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Polychlorinated Biphenyls in Fish and Shellfish of the Chesapeake Bay

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Introduction

Polychlorinated biphenyls (PCB's) were first synthesized in 1881 and prepared commercially in 1930 when physical characteristics and potential industrial applications were described (Standen, 1964). Since then they have been universally employed and highly regarded for their wide spectrum of useful chemical and physical properties, including low vapor pressure at ambient temperatures, resistance to combustion, remarkable chemical stability, high dielectric constant, high specific electrical resistivity, low water solubility, and high lipid solubility.

PCB's are synthesized commercially by controlled chlorination of biphenyls with anhydrous Cl_2 in the presence of iron filings or $FeCl_3$ as a catalyst, yielding a mixture of PCB's and HCl. The PCB's are identified by a four digit numbering code, the first two digits representing the molecular type, while the last two digits give the weight percent of chlorine (Fig. 1). Thus Aroclor 1254 (Monsanto)[1], is a 1-2 chlorinated biphenyl containing 54 percent chlorine. The line of biphenyls available from Monsanto, for example, ranged from 21 to 68 percent chlorine. Two hundred nine possible chlorobiphenyl isomers exist (Mieure et al., 1976).

Highly chlorinated PCB's are white crystalline solids, while the lower chlorinated compounds are clear, viscous liquids, the viscosity increasing with increased chlorine content. Practically, PCB's seldom appear as pure compounds, but rather as mixed isomers. The characteristics of PCB's which make them particularly suitable for industrial use are their thermal and chemical stability. Ironically, it is exactly these properties, plus the fact that PCB's are readily absorbed and concentrated as they proceed up the trophic levels of the food web, which makes them so environmentally hazardous.

As universal contaminants, PCB's have essentially the same distribution pattern as DDT. The ubiquitous presence of PCB's is partly explained by the range and diversity of their utility, which has been so extensive that scarcely anyone can or has escaped their contact.

Since 1971, the employment of PCB's has been closely restricted and at present they are principally used in "closed-system" transformers and capacitors. But prior to 1971, approximately 40 percent of U.S. PCB production went into such "open" applications as plasticizers, hydraulic fluids, lubricants, sealants, and adhesives; as laminates in the fabrication of safety glass, ceramics, and metals; and as additives in paints, varnishes, putties, and

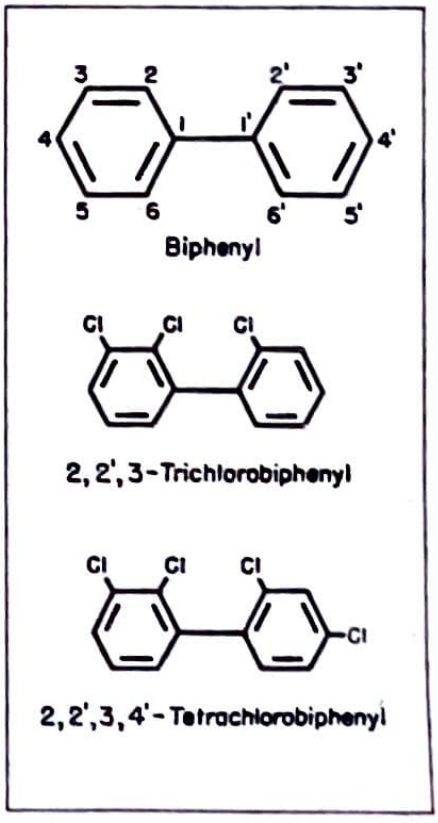

Figure 1.—Numbering system for biphenyl structure (from Mieure et al., 1976).

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[1]Reference to trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

ABSTRACT—Polychlorinated biphenyls (PCB's) are a class of persistent, highly stable, almost universally distributed toxic industrial chemicals with an affinity for fatty tissues of terrestrial and aquatic animals. Their use other than in closed-system electrical applications, such as transformers and capacitors, is banned in the United States. In 1976, a survey of approximately 300 samples of mollusks and finfishes from 100 stations in the Maryland portion of the Chesapeake Bay and its tributaries revealed no instances of PCB levels exceeding or approaching generally accepted safe levels.