which no part affects the other in isolation. It is also reflected in the effects it has on human organism. Many of the environmental agents are fundamental for our life and health, others can vary in its effects in a positive or negative way, without others we cannot live and we have to avoid others and remove them from our environment. Human being has been forming the environment in which he has lived in order to create suitable conditions for his existence (Ághová and team, 1993). The formation of a suitable environment for human society has brought, apart from many positive impulses and effects, many negative interventions too.

In the recent years there has been a global growth of industrial activities and that is closely connected with a significant pollution of the environment by toxic substances. Toxic pollutants are persistent substances that stay in the environment for a long period.

They can accumulate and enter into the food chain having all the unwanted effects on animal and human organisms.

Polychlorinated biphenyls (PCB) belong among the exceptionally toxic chemical substances. For its very good physical and chemical qualities PCBs have been used in various industrial areas (Podhradská and Šak, 1987). Their harmful effects have come, as it was in the past, into the centre of attention of many prominent scientist homelands and in the world.

## Characteristics of PCB

Polychlorinated biphenyls (PCB) are industrially produced chemical substances. They cannot be found naturally in the environment. Environmental transport of PCB is a complex and global process. They get into atmosphere, water or even into the soil sediments (Chriaštel' and team, 2004).

Polychlorinated biphenyls are chlorinated derivatives of a simple aromatic compound – biphenyl. Biphenyl is an aromatic hydrocarbon, in which there are two simply compound benzene rings. The group of PCB includes 209 compounds, concerning technical mixtures there is a smaller number – only a couple of dozens. PCBs were prepared for the first time in 1881. Industries started producing them in USA in 1929 and it was soon followed by other developed countries in the world (Safe, 1992). The whole amount that has been produced since 1929 is estimated at 1.2 to 1.5 million tonnes. PCBs belong to the group of carcinogens. Their production and usage is presently prohibited.

In the period 1959–1983 former Czechoslovakia produced PCB in chemist manufactory Chemko Strážske. In those years, the company also used to be an important exporter (products Delor, Hydeler, Delofet, Delorit and Delotherm) (Chriaštel' and team, 2004). During that period 21 500 tonnes of products were produced. The most vigorous production was carried out from 1974 to 1983, when the annual production reached 1200-2000 tonnes. Due to this aspect East-Slovakian region was classified as one of the risk localities, which was confirmed by the findings of positive samples during regular monitoring of animals and fish in Slovak Republic (Košutzký, Šalgovičová, 2003).

Development of modern analytical methods enables to gain superior and more complete information about the concentration of PCB in soil, water, air, food or in individual tissues of animals and people, in milk, hair and others. PCBs are presently determined through the method of gas or liquid chromatography.

## PCB in the environment

PCBs are organic pollutants, which have been identified in almost all elements of global ecosystem. Low water solubility and high hydrophobicity of these compounds are a cause of their accumulation in the environment and in the links of food chain (Veber and Kredl, 1991).

How much of PCBs gets into the environment depends especially on the way they are used. This can be divided into usage of PCBs in open or close systems.

The open systems are those where PCB cannot be detected and their usage consequently leads to contamination of the environment. In the past, in most areas, measures

were taken to reduce or respectively to cancel such applications. It considered application of PCBs in lubricants, solid impregnating materials, paints, adhesives, waxes, additives of plasters, sealing liquids, extinguishing agents, immersion oils, pesticides, impact paper and many other materials (Internet source 1, Murin and team, 2007).

## Atmosphere

Despite of the low volatility in the lifetime of products that contain PCB still some amounts get into the air. PCBs are present in atmosphere especially in vapour phase. The proportion of PBC in solid phase in the form of particles depends on air temperature and volatility pressure of the specific congener. Higher concentration of PCBs in particle phase happens in low temperatures and volatility pressures. The total amount of atmospheric PCBs is estimated at 10,000 to 100,000 kg (Internet source 2).

Other contaminations come from industrial, communal and hospital combustion processes and from evaporation of PBC coming from soil (especially waste dumps) and water. They are produced, for instance, during waste combustion, when chlorine in the burning plastics (PVC) reacts with phenols, coming from paper and wood (Veber and Kredl, 1991).

A significant sources of contaminations are outflows of PCBs from industries, that is infiltrations and leakages from electrical equipments (condensers and transformers), from industrial accidents (explosions of transformers).

**Table no. 1 – Industrial usage of PCB (Hegyí and Mistrík, 2001)**

<p><b>Open systems</b> (such systems where PCB outflows cannot be stopped and therefore their usage leads to contamination of the environments)</p>	<p><b>Close systems</b></p>
<ul style="list-style-type: none"> <li>• Plasticizers on the basis of PCB</li> <li>• Carbon-free copy paper</li> <li>• Lubrificates</li> <li>• Elements of compression-moulding materials</li> <li>• Impregnating materials</li> <li>• Glue components</li> <li>• Wax components</li> <li>• Additives into cements and plasters</li> <li>• Material for deletion of casting moulds</li> </ul>	<ul style="list-style-type: none"> <li>• Cooling liquids in transformers</li> <li>• Dielectric liquids in small and large condensers</li> <li>• Fire-proof and heat-transforming anticorrosive hydraulic liquids in vacuum pumps</li> <li>• Heat-transforming medias</li> </ul>

It is estimated that up to 20 % of the PCB amount gets into the environment. Out of that 5 % goes to air and 10–15 % into water, either directly or through soil (Chriaštel' and team, 2003). It is stated that there can be higher concentration of PBC in urban areas and also when the air temperatures is higher. The concentration is higher in

interiors than in exteriors (Internet source 2). In Slovakia, in the areas of contamination of Michaloviec, the registered values in air were up to 1,700 ng/m<sup>3</sup> (Kočan and team, 2001).

## **Hydrosphere and lithosphere**

PCBs are water-soluble at the minimum, that is why, in water environment, they are absorbed in sediments and other organic components. Most PCBs get into water ecosystems through industrial waste that is run into rivers, lakes and seaside areas and through outflows from open systems (Hegyí and Mistrik, 2001).

According to the accessible literal sources up to 90 % of PCB is present in soil; these are constantly being released into atmosphere through circulation. The amount of PCBs that are washed out from soil is insignificant (heavy rains are an exception). The process of biodegradation is very slow in soil. PCBs are transferred from soil into plants and they consequently get into bodies of animals through food chain (Trnovec and Palúchová, 2006).

## **PCB in Slovakia**

Czechoslovakia produced PCB in a chemical company Chemko Strážske in the period 1959–1984. At the same time the company was an important exporter of various products that included PCB (products Delor, Hydeler and Delothem) (Chriaštel' and team, 2004). In these years 21 482 tonnes of products on the basis of PCB were officially made and during that 1 000 tonnes of waste were produced. It is estimated that during the production a few tens of tonnes escaped into waste canal and contaminated the river Laborec together with Zmplínská Šírava. Due to this aspect the East-Slovakian region was classified as risk locality, which was confirmed by the findings of positive samples during the regular monitoring of water animals and fish in SR (Košutzký and Šalgovičová, 2003).

Matters concerning PCB have been an issue in Zemplín for several decades. Concentrations of PCB in soil in this area are one of the most significant in the world.

## **First data concerning harmfulness of PCB**

In 1966 Jensen pointed out the potential danger of PCB in external environment. He connected the reproduction changes of birds in Sweden with the content of PCB in cells.

Kurutsune (1969) was one of the first ones, who referred to the significant problems concerning damage of human body by PCB in connection with illness “Yusho”. In 1968 there was a mass intoxication of 1200 people (22 died) after an ingestion of rice oil that had been contaminated with PCB (2-3 g.kg<sup>-1</sup>) due to the leakage of heating pipes in a food factory in Japan. The illness was named “Yusho” (illness from rice oil).

Not only in the past, but even presently the focal point of potential health harmfulness is an excessive amount of PCBs in food. Many experiments and researches have confirmed harmfulness of PCBs and the negative effects they have on human health.

## **Effects of PCBs in human body**

PCBs get into organism through skin, respiratory and digestive systems. They harm skin and damage functioning of inner organs. They bring about enzymatic disorders, biochemical changes with consequent morphologic changes and in case of higher and long-term there is a danger of intoxication of human and animal organisms, they can cause death (Šak, 1978, Bilčík and team, 1978, Teleha and team, 1983).

PBCs are bioaccumulated in fat tissues of animals and people. High concentrations go hand in hand with serious skin disorders (for instance acne, chlorine), pigment change of skin, nails, eye irritation, functional disorders of liver (fat degeneration of liver). PCBs cause irritation of respiratory system, headaches, dizziness, depressions, memory lost, nervousness, fatigue, impotence and other problems. The presence of PBCs in organism causes disorders in immunity system, reduced concentration of dopamine in middle brain, a drop in the level of hormones T3 and T4. Negative effects during endouterine process appear as low weight of young ones, there have been changes in postnatal development observed. Concerning people also higher risk of breast tumour, endocrinal and reproductive disorders are expected (Trnovec and Palúchová, 2006, Murín and team, 2007, Internet source 3).

## **Negative effects of PCB on animal and human organisms**

PCBs get into organism through skin, respiratory and digestive systems. They harm skin and damage functioning of inner organs. They bring about enzymatic disorders, biochemical changes with consequent morphologic changes and in case of higher and long-term intoxication in human and animal organisms, they can cause death (Šak, 1978, Bilčík and team, 1978, Teleha and team, 1983).

## **Research of PCBs in Slovakia in the time of their production in Chemko Strážské**

In the former ČSSR the first scientist that got engaged into the problems concerning PCB was Doc. MUDr. Michal Šak, CSc., dermatovenerolog from Medical Faculty of University of Pavol Jozef Šafarik in Košice. Other scientific researchers of Medical and Natural-scientific Faculty UPJŠ in Košice have come along gradually, for example prof. Ing. Juraj Guzy, CSc., prof. MUDr. Konštantín Barna, DrSc., Doc. MUDr. František Longauer, CSc., Doc. MUDr. Bilčík, CSc., Doc. MUDr. Jozef Andrašina, CSc., prof. MUDr. Ivan Ahlers DrSc., Ing. Viera Rozdobud'ková, MUDr. Marieta Podracká, CSc., and others. In this way there have been various works carried out, such as "PCB and oxidative phosphorylation of liver mitochondria of rats", "Effect of Delore 103 on metabolic parameters of glycidic metabolism of liver", "Polychlorinated biphenyls and metabolism of liver of rats" and many others.

## **Current research of PCB in Slovakia**

During the resent years the research of PCBs has been addressed by several pedagogic and scientific figures from various educational, scientific and other work-

places. We might mention, for instance, professor MUDr. Tomáš Trnovec, DrSc., MUDr. Ľudmila Palkovičová, Ing. Anton Kočan, CSc. from SZU Bratislava, MUDr. Mária Tajtáková CSC. from LF UPJŠ in Košice, MVDr. Jozef Hajduk from Regional vet conduct in Michalovce and Ing. Natálie Rozdubud'ková, Ing. Marta Fratričová, Doc. Ing. Katarína Dercová, PhD., Peadr. Martin Murín and many others.

In May 2007 a conference issuing PCB reports took place in Michalovce, it concerned the newest researches. The fact that the present scientists carry out these researches in time long after the production of PCBs stopped (1984) must be stressed here. Presently there can be changes in human body observed, however we cannot see skin damage, which was relevant in the time of PCB production, nowadays.

## **Conclusion**

Even in these days PCBs present a serious health problem. This issue concerns especially areas in the region Košice, around Michalovece and the area of Zemplín. For such reason there is a need to observe the level of PCBs in the environment, the outflow concerning the food chain and watch health conditions of people living in such environment.

## **ZAŤAŽENIE ŽIVOTNÉHO PROSTREDIA POLYCHLÓROVANÝMI BIFENYLMÍ NA VÝCHODE SLOVENSKA**

**Abstrakt:** Príspevok je venovaný kvalite životného prostredia a vplyvu polychlórovaných bifenylov (PCB) na jeho kvalitu. PCB sú charakterizované z historického hľadiska, sú opísané ich cesty v atmosfére, hydrosfére a litosfére. Ďalšia časť článku je venovaná situácii s PCB na Slovensku a pôsobeniu na organizmus zvierat i človeka, ako aj súčasným trendom výskumu týchto látok.

**Kľúčové slová:** PCB, životné prostredie, atmosféra, hydrosféra, litosféra, zdravie, kvalita, polutant, škodlivosť, výskum