

C L O P H E N

Important information on the behaviour of

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CHLORINATED DIPHENYLS (PCB)

AS IMPREGNATING AGENT FOR HIGH POWER CAPACITORS ,  
in the Environment.

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Chlorinated Diphenyls (PCB) as  
impregnating agent for High Power Capacitors

1. GENERAL

For over 40 years polychlorinated Diphenyls (x) (in American polychlorinated Biphenyls, abridged PCB) have been used as impregnating agent in high power capacitors, especially also in high tension applications.

In the following two decennia they have superseded - at least in the European industrial countries and in the USA - the mineral oil, which was generally used for these applications. Nowadays - world-wide seen - about 90 % of the high power capacitors are impregnated with Chlorodiphenyls, most of them with Trichlordiphenyl.

This development could not fail because of the physical, chemical and electrical properties of PCB.

2. PROPERTIES OF PCB'S

Chemically and thermically seen, PCB is extraordinarily stable. As compared to Hydrocarbon-oils, it has the following characteristics :

- At temperatures up to the boiling point, it is non-inflammable.
- The high temperature behaviour of PCB and it's behaviour in the presence of metals such as Fe and Cu, which catalyse with hydrocarbon, is that even with pure oxygen, it doesn't oxidise.
- the gaseous decomposition products, created by the decomposition in electrical areas, consist besides hydrogen and hydrocarbon, mainly of dry HCl. This gas-mixture can never be the source of fire, nor will it spread a fire that has originated elsewhere.

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(x) Trademark of Bayer AG, Leverkusen (R) Clophen

Based on these properties, as a impregnating agent for capacitors, PCB has decisive preferences above mineral oils, in regard to the operating safety

- Owing to PCB's flame retardance, the capacitor can never be a source of fire, nor spread a fire that has originated elsewhere in the factory. The latter being very important when capacitors are installed in places exposed to fire such as stores, theaters, cinemas, as well as in the chemical and automotive industry.
- Due to the higher dielectric constant and the so-caused lower electrical strain of the impregnating agent, there is increased security against glow discharge particularly in the case of circuit- and switch overloading. Thus avoiding an untimely breakdown of the capacitor.

In the industrialised countries, fire-insurance companies give special premium-tariffs for high power capacitors impregnated with PCB, and this because of the increased safety factor.

### 3. ENVIRONMENTAL CONTAMINATION CAUSED BY PCB

3.1. Since a couple of years, technical journals in different countries, report on the behaviour of PCB's in the Environment. Conform statements in Swedish, Dutch, English and American publications show that only higher, eg. 5 to 7 times, chlorinated PCB's are found in different animal species. As compared to these discoveries, one publication reports the presence of Trichlorodiphenyl (x). This should be valued with critical care, especially because it is based on analysis by gaschromatography. Such a discovery can only be accepted, when it is confirmed by an independent analysis procedure eg. by mass-spectrometry method.

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(x) Külle, Ruf und Stieglitz : "Naturwissenschaften" (in the press)

The presence of insignificant quantities of PCB in different animal species can't lead to conclusions concerning the toxicity of these compounds.

Tests on animals showed that the toxic PCB dosis is a multiple of the amount found in dead animals, which proves that PCB wasn't the cause of death of these animals.

All reports in daily press and magazines<sup>(x)</sup> exceeding these relevant scientifically founded results - on the hazard of PCB's, have to be considered as pure speculation. It should be mentioned in this context that medical tests on people who have been exposed up to 19 years to a maximum degree in plants where PCB's are produced have shown no signs of organic damage caused by PCB's.

- 3.2 Whilst Pentachlordiphenyl (Clophen A 50) was almost exclusively used as an impregnating agent for high power capacitors until 1950, today the low chlorinated Trichlordiphenyl (Clophen A 30) is nearly exclusively used. Apparently this product is not deposited in the animal organism which is one of the reasons it cannot be considered as an environmental danger.

#### How PCB can enter the environment

PCB's found manyfold applications in open systems. The use and the substances which remain in open systems cannot be controlled, ie. in applications such as :

- plasticiser for coating resins
- impregnating agents for sealings
- carrier substance for insecticides

In the meantime, the most important PCB-producers have discontinued sales of PCB's for open applications. Suitable replacement products were disposed of.

In comparison to the open systems we have the closed systems where manufacture and the whereabouts of PCB's can be controlled

ie. in applications such as :

- Hydraulic Oil
- heat transfer liquid
- impregnating agents for capacitors
- insulants and coolants for transformers only

Whilst the first mentioned application can be described as "closed systems" under certain conditions, the real closed systems are the electrical machines filled with PCB, from where no PCB-quantities dangerous for the environment, can escape by pertinent operating during the manufacture and the running of the machine. Furthermore we have to take into consideration that - contrary as for the plasticisers - no technological equivalent replacement products with the same flame resistance and operating safety for the high power capacitors, could be realised.

5. Attitude of the German Federal Government and the FDA to the use of PCB

1. On the question what the German Confederation's action was to reduce the pollution caused by PCB's, Mrs. Strobel, the minister of Youth, Family and Health, during the "Bundestag" (13.8.71) said that it was still to early to evaluate the hazards PCB's can cause to the environment, because there are not yet enough informatory results concerning the toxicology of polychlorinated biphenyls and until now, no case of damage has yet been divulgated or diagnosed.
2. The spokesman of the FDA in the USA regrets that some inquietudes on the effects of PCB on human health which were made public are not justifiable.  
The speaker also said that because of stress of circumstances the use of these substances cannot be resigned, because of their flame retardant property which is an important factor for the State and Industry to protect people against fire. (1)
- 5.3 In connection with this one mentioned the contribution of the project-group "Environment-minded Techniques" (methods and products) for the Federal Ministry of Education and Science. (2)

) Statement by Charles C. Edwards, M.D., FDA commissioner PCB Press Briefing September 29, 1971

2) German "Bundestag" - 6th Election Period, printed matter VI/2710, Page 340

In point (1) "Introduction" of this project one can read :  
"... one of the most important measures for the future judgement of Environment-minded techniques will be the needs of the people. This inevitably leads to the conclusion that the protection of the environment doesn't equate with a reconstruction of environmental conditions of the pre-industrialised period ...

#### .. Disposal of used PCB

Since PCB's are not easily biodegradable, used PCB has to be disposed of, which is possible without difficulties. Notwithstanding it's incombustibility one can completely destroy PCB in special municipal or industrial incinerators , by mixing it with combustible materials such as every other organic substance. The end-products are water, carbon dioxide and hydrochloric acid which by means of absorption can eventually be removed from the combustible gasses.

#### 7. Summary and Conclusion

To valuate the danger of a possible contamination of the environment by capacitors using PCB as an impregnating agent we have to start from the following facts :

- PCB is used by the manufacture and the use of capacitors in a closed system ; i.e. controllable applications.
- low chlorinated PCB is used, which is not yet found in nature, because it obviously isn't accumulating in animal bodies.
- capacitors using PCB as an impregnating agent contain a fire resistant saturation substance and also don't spread factory-fires. Fire-insurance companies recognise this fact by asking low premiums.
- capacitors using PCB as an impregnating agent have a high operating reliability.

There is no pertinent reason to restrict the use of polychlorinated diphenyls, especially the low chlorinated types, for the construction of high power capacitors. Such a development would mean a technical step backward and create a safety risk in the running of electrical installations.