CHLORINATED BIPHENYL DIELECTRICS

THEIR UTILITY AND POTENTIAL SUBSTITUTES

1. Introduction

In 1971, Monsanto voluntarily withdrew chlorinated biphenyl from a number of major applicational areas. By 1973, product was sold only to manufacturers of sealed electrical equipment such as transformers and capacitors.

Major applications affected by our withdrawal were carbonless paper, fire resistant hydraulic fluids, heat transfer fluids, and plasticizers.

Sales for other miscellaneous minor applications were discontinued at the same time.

This action resulted in a reduction, in the use of chlorinated biphenyl in areas where entry to the environment was less controllable, of 32.5 million lbs. per year.

We decided at that time to continue supply to closed electrical applications because we believed that:

a) Entry of chlorinated biphenyl to the environment was limited and controllable;
b) The capacitor industry could use more biodegradable lower chlorinated homologs; and
c) Withdrawal would have brought to a halt production of equipment essential to the safe and efficient distribution and use of electrical energy.

Today we continue to sell chlorinated biphenyl observing the following policy.

1. We supply only to manufacturers of <u>sealed</u> electrical equipment such as capacitors and transformers.

2. We supply lower chlorinated homologs, Aroclor 1016, to the capacitor industry.

3. We offer an incineration service for liquid PCB wastes.

4. We continue to work with ANSI Committee C107 and other bodies to establish appropriate handling and control procedures for equipment containing chlorinated biphenyl.

5. We do not reclaim used dielectric fluid and, in those cases where our advice is sought, we seek to ensure that reclaimers are knowledgeable about PCB and exercise proper control.

6. We allocated increased research resources in 1969 to seek and develop effective replacements. This program continues.

7. In seeking possible replacements, we will ensure that differences between Aroclor and candidate fluids, from our program, are widely reviewed in order that the potential impact of any compromises is fully evaluated.

The implementation of these and other programs both by ourselves and electrical equipment manufacturers was prompted by the utility of this dielectric family and the difficulties inherent in developing substitutes to effectively and fully replace it.

2. Utility of Chlorinated Biphenyl in Capacitors

Fire Resistance

The adoption of chlorinated biphenyls in 1929 as capacitor dielectrics stemmed from their superior dielectric properties compared to mineral oil. However, recognition of the fire resistant character of the fluids influenced system and equipment design and standards over the subsequent 45 years. It is probably true that today many people find it difficult to assess potential capacitor fire hazard purely because Aroclor has been used for 45 years.

Particular examples where fire resistance in a capacitor is of benefit include:

a) fluorescent lighting ballasts;
b) air-conditioner motor capacitors;
c) television capacitors;
d) large power capacitors where high fault currents can cause case rupture and ejection of fluid from pole mounted units close to people and buildings;
e) industrial furnace capacitors.

Stability

The persistence of chlorinated biphenyl in the environment is associated with the high degree of thermal, chemical, oxidative, and hydrolytic stability which permits capacitor manufacturers to supply to the exacting reliability requirements which exist today.

Dielectric Constant/Dielectric Strengths

These properties are important in determining the size of a capacitor. In a mixed dielectric system, e.g., Paper/Aroclor or Paper/Polypropylene/Aroclor, the dielectric properties of Aroclor permit optimization of stress distribution between the components making up the dielectric layer.

This has enabled capacitor manufacturers to reduce paper and film volumes for a given capacitance. I shall discuss under the heading of "potential substitutes" the impact that this could have on:

a) paper/film availability;
b) design of equipment containing capacitors.

3. Utility in Transformers

Chlorinated biphenyl transformers represent less than 15% of transformers in service. Their use is associated with the need to limit fire hazard in installations.

1. Railroad Transformers

Multiple unit cars as used in rapid transit systems have transformers mounted beneath each car. By nature of the type of service, involving high passenger density, safety is essential.

2. Urban Power Substations (e.g., Underground Vaults)

These designs need to take account of city center space limitations and, also, the safety of the public and maintenance crews. Fire resistant liquid transformers are helpful to all these objectives.

3. Industrial Load Centers

Efficient system designs for large, power intensive, manufacturing plants (e.g., automotive assembly, steel production) often incorporate transformers close to the electrical load centers. The use of Aroclor transformers at these centers, in the heart of the plants, or overhead in roof structures, protects both employees and plant.

4. Transformer/Rectifiers

Programs to reduce the emission of particulate matter from stack gases, for example in fossil fuel generating plants, include installation of electrostatic precipitators. The transformer/rectifiers energizing the precipitator field must be located close to the electrodes. In many designs, the multiple transformers are located in a penthouse above the precipitator. A fire in the penthouse could lead to close down of the precipator and thus, the generating plant, if pollution control is to be maintained. A fire resistant fluid is of obvious benefit in this application.

In each of these applications, Aroclor protects the system from:

a) An electrical fault within the transformer initiating a transformer fluid fire;
b) Electrical breakdown of the fluid causing emission of flammable gases;
c) Propagation of fire if the transformer liquid content is involved in an external fire.

4. Potential Substitutes in Capacitors

Research Objectives

In seeking potential substitutes, our research objectives, of necessity, related to those properties which gave Aroclor its value. Equally, we recognized the need that an Aroclor replacement should eliminate environmental concerns.

Desirably, a replacement should operate across the full range of current Aroclor capacitor applications while requiring minimum changes in design of capacitors and equipment utilizing capacitors.

The use of chlorinated biphenyl is worldwide. Monsanto manufactures chlorinated biphenyls both in America and Great Britain. We supply to the capacitor industry of many countries. We sought potential replacement product that could be made available with the consistent quality control applied to Aroclor on a worldwide basis.

We referred earlier to availability of co-dielectric components in capacitors. A solution which required substantial changes in availability of polypropylene film (quantity or quality) or a major increase in short-term availability of capacitor paper, we considered unsatisfactory. If in 1974, such increased quantities had been required, they would not have been available. Capacitor production would have fallen short of demand, further jeopardizing efficient power supply.

Our research objectives can be broadly summarized in the following Table 1.