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Manufacturers

Electrical industry self-polices PCB use

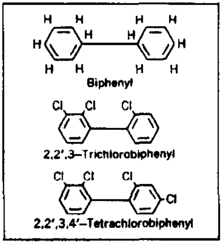
The furor in the local press all over the country about the introduction of polychlorinated biphenyls (PCBs) into the environment (primarily rivers and lakes) by manufacturers of electrical equipment creates the impression that industry has callously disregarded the environmental effects of PCBs. Further, the implication is that suppliers are blindly fighting to retain PCBs. Westinghouse Electric Corp, in a presentation to state and local officials at its Distribution Apparatus Div. in Bloomington, Ind, has effectively dispelled that aura of industrial arrogance.

Reference to or assessment of "PCBs" is an oversimplification. B.A. Kerns, Westinghouse manager of environmental control, pointed out that there are actually 209 possible homologs of PCBs—that is, 209 permutations of the number and placement of chlorine atoms in the biphenyl molecule, of which three are shown in Fig 1. PCBs used by the electrical-distribution-equipment industry since the introduction of PCBs in 1929 are few, and have included Aroclor 1260, 1254, 1242, and 1016, all made by Monsanto.

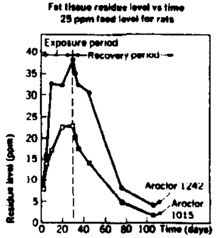
The basic differences in PCBs is the degree of chlorination, or the number of chlorine atoms in the molecule. For example:

- Aroclor 1254 contains 54% of chlorine by weight, and 77% of its polychlorinated biphenyls have five or more chlorine atoms.
- Aroclor 1242 has 42% chlorine, but only 9% of its molecules have five or more chlorine atoms. This is the fluid used in Westinghouse transformers.
- Aroclor 1016 contains 41% chlorine, and only 1% of its molecules of five or more chlorine atoms. This is the fluid used in Westinghouse capacitors.

The level of chlorination apparently is the most significant factor in the relative biodegradability of PCBs—the rate of biodegradability decreasing as the number of chlorine atoms per biphenyl molecule increases. Analysis of PCBs that have been passed through activated sludge—such as found in sewage plants—has shown that 15% of Aroclor 1054 degrades in a 48-hr cycle with a semicontinuous treatment method. 25% of Aroclor 1242 degrades in 48 hr, and 33% of Aroclor 1016 degrades in the same period. Results of additional tests with Aroclor 1016 showed that treatment for 14 days reduces the various



A PCB is a linked pair of benzene molecules (Fig 1), in which two or more hydrogen atoms have been replaced by chlorine atoms



Accumulation is not irreversible (Fig 2), and PCB residual in animal fat declines with the passage of time after exposure

mixtures in 1016 by as much as 98%-plus. These tests have led Westinghouse to the conclusion that Aroclor 1016 is sufficiently biodegradable to remain in controlled usage, Kern said.

Chromatographically derived data on degradation, plus the extreme difficulty experienced in developing analytical tools to correctly identify and quantify the mixtures of PCBs used within Westinghouse's own plants, led Westinghouse to conclude that many of the agencies supervising PCB analyses are arriving at erroneous results, Kern declared.

For example, analytical data provided to Westinghouse by agencies in Indiana show amounts of Aroclor 1016 in waters and in fish that, because of its degradation, could not possibly be there. In addition, the analysis for PCBs in fish used the whole fish, when only the edible portions are commonly analyzed. This, in itself, allows a correction factor of about 4:1 in the state's results.

Fish found to contain the highest levels of PCBs were the bottom-dwelling scavengers, such as catfish, carp, and eel; game fish showed much lower levels. Factually, in surveys carried out in Lake Michigan, the number of fish that are found to contain PCBs actually decreased between 1973 and 1975.

It is incongruous, Kern feels, that PCB standards are being imposed on the basis supporting data that are derived from an analytical technique that stretches technology to the limit, and are subject to errors ranging up to ±50%.

In November 1975, at an Environmental Protection Administration conference on PCBs in Chicago, many papers were presented on research studies made under EPA supervision and support, to determine the effects of PCBs on fish and animals. It was unfortunate that practically all experiments, at that time, were conducted using Aroclor 1254, a material which has not been used—at least in Westinghouse transformers—since 1968, *because* of its nonbiodegradability and its possible detrimental effects on the environment; and which has never been used in Westinghouse's Bloomington (Ind) capacitor plant. While a few screening studies were carried out by EPA on Aroclor 1242, no studies on the use of Aroclor 1016 had been planned at that time.

Most of the data reported at this meeting indicated that massive doses of PCBs—a type not even available for the last few years was used in the test—had detrimental effects when given to rats and monkeys. However, little work was carried out using realistic concentrations as actually found in the environment. Overlooked too often, according to Kern, is the fact that residual PCB levels in the fat tissues of animals decrease rapidly following the cessation of exposure to PCBs (Fig 2).

EPA is now carrying out studies on the effects of Aroclor 1016 and 1242, and data should be available within 12-18 months. Kern feels that these studies will show a dramatically reduced environmental effect from these lower homologs effects that will allow a timely and orderly conversion to other dielectric fluids and that will not cause severe penalties in safety and in energy use.

By 1971, accumulated proof showed that uncontrolled industrial applications of PCBs were contaminating the environment. Consequently, according to R.E. Wills Jr, a Westinghouse attorney, in the absence of federal and state action, industry itself began to impose appropriate restraints. Monsanto, for instance, the single domestic supplier of PCBs, restricted sales to uses only in "closed-system" electrical applications such as capacitors. This voluntary effort in itself removed about 40% of the PCBs used in the US.

Manufacturers also initiated specific controls. And, to strengthen and supplement these, the electrical industry, through the National Electrical Manufacturers Assn (NEMA), began developing standards and guides to prevent the inadvertent introduction of PCBs into the environment. NEMA appropriately included all stages, from initial manufacture of PCBs to ultimate disposal.

This work resulted in an industry Official Standard Proposal document, which was published Jan 25, 1973. Guidelines for plant housekeeping, bulk-fluid shipment, receiving and transfer, employee safety, control of water effluent, labeling, and scrap-disposal procedures are covered by this proposal. The guide also listed known facilities with the capability of safely incinerating PCBs, or of maintaining a regulated chemical and scientific landfill area. Further, the proposal recommended that only Aroclor 1016, a PCB with a low concentration of the higher chlorinated homologs, be used in capacitors.

These guidelines were formally adopted in January 1974 by the American National Standards Institute (ANSI). On April 1, 1976, EPA published a notice of recommended disposal procedures that are substantially in accordance with the ANSI guidelines.

EPA has also attempted to develop regulations that would control the discharges of PCBs under the provision of Section 307(a) of the 1972 amendments to the Federal Water Pollution Control Act. Wills sees this method of control as proper because the forthcoming regulations will then be based on complete scientific information, and will not subject industry to inconsistent or unrealistic requirements. Thus, on Dec 27, 1973, EPA proposed effluent limitations for the control of PCBs. A major problem developed, however, during the course of the hearings on these proposals.

Section 307(a) of the FWPCA required EPA to establish a scientific basis to justify the limits set. In addition, EPA was constrained to consider the toxicity, the persistence, the biodegradability, the importance of affective organisms, and the effect of the pollutant on the organisms.

Unfortunately, Wills explained, EPA failed to recognize the essential differences in the various PCBs, and used data associated with the higher-chlorinated PCBs—and even some mixtures the electrical industry had not used for 10 years. In fact, Wills declared, EPA said it did not have an adequate basis upon which to promulgate justifiable standards to carry out the purposes of Section 307(a).

There was almost no information submitted in the "Basis and Purpose" document that related to Aroclor 1016, for instance, even though manufacturers of electrical capacitors had used this improved material for more than two years. Thus, at the end of the hearing and after expert witnesses from both sides had been examined, the proposed limitations were withdrawn. Later, during subsequent litigation, officials of EPA stated that the record of the proceeding would not support their proposed limitations.

The Food & Drug Administration also took action in 1972 to limit the amount

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of PCBs that may be lawfully present in food, resulting from unintentional contamination. The tolerances were established in July 1973. This provided that the edible portion of fish was limited to a concentration of 5 ppm. Based upon recent information, FDA is reviewing this tolerance limit; it published this decision on Feb 26, 1976.

However, FDA also stated, "Surveillance data gathered by FDA and the US Dept of Agriculture subsequent to the effective date of the temporary tolerances . . . have shown that, with the exception of certain fresh-water fish, the presence of PCBs in those foods subject to the tolerances continues to be sporadic, and that there has been an overall and substantial decline in frequency and levels. These data further show that the average daily dietary intake of PCBs is quite low and well within the margin of safety."

Michigan and Indiana have also taken action to eliminate PCBs from items, products, or materials used in these states. These laws will effectively limit PCB content over the next three years through a sliding scale of prohibition.

Nevertheless, both laws recognize that use of PCBs in the electrical equipment industry continues to be indispensable. Accordingly, an exemption was provided for their use in a closed system, such as the dielectric fluid for an electrical transformer or capacitor. This exemption is to continue until it is documented that substitutes are available to meet performance standards and environmental acceptance. Monsanto meanwhile has publicly stated that they will cease the manufacture of PCBs as soon as there are adequate substitutes.

Several alternative fluids have been proposed by Monsanto, Dow Chemical, General Electric, Sun Oil, Shizuki in Japan, and others (EW, Jan 1, 1976, p 56). But the one key drawback is that not one of them is as nonflammable as PCBs.

J.B. Brittain, manager of engineering of Westinghouse's Distribution Apparatus Div, outlined some of the difficulties in finding a suitable replacement for PCBs. In 1974, Westinghouse did develop an alternative fluid, according to Brittain, which it decided to use if PCBs were eliminated. But, after a full development program had been completed and units had been actually built for customer field testing, Westinghouse decided that, because of its high flammability, workers should not be exposed to it. At this point, $250,000 had been invested in this venture.

Another fluid, safer to handle but still with inferior flammability characteristics to PCBs, is now being tested. Westinghouse is constructing capacitors using this fluid for field tests, as the culmination of a $500,000 development program. ■

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