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Monsanto Company
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166
Phone: (314) 694-1000

THE POLYCHLORINATED BIPHENYLS

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POLYCHLORINATED BIPHENYLS

CONTROL OF ESCAPE TO THE ENVIRONMENT

Manufacture

The PCB's are manufactured by the chlorination of biphenyl produced by cracking benzene. The process is a relatively simple, high-yield reaction which takes place in a closed system with no inherently difficult emission problems. There are no stack gases or water streams which are in contact with the product during the manufacturing process. Control of emissions is therefore concerned with the prevention of leakage and spillage and safe disposal of any material which escapes in this way.

High priority is given to maintenance of all equipment and curbs and drip pans have been provided to collect leaks where they occur. We are constructing catch basins in the main sewer of each of our PCB plants as an added safety measure.

Air emissions are virtually non-existent as the boiling point of the PCB's is extremely high and they can only be distilled under vacuum. This means that vapors are easy to control and they are returned to the system by means of condensers.

A special high-temperature incinerator has been developed for the destruction of PCB residues collected from the process. The flue gases produced contain CO_2, H_2O and HCl which is scrubbed out, neutralized and passed through our normal waste treatment plant.

The above actions have resulted in our PCB losses to the environment being reduced to the parts per billion level, but we are still not satisfied and are carrying out research work on a tertiary treatment process designed to remove even these minute traces from our waste water streams. We expect to complete this program prior to year-end when the additional equipment will be installed in our plants.

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Industrial Usage

The PCB's as a group exhibit many interesting properties:

Fire Resistance
Chemical Resistance
Adhesivity
Resistance to Oxidation
Low Volatility
Resistance to Hydrolysis

These properties together with their compatibility with a wide range of natural and synthetic polymers and copolymers have made the PCB's extremely useful components in many industrial formulations such as specialty paints, adhesives and coating compounds.

Major volume uses for the PCB's, however, are as fire resistant fluids in closed system applications such as:

Transformers
Capacitors
Heat Transfer Systems
Industrial & Hydraulic Applications

where their excellent dielectric properties, fire resistance, inertness and stability at elevated temperatures make them key factors in maintaining a high level of safety in many industrial operations.

In view of the possible threat to the environment posed by the polychlorinated biphenyls, Monsanto has taken the position that it will restrict sales of PCB's only to those applications where their unique fire resistant properties are important and where it is possible to control collection and regeneration or incineration of spent material. We are therefore taking the following actions:

1) Discontinue sales of PCB's for all general plasticizer applications. - August 30th, 1970.

2) Phase out the PCB's as components of industrial and hydraulic fluids where control of spillage and collection of spent material is not possible--the major part of this program will be completed within six months.

3) Continue sales of PCB's as dielectric fluids for transformers and capacitors, cooperating with customers collecting spent and arced fluid for regeneration and/or incineration.

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4) Continue sales of PCB's as fire resistant heat transfer fluids ensuring modification to systems designed to make provision for collection of spills and leakage. Collect spent fluid for regeneration and/or incineration.

5) Continue research effort to develop alternatives to the PCB's and modify PCB's to make them biodegradable in conventional secondary waste treatment facilities.

Other Work

In addition to these major actions, we are continuing to study analytical techniques for accurately determining the PCB's in air, water and animal tissues--the biodegradation of the PCB's--the toxicity of the PCB's to mammals, birds and fish. Detailed information on our analytical techniques and procedures is attached, and also brief summaries on the status of biodegradation and toxicity studies.

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Monsanto

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SUMMARY--INTERIM STATUS

CHRONIC TOXICITY WITH AROCLORS

In May and June of 1969, two-year feeding studies were initiated with *Aroclors 1242, 1254 and 1260. The materials are being fed to rats and dogs at levels of 1, 10 and 100 parts per million in the diet.

After 11 months there have been no clinical effects observed in the rats in the Aroclor 1242 study. Animals sacrificed at six months showed negative micropathology. There have been no clinical effects in the dogs and blood and urine chemistry studies at the one, three and six month intervals were negative.

In the case of Aroclor 1254, rats have shown a slightly depressed weight gain at 100 ppm. In the animals sacrificed at six months, there was slight increased liver weights in males of the animals on the 100 ppm diet. Micropathology was negative at all levels. In the dogs there have been depressed weight gains in the females at all levels fed and at the 100 ppm level in the males. Blood and urine chemistry has been negative.

With Aroclor 1260 there has been no effect on weight gain but has been increased liver weights in males at the 10 and 100 ppm in the animals sacrificed at six months. Micropathology is negative. In the dogs there has been depressed weight gains in the females at 10 and 100 ppm and in the males at 100 ppm. Blood and urine chemistry has been negative.

The above data indicate that these materials are about the same order of toxicity as DDT in rats and dogs. This is reassuring in that DDT is probably the least toxic insecticide to mammalian species. Further, there is general agreement that DDT has not presented a hazard in animals or man in spite of its presence in the environment.

Interim or progress reports such as above have been provided periodically to the U. S. Food and Drug Administration, the U. S. Department of Agriculture and other governmental agencies. In addition, the data and the progress of the studies have been discussed candidly with Dr. Edward J. Burger, Jr., in the Office of Science and Technology, Executive Office of the President.

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*Aroclors 1242, 1254 and 1260 are polychlorinated biphenyls containing 42%, 54% and 60% of chlorine respectively.

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Biodegradation Studies

Monsanto is currently involved in research studies on the biodegradation of PCB's both in the U.S.A. and in the U.K. where we are working closely with Professor E. C. Evans of the University of North Wales.

This work is aimed firstly at establishing the degree of biodegradability of the commercially produced PCB's, and secondly to develop ways and means of modifying these products to enable them to be broken down into harmless by-products in a conventional secondary treatment waste plant.

As anticipated, the PCB's have proven extremely resistant to biodegradation under conditions which normally exist in the environment. This is particularly true of those products containing isomers with high chlorine content, i.e. those containing 5 or more chlorine atoms. However, progress has been made in developing strains of microorganisms which are effective in degrading isomers containing 2, 3, and 4 chlorine atoms. Work is continuing in this area with the aim of finding new and more effective cultures which are capable of degrading the higher chlorine containing isomers.

As a result of this initial work, we are currently developing commercial PCB products where the higher chlorinated isomers have been removed. Although the resultant reduction in chlorine content reduces fire resistance and affects dielectric properties, we are hopeful that we can develop satisfactory products which can be broken down into harmless by-products, when passed through conventional waste treatment facilities.

It should be clearly understood that we have no intention of trying to develop PCB compounds which will degrade in the environment. Our aim is to keep the PCB's out of the environment, but by making them degradable in conventional waste treatment facilities we hope to add an extra safety measure should spills and leakages escape the other safety measures we have already established.

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