DOW CHEMICAL U.S.A.

November 10, 1976

MIDLAND, MICHIGAN 48640

Monsanto Co.
Mr. R. Geisman
1700 S. 2nd Street
St. Louis, MO 63177

Thank you. . .

. . . for your inquiry regarding the new dielectric fluid that Dow has developed for high-voltage capacitors. XFS-4169L, butylated monochlorodiphenyl oxide, has been investigated extensively, using currently accepted methods of evaluation, and to date has been shown to be an environmentally acceptable alternative to replace the polychlorinated biphenyl capacitor fluid. Dow is proud to have won an IR-100 award for the development of this product.

The Dow dielectric fluid has reached semi-commercial production and is available at developmental cost for use in capacitors only. All other applications will not be supplied. Capacitors containing XFS-4169L are available from McGraw-Edison and can soon be obtained from other manufacturers.

An informational brochure on XFS-4169L is enclosed. Additional technical data may be obtained by a letterhead request.

Dale McDonald

Dale McDonald
Manager of Inquiry Services

Enclosure

MONS 064708

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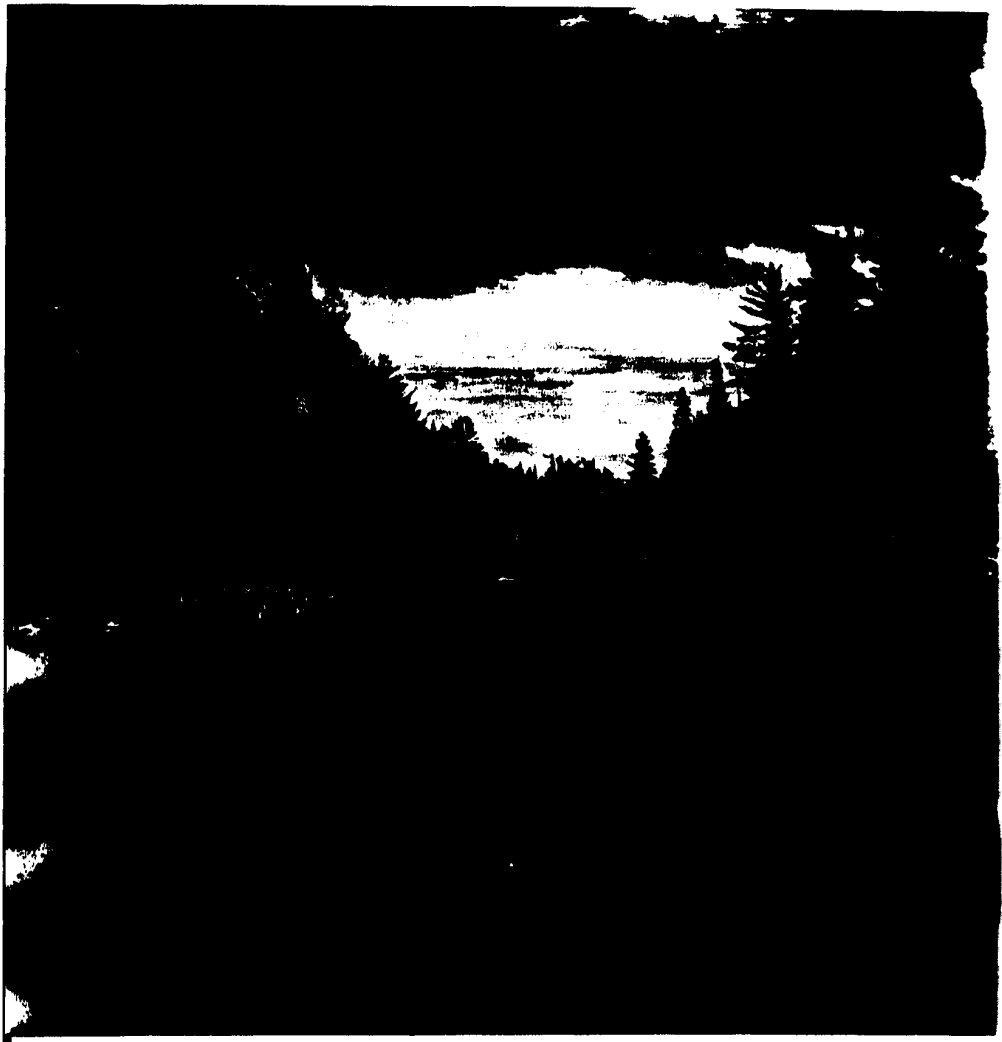
AN OPERATING UNIT OF THE DOW CHEMICAL COMPANY



The Environmentally Acceptable Dielectric

Dow Capacitor Fluid

DOW

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Needed—An Environmentally Acceptable PCB Substitute

Polychlorinated biphenyls (PCBs) have been widely used in plasticizers, paints, textile coatings, carbonless "carbon" paper and flameproofing compounds, and as impregnants in transformers and power capacitors. The great virtue of PCBs is that they are practically indestructible; unfortunately they have been found to possess long-term toxic effects as determined by data from the laboratory and from nature. Thus, when it was found in the late 1960's that PCBs were building to unacceptable levels in the environment, industry was challenged to find environmentally acceptable substitutes.



New Dielectric Specifically Designed for Capacitors

● In electrical power distribution systems, capacitors are used to improve power factors, reduce losses and decrease voltage drops. They are also used by industry and utility companies to protect electrical service systems against surges. Use of capacitors results in cheaper and more efficient electrical power.

In the search for a suitable dielectric for such capacitors, The Dow Chemical Company evaluated more than 50 compounds. The candidate fluids were screened according to stringent criteria.

For example:

- Dielectric losses must be as low as those of PCB.
- Partial discharge inception voltage of system must be equivalent to that with PCB.
- System must be as reliable as a PCB capacitor system.
- There should be no increase in volume per kVAR.
- The new fluid must be environmentally acceptable.

After five years of targeted development in Dow's laboratories and extensive testing by McGraw-Edison, the electrical equipment manufacturer, a new ecologically, electrically and economically acceptable substitute for PCBs has been perfected for use in power capacitors. The new product, DOW Capacitor Fluid, performs as well as PCB or better

DOW Capacitor Fluid is available now to manufacturers. Developed specifically for capacitors, DOW Capacitor Fluid is presently used only in electrical power systems, but the fluid is being tested by several major capacitor manufacturers for use as the insulating dielectric for low-voltage capacitors and for ballasts in fluorescent lights.

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Environmental Advantages

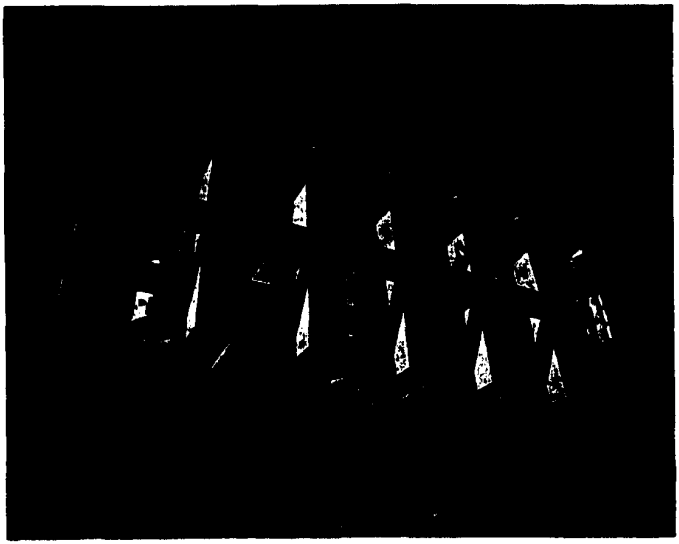
● DOW Capacitor Fluid is biodegradable — The new dielectric fluid, which is based on butylated diphenyl oxide (DPO), has the advantage of biodegradability. In fact, the major component of DOW Capacitor Fluid is 45 times as biodegradable as the major component in PCB Capacitor Fluid. Biodegradability was determined by sludge degradation of the separate radioactive-labeled components of the fluid and monitoring of the subsequent evolution of radioactive CO_2.

● ***Lower toxicity to fish*** – Compared to PCBs, DOW Capacitor Fluid is 36 times less toxic to fish as determined by the 25-day flow-through test on fathead minnows.

● ***Low bioconcentration in fish*** – the components in DOW Capacitor Fluid are $^1/_{30}$ as bioconcentratable in trout muscle as the components of the PCBs.

● ***Lower toxicity to mammals*** – In rats an acute dose of 10 grams of DOW Capacitor Fluid per kilogram of body weight administered orally had no observable effect and the 90-day toxicity test showed very little activity.

● ***Far less accumulation in animal fat*** – In a 150-day feeding study, the accumulation of components of DOW Capacitor Fluid in the fat of rats was $^1/_{22}$ that of PCB components. The apparent plateau level for accumulation was 1 to 2 months for DOW Capacitor Fluid and 6 to 7 months for PCB.



◀*Capacitors are commonly installed outdoors on poles*

TEST DATA	DOW Capacitor Fluid	PCB	Nature of Test
Biodagradation (microbes)	0.41 g/g-hr	0.009 g/g-hr	CO_2 formation rate constant
LC_{50} (fathead minnow)	1.8 mg/l	0.050 mg/l	Continuous flow threshold
Bioconcentration (trout)	307	9500	99% steady-state in muscle
Acute oral toxicity (rat)	10 g/kg	1 g/kg	100% survival
Accumulation in fat (rat)	10 ppm	220 ppm	90-day feeding test

Electrical Advantages*

- Low dielectric losses — In both paper/film and all-film high-voltage capacitors, the dielectric losses for DOW Capacitor Fluid are as low as those for capacitor grade PCB, or slightly lower. As a result, the capacitors will be operated at normal temperatures and minimal operating costs.
- Higher discharge-inception voltage — Significantly higher discharge-inception voltage means fewer malfunctions due to corona discharges.
- Greater capacitor reliability — Three years of accelerated life tests in full-size units without failures (a total of 18 million kilovar hours) and experience with hundreds of sample capacitors operating at up to 200% of the rated voltage over a wide range of temperatures (−60°C to 125°C), have proved the superior reliability of capacitors impregnated with DOW Capacitor Fluid.
- ***No Need To Redesign Capacitors*** — Capacitors impregnated with DOW Capacitor Fluid furnish the same power-factor correction (kVAR) per unit size or volume as comparable capacitors containing PCBs. As a result, there is no need to redesign the capacitors or alter procedures of manufacturing and methods of application.

* Data developed by McGraw-Edison Company

Summary of Advantages

Extensive testing by McGraw-Edison has shown that DOW Capacitor Fluid offers the following in operation:

- Low dielectric losses
- High discharge-inception voltage
- Great reliability

The environmental acceptability of DOW Capacitor Fluid is due to:

- Biodegradability
- Low bioconcentration
- Low animal toxicity
- Moderate fish toxicity
- Relatively little movement in the environment

In short, DOW Capacitor Fluid outperforms PCBs. In addition, the health and environmental characteristics of DOW Capacitor Fluid are significantly superior. Capacitors containing this fluid are now commercially available.

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